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Øystein Døhl

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Application on a large Norwegian municipality

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Norwegian University of Science and Technology
Thesis for the degree of Philosophiae Doctor
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Oppsummering (Norwegian summary)

Europeiske land står overfor store demografiske endringer. Antall eldre over 80 år vil dobles i løpet av de neste 25 årene og sterkest vil veksten bli etter 2020. Samfunnets ressursinnsats til eldre med hjelpebehov kommer til å øke kraftig. Vi vet videre at funksjonsnivå er den viktigste predikatoren for eldre sitt hjelpebehov. Hovedmålet med denne studien var å undersøke sammenhengen mellom individuelle variasjoner i funksjonsnivå og offentlig ressursinnsats. Både for de som mottar heldøgns tjenester som for eksempel sykehjemstjenester, og hjemmeboende som mottar punkthjelp.

I 2006 ble det innført et nasjonalt system i Norge (IPLOS) som innehar en funksjonsevaluering. Instrumentet brukes i alle norske kommuner og for alle personer som mottar offentlige pleie og omsorgstjenester. I denne studien har vi brukt de funksjonsvariablene som brukes i IPLOS. Studien har sett på mottakere av tjenester i Trondheim kommune.

Funnene fra studie 3 viser at det norske instrumentet har problemer med å predikere forskjeller i hjelpebehov hos de friskeste eldre. Det må hele tiden gjøres avveininger mellom ideell utforming og administrativ ressursbruk. Og de fleste instrumenter har problemer med å predikere hjelpebehov langs deler av kontinuumet fra helt frisk til fult hjelpebehov. Likevel er vurderingen at det norske systemet burde hatt flere variabler som kunne bidratt til en bedre predikering av hjelpebehov hos de friskeste eldre.

I studie 1 fant vi at forskjeller i mengde hjelp den enkelte pasient mottar på sykehjem kan forklares både ut fra individuelle forskjeller i funksjonsnivå og forskjeller mellom sykehjem. Totalt kan ¼ av individuelle forskjeller forklares med ulik praksis mellom sykehjemmene. Videre fant vi at i en situasjon hvor alle pasienter budsjetteres med samme beløp så vil hjelpen den enkelte pasient mottar ikke bare avhenge av den enkelte pasients funksjonsnivå, men også funksjonsnivå til alle andre pasienter på samme sykehjem. Det vil si; bor du sammen med friskere pasienter så mottar du mer hjelp enn dersom du bor sammen med sykere pasienter, gitt at du har samme funksjonsnivå i begge tilfeller.

I studie 2 fant vi at offentlig ressursbruk til hjemmeboende eldre i stor grad kan forklares med funksjonsnivå. Her ser IPLOS ut til å kunne forklare ressursbruk på lik linje med andre brukte instrumenter. Videre fant vi at de med mer komplekse sykdomsbilder (målt med comorbiditet) mottar 21 prosent mer offentlig hjelp enn andre. Aleneboende eldre mottar mer offentlig hjelp enn de som bor sammen med noen. Kvinner med samboere mottar omtrent 30 prosent mindre hjelp enn aleneboende, mens menn med samboere mottar omtrent 50 prosent mindre hjelp enn aleneboende. Videre fant vi at for personer med psykisk utviklingshemming er adferd den viktigste predikatoren for offentlig ressursbruk, men hjelp til dagligdagse aktiviteter er også viktig for denne gruppen. Hjelp fra pårørende eller andre bistandspersoner kommer i tillegg til og ikke som erstatning for offentlig hjelp. Pårørende sin innsats slår dermed ulikt ut i offentlig ressursbruk for eldre hjemmeboende enn for psykisk utviklingshemmede.

Resultatene fra denne studien kan brukes i planlegging av tjenester til eldre og psykisk utviklingshemmede personer. Trondheim kommune har etter denne studien endret sine budsjetteringssystemer på sykehjem og for hjemmeboende eldre, og er i gang med å endre sine budsjetteringssystemer for psykisk utviklingshemmede.

Summary

In the coming decades, the European countries will witness great demographic changes. Within the next 25 years, the number of people aged 80 years or older will double. The elderly's overall use of resources will increase considerably. Disability is the most important cause of the amount of care needed. The overall aim of this thesis is to assess the relationship between factors describing disability and impairment and the use of long-term care services both in a nursing home setting and at home.

Since 2006, all Norwegian municipalities have been required to assess user needs using a standardised national registration system (IPLOS) that contains variables describing physical disability and cognitive impairment. This is the only instrument used across all Norwegian municipalities. Here, we utilised the same variables as those used in the national registration system and combined them with detailed time studies with recipients in the municipality of Trondheim.

Our findings from study 3 show that the Norwegian instrument had difficulties in differentiating the need of the least disabled elderly individuals. However, this is a well-known problem of disability instruments due to the trade-off between administrative burden and an "ideal" instrument. Introducing new variables to close these gaps should be considered.

In study 1, we found that the amount of individual care received depends on both individual disability and differences between nursing homes. Approximately ¼ of individual differences could be explained by differences between nursing homes. Furthermore, we found that within a financial reimbursement model with no adjustment for case-mix, the amount of care that patients receive depends not only on the patients' own needs but also on the needs of all the other residents. Thus, if one lives with less disabled patients, one receives more care than an individual who lives with more heavily disabled patients.

In study 2, we found that home-dwelling elderly's public use of care could largely be explained by disability and cognitive impairment. IPLOS seems to explain use of public care to the same extent as other indices. Those with comorbidity received 21 percent more public care than others. Those living alone received more public care than those living with others. Cohabiting women received approximately 30 percent less care than those living alone, while cohabiting men received approximately 50 percent less care. Furthermore, we found that behaviour is the most important predictor of the amount of public care for intellectually disabled persons but that help in performing everyday activities is also important for these persons, as it is for elderly individuals. Care from relatives or other private care is complementary and does not affect the amount of public care. Thus care from relatives or others act as a substitute for public care for home-dwelling elderly while it is complementary to public care for intellectually disabled persons.

The results from this study could be used in overall administrative planning of public long-term care. The municipality of Trondheim has changed its reimbursement model for nursing homes and home-dwelling elderly since these results were found. Furthermore, the municipality is now changing its reimbursement system for intellectually disabled persons according to the results of this study.

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In the loving memory of my father.

Melhus, December 2015, Øystein Døhl

List of papers

This thesis is based on the following three publications:

I: Døhl Ø, Garåsen H, Kalseth J, Magnussen J: Variations in levels of care between nursing home patients in a public health care system. *BMC Health Services Research* (2014), 14(1):108.

II: Døhl Ø, Garåsen H, Kalseth J, Magnussen J: Factors associated with the amount of public home care received by elderly and intellectually disabled individuals in a large Norwegian municipality. *Health & Social Care in the Community* (2015). doi/10.1111/hsc.12209

III: Døhl Ø, Garåsen H, Kalseth J, Magnussen J: Physical disability and cognitive impairment among recipients of long-term care. A cross-sectional study in a large Norwegian municipality. *Journal of Nursing Education and Practice (2016), 6(7)*.

Abbreviations

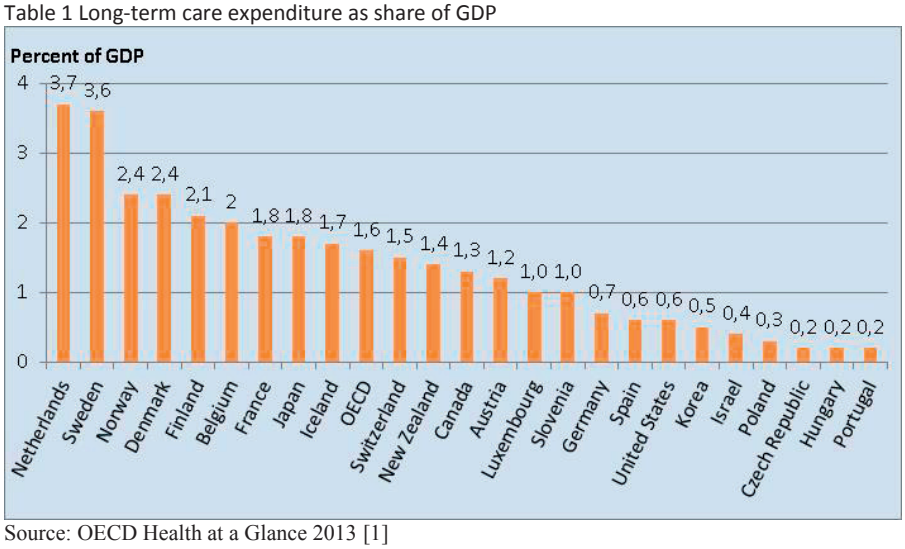
ADL	Activities of Daily Living
AM-PAC	Activity Measure for Post Acute Care
CFA	Confirmatory factor analysis
EFA	Exploratory Factor Analysis
FIM	Functional Independence Measure
GDP	Gross Domestic Product
IADL	Instrumental Activities of Daily Living
ICC	Intraclass Correlation Coefficient
ICC	Item Characteristic Curve
ICF	International classification of functioning, disability and health
ICPC	International Classification of Primary Care
IRA	Inter-rater agreement
IRR	Inter-rater reliability
LTC	Long Term Care
LTCE	Long Term Care Expenditure
MDS	Minimum Data Set
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Square
PAF	Principal Axis Factoring
PCA	Principal Component Analysis
RAI	Resident Assessment Instrument
RUG	Resource Utilization Groups

SEM	Structural Equation Modelling
SMAF	Système de Mesure de l'Autonomie Fonctionnelle (French). The functional autonomy measurement system.
WHO	World Health Organization

1 Background

Across OECD countries, public long-term care expenditure (LTCE) varies between 0.1 and 3.7 percent of GDP and, on average, constitutes approximately 1.6 percent. In Norway, LTCE in 2011 was 2.4 percent of GDP, with only the Netherlands and Sweden spending a higher proportion of GDP on long-term care (LTC) [1]. Approximately 50 percent of long-term care recipients are 80 years or older [2]. Across the European countries, the number of people aged 80 years or older is expected to double within the next 25 years [3, 4]; thus, it is expected that the costs of health and long-term care will increase sharply within the OECD countries [5].

Table 1 Long-term care expenditure as share of GDP



Source: OECD Health at a Glance 2013 [1]

In Norway, nearly 3.9 percent of the population receive long-term care; the average rate within the OECD is 2.3 percent [2]. The majority of the elderly want to live at home as long as possible and, when needed, receive long-term care in their homes [6]. Home care is generally considered as less expensive than nursing home care [7]; thus, the use of home care is viewed as important for reducing the total LTCE. In the past decade, the proportion of recipients receiving long-term care at home has increased; in 2011, within

the OECD, nearly 64 percent of all long-term care recipients received their care at home [1]. In Japan and Norway, more than 75 percent of those in need of long-term care receive it at home [1, 8]. Although the majority of recipients receive long-term care in their homes, LTCEs for institutions are higher than those for home care in most OECD countries [2].

Although the elderly is the largest group of LTC recipients, in the Scandinavian countries, those below 65 years of age constitute approximately 21-32 percent of the long-term care recipients [2]. During the past two decades, in Norway, the number of recipients below 67 years old has increased at a higher rate than those above 67 years [9]. Recipients below 67 years old account for approximately 40 percent of the LTCE, and persons with intellectual disabilities constitute nearly 50 percent of LTCE for those below 67 years [9, 10].

2 The need for long-term care

One of the main drivers of population ageing is lower mortality rates. In Norway, the life expectancy is anticipated to increase by three to four years by 2040 [11]. There is no controversy that an ageing population implies increased use of long-term care. However, the cost of the ageing population is not necessarily due to age; rather, it concerns the need for care following the ageing process. It has been argued that time to death, not age, is the driver of long-term care use [12]. More recent studies have shown that time to death is a substitute for underlying causes such as disability [12-14].

2.1 Disability and impairment

Two terms commonly used to describe individuals in need of long-term care are "impairment" and "disability". Impairment can be defined as loss in physiological or psychological structure or function at the organ level resulting from a disease [15]. Disability is defined as *"any restriction or lack of ability to perform an activity in the*

manner or within the range considered normal for a human being" [15, 16]. Disability is, therefore, related to the ability to perform an activity, while impairment can be viewed as the cause of disability. Impairment does not necessarily imply disability, but disability results from impairment. Disability is often considered in relation to physical factors, i.e., limited physical ability to perform tasks, and is often used to describe decrepitude. Intellectual disability, by contrast, is related to reduced cognitive ability to understand new or complex situations and reduced ability to learn and apply new skills [17]. Hereafter, I will use the term *disability* instead of physical disability for limitations due to physical factors.

2.2 A framework for assessing need

The consequences that disability has on the need for services depend on both the individual's degree of disability and the social environment. Thus, there are several social and economic modifiers that should be taken into account when assessing an individual's need for care.

There are a number of conceptual models used to describe need for care. Three commonly used models are described here. Two models focusing on the social implications of disability are Nagi's disablement model [18] and the International Classification of Functioning, Disability and Health ICF [19]. Both models describe functioning at three levels: separate parts of the body, the whole person and the person within a specific community setting [20]. A central issue for both Nagi's and the ICF model is that disability is largely dependent on the social and/or the environmental context. Another largely used conceptual model is the Andersen behavioural model [21, 22]. The explanatory factors for care utilisation are decomposed into *Predisposing factors*, i.e., age, gender, marital status, education etc.; *Enabling factors,* i.e., financial and organisational factors such as price and access; and *Need factors*, i.e., disability, diagnosis etc. The papers in this thesis are based on the framework of Andersen & Newman [21], also commonly referred to as the Andersen-Newman model. This

framework is well suited to discuss individual determinants and determinants at a more aggregated level.

2.3 The use of disability and impairment instruments

One of the most frequently used methods of assessing disability is through variables describing the ability to perform activities of daily living (ADL) and instrumental activities of daily living (IADL). ADLs characterise basic everyday tasks, while IADLs characterise basic abilities for independent living.

2.3.1 Choosing variables to assess need

The idea that diagnosis does not sufficiently describe the needs of the elderly and chronically ill emerged in the 1950s [23]. Thus, more detailed information was needed, and Katz's [24] and Barthel's [25] instruments described functional dependences and need for help using everyday activities such as bathing, dressing, going to the toilet, transferring, continence and feeding [24, 25]. These two instruments are still commonly used in the characterisation of the elderly's basic needs. In a clinical setting, Katz's instrument has been criticised for assessing too few activities and Barthel's has been criticised for having an overly narrow rating, as it only contains two scores (help/no help) [26]. There is no agreement on how many variables are needed to give a sufficiently detailed description of needs. Roherig [27] found that four out of ten variables in the Barthel instrument identified 95.3 percent of patients with limitations in ADL variables. Katz argued that in addition to the variables in the original ADL instrument, *mobility* should also be viewed as a basic requirement for self-maintenance [28, 29]. In Barthel's instrument, mobility is explicitly included as separate variables [25].

An ADL instrument includes the most fundamental activities, but it is still not sufficient for assessing the possibility of independent living. Lawton [30] introduced a broader description of disability by using IADL variables. The variables in the IADL instrument

describe one's capability for independent living and includes variables such as shopping, using the telephone, cooking, housekeeping, laundry, transportation, responsibility for own medications and ability to handle money [30]. Today, there exist many different disability instruments, and most of them are adjustments of the basic ideas of Katz, Barthel and/or Lawton [31, 32].

The Katz, Barthel and Lawton instruments do not include variables describing cognitive impairment. There are several instruments for measuring cognitive impairment in use, i.e., the Mini-Mental State Examination (MMSE) [33, 34] and the Cognitive Performance Scale (CPS) [35]. The MMSE is frequently used to evaluate how cognitive impairment impacts the use of resources [36-38]. It has been shown to perform well in classifying cognitive impairment compared to more detailed cognitive surveys [39]. The CPS is based on the Minimum Data Set (MDS) used in the US and is a shorter evaluation of cognitive impairment than the MMSE [35, 40]. The CPS was designed to assess cognitive impairment among long-term care recipients. The CPS has been shown to reveal cognitive impairment equally well as the MMSE [35]. It has been used both in home care and nursing home settings [41, 42].

Some instruments combine disability and cognitive impairment, such as the Resident Assessment Instrument (RAI), the Functional Independence Measure (FIM) and the Activity Measure for Post Acute Care (AM-PAC). The RAI is based on the MDS, and there is a version for long-term care both in nursing homes and at home [40, 42-44]. The RAI is also a basis for the reimbursement system RUG [45-49]. The FIM could be considered an expanded Barthel instrument with the addition of five variables that measure cognitive impairment. As is the case for the Barthel instrument, the FIM lacks IADL variables [50]. The FIM is widely used in rehabilitation settings and is considered as more appropriate than the measurements of Katz and Barthel in terms of the rehabilitation of elderly people [51]. The AM-PAC is based on the WHO's ICF [19]; it is mainly used in post-acute care settings [52]. The AM-PAC constitutes 41 variables covering ADL, mobility and cognitive impairment but only two IADL variables. In this

measure, the IADL variable “using phone” is defined as a cognitive variable. The AM-PAC has a short form with 30 variables. The variables in the two versions are not exactly the same; the short form has several IADL variables [53].

There will always be a trade-off between the desired degree of detail and the practicality of the use of an instrument to measure disability. Instruments that have fewer variables should raise more concerned about potential gaps in the information provided by the instrument. There could be aspects of disability that will not be detected. If one focuses only on basic domains measured with ADL variables, one would not been able to detect differences between the less disabled persons. However, if one focuses only on IADL variables, one could experience difficulties in detecting differences between the most disabled individuals. More generally, one should be aware of the information gaps of instruments before using them [31].

2.3.2 Scoring

There are several ways to score the variables included in an instrument. All disability instruments make some distinction between need for help (or receiving help) and no need for help. The least detailed classification is the dichotomous need/no need for help, which is used in the Barthel instrument for all variables except one [25]. Katz’s measure uses a three-point scale [24], Lawton’s instrument uses either a three- or five-point scale [30], and the FIM has one of the most detailed scores, using a seven-point scale. An instrument’s potential to describe need also depends on how well the variables cover the full spectrum of needs [31].

Capability to perform or actual performance of a task

When describing disability, a distinction should be made between an individual’s capability to perform tasks and whether she/he is actually performing the tasks. Some instruments describe what the individual actually does [24], while others describe the

individual´s ability to manage the tasks [30, 54]. The first approach could produce a higher disability score than the latter approach. This problem is more relevant for IADL variables than ADL variables [55]. This is due to the fact that some individuals do not perform IADL activities regularly even though they are able to do so.

Another distinction is between whether the instrument is based on *observed functioning* or s*elf-evaluated functioning*. Observed functioning is typically done by professional care personnel. Using observed or self-evaluated ability could affect the score, and the resulting scores may not be comparable. Findings indicate that an observed score could imply higher measured disability than a self-evaluated score [56, 57].

2.3.3 Dimensionality

A detailed description of disability is useful for assessment and planning at an individual level. For planning and analyses on an aggregated level, however, a more aggregated description of user needs will often be more helpful. There are basically two methods of aggregation in use. One method is summing all scores on all variables, which in regression analysis, is equal to an average score [25, 58, 59]. Another method is summing the scores on the variables for which persons require need help [24, 30, 60, 61]. The aggregation of variables into one or more indices could ease the interpretation of complex relationships. However, variables that measure different aspects could mislead policy messages if they are poorly combined [62]. Both Katz and Lawton noted that the variables in their ADL and IADL instruments had a hierarchic classification, but they did not address the question of whether the variables represent one unique dimension with increasing complexity or should be combined into different dimensions of disability. ADL and IADL are often used separately, and it has been argued that they represent two or even several unique dimensions [63]. Spector [64] argued that ADL and IADL variables could be considered as one dimension due to the high correlation between them. Others have noted that the number of dimensions could be related to other factors such as gender [65], severity [66, 67] or different type of diseases [68, 69]. Thomas [63] found that ADL/IADL variables constituted three

dimensions, one ADL and two IADL, and argued that one of the IADL dimensions constituted variables with higher cognitive complexity. Then, the number of dimensions in an instrument could rely on both the characteristics of the recipient being analysed and the number of variables used.

3 Explanatory factors for the use of long-term care

Given the various aspects of disability, the next question is how these, in addition to other aspects described in the Andersen-Newman framework, are related to the utilisation of long-term care. There are broadly two types of studies: Those that discuss factors that can predict *whether or not* an individual uses long-term care either in their own homes or in nursing homes and those that study factors that can predict the *amount* or volume of long-term care. These studies capture different aspects of long-term care, as individual determinants of whether one is given access to long-term care may differ from the determinants of the amount of care received.

3.1 Care for elderly

Home care is care provided in the recipient's own home. Care may be provided by health care personnel or by, e.g., family members. Home care ranges from help with cleaning and preparing meals to around the clock care. Sheltered housing[1] is a wide range of self-owned or rented housing for disabled people. People living in sheltered housing receive home care. In extra care sheltered housing[2], residents live in facilities defined as their own private homes (paying their own rent) and receive care according to their assessed needs. The services could be similar to those delivered in nursing homes. A nursing home provides 24-hour continual nursing care to people who are not able to live at home.

[1] In Norwegian: Omsorgsbolig

[2] In Norwegian: Omsorgsboliger med heldøgns omsorg

3.1.1 Use of home care

Disability is consistently found to be strong a predictor of both the access to and the amount of home care services [61, 70-74]. Disability, mobility and age seem to be more important predictors of the probability of public home care use than variables describing cognitive impairment [37, 74-77]. Additionally, those living alone have higher odds of receiving formal help [37, 78]. The effect of cognitive impairment on the probability of use is less clear [71, 79].

For recipients of home care disability, age and living alone seem to be the most important predictors of the amount of care [38, 61, 70, 72]. The effect of cognitive impairment on the amount of care received is less clear [72]; however, Meinow [61] found that those with cognitive impairment received 25 percent more care than those without any cognitive impairment.

Other health-related need variables mentioned in the literature include diagnosis; comorbidity[3]; physical, psychological, and emotional well being; and self-rated health status. The results related to these variables are mixed, and the effects are often nonsignificant [71, 73, 80, 81]. 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 [82]. Furthermore, people with dementia are nearly five times more likely to use public home care than other older people living alone [83]. Studies have also shown effects of depressive mood [79], psychosocial well being [73], and emotional problems [77] on home care use. Disability is also clearly related to well being [84] and depression [85]. The role of relatives (cohabitant, spouse or children) is substantial throughout OECD countries. More than 10 percent of the population aged 50 or older receive help from an informal care giver, and the amount of informal care is higher in countries with stronger family ties [86-88]. Dependent people who live alone typically have greater use of formal care than people

[3] Comorbidity is defined as the presence of two or more medically diagnosed diseases [16]

who live with their spouses or children [37, 71, 73, 77]. Algera [80], however, reported more mixed results for patients with long-term conditions. Informal care may serve as a substitute and reduce the need for public care [37, 72, 74]. However, such care may have a positive effect on formal care because informal care givers, such as children, serve as advocates. Blomgren [37] reported that elderly who receive help from children and elderly without children used more home care than elderly with children who do not provide informal care. The literature is inconclusive with regard to the effect of socio-economic status, as measured by education and income, on home care use [37, 61, 81].

3.1.2 Use of nursing homes

There is a large body of literature examining nursing home admissions (NHA), including several meta-analyses [89-91]. There seems to be a consensus in the literature that ADL, cognitive impairment and age are indisputable predictors of NHA. Somewhat surprisingly, IADL variables are not consistently found to be predictors of NHA, but de Meijer [74] found that IADL, age and ADL were significant predictors of NHA. Living alone and prior nursing home stay increase the risk for NHA. The effect of living alone has been found to be gender specific [91-94].

Relatively few studies have analysed the amount of resources at an individual level within a nursing home setting. Most of these studies have been done within the RUG system, which is a classification system of nursing home patients based on ADL score and is used as a reimbursement system in the US [60]. Patients' ADL score is a strong explanatory factor of variation in individual care within nursing homes [95-97]. There is also evidence of increased use of resources related to gender (female) and age (those below 75 years) [95]. As noted above, the importance of cognitive impairment as a predictor of NHA is indisputable; however, the effect of cognitive impairment on the use of resources within a nursing home setting is less clear. Within the RUG system, the effect of cognitive impairment is not found to be important in explaining use of care resources [98]. Other studies have indicated that cognitive impairment affects resource use indirectly through ADL [36, 41]. Nordberg [36] found that patients with dementia

received 30 percent more care than those without dementia; furthermore, worsened ADL had a significant effect for the non-demented but not for the demented. The RUG system has been criticised for only focusing on patient-level data and not taking into account differences that arise at the nursing home level. Nearly 37 percent of the variation between patients is observed at the nursing home level, and this could affect the estimates [99].

3.2 Care for intellectually disabled individuals

Elderly above 67 years old are the most frequent consumers of public long-term care. Another large group of consumers is intellectually disabled persons. In most Western countries, services provided for people with intellectual disabilities have been deinstitutionalised over the past decades and replaced by community-based homes or service flats. Instruments that are commonly used to assess intellectually disabled persons such as, e.g., the Behaviour Problems Inventory (BPI) and the Inventory for Client and Agency Planning (ICAP) focus primarily on behavioural problems; however, some also include ADL and IADL variables, i.e., the Learning Disability Casemix Scale (LDCS) [100-102]. Behavioural problems have been found to be the strongest predictors of the amount of care among the intellectually disabled [103-105]. Behavioural problems are commonly captured by a set of variables covering, e.g., self-abusive behaviours and both physically and verbally offensive behaviours towards others. Although these individuals' intellectual disability is the main reason they need public services, disabilities could also restrict their participation in the community. Few studies have isolated the effects of ADL or IADL as predictors of need for this group [106]. Studies of those with mild or moderate intellectual disability have found that they could have problems with activities of daily living [107] and that the use of ADL and IADL is certainly appropriate for intellectually disabled individuals [108-110].

3.3 Supply of long-term care

The financing of the home care sector in Europe is a complicated mosaic, with a wide variety of funding and payment systems for providers [111]. Within the Nordic welfare

model, the financing of long-term care is a part of the public's responsibility. The supplier of long-term care is a mix of private and public providers. In Norway, the dominant form of financing the suppliers is through global budgeting. A financial reimbursement system based on Case-mix models has been used in nursing homes in several countries [41, 45, 46, 112-116]. One of the most commonly used system is the RUG system, which is based on the RAI/MDS [40, 43]. In RUG, the recipient is divided into seven homogen groups and subgroups beneath each group, and the reimbursement is based on the number of recipient in each group [46]. The RUG is primarily developed for use in nursing homes. Several states in the US, as well as other countries, use RUG as a reimbursement system through Medicare and Medicaid [46, 47]. There is also a version for home care, RUGHC [42, 44, 48, 49].

4 Aims of the study

The aim of this study is to assess the relationship between factors describing individual disability and impairment and the use of long-term care services both at home and in a nursing home setting.

- The aim of paper 1 was to determine whether there were systematic variations between nursing homes' level of care given to patients and whether such variations could be explained by nursing home characteristics and/or individual need-related variables.

- The aim of paper 2 was to relate the amount of home care provided to elderly individuals aged 67 years or older and intellectually disabled individuals aged 18 years or older to disability and impairment characteristics.

- The aim of paper 3 was to examine how disability and impairment variables could be grouped into common factors and whether the number of factors (dimensions) differed between groups of elderly users in the Norwegian health care system.

5 Study setting

5.1 Long-term care in Norway

Long-term care is a part of the universal social and welfare system. It is an individual's right to services when the need arises. Responsibility for providing long-term care lies with each of the 428 municipalities. Services may be provided by private firms, the municipality or a combination of the two. The majority of services are provided at home (home care) or in nursing homes; however, some services are also provided in sheltered housing and extra care sheltered housing units. Sheltered housing consists of self-owned or rented housing for elderly or disabled individuals and is often located adjacent to a nursing home. Extra care sheltered housing units provide 24-hour care and are considered as an alternative to nursing homes. For the intellectually disabled, extra care sheltered housing is the typical living arrangement for independent living. In addition to long-term care, the municipalities are responsible for rehabilitation, short-term stays at nursing homes and post-acute care.

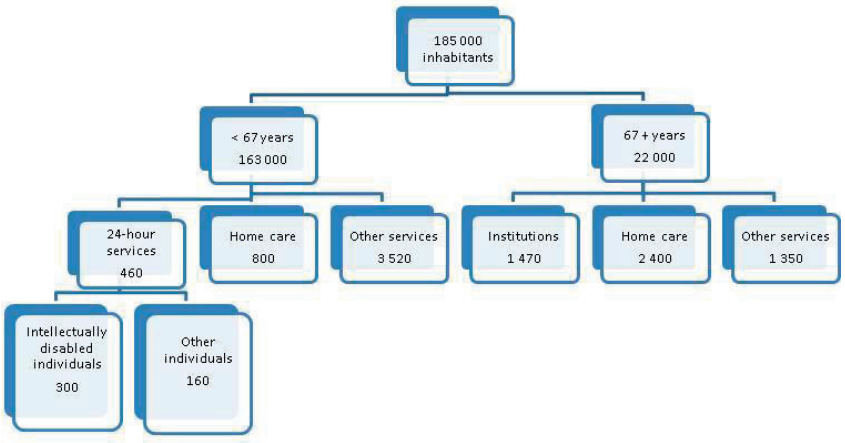
Specialised health care, including hospitals, is the responsibility of the central government (state). General practitioners operate through a contract with the municipalities, are responsible for primary health care and serve as gatekeepers who make referrals to acute health care. However, they cannot refer patients to long-term care.

The financial responsibility of long-term care lies with the municipalities. There is a co-payment. The individual co-payments are means tested and differ between nursing home and home care. In nursing homes, individual pay 75 percent of income below and 85 percent of income above NOK 90 068 (2015), with a deductible of NOK 7 500 [117, 118]. Home care is practically free of charge; payment is restricted to help with practical tasks such as house cleaning. Those with an income below NOK 176 740 pay a maximum amount per month of NOK 186 (2015) [117]. In sheltered housing, the payment follows the same structure as that for home care; thus, the payment of services is much lower in sheltered housing than in nursing homes. However, recipients pay no additional rents in nursing homes, but they do in sheltered housing.

5.2 The municipality of Trondheim

Trondheim has approximately 185 000 inhabitants and is Norway's third-largest municipality. The share of nursing home residents in the population above 80 is slightly above the national average, while the share receiving home care is below the national average [119]. Of those aged 67 years or older, approximately ¼ receive some type of services from the municipality. These services range from having a safety alarm or meals on wheels to living in a nursing home.

Table 1. Share of long-term care recipients in the municipality of Trondheim



The municipality of Trondheim has been using various instruments (Gerix and the Hovedkort) to measure disabilities since the mid 1980s. Among Norwegian municipalities, Trondheim has one of the longest experience in using such instruments [120, 121]. In 2006, Trondheim, as all other Norwegian municipalities, started to use IPLOS.

6 Materials and Methods

6.1 Disability instruments

In 2006, a mandatory system for nursing and home care statistics (IPLOS) was introduced in all Norwegian municipalities, covering all recipients of public care [122, 123]. The measures of disability and impairment used in this study are based on the Individual Nursing and Care Statistics (IPLOS). IPLOS contains 15 variables describing disability and cognitive impairment and two variables describing loss of hearing and sight. Disability and impairment is assessed on a five-point scale, where a score of 1

indicates no loss of function, and a score of 2 indicates able to manage the task but with reduced quality or speed. Scores of 3-5 indicate an increasing need of help. IPLOS uses observed functioning, which is also used in this study. In this study, we have assessed capability to perform tasks, and the average score was used.

In acute care, several tools are used to score disability [124-130], and all of these tools are based on a diagnosis. As mentioned above, disability is caused by an impairment due to a disease, e.g., stroke, dementia, and COPD. The care given by the municipality is based on the need for care and not the initial medical explanation for the disability. Therefore, this type of tools is less suitable in LTC. Thus, IPLOS is compared with more general instruments that are not based on a specific diagnosis.

6.1.1 IPLOS compared with other commonly used instruments

IPLOS is based on the same types of variable as those found in other commonly used instruments [131]. Table 2 compares IPLOS with the Katz, Barthel, Lawton and FIM instruments.

Table 2 Variables used in some commonly used instruments compared with IPLOS

Variables	Katz	Barthel	Lawton	FIM	IPLOS
ADL:					
Eating	X	X	X	X	X
Bathing	X	X	X	X	(X)
Grooming/Personal hygiene		X	X	X	X
Dressing	X	X	X	X	X
Transfer	X	X	X	X	X
Using the toilet	X	X	X	X	X
Continence	X	X		X	
Controlling bowel		X		X	
Indoor mobility		X	(X)	X	(X)
Ascend and descend stairs		X		X	(X)

Outdoor mobility		(X)	X
IADL:			
Use of phone	X		
Shopping	X		X
Food preparation/cooking	X		X
Housekeeping	X		X
Laundry	X		(X)
Mode of transportation	X		
Handling finance	X		
Responsibility for own medication	X		(X)
Cognitive:			
Communication[1]		X	X
Social interaction		X	X
Daily decision taking/ Plan and - manage daily routine			X
Memory		X	X
Problem solving		X	
Behavioural control			X

[1]Comprehension and expression

IPLOS compared with the Barthel and Katz ADL instruments:

The Barthel instrument has seven variables, and the Katz instrument has six. In addition to ADL, the Barthel instrument has 3 variables measuring mobility. It makes a distinction between Grooming/Personal toilet and Taking a bath. In IPLOS, Grooming, Personal toilet and Taking a bath are measured within the same variable. IPLOS has the same ADL variables as the Katz instrument except Bladder. While Katz's and Barthel's instruments make a distinction between using the Toilet and Controlling bladder and bowel, all this information is included in the variable Using toilet in IPLOS. The Barthel instrument has one variable for Transfer between (wheel-) chair and bed and one for Walk on a surface; IPLOS merges these into the same variable Indoor mobility. Barthel's instrument has a variable Ascend and descend stairs; in IPLOS, this is a part of Outdoor mobility. The Katz instrument uses a 3-point scoring system, and the Barthel instrument uses 2- or 3-point scores. IPLOS uses a 5-point score. Neither Barthel's nor Katz's instrument has IADL or cognitive variables.

IPLOS compared with Lawton's instrument:

Lawton's instrument has eight IADL variables, while IPLOS has three. In addition, IPLOS has a variable Maintaining own health, which has a much wider definition than Lawton's Responsibility for own medication. Housekeeping in IPLOS includes laundry, while this variable is separated from Housekeeping in Lawton's measure.

IPLOS compared with the FIM:

The FIM has the same ADL variables as those used in Katz's and Barthel's instruments. The FIM does not have any IADL variables but does have five cognitive variables. The FIM divides communication into Comprehension and Expression, while IPLOS merges these two variables into one variable called Communication. The instruments' variables of Social interaction and Memory are quite the same, while the FIM includes a variable labelled Problem solving, which is not included in IPLOS. IPLOS has a variable Daily decision taking, which is close to Plan and manage daily routine. In the FIM, the variable Social interaction is more related to adequate social behaviour, while in IPLOS, it is more related to maintaining social relations. Adequate social behaviour in IPLOS is measured in the variable Behavioural problems.

6.1.2 Validity and reliability tests of IPLOS

While IPLOS shares many similarities with other instruments, a possible objection is that is has been tested for validity only to a limited degree. Selbæk [132] performed a validity test of the variables in IPLOS among 652 home-dwelling elderly. ADL and IADL variables in IPLOS were tested against similar variables in Lawton's instrument, and the validity of two the cognitive impairment variables (memory and communication) in IPLOS was tested against the MMSE, the Clinical Dementia Rating (CRD) [133] and the Neuropsychiatric Inventory (NPI) [134]. The correlation (Spearman's rho) between IPLOS ADLs and Lawton's ADLs was 0.66 and between

IPLOS IADLs and Lawton's IADLs was 0.53. There is no common agreement of what is considered as strong or weak correlation; in most definitions, 0.66 is considered as a strong correlation, while 0.53 is considered as a moderate to strong correlation. The correlation between IPLOS cognitive impairment and CRD was 0.65 and between MMSE and IPLOS was -0.53; the negative value is because lower values on the MMSE imply worsened cognitive ability. The correlation with a behavioural rating, the NPI, was weak to moderate. Thus, compared to the MMSE, CRD and NPI, IPLOS could underestimate cognitive impairment. However, whether this is due to unclear definitions of the variables in IPLOS or the training of the employees is unknown.

This thesis did not aim to perform a reliability or validity test of IPLOS. The IPLOS has been used in Norway for nearly 10 years. Here, we were interested in whether routinely collected data could be used for planning. Using data from the municipality a limited inter-rater reliability test was conducted. Inter-rater reliability (IRR) and inter-rater agreement (IRA) tests were performed [135, 136]. Intraclass correlation coefficient (ICC) tests are often used to test the reliability of disability indices [43, 137-139]. Four cases were used, 38 employees were tested in case 1, 44 in case 2, 63 in case 3 and 39 in case 4, of these employees, respectively 38, 44, 47 and 23 had completed an earlier training program [140].

The test was conducted according to Shout and Fleiss [141]. A high ICC indicates both high reliability and agreement [142]. ICC values above 0.75 were interpreted as good reliability, values between 0.4 and 0.75 as moderate to good reliability, and values below 0.4 were considered as poor reliability [143].

For each single variable, an inter-rater agreement test was performed. This test examined observed vs. expected variance [144-146]. In accordance with LeBreton [135], we used r_{wg} as measure between observed and expected variance. r_{wg} values above 0.91 were interpreted as very strong agreement, values between 0.71 and 0.90 as

strong agreement, values between 0.51 and 0.70 as moderate agreement, values between 0.31 and 0.50 as weak agreement, and values below 0.3 as no agreement [135].

The main finding of this limited reliability analysis was that those who had completed an organised training program (authorised) had higher ICC and higher agreement than those who did not (non-authorised). When the Minimum Data Set (MDS) was implemented in the US in the early nineties, the importance of training and education were noted [147]. All but three variables had strong to very strong agreement. Social interaction had the lowest agreement for both authorised and non-authorised. In other indices such as the FIM and the RAI, a similar variable is more limited to deviant behaviour. For the non-authorised, Using toilet and Maintaining own health had moderate agreement. This confirms results from other studies that report difficulties in scoring variables such as Maintaining own health and Social interaction [148]. There are several caveats to this approach. Because we needed to use those who participated in the training program, there was no randomisation of the participants. The authorised were more numerous than the non-authorised, and this could affect the estimates. The number of cases was limited, and we could not properly determine whether all variables had the same dispersion in difficulty. The study was conducted in one municipality, making it less suited for generalisations.

6.2 Other variables

The outcome variable in this study was amount of long-term care provided, as measured in hours per week. Time was registered by personnel using handheld computers and registered after each visit. In nursing homes and sheltered housing for intellectually disabled individuals, time was registered after each shift.

All variables, including diagnosis, gender, age group, living arrangement and other enabling variables, were registered in the municipality's electronic patient record system.

6.3 Statistical methods

In all three studies, a quantitative cross-sectional analysis was performed. In paper 1, exploratory factor analysis and multilevel regression analysis with random intercepts (sometimes referred to as mixed model) were used. In the second paper, exploratory factor analysis and multivariate regression analysis were used. In the third paper, exploratory factor analysis, confirmatory factor analysis and item response theory were used. Analyses were performed with SPSS version 21. IBM Corp. Armonk, NY or Stata 13.1 StataCorp. College Station, TX.

6.3.1 Factor analysis

Factor analysis is a set of methods used to cluster variables that statistically depend on each other. Variables with high correlation could be grouped together into a common factor. There are two major types of factor analysis. In *exploratory* factor analysis (EFA), one attempts to find the underlying structure based on the observed correlation among the observed variables. No assumption is made about the underlying structure. In *confirmatory* factor analysis (CFA), one seeks to test whether an assumable underlying structure is true. Confirmatory factor analysis should be based on a theory of the underlying structure [149].

In exploratory factor analysis, there are several decision points. The lack of clear guidelines makes EFA a bit puzzling [150, 151]. In this study, ordinal variables were used. Although polychoric correlations are considered to be the "gold standard" when analysing dichotomous items, Pearson's correlation is often used. Polychoric correlations assume that the underlying latent variables are normally distributed [64]. If the variables are non-normal distributed the use of polychoric correlation may lead to biased estimates. Still, polychoric correlation is often preferred for ordinal data [152]. Pearson's correlation could lead to underestimating the factor loadings and, thus,

retaining too many factors. With as many as 5 response categories, this may not represent a serious problem [64, 153, 154].

Decision points in EFA:

1) Factor extraction method
2) Number of factors to retain
3) Rotation

1) The most frequently used extraction methods are principal component analysis (PCA) and principal axis factoring analysis (PAF). In this study, we used PAF, which is often recommended [150].

2) There are no clear commonly accepted statistical criteria for the number of factors to retain, and the number of factors retained should be examined in light of existing theory. Here, Kaiser criterion, scree plot and parallel analysis were used. Parallel analysis is not a part of the standard version of SPSS; thus, a script by Hayton [155] was used.

3) Rotation does not influence the number of factors to retain; it is done only to maximise the high correlations and to minimise the low correlations. There are two main categories of rotation, *orthogonal* and *oblique rotation*. In *orthogonal rotation,* the factors are assumed to not be correlated, while in *oblique rotation,* the factors are allowed to correlate. In social science, correlations between factors are nearly always the case; thus, oblique rotation is considered as best practice [150].

The frequently recommended minimum sample size for EFA is at least ten times the number of variables. There is no clear consensus in the literature concerning whether this is a reasonable minimum, but a minimum ratio of 20:1 seems to be more justifiable [151].

In CFA, one estimates variables that minimise the difference in correlation matrix from the constraint model and the correlation matrix from the observed variables and tests whether the estimated correlation matrix has consistent fit with the observed correlation matrix [156].

Because there are no clear guidelines regarding how to arrange the variables, we used both an exploratory and a confirmatory factor analysis in the studies [157].

6.3.2 Multilevel analysis

Multilevel analysis allows for the differentiation between variations at different levels. In article 1, we were interested in determining whether a large part of the difference in individual care was caused by differences between nursing homes compared to differences between individuals [158, 159]. Furthermore, multilevel regression analysis could be an appropriate way to adjust for heterogeneity. A common practise in standard regression analysis is to add dummy variables to adjust for heterogeneity. An obstacle with the use of dummies is that it could reduce the degrees of freedom, which could be a problem if the number of observations is low. This problem could be reduced by using random coefficient analysis in a multilevel analysis. In this article, the estimation procedure was done by maximum likelihood methods, assuming an unstructured covariance matrix.

6.3.3 Multivariate regression analysis

Multivariate regression analysis was used in article 2. Heteroscedasticity was tested by using Cook-Weisberg and White's heteroscedasticity-consistent estimators [160]. Multicollinearity was tested by using variance inflation factor. Because of the skewed distribution of the error term, a natural logarithm was used to normalise the distribution.

For categorical dummy variables and discrete variables, Kennedy's approximation was used to adjust the data for bias [161, 162].

In article 2, potential heterogeneity was adjusted by fixed coefficients. Although random coefficients increase the degree of freedom, they do not necessarily improve the model compared to fixed heterogeneity coefficients [163].

6.3.4 Item Response Theory - IRT

In article 3, item response theory (IRT) was used. IRT is considered as a proper technique to determine the hierarchical order of the variables and potential information gaps between variables. Both one-parameter logistic (1PL) and two-parameter logistic (2PL) IRT models were used. The variable (or item) difficulty parameter is measured, in standard deviations, as the distance from the overall mean score (standardised) on the latent variable when the probabilities of scoring "need for help" or "no need for help" are equal (i.e., 50 percent) [164, 165]. Thus, higher parameter values are associated with more difficult tasks (variables) or the increased ability to possibly manage an item increase. There are no clear guidelines for the recommended size of the gaps between variables, although some reports have suggested values between 0.15 and 0.30 [166-168].

6.4 Ethical considerations

The study was approved by the Regional Committee for Medical and Health Research Ethics (REK) and the Ombudsman for Research at the Norwegian Social Science Data Services (NSD). The data from the municipality was de-identified.

7 Summary and results

7.1 Paper 1:

Within the setting of a public health service, we analysed the distribution of resources between nursing homes funded by global budgets. Three questions were pursued. First, are there systematic variations between nursing homes in terms of the level of care given to patients? Second, can such variations be explained by nursing home characteristics? Third, how are individual need-related variables associated with differences in the level of care given? As much as 24 percent of the variation in individual care between patients could be explained by variation in nursing homes. Adjusting for structural nursing home characteristics did not substantially reduce the variation in nursing homes. For the average user, one point increase in individual ADL increases the use of resources by 27 percent. A negative association was found between individual care and mean ADL at the nursing homes. In other words, at the nursing home level, a more resource-demanding case-mix is compensated by lowering the average amount of care. In a financial reimbursement model for nursing homes with no adjustment for case-mix, the amount of care patients receive depends not only on the patients' own needs but also on the needs of all the other residents.

7.2 Paper 2:

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. Both disability and cognitive impairment were strong predictors of the amount of care received for both elderly and intellectually disabled individuals. For elderly individuals, we also found significant positive associations between weekly hours of home care and having comorbidity and living alone. 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.

7.3 Paper 3:

The aim of this study was to utilise a national information system that comprises 15 variables characterising disability and cognitive impairment to analyse the number of factors (dimensions) necessary to determine whether long-term care is needed as well as the hierarchical order of the variables within each factor. Specifically, we examined whether the number of factors and their structures differed across elderly in the Norwegian health care system. Two factors were sufficient to characterise need for all groups of recipients. For the elderly, disability and cognitive impairment appeared to represent different dimensions of need. The IRT analysis suggested a nearly identical hierarchical ordering for elderly persons receiving care at home and those living in nursing homes. Grouping variables that describe disability and cognitive impairment are most suitable for broad factors that could be used in explaining the elderly's needs. IRT analysis revealed large information gaps between different variables in the system used in Norway today; thus, there is a need to (re-)consider the design of the standardised national registration system (IPLOS).

8 Discussion

8.1 Description and measures of need of long-term care among the elderly

8.1.1 How to describe need at the individual and group levels

Today, IPLOS is the only need-based evaluation of elderly and intellectually disabled individuals with the potential to be used throughout the Norwegian long-term health care system. This makes it a potential tool for both cross-sectional and longitudinal

comparison between and within municipalities. Although the use of IPLOS variables is central in this thesis, the intention has not been to evaluate IPLOS as a system per se. However, results based on IPLOS data are of interest because IPLOS is a mandatory system for all Norwegian municipalities and all recipients of public long-term care and has remain nearly unchanged since 2006.

When moving from the individual level to comparisons at the group level, there is a need to aggregate the variables for two reasons. The first reason is that the comparison of all variables would be overly complex. An aggregation, thus, eases the interpretation of the results. Second, the underlying causes of disability affect the variables to a more or less degree, implying that the variables are correlated. The estimation of correlated variables could give biased results. How to group the ADL, mobility and IADL variables into factors has been extensively analysed. The literature, however, is largely inconclusive, suggesting that ADL, mobility and IADL variables may be placed in groups that include one to three unique factors [63, 64, 169]. In article 3, we found that need could be described by two factors: one containing variables related to disability and another containing variables related to cognitive impairment. Our results support studies that found that ADL and mobility variables constitute a common dimension in describing the service needs of the home-dwelling elderly and nursing home residents and that the IADL variables could be both physical and cognitive [66, 67, 69]. Thus, the distinction between physical and cognitive variables may be more relevant than that between ADL, IADL and cognitive variables. Furthermore, the factorisation seems to be independent of whether care is provided at home or in nursing homes. In addition, the distinction between the "younger elderly" (67-80) and the "older elderly" (80+) and gender do not seem to be important when choosing the number of factors or the variables contained in each factor.

The exploratory factor analysis produced three dimensions for nursing homes in article 1 and two dimensions in article 3. In article 1, Pearson's correlation was used, and in article 3, polychoric correlation was used. This is an example of Pearson's correlation

retaining too many factors. The data used in article 1 were from 2004 and those used in article 3 from 2012. The use of polychoric correlation also led to two factors in the 2004 data used in article 1. The estimated results and the conclusions from article 1 remain the same when a physical disability index was used instead of a combination of ADL and IADL.

We also analysed how the variables measure disability along a continuum. Our results suggest that the hierarchical ranking of variables is quite similar for elderly living at home and those living in nursing homes as well as across age and gender. These findings are in accordance with Finlayson [170]. Second, we found large information gaps between the variables that represent the simplest tasks, more precisely, between the variables Eating and Indoor mobility, both for patients in nursing homes and home-dwelling elderly. A possible solution to reduce this gap could be to split the variable Indoor mobility into more detailed variables. In Garcia [65], indoor mobility is split into three separate variables, and this split seems to reduce the gap. McHorney [32] performed an IRT analysis on 166 ADL/IADL variables with much more detailed information than IPLOS. This detailed analysis gives an overview of potential variables that could cover gaps along the continuum. In practical use, there will always be a trade-off between an instrument that includes multiple variables and covers a wide spectrum of need and a more parsimonious instrument that reduces the administrative burden [31]. A possible solution to increase the ability to detect differences and, at the same time, keep the administrative burden to a minimum is to replace some of the variables. However, we did not find any gaps small enough to justify rejecting variables without an important loss of information. Accurately accounting for differences in need among the less disabled is a limitation in most indices based only on traditional ADL/IADL variables [168], and our analysis suggests that the best solution is to trade administrative ease in favour of a more detailed instrument.

8.1.2 The relationship between need and amount of care

8.1.2.1 Home Care

In home care, cognitive impairment together with disability, age and living alone seem to be the most important predictors of the amount of care provided [38, 61]. We found that worsened disability increased the use of public home care more than did worsened cognitive and behavioural impairment. At the mean value of cognitive impairment score, the marginal effect of a one-point increase in disability was an increase of 120 percent in the amount of care provided. At the mean value of disability, the marginal effect of a one-point increase in cognitive impairment was an increase of 66 percent in care. This establishes a strong relationship between both disability and cognitive/behavioural impairment on the amount of public home care received by the elderly. The importance of disability as a predictor of the amount of care received has been stated in other studies, while the effect of cognitive impairment has been more unclear [61, 70, 72]. We found that the model explained 45 percent of the variation in individual care. This is in the same range as that in other studies, which have explained 37-49 percent [48, 49, 61].

In our study, we did not find any age effect. This result is contrary to Meinow [61] and Lindholm [38], but as Meinow stated: "… *older age had a significant positive effect on the amount of home help allocated. Although this could be a result of privilege solely by age, it is likely that the age variable covered some kind of frailty related to the amount of home help received, and not included by the IADLs and ADLs measures"*.

The role of informal care (cohabitant, spouse or children) is substantial throughout OECD countries. More than 10 percent of the population aged 50 or above receive help from an informal care giver [37, 72, 86, 87]. Our results support the hypotheses that cohabitants serve as substitutes for public care and that their effect on the amount of care given can be quite substantial. However, we found a strong gender effect for home-dwelling elderly, which is contrary to other studies [72]. Men living with cohabitants received substantially less care than females. The lack of an association between gender and help received among those who lived alone may be due to the cohabitant. This

implies that female cohabitants serve as a substitute for public care to a larger degree than male cohabitants. Cohabiting women receive approximately 30 percent less care than those living alone, while cohabiting men receive approximately 50 percent less care than those living alone. Comorbidity among the elderly is associated with worsened disability and increased hospitalisation [171]. To our knowledge, no previous study has conducted an analysis of the association between comorbidity and the amount of public home care provided. The presence of comorbidity increased the amount of home care by approximately 20 percent. We did not find a direct effect of any of the most frequently used diagnoses, i.e., dementia, stroke or diabetes; thus, diagnoses may be too crude a measure to describe need. Diagnosis is measured as yes/no, while the degree of disability resulting from a diagnosis could vary substantially. Dementia is considered as one of the most important diseases that impact the future use of public health care. We do not have precise information about the prevalence of dementia in the Norwegian population [172]. In Europe and Northern America, estimates of the prevalence of dementia are approximately 12 percent for those 80 to 85 years old and 25-30 percent for those above 85 years old [173]. Dementia is an important cause of increased disability. However, in this study, the diagnosis of dementia itself was not a significant predictor of the amount of public home care beyond what was captured by cognitive impairment.

8.1.2.2 Nursing home

It has been established that ADL are an important predictor of time the staff allocates to recipients of long-term care in nursing homes [36, 60, 95, 98, 99]. Although the importance of cognitive impairment as a predictor of admissions to nursing homes is indisputable, the effect of cognitive impairment on the use of resources within a nursing home setting is less clear. Arling [41], however, found that increased cognitive impairment led to worsened ADL, which in turn led to increased staff time. Fries [98] found that cognitive impairment led to (slightly) increased staff time for those with less ADL disability. In addition, we found that disability, measured with ADL, was the strongest predictor of increased staff time use. For the average user, a one-point increase

in ADL-disability increases the use of resources by 27 percent. We also found a significant effect of increased cognitive impairment. For the average patient, the marginal effect of a one-point increase in cognitive impairment was 1.1 percent. When disabilities were held constant, worsened cognitive impairment led to increased staff time, but as in Fries [98], we also found that increased cognitive impairment led to a greater increase in staff time for those with less disability. For those with the most severe disability, a one-point increase in cognitive impairment actually led to decrease in staff time.

Heterogeneity between nursing homes could account for as much as 29-37 percent of the variation between patients direct care [99]. In our study, we found that variation between nursing homes accounted for approximately 25 percent of the variation in total individual care. However, the variation between nursing homes was smaller (14 percent) for personal care. In other words, variation between nursing homes differs a great deal according to what type of staff time was analysed. However, not taking the heterogeneity into account could lead to less efficient estimated parameters.

When we compare studies 1 and 2, we see that worsened cognitive impairment has a stronger effect, as measured in percent, on the staff time in home care than in a nursing home setting. Those with cognitive impairment need some type of supervision, which is a natural part of a nursing home setting with staff available 24 hours per day. This supervision is not necessarily captured in direct care time in a nursing home setting. In a home care setting, increased need for supervision led to more frequently visits. The results from study 1 and study 2 are not directly comparable according to the role of informal care. However, in study 1, we found that those who received a substantial amount of informal care (more than 3 hours per week) also received more formal care. However, there were no differences in formal care between those who received no informal care and those who received up to three hours of informal care per week. For those who received home care (study 2), the amount of informal care received had no significant effect on the amount of public care received. It is noteworthy that the effect

of cohabitating in home care and receiving substantial informal care in nursing homes had opposite effects on the amount of formal care. Unfortunately, the data did not provide information that would allow us to look further into this question. One possible explanation for this finding could be that in the nursing home setting, we observed people at the end of life and that this influences time used both by staff and relatives. Relatives and the staff could also have different definitions of "desirable level of care". Another possible explanation is that relatives that spend a substantial amount of time with the patients serve as strong advocates.

Unfortunately, enabling variables such as income and education were not available for this study. Most studies have not found any significant effect of education on the amount of care, but to some degree, it seems to affect the probability of having care [71]. In a Norwegian health care setting, those with high education were more likely to receive more frequent care than others [81]. Within the Nordic welfare model, this is contrary to a Finnish study that did not find any education effect [37]. Some of the same pattern seems to occur related to income. It is most common to not find any effect of income on the amount of care, while the effect of income on the probability of care is more unclear [71]. Researchers who found that those with higher income use more care services are mainly from a US health care setting. A study by Blomgren [37], which was conducted within a Nordic welfare system, did not find any income effect on the probability of home care use. More detailed information about informal care would be of interest. We know that the presence of children could affect the probability of having home care, but the effect on the amount of care is unknown [37].

It seems to be indisputable that cognitive impairment seems impacts the amount of home care and NHA; however, whether it is a good predictor of amount of care in the nursing home sector is more debatable. In our study, we found cognitive impairment to be a solid factor in predicting the amount of care both in home care and nursing home settings. It has been noted that IPLOS may underestimate cognitive impairment [132]. If

this is truly the case, we may have underestimated the effect of cognitive impairment rather than overestimating the effect by using IPLOS.

8.2 Description and measures of need of long-term care among intellectually disabled persons

There are some distinct differences between elderly and intellectually disabled individuals according to the disability instrument. According to the findings from study 2, the same variables could be used for both groups, but the interpretation of the variables differs. For the elderly, the variables could be divided into disability and cognitive impairment. For intellectually disabled individuals, the factor analysis identified behavioural impairment as a separate factor, whereas all the other variables were grouped into one common composite index, which constitutes both disability and cognitive impairment.

Behavioural impairment and coercive measures were the most important predictors of care provided to intellectually disabled care recipients. A one-point change in behavioural impairment increased the amount of public care provided by 50 percent. Furthermore, individuals who were subjected to coercive measures received 56 percent more care per week than individuals who were not subjected to such measures. Our findings support the notion that behavioural problems are among the strongest predictors of the use of public care among intellectually disabled individuals [103, 105]. Furthermore, our findings support the notion that, in addition to behavioural measures, disability and cognitive impairment are important explanatory factors of the variation in long-term care provided to intellectually disabled service recipients. For the average care recipient, the marginal effect of a one-point increase in the composite index was an increase of 77 percent in weekly care hours.

For intellectually disabled individuals, behavioural impairment is certainly important when describing the need for care. However, IPLOS has only one variable describing behavioural impairment, and this variable may not describe the full range of behavioural impairment. Other instruments, for instance the Learning Disability Casemix Scale (LDCS) [101, 105], the Behaviour Problems Inventory (BPI) [102] or Inventory for Client and Agency Planning (ICAP) [100], have at least seven variables to describe behavioural impairment. IPLOS's limitation in describing challenging behaviour could be a reason why the model only explained 29percent of the individual variation. Other models has an explanatory power of explaining differences in nearly 40 percent [103], on the other hand some models has an explanatory power of 33 percent [105].

Challenging behaviour is common among the elderly with dementia; most of the elderly with dementia experience (short) periods with behavioural disturbance [174]. In article 3, we found that after Eating, Behavioural control was the variable for which the elderly had the lowest score both in nursing homes and in home care. We also observed large gaps between Behavioural control, Communication and the other cognitive variables. Although those with severe challenging behaviour seem to be a small group of the elderly, they are viewed as a challenge for and threat to both the staff and other residents, and they create a substantial amount of stress [175, 176].

9 Implications and further research

9.1 Implications for the score system

IPLOS is a mandatory system, and in national statistics, it is used in the same manner for all recipients. Based on the results from this study, there are some suggestions for improvement.

9.1.1 New variables related to "information gap"

For elderly, there were information gaps at both ends of the scale. To improve the scale's ability to detect differences in disability, one should attempt to find variables between "housekeeping" and "shopping" at the most difficult end and between "eating" and "indoor mobility" at the easiest end. This is similar for both home-dwelling elderly and those living in nursing homes. For cognitive variables, one should find variable(s) covering the gap between "maintaining own health" and the other cognitive variables. The system would benefit from closing gaps. This study has not tested potential variables to fill the gaps, but there are several suggestions listed in other studies [32].

As a consequence of IPLOS's limitation of having only one variable that describes behavioural impairment, in 2015, the municipality of Trondheim incorporated three variables to cover a wider spectrum of challenging behaviour. It would be of interest for further research to investigate whether more detailed scoring of challenge behaviour combined with staff time could give more accurate information concerning both intellectually disabled individuals and the elderly with behavioural disturbance.

9.2 Implications for planning

9.2.1 Practical use in the planning and financing of long-term care

One of the main findings from study 1 was that a reimbursement system with no adjustment for case-mix could lead to a situation in which the amount of care received depended not only on the patient disability and impairment but also on the case-mix of the entire nursing home. At the time of the study, nursing homes in the municipality of Trondheim received the same amount of budget regardless of the acuity of the residents. The consequence of this was that for elderly living at nursing homes, the amount of care received depended on the ADL level of all the other residents. This has implications for the planning of the services as well as implication for the patients. The municipality of

Trondheim changed its reimbursement system after this time study was conducted. The most common way to finance nursing homes in Norway is through global budgeting. An interesting task for further research would be to investigate whether budget allocation based on case-mix will eliminate differences in individual care depending on the overall case-mix in the institution. The nursing homes in the study certainly had different ways of allocating their care time to recipients. Some prioritised individual care time, while others used more of their resources in group time. Unfortunately, we did not have any indicators of the quality of the care provided. It would be of interest for further research to investigate whether differences in quality between nursing homes could be related to different methods of providing care.

RUG is used as a reimbursement system for nursing homes [45, 46, 60]. A system for home care, RUG HC, has also been developed [48]. The White Paper 50 1997 [177] concluded that RUG would not be introduced in Norway at the moment but that it should be considered later. When IPLOS was prepared, the goal was for it to be a part of a potential introduction of RAI [131]. Thus, municipalities that choose to use the more comprehensive RAI should not have to use two parallel systems. That was not the final solution. The results from our studies show models that explain the individual differences in care as well as RUG measured with adjusted r square. Thus, IPLOS is a potential tool for reimbursement purposes.

The decision to admit an intellectually disabled person into a community home is based on the municipality´s assessment of the person's needs. In Trondheim, the assessment is performed by an independent office. The financial system for the intellectually disabled is partly based on dialogue between this office and those who deliver the services and partly constrained by global budgeting. A system based on case-mix for intellectual disabled individuals is under development in the municipality.

9.3 Further research

This study was only conducted in one municipality. This reduces potential noise in the data resulting from differences between municipalities. To determine whether the generality of the results hold, the datasets should be expanded to include several municipalities. First, more validity and reliability tests should be conducted across municipalities.

It would be of interest to see if there is larger heterogeneity between nursing homes within the same municipality than those in different municipalities. It would also be interesting to include several specialised units with more extensive care, e.g., rehabilitation, behaviour problems such as out acting or special treatments [99].

Although the explained variance in this study corresponds with that in other studies, a large part of the variation in individuals' care remains unexplained. This should be addressed in future research.

In study 1, there seem to be economies of scale. For nursing homes, there could be economies of scale at least up to 75-95 beds [178]. For intellectually disabled persons, the economies of scale are unclear. It has been found that few residents leads to higher costs [103]. These findings are disputable; some scholars argue that differences are relatively small and that results could be related to the fact that a small community setting could serve as a proxy for other non-/ or poorly measured variables such as behaviour [179]. It would have been interesting to incorporate facility size in the analysis. Cost differences related to diagnosis have also been found [179]. Our data did not include information on diagnosis for intellectually disabled individuals; this would have strengthened the analysis.

10 References

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Appendix - Variable list

Variabel	Norwegian	Variable	English
1. Spise	Har behov for bistand/assistanse til å innta servert mat og å drikke.	Eating	Needs assistance to eat served food and drinks
2. På og avkledning	Har behov for bistand/assistanse til å ta og av seg klær og fottøy finne fram og velge i overensstemmelse med årstid, vær og temperatur.	Dressing/undressing	Needs assistance to dress/undress clothes and shoes, and to choose appropriate clothing etc. according to season, weather and temperature.
3. Personlig hygiene	Har behov for bistand/assistanse til å vaske og stelle hele kroppen inkl. pusse tenner/munnhygiene.	Personal hygiene	Needs assistance to clean the whole body, including brushing the teeth.
4. Toalett	Har behov for bistand/assistanse til å utføre toalettbesøk/-funksjoner.	Using the toilet	Needs assistance with toileting
5. Bevege seg innendørs	Har behov for bistand/assistanse til å gå, bevege eller forflytte seg på ett plan innendørs; på flatt gulv, over terskler, ut og inn av seng, opp og ned av stol. Trapper innendørs er ikke med.	Indoor mobility	Needs assistance to move around on one floor (internal stairs not included). Crossing doorsteps, getting, inn and out of bed / chair.
6. Bevege seg utendørs	Har behov for bistand/assistanse til å gå, bevege eller forflytte seg utenfor egen bolig, opp og ned trapper, fortauskanter, på ujevne underlag mv. Med utenfor egen bolig menes her alt utenfor egen inngangsdør. Trappeoppganger og trapper ute er utendørs.	Outdoor mobility	Needs assistance to move around outside own residence. Getting up and down stairs, curb stones, uneven surfaces etc. This includes everything outside ones own front door.
7. Lage mat	Har behov for bistand/assistanse til å planlegge, organisere og tilberede enkel og sammensatte måltider, skjære opp maten, smøre brødskiver og tilberede annen tørrmat, varme opp mat og lage kaffe og te.	Cooking	Needs assistance to plan, prepare and cook cold and hot meals and drinks.
8. Alminnelig husarbeid	Har behov for bistand/assistanse til å utføre vanlig husarbeid som å gjøre rent, vaske klær, bruke husholdningsapparater, lagre matvarer og kaste avfall.	House keeping	Needs assistance to perform ordinary housework like cleaning, the use of home appliances, store groceries and get rid of rubbish.
9. Skaffe seg varer og tjenester	Har behov for bistand/assistanse til å skaffe seg varer som mat/drikke, klær/sko, husholdningsartikler, tekniske tjenester og husholdningstjenester, som er nødvendige og relevante i dagliglivet. (Enten via internett / telefon eller direkte i butikk.)	Shopping	Needs assistance with shopping for example food/drink, clothes/shoes, household goods, services etc. necessary to live independently (Either bought in a shop, by phone or on the internet)
10. Ivareta egen helse	Har behov for bistand/assistanse til å håndtere egen sykdom, skade eller	Maintaining own health	Needs assistance to deal with own sickness, disease, injury or disability, to contact a doctor or other relevant

	funksjonsnedsettelse, til å ta kontakt med behandlingsapparatet når symptomer eller skade oppstår, følge behandlings-opplegg og håndtere egne medisiner.		health personnel. Needs assistance to take responsibility for following recommended treatment regimes and to manage ones own medication.
11. Kommunikasjon	Har behov for bistand/assistanse til å kommunisere med andre personer. Med kommunikasjon menes å forstå og uttrykke seg verbalt/nonverbalt, evt. ved bruk av kommunikasjonsutstyr, tolk og teknikker.	Communication	Needs assistance to communicate with other people. By communication means ability to comprehend and express one selves, both verbal and nonverbal. If needed be by the use of technical equipment.
12. Sosial deltakelse	Har behov for bistand/assistanse til å styrke og opprettholde et sosialt nettverk, ha/ta kontakt med familie, venner, kolleger og personer i nærmiljøet.	Social interaction	Needs assistance to maintain a social life, to maintain contact with family, friends, colleagues and other relevant persons.
13. Beslutninger i dagliglivet	Har behov for bistand/assistanse til å ta avgjørelser og organisere daglige gjøremål, gjøre valg mellom alternativer, disponere tiden gjøremålene tar og integrere uforutsette hendelser.	Daily decision taking	Needs assistance to make everyday decisions and to organise their lives, make choices and administrate their own time.
14. Hukommelse	Har behov for bistand/assistanse til å huske nylig inntrufne hendelser, finne fram i kjente omgivelser, være orientert for tid og sted, gjenkjenne kjente personer, huske avtaler og viktige hendelser den siste uken.	Memory	Needs assistance to memorise recent events, recognize well-known places, to be orientated for time and space, recall appointments and important episodes during the preceding week.
15. Styre adferd	Har behov for bistand/assistanse til å styre egen atferd. Med dette menes å ha kontroll over impulser, verbal og fysisk aggresjon over for seg selv og andre.	Behavioural control	Needs assistance to maintain own behavioural manners. Having control with verbal and physical impulses and aggression towards ones self and towards others.

Paper I - III

Paper I

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RESEARCH ARTICLE Open Access

Variations in levels of care between nursing home patients in a public health care system

Øystein Døhl[1,2*], Helge Garåsen[1,2], Jorid Kalseth[1,3] and Jon Magnussen[1]

Abstract

Background: Within the setting of a public health service we analyse the distribution of resources between individuals in nursing homes funded by global budgets. Three questions are pursued. Firstly, whether there are systematic variations between nursing homes in the level of care given to patients. Secondly, whether such variations can be explained by nursing home characteristics. And thirdly, how individual need-related variables are associated with differences in the level of care given.

Methods: The study included 1204 residents in 35 nursing homes and extra care sheltered housing facilities. Direct time spent with patients was recorded. In average each patient received 14.8 hours direct care each week. Multilevel regression analysis is used to analyse the relationship between individual characteristics, nursing home characteristics and time spent with patients in nursing homes. The study setting is the city of Trondheim, with a population of approximately 180 000.

Results: There are large variations between nursing homes in the total amount of individual care given to patients. As much as 24 percent of the variation of individual care between patients could be explained by variation between nursing homes. Adjusting for structural nursing home characteristics did not substantially reduce the variation between nursing homes. As expected a negative association was found between individual care and case-mix, implying that at nursing home level a more resource demanding case-mix is compensated by lowering the average amount of care. At individual level ADL-disability is the strongest predictor for use of resources in nursing homes. For the average user one point increase in ADL-disability increases the use of resources with 27 percent.

Conclusion: In a financial reimbursement model for nursing homes with no adjustment for case-mix, the amount of care patients receive does not solely depend on the patients' own needs, but also on the needs of all the other residents.

Keywords: Nursing home, Care level, ADL, IADL, Cognitive impairment, Multi level analysis

Background

Within the OECD area long term care (LTC) costs have risen steadily in the past 10–15 years. This growth is expected to continue and, on average, public spending on LTC could almost double across OECD countries by 2050 [1]. LTC is provided in nursing homes or as home care, but in most OECD countries nursing home is the dominant form of provision [2]. Cognitive impairment and physical disabilities as well as prior nursing home use are strong predictors of nursing home admission [3].

Several instruments are available to assess level of disability and by extension the level of care need in individual LTC patients [4-7]. Based on these assessment instruments, case mix systems for nursing homes have been developed [8]. They are used as a base for provider payment, mainly in the US, but also in some countries in Europe [9]. However, the dominant form of provider payment in Europe is a mixture of global budgets, patient co-payment and per diem financing without any specific case-mix adjustment [2]. To what extent this leads to a situation whereby individuals with the same level of need receive different care has, to our knowledge, not been analysed in a public health care setting.

In this paper we utilise a data set of individually received direct care in nursing homes, combined with a national

* Correspondence: oystein.dohl@ntnu.no
[1]Department of Public Health and General Practice, Norwegian University of Science and Technology, P.O. Box 8905 MTFS, N-7491 Trondheim, Norway
[2]Department of Health and Welfare Services, City of Trondheim, Trondheim, Norway
Full list of author information is available at the end of the article

instrument that describes physical disability and cognitive impairments of patients. We use these to pursue three questions: Firstly; to what extent are there systematic variations between nursing homes as to the level of care given to individuals with presumably similar needs. Secondly, can nursing-home level variations be explained by structural nursing home characteristics? And thirdly, how are need-related variables at individual level related to differences in the level of care given?

Institutional setting and study area

In Norway LTC is an integral part of the welfare system, and is provided in a predominantly public and tax based health care system. Approximately 14 percent of the population 80 years or older live in nursing homes [10]. In the Nordic tradition responsibility for long-term-care is devolved to multi-purpose local authorities. These will both finance and operate LTC services, with some financial contribution from service recipients. There are no national standards (norms) for long term care, and gross per capita expenditure varies substantially between municipalities [10]. While this in part will reflect differences in demographical composition, variations are also likely to be the result of differences in both municipal income and local political prioritizing. Differences in expenditure (costs per capita) will be due to differences in access (recipients per capita) or the amount of care given (costs per case). To avoid confusing different levels of care with different prioritization between local authorities we have limited our analyses to nursing homes in one municipality; the city of Trondheim with 180.000 inhabitants. At the time of the study the municipality had 197 beds per 1000 person 80+, which was slightly above the national average at 193 [10].

Long term care may be provided at home or in an institution. The decision to admit an individual to a nursing home will be based on the municipality's assessment of their needs. In Trondheim the assessment is done by an independent office and patients are allocated to each nursing home based on the availability of beds. Thus a nursing home can not select its own case-mix. Individual patient-level data used in this analysis are from 2004; at that time all nursing homes in Trondheim were financed by global budgets based on the number of patients and wards, with no adjustment for case-mix. Thus a nursing home would receive a budget that would cover 3.9 full time equivalents (FTE) per ward and 0.5 FTE per resident. The cost of a FTE included the average cost of a man year plus substitutes at holidays and sick leaves. In addition costs of night-watch and administration were included in the budget. Other operating expenses were based on a rate per resident. Financial contributions from the nursing home residents were collected by the municipality and are not part of nursing home incomes. However, the financial contributions do partly finance the overall municipal budget for nursing home care. This model is still the most common model used for financing nursing homes in Norway. Notably Trondheim changed its financial model after the time study; nearly 45 percent of labour related costs are now distributed depending on differences in individual ADL and IADL disability and cognitive impairment.

Methods

Nursing home characteristics

The study includes 35 residential facilities. There are two types of residential facilities, "traditional" nursing homes and extra care sheltered housing. In extra care sheltered housing, residents live in facilities defined as their own private homes (paying their own rent) and receive care according to their assessed needs. Nursing and care services in both types of facilities are financed by global budgets, using the model described above. The level of care and nursing are considered as being equal in both facilities. There are some minor financial differences related to other operational expenses like energy, medicine and medical equipment. For the purpose of this analysis these are however not of any consequence. Ten of the residential facilities in the study were extra care sheltered housing. The average size of the sheltered housing was 16 residents (ranging from 6 to 29) compared to 41(ranging from 9 to 129) for nursing homes. In the reminder of the paper we use the term nursing home for both types of residential facilities, if not stated otherwise. Rehabilitation and post-acute facilities were not included in this study (Table 1).

Although long term care is a public responsibility, delivery may be by private non-profit organizations. In our material five of the 35 nursing homes are private, non-profit making organizations. These private nursing homes have contracts with the local authority and are obliged to deliver services at the same level of care and quality as in public nursing homes.

Several studies have investigated the significance of nursing home size on costs. Some findings indicate that there exists economics of scale, particularly for the smallest nursing homes [11]. Others have identified economic of scale up to 75–95 beds [12]. In this study size was measured as the inverse number of beds, thus allowing for possible non-linearity.

Some studies suggest a positive association between both staffing levels, numbers of licensed nurses and the quality of care in nursing homes [13]. In this analysis we include skill mix as a possible explanatory factor. While the total available amount of FTEs depends on the budget, the skill mix is under the discretion of each nursing home. Staff skill mix is characterized by two variables; the proportion of employees with health related *college/university*

Table 1 Characteristics of study sample, nursing homes (N = 35) and residents (N = 1204)

	Share% or average (sd)				
Nursing home level data:		Median	Minimum	Maximum	Quartile 25 -75
Extra care sheltered housing	29%				
Private ownership	14%				
Nursing home size; beds	34.4 (30.7)	25.0	6	129	17 – 36
Staff skill mix - average proportion;					
College/university degree	25% (10)	24%	8%	48%	16% - 31%
Upper secondary education	62% (13)	62%	27%	92%	51% - 70%
None health related education	14% (10)	12%	0%	56%	8% - 18%
Average case-mix; ADL - mobility	3.28 (0.43)	3.38	2.16	4.20	3.04 - 3.54
Residents level data:					
Age:					
<80	24%				
80-89	49%				
90+	27%				
Private care					
None	66%				
<3 hours	32%				
3 < hours	3%				
Disability score:		Score 1–1.9	Score 2–2.9	Score 3–3.9	Score 4-5
ADL	3.35 (1.12)	13.0%	24.1%	26.1%	36.8%
IADL	4.51 (0.70)	0.7%	2.7%	11.6%	85.1%
Cognitive impairment	3.43 (0.95)	7.0%	23.3%	34.4%	35.3%
Vision & hearing	1.82 (0.79)	52.5%	33.7%	11.5%	2.2%
Diagnose:					
Dementia/Alzheimer	42%				
Stroke	17%				
Diabetes	8%				

Standard deviation-sd.

degree and the proportion of employees with a health related *upper secondary education.* A third group, employees with no health related education serves as a reference category.

Case-mix was measured as average ADL-disability score (see definition below) for all patients in each nursing home.

Patient level data

We utilised a standardised national registration system (IPLOS) [14] that describes patient needs, and combined this with a detailed time study of 1204 residents in the 35 nursing homes and extra care sheltered housing facilities.

The time study

The time study was performed by employees in the municipality of Trondheim in 2004. Nursing home staff were asked to register only direct face to face time spent with patients according to 16 different categories. To ensure reliability all of the personnel who were to register data were trained by a team from the municipality prior to the registration. The training had both a theoretical and a practical part. The training team was available for questions during the registration period. The registration was done by personnel responsible for the patients' daily care. Direct care time for the all the staff was registered. Two members of staff on each ward were responsible for the registration, and did this together with the personnel responsible for the patient. Time spent by the attending doctor is not included, on average this constituted about 0.2 hours per patient per week included time to administration (personal communication with the chief doctor). For the purpose of this analysis we have grouped the 16 registration categories into five separate main categories; personal care,

assistance with meals, communication, medical care and other care (Table 2). While our main focus is on variations in and determinants of total individual care, all analyses have also been done separately on personal care and assistance with meals, which were the two largest categories. The average amount of individual care was 14.8 hours per week, with a standard deviation of 6.9. In nursing homes the average amount of individual care was 14.5 hours per week, with a standard deviation of 6.4. In sheltered housing the average amount of individual care was 17.6 hours per week, with a standard deviation of 9.8.

Disability data

IPLOS has several similarities with the Canadian SMAF [15]. IPLOS characterizes patient dependencies using 17 variables. We have grouped these 17 variables into four groups based on a factor analysis (see Additional file 1). Activities of Daily Living - *ADL* (including mobility) comprise personal hygiene, dressing, eating, ease of using the toilet, indoor and outdoor mobility. Instrumental Activities of Daily Living - *IADL* contains shopping, house-keeping and cooking. *Cognitive impairment* (including behavioural impairment) contains memory, communication, social interaction, daily decision taking, maintaining ones' own health and behavioural control. The final group contains *sight and hearing.* In IPLOS patients are described on a scale from one to five. Score one indicates no disability. Score two indicates some difficulties performing the task or performing it with reduced quality, but without need for assistance. Score three or higher indicates an increased need for care. In nursing home settings patients do not perform all tasks even if they are capable of doing so. This especially concern IADL tasks. All patients were scored according to their potential capacity to perform the tasks.

We also included additional individual characteristics. Three age groups were used; below 80 years, between 80 to 89 years and 90 years or older. Diagnosis was registered for each patient according to ICPC code. The most frequently occurring diagnoses were *Dementia/Alzheimer*, *Stroke* and *Diabetes.* We also included the amount of informal care a patient received. The data from the municipality enabled us to separate between patients with no informal care, less than 3 hours per week and more than 3 hours per week. All data was provided by the municipality (Table 2).

Analytical methods

The 17 variables were sorted into four groups based on a factor analysis. Principal axis factoring (PAF) was used as the extraction method [16]. Kaizers normalization with cut-off at eigenvalues equal 1 was used together with a scree plot and parallel analysis to decide the number of factors to retain. Oblique rotation was used as rotation method (direct oblim with $\delta = 0$). The results are shown in the Additional file 1. In the regression analysis a multilevel approach with random intercept was used. This allows us to determine to what extent variation in individual care is due to nursing home factors and to what extent it is due to individual characteristics. We do not use random slopes, thus the marginal effect of individual level variables is assumed to be equal across nursing homes, although the *level* of care may differ. Because of skewed distribution

Table 2 Distribution of individual care, hours per week, standard deviation (sd)

Activity	Share	Grouped activity (share)	Average hours per week (sd)
Get out of bed - morning	16.4%	Personal care (48%)	7.1 (4.2)
Go to bed - evening	10.9%		
Resting – (in/out of bed. etc.)	5.7%		
Shower. bath	3.8%		
Toilet	10.9%		
Eat breakfast	6.9%	Assistance with meals (27%)	4.0 (2.9)
Eat dinner	7.6%		
Have a cup of coffee or tea	5.6%		
Eat supper	6.7%		
Conversation with residents	10.6%	Communication (12%)	1.8 (1.9)
Dialogue with relatives	1.6%		
Administrating Medication	5.7%	Medical care (8%)	1.2 (0.9)
Prepare pill dispenser/medication	2.2%		
Cooperation with doctor	0.4%		
Extra attention at night. dentist. hairdresser. pedicure etc.	4.9%	Other care (5%)	0.7 (1.4)
Sum	100%	Individual care (100%)	14.8 (6.9)

a natural logarithm was used to achieve an approximately normal distribution. We did separate analyses for the total individual care, personal care and assistance during meals. Three models were estimated. Model (1) is an empty model without any explanatory variables included.

$$\text{In } y_{ij} = \gamma + \mathrm{u_j} + \mathrm{r_{ij}} \quad (1)$$

Where:

In y_{ij} – Individual care for a person i at nursing home j, measured as logarithm number of hours per week.

γ – The grand mean of In y_{ij}

$\mathrm{u_j}$ – A nursing home specific effect, treated as a random effect assumed to be normally distributed with constant variance τ_0

$\mathrm{r_{ij}}$ – Individual error term assumed to be normally distributed with constant variance σ^2

The share of variation in care at nursing home level, as measured by the Intraclass correlation coefficient (ICC), shows the amount of variation between nursing homes as a proportion of the total variation.

$$\mathrm{ICC} = \frac{\tau_0}{(\sigma^2 + \tau_0)} \quad (2)$$

In model 2 explanatory factors at the nursing home level where added.

$$\text{In } y_{ij} = \gamma + \sum_{h=1}^{H} \delta_h x_{hj} + \mathrm{u_{0j}} + \mathrm{r_{ij}} \quad (3)$$

x_{hj} – A set of H nursing home variables, this is fixed effects.

In model 3 individual variables were added.

$$\text{In } y_{ij} = \gamma + \sum_{h=1}^{H} \delta_h x_{hj} + \sum_{m=1}^{M} \theta_m x_{mji} + \sum_{m=1}^{M} \sum_{r=1}^{M} \theta_{mm} x_{mji} x_{rji} + \sum_{l=1}^{L} \beta_l x_{lji} + u_{0j} \quad (4)$$

x_m and x_r – A set of M individual disability variables. We use a specification that allows interaction between individual variables.

x_l – A set of L other individual variables.

For a continuous variable the estimated value $\hat{\theta}_m$ has an interpretation as percentage increase in y with one unit increase in x_m. For categorical dummy variables we have used Kennedy's approximation to adjust for bias [17]; $\left(\hat{\beta}'\right) = \left(e^{\hat{\beta} - \frac{1}{2}V\left(\hat{\beta}\right)} - 1\right)$, where $V\left(\hat{\beta}\right)$, is the variance to the estimated $\hat{\beta}$. It is simple and has shown to be very close to exact unbiased estimates [18]. The interpretation of the Kennedy's approximation is percentage increase in y for a change in the categorical variable. For the disability variables note that the marginal effects include interaction effects and hence depends on the level (score) of the variables.

The model was estimated using the restricted maximum likelihood method, assuming an unstructured covariance matrix, using Stata version 12.1.

The study was approved by the Regional Committee for Medical and Health Research Ethics (REK) and the Ombudsman for Research at the Norwegian Social Science Data Services (NSD).

Results

Total individual care constituted about 60 percent of the available staff hours in our study and the average patient received 14.8 hours individual care per week. The results from estimation of Equation 1, 2, 3, 4) are shown in Table 3.

We see from Figure 1 that there is a substantial variation in individual care both between and within nursing homes. The Intraclass correlation coefficient shows that variations between nursing homes account for 24 percent of the total variation between individuals (Table 3). However, when we analyse the different categories of care time separately, we see that only 13.7 percent of the variation in "personal care" can be attributed to differences at nursing home level. For assistance during meals the variation was 25.5 percent.

When nursing home characteristics were included, the variation at nursing home level was only marginally reduced, with the ICC for individual care now at 22.1 percent.

Nursing home variables

Nearly one fourth (24%) of total variation can be attributed to the nursing home level. Of the structural nursing home variables size, ownership and average case mix are significantly associated with total amount of care given. The association between size and care is negative, implying that patients, other things equal, receive less care in larger facilities. The relationship is, however, non-linear and strongest for the smallest nursing homes. The size-effect was particularly evident for assistance with meals.

The effect of ownership is positive, with patients in private, non-profit institutions receiving 30 percent more individual care than those in public nursing homes.

There is a positive association between average case-mix in a nursing home and the amount of care provided. A tenth of a unit increase in the average case-mix decreases the average amount of direct individual care for patients with about three percent. On average this constitutes about 25 min per week per patient. The 25th and 75th percentile case mix was at 3.04 and 3.54. Staff skill mix was not associated with amount of care given.

Individual level variables

There is an association between all of the four grouped disability/impairment variables and the total amount of

Table 3 Results of multilevel regression analysis of individual care time in nursing homes

	(Total) individual care	Personal care	Assistance with meals
Model 1:			
Variance-nursing home level $\hat{\tau}_0$	0.064 (0.037-0.110)	0.075 (0.042-0.137)	0.142 (0.082-0.246)
Variance-individual level $\hat{\sigma}^2$	0.204 (0.188-0.221)	0.475 (0.438-0.516)	0.414 (0.382-0.450)
ICC	24.0%	13.7%	25.5%
Model 2:			
Variance-nursing home level $\hat{\tau}_0$	0.058 (0.032-0.106)	0.061 (0.031-0.122)	0.113 (0.060-0.215)
Variance-individual level $\hat{\sigma}^2$	0.204 (0.188-0.221)	0.476 (0.438-0.516)	0.414 (0.382-0.450)
ICC	22.1%	11.4%	21.4%
Model 3:			
Intercept $\hat{\gamma}$	0.31 (−0.70-1.33)	−3.39*** (−4.60- -2.18)	0.71 (−0.80-2.23)
Nursing home characteristics:			
Extra care sheltered housing $\hat{\delta}_1$ ($\hat{\delta}_1'$)	0.02 (0.02) (−0.14-0.18)	0.10 (0.10) (−0.10-0.31)	0.13 (0.13) (−0.12-0.38)
Private ownership $\hat{\delta}_2$ ($\hat{\delta}_2'$)	0.27** (0.30) (0.03-0.52)	0.21 (0.23) (−0.05-0.47)	0.04 (0.03) (−0.31-0.39)
Nursing home size $\hat{\delta}_3$	2.73** (0.04-5.42)	1.13 (−1.92-4.18)	6.09** (2.14-10.03)
College/university degree $\hat{\delta}_4$ ($\hat{\delta}_4'$)	0.65 (0.66) (−0.41-1.71)	0.72 (0.74) (−0.41-1.85)	−0.23 (−0.41) (−1.74-1.29)
Upper secondary education $\hat{\delta}_5$ ($\hat{\delta}_5'$)	0.24 (0.16) (−0.60-1.08)	0.45 (0.41) (−0.44-1.33)	−0.51 (−0.50) (−1.69-0.68)
Case mix $\hat{\delta}_6$	−0.29** (−0.49- -0.09)	−0.16 (−0.38-0.06)	−0.25* (−0.54-0.05)
Individual characteristics:			
ADL-disability $\hat{\theta}_1$	0.73*** (0.56-0.90)	1.95*** (1.69-2.21)	−0.23 (−0.52-0.06)
IADL-disability $\hat{\theta}_2$	0.31*** (0.18-0.44)	0.64*** (0.44-0.85)	0.15 (−0.08-0.39)
Cognitive impairment $\hat{\theta}_3$	0.47*** (0.31-0.64)	0.21* (−0.04-0.47)	0.46** (0.17-0.74)
Vision and hearing V&H $\hat{\theta}_4$	−0.28** (−0.45- -0.10)	−0.41** (−0.67- -0.15)	−0.20 (−0.50-0.10)
ADL -IADL $\hat{\theta}_{12}$	−0.08*** (−0.12- -0.04)	−0.26*** (−0.32- -0.21)	0.01 (−0.05-0.08)
ADL - Cognitive $\hat{\theta}_{13}$	−0.04*** (−0.07- -0.02)	−0.07*** (−0.11- -0.04)	0.06** (0.01-0.10)
ADL -V&H $\hat{\theta}_{14}$	0.02 (−0.01-0.05)	−0.03 (−0.07-0.01)	0.10*** (0.06-0.15)
IADL-Cognitive $\hat{\theta}_{23}$	−0.06** (−0.09- -0.02)	0.00 (−0.06-0.05)	−0.06* (−0.12-0.01)
IADL-V&H $\hat{\theta}_{24}$	0.07** (0.02-0.12)	0.10** (0.03-0.18)	0.06 (−0.02-0.15)
Cognitive-V&H $\hat{\theta}_{34}$	−0.03 (−0.06-0.01)	0.01 (−0.04-0.06)	−0.13*** (−0.18- -0.07)
Dementia/Alzheimer $\hat{\beta}_{31}$ ($\hat{\beta}_{31}'$)	0.03 (0.03) (−0.02-0.07)	0.06** (0.07) (0.00-0.13)	−0.02 (−0.02) (−0.09-0.05)
Stroke $\hat{\beta}_{32}$ ($\hat{\beta}_{32}'$)	0.01 (0.01) (−0.04-0.06)	0.09** (0.09) (0.01-0.16)	−0.10** (−0.10) (−0.18- -0.02)
Diabetes $\hat{\beta}_{33}$ ($\hat{\beta}_{33}'$)	0.05 (0.05) (−0.01-0.12)	0.01 (0.01) (−0.08-0.11)	0.00 (0.00) (−0.11-0.10)
Private care <3 hours $\hat{\beta}_{21}$	0.02 (0.02) (−0.03-0.07)	0.01 (0.01) (−0.06-0.08)	−0.09** (−0.09) (−0.18- -0.01)
Private care 3 < hours $\hat{\beta}_{22}$ ($\hat{\beta}_{22}'$)	0.17** (0.18) (0.05-0.28)	0.01 (0.00) (−0.16-0.18)	0.22** (0.24) (0.02-0.41)
age 80–89 $\hat{\beta}_{11}$ ($\hat{\beta}_{11}'$)	−0.04 (−0.04) (−0.08-0.01)	−0.01 (−0.01) (−0.08-0.05)	0.02 (0.02) (−0.05-0.10)
age above 90 $\hat{\beta}_{12}$ ($\hat{\beta}_{12}'$)	−0.04 (−0.04) (−0.10-0.01)	0.02 (0.02) (−0.06-0.09)	0.00 (0.00) (−0.08-0.09)
Model fit Statistics:			
Restricted log. Likelihood Model 3	−339.8	−750.8	−900.4

Estimated values are expressed with ^.
***p ≤ 0.001 **p ≤ 0.05 *p ≤ 0.1 (95% Confidence Interval).

individual care given. There was a significant direct marginal effect of ADL-disability, IADL-disability and cognitive impairment. (For simplicity we use "ADL" and "IADL" for ADL-/IADL-disability for the remainder of the discussion.) Due to interaction effects among the disability/impairment variables, marginal effects will vary depending on the scores for the different variables. The calculated marginal effects will be most accurate around average scores and for the most frequent combination of scores. The relevant ranges in our material are quite narrow for IADL (high values) and

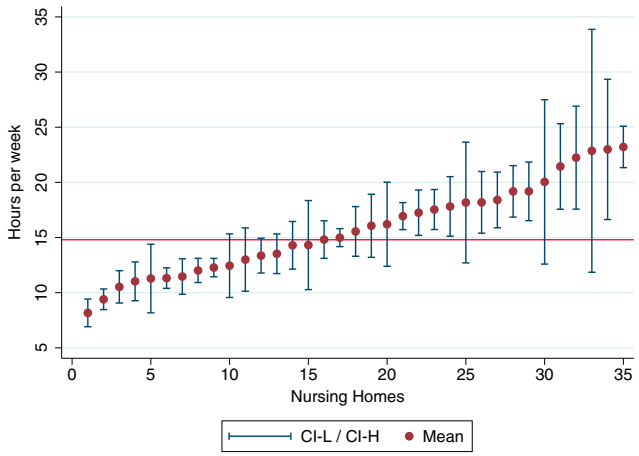

Figure 1 Variation in individual care. Mean and 95% confidence interval for each nursing home, Total average = 14.8

sight and hearing (low values) (see Table 1). In evaluating marginal effects of the ADL, IADL and cognitive variables, the average score for sight and hearing is used.

There were negative interaction effects among ADL, IADL and cognitive impairment on the amount of individual care given.

For the average patient the marginal effect of one point increase in ADL was 27 percent [i.e.: 0.73 – (0.08 × 4.51) – (0.04 × 3.43) + (0.02 × 1.82)]. For the majority of patient cases the marginal effect of ADL lies between 17–35 percent.

For the average patient the marginal effect of one point increase in IADL was minus 4 percent. The marginal effect of one point increase in IADL is positive for values of ADL and cognitive impairment below the average, and negative for ADL and cognitive impairment values at the average or higher. For the majority of patient cases the marginal effect of IADL lies between 16 and minus 26 percent.

For the average patient the marginal effect of one point increase in cognitive impairment was 1.1 percent. The marginal effect point increase in cognitive impairment is positive in the majority of patient cases, but for the most severe it is negative. For the relevant ranges, the marginal effect of cognitive impairment lies between 15 and minus 8 percent.

In the relevant ranges of scores, the marginal effect of sight and hearing is close to zero or negative.

The results for personal care resemble the result for total individual care. However, the marginal effect of ADL is almost twice the size evaluated at average disability scores. Furthermore, the interaction effect between ADL and IADL is much stronger whilst there is no interaction effect between IADL and cognitive impairment.

The results for assistance with meals show positive marginal effects for ADL, IADL and cognitive impairment for most relevant ranges of disability scores, in the range of about 10–20 percent for average scores. The marginal effect of IADL is smallest, and close to zero for high values for cognitive impairment due to a negative interaction effect. The estimated effect of sight and hearing is close to zero for average disability scores. However, there are quite strong interaction effects with ADL (positive) and cognitive impairment (negative).

None of the diagnostic variables influenced the *total* individual care patients received, when disability levels were adjusted for. A positive association was found between Dementia/Alzheimer and stroke diagnoses and the amount of personal care given. Those with dementia/Alzheimer and stroke got respectively 7 and 9 percent more personal care. Those with stroke got 10 percent less assistance with meals.

Informal care was only significant for those receiving more than three hours informal care. Those who received more than three hours informal care also received more care from the nursing home staff. For assistance with meals, those who received less than three hours informal care received 9 percent less help from the nursing home staff, while those who received more than three hours informal care received 24 percent more help.

When all other factors are kept unchanged age did not influence the amount of individual care.

Discussion

As much as 24 percent of the variation in individual care was found to be at nursing home level. We are not aware of similar studies in public settings, but one US study found that variation between nursing homes accounted for 29–37

percent of the total variation between patients [19]. The implication of this finding is that the amount of care patients receive will critically depend on the nursing home they are admitted to. Remembering that these are nursing homes, within one municipality, in a public health care system where equity is a central goal, this result is surprising. Furthermore, only a small amount of nursing home variation was explained by our structural variables. The time registrations only covered face-to-face care given and not time spent in group activities. Some of the nursing homes may prioritize group activities and this could explain some of the variation. A second explanation could be differences in efficiency. Such differences could be related to differences in management style, management capacity or culture, but also due to physical limitations due to building structures and patient logistics. Neither of these variables are, unfortunately, observed (or observable) in this study.

The core of nursing home production is compensation for disability or poor health. Our results show that the amount of care given to a patient, other things equal, will depend on the case mix of the nursing home; in other words on the level of disability of all other patients at the same nursing home. We interpret this as a consequence of a financial model where there is no compensation for case-mix and differences in the need for care. As average case-mix increase nursing homes respond by lowering the level of care for all users. Thus a financial model that does not take variation in needs for individual assistance into account could lead to a situation whereby patients with the same needs, receive different levels of care. It should also be noted that the municipality of Trondheim changed their reimbursement model based of the findings of the time study. What we found correlates to some extent with other findings from Canada. By using SMAF in nursing homes it was found that nursing home funding based on the number of beds has some major obstacles. Firstly, the increased level of disability among the patients in nursing homes over time was not taken into account in the budgets. Secondly, there were large differences between nursing homes in actual budgets compared to the needs of the patients [20].

We did find some variation between nursing homes related to structural factors. Nursing home size was negatively associated with the amount of individual care given, especially related to assistance with meals. This could also be related to constructional factors. Larger nursing homes do often have larger dining rooms, which could be more effective for the employees. A higher individual personal care level was also found for patients at private owned nursing homes. The time registrations only covered direct face-to-face care performance and not time spent in group activities. Some of the nursing homes may prioritize group activities, and this could explain some of the variation. Another explanation could be differences in efficiency. A study from Switzerland found that non-profit owned nursing home could be more cost effective than public owned nursing homes [21]. Data from our study gave no opportunity to compare differences in efficiency.

The patients ADL score is a strong explanatory factors for variations in individual care within nursing homes [22-24]. Our study also shows that the patients ADL-disability was the strongest predictor for use of resources. Other studies have indicated that cognitive impairment affects resource use indirectly through ADL [25,26], but in our study cognitive impairment had a separate direct effect on the amount of care. We also found that both IADL and sight and hearing had a significant association with provided care. IADL measures activities that are considered to be important for living independently in the community [5]. Therefore measurement of IADL is often left out in nursing home settings. Our results would indicate that IADL measures provide valuable information also in nursing homes. This is in line with other studies where activities related to IADL accounted for about 16% of the total time in nursing homes [27]. Thus our results suggest that excluding IADL may result in a loss of information regarding variation in care provided to nursing home patients. There seems to be substantial interaction effects between the different disability variables. It was only for ADL that the marginal effect was positive for all ranges of disability scores.

The marginal effect of cognitive impairment was positive for low values of ADL or IADL and negative for high values. The development of dementia is often connected with challenging behaviour. Challenging behaviour is more demanding when patients have a high physical ability. Also loss of cognitive functioning probably means that the patient becomes less able to perform ADL activities. Whether the negative marginal effect for patients with most severe physical disability is related to unmet needs e.g. due to problems with expressing their needs and wishes, or a natural reduction in need for care time is uncertain. We do not find such a negative interaction effect for assistance with meals.

The marginal effect of IADL was positive for low values of ADL and cognitive impairment, and was negative for high values of ADL and cognitive impairment. One possible interpretation is that worsening IADL implies that it takes more time to assist patients to perform activities when they are relatively well functioning. When disabilities are severe the patient is less capable of participating in performing activities and it is less time consuming for care personnel to perform the activity without the participation of the severe disabled elderly. Another explanation for the inverse relationship between care and some levels of disability may be differential levels of movement restriction including differing levels of medication.

The complex relationships between disability dimensions and direct care time is illustrated both by the significant

interaction effects among disability variables and by the differences in results for different types of care.

We found no evidence that patient diagnoses affected the total amount of care given. Thus disability seems to be a better predictor of care received than diagnoses. This could imply that diagnoses are too crude a measure to capture need. Diagnosis is measured as yes/no, while the degree of disability resulting from a diagnosis could vary substantially. It is often the degree of disability that is compensated for by nursing home care.

In an analysis excluding disability measurements (not shown, available on request) both Dementia/Alzheimer and Stroke became significant explanatory factors for individual care. This is not a new finding. Earlier studies of nursing home admissions have found that the effect of diagnosis weakens or becomes insignificant when disability is introduces as a factor [28]. Even if disabilities were a better predictor for the amount of care given, ignoring diagnosis could lead to overlooking some important explanatory factors. When we analysed personal care separately we found that both Dementia/Alzheimer and Stroke add some explanatory effect which was not captured in the disability measure. We found that patients with stroke got more assistance with personal care and less assistance during meals than patients with other diagnoses. Stroke patients often have a one-side paralysis. This could imply that stroke patients are often capable of eating by themselves, but need help with personal care, such as help to get dressed.

Studies on LTC focusing on home care recipients have found that informal care may be a substitute for public care [29]. We find that patients who received more than three hours informal care also received more nursing home care, thus informal care seems to be complementary rather than substitute to public care. One possible explanation is that nursing homes are not able to provide the desirable level of care for all patients, and thus must depend on additional informal care. Another possible explanation is that relatives that spend a lot of time with the patients act as strong advocates.

A study from Finland found that patients over 75 years got about 40 minutes less direct care per week [22]. Our results show no strong systematic relationship between age and care levels.

There are caveats in this approach. The analysis was limited to variations in individual direct care. On average the share of time used for direct care was 60 percent. This leaves about 40 percent of the total labour costs out of the study. Dealing with non-individual time is a common obstacle in most time study in nursing home. This obstacle is often overcome by dividing the non-individual time equally between all of the patients [23]. Increasing the amount of hours each patient receives will not alter the results for individual need variables. Using data from only one municipality reduces the generality of the results. Expanding the data set would enable us to see whether the large share of nursing home variation is coincidental, or a common feature across municipalities. It would also enable us to test the robustness of the associations within a more diversified institutional setting. This should be a question for further research.

Conclusion

As much as 24% of the variation of individual care between patients could be explained by variation between nursing homes. Structural nursing home characteristics, however, only reduced the unexplained variation between nursing home minimally.

Our findings show that in a financial reimbursement model with no adjustment for case-mix, the amount of care patients receive does not solely depend on the patients own disability, but also on the disability level of all the other patients.

ADL disability was the strongest explanatory factors for use of resources in nursing homes. But also IADL and cognitive disability are important explanatory factors. Analysing different care components separately adds valuable information on the relationship between individual characteristics and the type of care provided to nursing home patients.

Additional file

Additional file 1: Results from the factor analysis: Eigenvalues from the initial solution with its explained variance. Eigenvalues from a parallel analysis. Factor loadings from the rotated pattern matrix and correlation between factors.

Abbreviations

ADL: Activities of daily living; IADL: Instrumental activities of daily living; IPLOS: Individuell Pleie og OmsorgsStatistikk (Norwegian). Individual nurse and care statistics.; Sd: standard deviation; SMAF: Système de Mesure de l'Autonomie Fonctionnelle (French). The functional autonomy measurement system.

Competing interests

The authors have no competing interests.

Authors' contributions

ØD carried out the statistical analysis. ØD, HG, JK, and JM prepared the manuscript. All authors read and approved the final manuscript.

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Author details

[1]Department of Public Health and General Practice, Norwegian University of Science and Technology, P.O. Box 8905 MTFS, N-7491 Trondheim, Norway. [2]Department of Health and Welfare Services, City of Trondheim, Trondheim, Norway. [3]SINTEF Health research, SINTEF Technology and Society, Trondheim, Norway.

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Paper II

Is not included due to copyright

Paper III

ORIGINAL RESEARCH

Physical disability and cognitive impairment among recipients of long-term care

Øystein Døhl *[1,2], Helge Garåsen[1,2], Jorid Kalseth[3], Jon Magnussen[1]

[1] Department of Public Health and General Practice, Faculty of Medicine, Norwegian University of Science and Technology, Trondheim, Norway
[2] Department of Health and Welfare Services, City of Trondheim, Norway
[3] Department of Health Research, SINTEF Technology and Society, Trondheim, Norway

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ABSTRACT

Background and objective: For practical policy purposes variables describing disability and impairment should be aggregated into broader factors. By using data from a Norwegian mandatory system the objective of this study was to analyse whether the number of factors describing the need for long-term care differs between recipients of home care and nursing home residents and according to the age or gender of long-term care recipients. The hierarchical order of the variables within each factor is determined to assess whether there are important informational gaps in the description of recipients.
Methods: Data are from a mandatory system characterizing all recipients of public long term care in Norway. Two groups of public care recipients were included: elderly (67 years and older) individuals receiving home care services (N = 2,493) and patients in nursing homes (N = 1,218). Exploratory factor analysis (EFA), Confirmatory factor analysis (CFA) and item response analysis (IRT) were used to determine the number of factors and the hierarchical structures of the variables.
Results: Two factors were sufficient to characterise need for both nursing home residents and home dwelling elderly. This result is not sensitive to stratification by age and gender. IRT analysis revealed large informational gaps suggesting that the used instrument fails to sufficiently capture important aspects of user needs.
Conclusions: Factorization suggests that all elderly long term care users can be adequately described along two dimensions; on reflecting physical disability and one reflecting cognitive impairment. However, both the number of factors and the variable contained in each factor are likely to depend on the instrument used to characterise LTC users. Large informational gaps suggest a need to supplement the national information system used in Norway.

Key Words: Elder care, Nursing home care, Disability, Long term care

1. INTRODUCTION

Using data from a mandatory system used to characterize individual users of long term care in Norway (the IPLOS-system), the objective of this article is to analyse whether the number of factors describing the need for long-term care differs between recipients of home care and nursing home residents. Furthermore whether there are differences between those aged 67-79 and those aged 80+, and also whether there are differences between men and women. Through this analysis we assess how variables describing physical disability and cognitive impairment can be grouped in broader factors for the purpose of financing and planning of long term care

*Correspondence: Øystein Døhl; Email: oystein.dohl@ntnu.no; Address: Department of Public Health and General Practice, Faculty of Medicine, Norwegian University of Science and Technology, Trondheim, Norway.

services. Finally we discuss the IPLOS system in terms of how well it describes the full spectrum of the variables that are important in the assessment of user needs.

Both disability and cognitive impairment have consistently been found to be strong predictors of the use of long-term care services.[1–5] Although the scores on a variety of separate variables are important for individual assessment and follow-up, some form of aggregation/grouping of variables is convenient if this information is to be used for planning purposes, financing or population-based resource allocation. This raises the question of how disability and impairment variables can be grouped together and also how many separate factors that are needed to sufficiently capture needs. What is also important, from a policy perspective, is whether the grouping of variables and the number of factors differ between different types of users.

Disability is commonly evaluated according to a range of functional capabilities, *e.g.*, activities of daily living (ADL), mobility and instrumental activities of daily living (IADL). Indeed, many of the available instruments use ADL/IADL variables to describe disability, most built on the works of Katz, Lawton and Barthel.[6–8] Cognitive impairment can be evaluated according to, *e.g.*, the Mini Mental State Examination (MME), the Cognitive Performance Scale (CPS) and diagnoses.[9,10] Some instruments also include variables that capture both disability and cognitive impairment, *e.g.*, The Functional Independence Measure (FIM), The Functional Autonomy Measurement System (SMAF) and The Activity Measure for Post-Acute Care (AM-PAC).[11–14]

There is a large literature that analyses how ADL, mobility and IADL variables can be aggregated into broader factors. The literature, however, is largely inconclusive, suggesting they may be grouped in from one to three unique factors.[15–17] One explanation for the conflicting results may be differences in the underlying set of variables that describe disability or cognitive impairment. Whereas ADL variables describe basic self-care activities and mobility, the IADL variable sub-domains are often less precisely defined.[18,19] Moreover, some instruments include variables that describe social factors and/or cognitive impairment under the IADL heading, and thus, the reason for not combining ADL and IADL into one common factor could be because the latter can include social[20,21] or cognitive variables.[14,17,22–25]

The number of factors needed to describe needs may also vary between different types of users, depending on setting (home care vs. nursing home), age or gender. Again, the literature provides conflicting results on this topic.[13,15,21,26,27]

In practical use, there will be a trade-off between an instrument that includes multiple variables and covers a wide spectrum of needs and a more parsimonious instrument that reduces the administrative burden.[19] Measures of ADL, mobility, IADL and cognitive impairment have been shown to vary in their ability to detect disability.[13,16,28–30] Thus, important variables may be missing in the instruments that are used ("gaps"), and the aggregated factors may consequently be less precise.

In Norway, the provision of public long-term care is decentralised to 428 municipalities. Since 2006 municipalities have been required to assess user needs using a standardised national registration system (IPLOS) that contains 15 variables describing physical disability and cognitive impairment.[31] While the primary purpose with IPLOS was to provide local and central authorities with information about long term care use and long term care users, the potential for using the system for financial purposes was also considered. Intentionally the idea was to link IPLOS to the Resident Assessment Instrument (RAI) and the Resource Utilization Groups system (RUG).[32–34] In the final version, however, the selected ADL variables had clear similarities with those used by Katz, Lawton and Barthel.[6–8] Characterisation of disability in IPLOS is based on the principles described by the World Health Organization's (WHO) classification of disabilities.[35] The IPLOS system is unique for Norway, the most similar system is the Canadian SMAF.[12] While IPLOS is now an established tool in the assessment of individual user need,[36] it is still rarely used by municipalities in aggregate planning, monitoring or financing of services.

2. METHODS

The data obtained covered all recipients of long term care aged 67 years or older in the municipality of Trondheim. The first group comprised 2,493 persons who received public home care (home-dwelling elderly). The second group consisted of 1,218 elderly who received long-term care in nursing homes (1,152 persons) or sheltered housing units (64 persons). Together, these two groups constitute approximately 18% of the elderly aged 67 years or older who lived in Trondheim at the time of the study. A quantitative cross-sectional design was used.

Data were collected during a four-week period in October 2012. Data are routinely registered for all individuals who receive public nursing home or home care services. We utilised the 15 variables (see Table 1) that described disabilities related to ADL (variables 1-4), mobility (variables 5-6), IADL (variables 7-9), and cognitive and behavioural impairment (variables 11-15). Variable 10, "maintaining one's own health", is similar to Lawton and Brody's original IADL variable "responsibility for own medications",[7]

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but it has a broader definition. It is not clear whether this expanded variable should be interpreted as an IADL or a cognitive variable. The 15 variables were scored using a five-point scale. Higher scores imply lower capability and scores of three or higher indicate the need for assistance. A score of one indicates no need for help, and a score of two indicates that the person is capable of performing the task but with difficulties. Scores are updated whenever the recipient's condition changes. The data contained no missing values. All personnel who registered the data had been licensed and trained by the municipality's authorisation program.[37] All recipients were scored according to their potential capacity to perform the tasks described in each variable.

Data analyses

Data were analysed using the following procedure. The datasets were randomly divided into two halves. First, the number of factors was established using exploratory factor analysis (EFA) on one half of the datasets.[38] Because data were ordinal, polychoric rather than Pearson correlation was used.[39] The number of factors to retain was determined based on combining the Kaizer criteria, a parallel analysis and a scree plot.[40] The parallel analyses were conducted with 50 randomisations. Variables were grouped into one factor if their factor loading was higher than 0.40.[40] Internal consistency was tested with Cronbach's alpha and was computed for each factor, based on the factors for which the variables showed the highest loading. Cronbach's alpha values above 0.70 were interpreted as good, and values above 0.90 were considered very good.[41]

Secondly the factorisations from the step 1 were tested by use of confirmatory factor analysis (CFA) on the other half of the sample. We used a Root Mean Square Error of Approximation (RMSEA) to test the covariance of the model against the covariance of the sample. As a measure of the residual correlation we used Standardized Root Mean Square Residual (SRMR). Chi squared tests which is often used could be inflated by high sample size, and a Comparative fit index (CFI) is considered as more prober for large samples.[40,42] CFI was used to compare the model with a more restrictive model assuming no covariance among the variables.[40,43,44] RMSEA should be as low as possible preferable below 0.06 and the upper 90% confidence interval should be 0.10 or below. SRMR should be as low as possible preferable 0.10 or below and the CFI should be close to 0.90 or higher.[16,40] We used both a maximum likelihood and quasi-maximum likelihood with robust standard errors procedure to correct for the effect of nonlinearity of the standard errors. The two methods produced nearly the same values. The results from the maximum likelihood are presented.

To determine the hierarchical order of the variables, we used item response theory (IRT). IRT analysis requires a dichotomy in the responses; thus, all recipients of care were categorised as either disabled (score 3 to 5) or non-disabled (score 1 or 2) for each variable. Both one-parameter logistic (1PL) and two-parameter logistic (2PL) IRT models were estimated. Our main interest was the parameter that describes variable (or item) difficulty, β (see Tables 2 and 3). This parameter measures, in standard deviations, the distance from the overall mean score (standardised) on the latent variable θ (disability/impairment) when the probabilities of scoring "need for help" (score 3-5) or "no need for help" (score 1-2) are equal (*i.e.*, 50%).[45,46] Thus, higher β values are associated with more difficult tasks (variables). There are no clear guidelines for the recommended size of the gaps between items, although some reports have suggested values between 0.15 and 0.30.[30,47,48]

The analyses were performed with SPSS version 21. IBM Corp. Armonk, NY. and Stata 13.1 StataCorp. College Station, TX.

The study was approved by the Regional Committee for Medical and Health Research Ethics (REK) and the Ombudsman for Research at the Norwegian Social Science Data Services (NSD).

3. RESULTS

3.1 Descriptive statistics

About 2/3 of elderly receiving home care and nearly 3/4 of elderly in nursing home were female (see Table 4). The average score of all 15 variables were 2.1 for home dwelling elderly and 3.5 for those living in nursing home.

The average score for each of the 15 disability/impairment variables was generally higher (indicating greater needs) for the elderly in nursing homes than for the home-dwelling elderly.

3.2 Dimensionality

Table 1 shows that the data were non-normal; thus, the use of polychoric correlation based on maximum likelihood may lead to biased estimates. Still, polychoric correlation is often preferred for ordinal data.[49] Because of the correlations between the factors, an oblique rotation was used in the EFA (direct oblim with $\delta = 0$).[50,51] Estimated factor loadings are shown in Tables 5-7.

The EFA indicated that the 15 variables could be grouped into two factors for both the home-dwelling elderly and the elderly who lived in nursing homes. For both groups, the eigenvalue for a third factor was below Kaizer's eigenvalue criteria, at 0.34 and 0.67, respectively. A two-factor model

was supported by both the parallel analysis and the scree plots (not presented here). For both groups, the first factor consisted of disability variables (ADL, mobility and IADL) and the second of cognitive and behavioural variables. For the elderly individuals who lived at home, the variable "shopping" demonstrated loadings above the threshold of 0.40 on both factors, it also had high loadings on both factors for those who lived in nursing homes. The results from the EFA analysis for home dwelling elderly and nursing home residents related to age and gender is in Tables 6 and 7. Due to small sample sizes it was not possible to do an age-group or gender-specific CFA on the nursing home residents. However for the home dwelling elderly results were nearly identical for the two age groups as well as for men and women. These results are shown in Table 3.

Table 1. Characteristics of the study sample, share of recipient who score 1 and 2 and share of recipient who score 3, 4 and 5,with the average score and 95% confidence interval (C.I.). Home care (N = 2,493) and nursing home residents (N = 1,218)

	Home-dwelling elderly			Nursing home residents		
	Score 1-2	Score 3-5	Mean score (C.I.)	Score 1-2	Score 3-5	Mean score (C.I.)
1 Eating	96%	4%	1.16 (1.14-1.18)	62%	38%	2.12 (2.05-2.19)
2 Dressing	61%	39%	2.01 (1.96-2.05)	11%	89%	3.72 (3.66-3.78)
3 Personal hygiene	40%	60%	2.44 (2.40-2.48)	2%	98%	4.00 (3.95-4.05)
4 Using the toilet	81%	19%	1.61 (1.57-1.65)	25%	75%	3.36 (3.29-3.44)
5 Indoor mobility	83%	17%	1.87 (1.83-1.90)	37%	63%	3.07 (2.99-3.15)
6 Outdoor mobility	51%	49%	2.55 (2.51-2.60)	10%	90%	4.03 (3.97-4.09)
7 Cooking	51%	49%	2.33 (2.28-2.38)	1%	99%	4.50 (4.46-4.55)
8 Shopping	29%	71%	2.82 (2.78-2.87)	1%	99%	4.53 (4.49-4.57)
9 House keeping	11%	89%	3.40 (3.37-3.44)	0%	100%	4.72 (4.68-4.75)
10 Maintaining own health	15%	85%	2.93 (2.90-2.96)	1%	99%	4.24 (4.20-4.28)
11 Communication	94%	6%	1.23 (1.20-1.25)	54%	46%	2.41 (2.34-2.47)
12 Social interaction	67%	33%	1.84 (1.81-1.88)	19%	81%	3.13 (3.08-3.19)
13 Daily decision making	74%	26%	1.76 (1.72-1.80)	9%	91%	3.77 (3.72-3.83)
14 Memory	77%	23%	1.74 (1.70-1.77)	17%	83%	3.43 (3.37-3.49)
15 Behavioural control	96%	4%	1.14 (1.13-1.16)	58%	42%	2.20 (2.13-2.27)

Table 2. Confirmatory factor analysis on one half of the sample of home dwelling elderly and nursing home residents

	Home dwelling elderly		Nursing homes patients	
Fit statistics				
RMSEA	0.09 (0.08-0.09)*		0.14 (0.13-0.15)*	
CFI	0.83		0.81	
SRMR	0.06		0.10	
Covariance	1	2	1	2
1	1		1	
2	0.56	1	0.59	1

*90% confidence interval

Cronbach's alpha values were between 0.79 and 0.94, thus all but one was well above the recommended level of 0.70.

The results from the CFA analysis partly confirmed the results from the EFA analysis. For the home dwelling elderly both the RMSEA and SRMR results supported the two factor model. For the nursing-home residents the CFA results did not clearly support the two factor model from the EFA analyses. However, the covariance between the two factors was 0.59, and a CFA testing whether a composite (one-factor) model gave an even poorer fit (results not shown).

3.3 Hierarchical ordering of the variables and gaps

IRT analysis was conducted separately for each of the factors. Because the differences between the 1PL and 2PL models were negligible, only the 1PL results are presented (see Table 8).

For both groups of elderly, "housekeeping" was found to be the most difficult disability task, whereas "eating" was the least difficult. For the cognitive variables, "maintaining own health" was the most difficult, whereas "behavioural control" was the least difficult task. Generally, all variables were relatively more difficult for those who lived in nursing homes than for the home-dwelling elderly.

Table 3. Confirmatory factor analysis of home dwelling elderly, according to gender and age

	Female		Male		67-79		80+	
RMSEA	0.10 (0.09-0.10)*		0.12 (0.11-0.12)*		0.12 (0.11-0.12)*		0.09 (0.09-0.10)*	
CFI	0.88		0.86		0.86		0.89	
SRMR	0.07		0.07		0.07		0.06	
Covariance	1	2	1	2	1	2	1	2
1	1		1		1		1	
2	0.58	1	0.66	1	0.61	1	0.58	1

*90% confidence interval

Table 4. Descriptive statistics of recipients

	Home dwelling (N = 2,493)	Nursing homes (N = 1,218)
Percentage Men	34%	27%
Percentage age 67-79	28%	22%*
Average score 15 items	2.1	3.5
Men	2.1	3.5
Women	2.0	3.6
67-79	2.1	3.6
80+	2.0	3.5

*Some recipients in nursing homes might be below 67 years old

Large differences between the item difficulty parameters (β) identified areas in which the IPLOS instrument could be said to lack precision. For the home-dwelling elderly, there were larger gaps than recommended at both ends of the disability scale. For patients in nursing homes, there were smaller gaps between the most difficult variables but larger gaps between the moderately difficult variables.

4. Discussion

Grouping users of long-term care according to their needs is useful for policy makers for planning, financing and monitoring purposes. With a variety of available instruments that describe disability and cognitive impairments the literature is inconclusive as for how such a grouping should be done. Our analyses are based on the Norwegian IPLOS system, but the challenges in long term care facing policy makers are similar in other countries, thus we believe that our comparison of recipients of home care and nursing home provide insight beyond a specific Norwegian setting.

Table 5. EFA results-Eigenvalues, factor loadingsa from the pattern matrix and Cronbach's alpha values from home-dwelling elderly and nursing home residents

Factors	Home-dwelling elderly		Nursing home residents	
	1	2	1	2
Eigenvalues	8.08	1.70	8.06	1.91
Eigenvalues from parallel analysis	1.13	1.10	1.19	1.15
1 Eating	**0.48**	0.32	**0.54**	0.33
2 Dressing	**0.82**	0.09	**0.86**	0.11
3 Personal hygiene	**0.76**	0.18	**0.70**	0.32
4 Using the toilet	**0.81**	0.06	**0.83**	0.10
5 Indoor mobility	**0.96**	-0.24	**0.95**	-0.24
6 Outdoor mobility	**0.90**	-0.11	**0.91**	-0.14
7 Cooking	**0.64**	0.34	**0.60**	0.34
8 Housekeeping	**0.72**	0.17	**0.71**	0.17
9 Shopping	**0.56**	**0.42**	0.37	**0.54**
10 Maintaining own health	0.18	**0.67**	0.19	**0.72**
11 Communication	0.18	**0.59**	0.15	**0.65**
12 Social interaction	0.20	**0.60**	0.19	**0.61**
13 Daily decision taking	-0.01	**0.91**	0.02	**0.88**
14 Memory	-0.12	**0.86**	-0.16	**0.86**
15 Behavioural control	0.05	**0.63**	-0.11	**0.66**
Cronbach's alpha†	0.91	0.79	0.90	0.85

* Loadings > 0.40 are marked with boldface; † The Cronbach's alpha was computed within each factor based on the boldface variables.

Table 6. EFA results-Eigenvalues, factor loadingsa from the pattern matrix values from home-dwelling elderly, above and below 80 years old, female and male

Factors	67-79		80+		Female		Male	
	1	2	1	2	1	2	1	2
Eigenvalues	8.58	1.86	7.86	1.64	7.86	1.75	8.55	1.70
1 Eating	**0.49**	0.34	**0.47**	0.29	**0.44**	0.34	**0.55**	0.30
2 Dressing	**0.83**	0.13	**0.82**	0.06	**0.84**	0.03	**0.79**	0.17
3 Personal hygiene	**0.77**	0.22	**0.76**	0.15	**0.77**	0.14	**0.74**	0.24
4 Using the toilet	**0.86**	0.04	**0.79**	0.05	**0.83**	0.02	**0.79**	0.09
5 Indoor mobility	**1.00**	-0.21	**0.93**	-0.25	**0.94**	-0.23	**1.00**	-0.24
6 Outdoor mobility	**0.96**	-0.16	**0.87**	-0.08	**0.87**	-0.07	**0.95**	-0.14
7 Cooking	**0.66**	0.35	**0.64**	0.32	**0.67**	0.31	**0.61**	0.37
8 Housekeeping	**0.74**	0.18	**0.72**	0.15	**0.75**	0.12	**0.69**	0.22
9 Shopping	**0.57**	**0.42**	**0.56**	**0.42**	**0.54**	**0.42**	**0.57**	**0.44**
10 Maintaining own health	0.12	**0.71**	0.23	**0.64**	0.18	**0.67**	0.20	**0.66**
11 Communication	0.22	**0.60**	0.17	**0.58**	0.15	**0.61**	0.24	**0.54**
12 Social interaction	0.19	**0.65**	0.21	**0.57**	0.22	**0.55**	0.16	**0.70**
13 Daily decision taking	-0.03	**0.95**	0.02	**0.89**	-0.02	**0.92**	0.02	**0.90**
14 Memory	-0.11	**0.83**	-0.13	**0.90**	-0.11	**0.87**	-0.13	**0.84**
15 Behavioural control	0.02	**0.68**	0.07	**0.60**	0.09	**0.58**	-0.02	**0.71**

* Loadings > 0.40 are marked with boldface

Table 7. EFA results-Eigenvalues, factor loadingsa from the pattern matrix values from nursing home residents, above and below 80 years old, female and male

Factors	67-79		80+		Female		Male	
	1	2	1	2	1	2	1	2
Eigenvalues	8.31	2.17	10.42	1.25	7.99	1.94	8.12	1.86
1 Eating	**0.61**	0.32	0.39	**0.50**	**0.55**	0.35	**0.52**	0.28
2 Dressing	**0.84**	0.15	0.22	**0.77**	**0.87**	0.09	**0.82**	0.17
3 Personal hygiene	**0.73**	0.34	0.40	**0.61**	**0.72**	0.29	**0.63**	**0.42**
4 Using the toilet	**0.86**	0.09	0.22	**0.76**	**0.83**	0.10	**0.82**	0.12
5 Indoor mobility	**1.03**	-0.30	-0.21	**1.00**	**0.94**	-0.23	**0.97**	-0.26
6 Outdoor mobility	**0.93**	-0.11	-0.01	**0.89**	**0.91**	-0.16	**0.90**	-0.08
7 Cooking	**0.66**	0.35	**0.54**	**0.47**	**0.63**	0.31	**0.54**	0.43
8 Housekeeping	**0.77**	0.13	**0.44**	**0.54**	**0.74**	0.14	**0.59**	0.28
9 Shopping	**0.48**	**0.51**	**0.71**	0.28	0.38	**0.51**	0.38	**0.57**
10 Maintaining own health	0.28	**0.67**	**0.80**	0.13	0.22	**0.69**	0.11	**0.80**
11 Communication	0.10	**0.72**	**0.69**	0.17	0.18	**0.65**	0.10	**0.68**
12 Social interaction	0.08	**0.71**	**0.64**	0.20	0.19	**0.62**	0.16	**0.60**
13 Daily decision taking	0.09	**0.83**	**0.98**	-0.03	0.03	**0.88**	0.00	**0.88**
14 Memory	-0.19	**0.85**	**0.97**	-0.13	-0.16	**0.83**	-0.15	**0.91**
15 Behavioural control	-0.15	**0.57**	**0.83**	-0.09	-0.14	**0.68**	-0.04	**0.64**

* Loadings > 0.40 are marked with boldface

The existing literature is inconclusive as to whether disability, as expressed through ADL and IADL variables, represents one, two or even more dimensions in describing needs for the home-dwelling elderly.[15–17] Our findings show firstly, the need for both home health and institutional care for the elderly can be described by using two factors; one containing

variables related to physical disability, and one containing variables related to cognitive impairment. Thus factorization seems to be independent of whether care is provided at home or in nursing homes. Secondly, the distinction between the "younger elderly" (67-80), and the "older elderly" (80+) does not seem to be important when choosing neither the number of factors nor the variables contained in each factors. Thirdly, we find no systematic differences between men and women in the characterization of user needs. Thus both the number of factors and the variables contained in each factor seems to be the same for men and women. Others has found that more factors are needed to describe needs for females than males related to household activities.[21] This difference could be related to different social structures between countries.

Table 8. Item parameter estimates of β (standard error) from the 1PL model for home-dwelling elderly individuals and nursing home residents

Home-dwelling elderly		**Nursing home residents**	
ADL/IADL/mobility	**Item difficulty (β)**	**ADL/IADL/mobility**	**Item difficulty (β)**
Housekeeping	3.78 (0.11)	Housekeeping	8.13 (0.49)
Shopping	1.68 (0.08)	Cooking	6.92 (0.33)
Personal hygiene	0.78 (0.08)	Personal hygiene	6.23 (0.28)
Outdoor mobility	-0.04 (0.08)	Outdoor mobility	3.97 (0.17)
Cooking	-0.07 (0.08)	Dressing	3.69 (0.16)
Dressing	-0.84 (0.08)	Toilet	2.09 (0.13)
Toilet	-2.76 (0.09)	Indoor mobility	1.02 (0.11)
Indoor mobility	-3.00 (0.10)	Eating	-0.97 (0.11)
Eating	-5.52 (0.15)		
Cognitive		**Cognitive**	
Maintain own health	2.80 (0.09)	Maintain own health	6.95 (0.42)
Social interaction	-1.19 (0.07)	Shopping	5.96 (0.29)
Daily decisions making	-1.74 (0.08)	Daily decision making	3.49 (0.15)
Memory	-2.07 (0.08)	Memory	2.46 (0.12)
Communication	-4.36 (0.13)	Social interaction	2.34 (0.12)
Behavioural control	-4.94 (0.15)	Communication	-0.28 (0.09)
		Behavioural control	-0.52 (0.09)
-2*log likelihood ADL/IADL 1PL	18,451.2	-2*log likelihood ADL/IADL 1PL	5,558.0
-2*log likelihood Cognitive 1PL	11,140.4	-2*log likelihood Cognitive 1PL	5,879.3

Our analysis supports previous studies that found that ADL and mobility variables constitute a common dimension in describing the service needs for the home-dwelling elderly and for nursing home residents, whereas the IADL variables could both be physical and cognitive depending on the recipients being analysed.[23–25] Furthermore, our results indicate that behavioural problems can be grouped with other cognitive variables for elderly users. This finding is in contrast to others, who has found that aggressive behaviour could be treated as a separate dimension for nursing home residents.[52] This further underscores the point that some IADL variables have a strong cognitive element. Thus, the distinction between physical and cognitive variables may be more relevant than that between ADL, IADL and cognitive variables. This could explain why some variable as for instance shopping is a physical disability for some recipients while it appears as a cognitive dimension for others.

The IPLOS system contains 15 variables describing disability and cognitive impairment. Although other instruments will contain different variables, we still believe that our analyses suggest that a common factorization is applicable for the population 67+. For policy makers this means that a common "case-mix system" based on this factorization can be developed for planning, financing and monitoring the use of long-term care services for this group.

We found that the hierarchical ranking of variables to be quite similar between home dwelling elderly and those living

at nursing homes. There was one exception namely cooking which was considered as medium difficult for home dwelling elderly, while it emerged as the second most difficult task for those living in nursing homes. This is in contrast to others who found that cooking, unlike other tasks, was considered as less difficult in a nursing home setting than among home dwelling elderly.[53] However, the level of difficulty for performing different tasks was generally higher for the elderly living in nursing homes. This result suggests that the transition from home care to nursing home care is attributable to a general worsening of disability more than to a sudden change in the capacity to perform specific tasks, and thus that setting (home vs institutional care) in our case is a proxy for severity. These findings are in accordance with others.[53] Among home dwelling elderly there were small differences in gaps and no differences in hierarchical ranking stratified by gender or age (results not shown), which is in accordance with others.[26]

Large differences between the difficulty parameters of the variables studied highlight areas where the IPLOS system could have a low level of precision. When instruments show gaps between the least difficult variables, it becomes more difficult to separate between the least disabled individuals; conversely, gaps between the most difficult variables make it more difficult to distinguish between the most disabled persons.[14, 30, 54] This scenario may be related to both the number and the types of variables included.[14] For both groups of elderly, we found relatively large gaps at both ends of the physical disability measures. For the home-dwelling elderly, the difference between eating and indoor mobility was large, although we consider this to represent a minor problem. As shown in Table 1, approximately 96% of home-dwelling elderly were capable of eating alone, and most of those living in nursing homes were also able to eat by themselves. For the home-dwelling elderly, the gap between housekeeping and shopping was more striking, as approximately 70%-90% of home-dwelling recipients required help with housekeeping or shopping. This large gap could make it more difficult to differentiate among the least disabled. Large gaps for the least and most disabled home-dwelling elderly persons have also been detected in studies using other instruments, suggesting that this problem is not specific to the IPLOS system.[29, 55] For patients in nursing homes, the gaps were large between the most difficult variables. The large gap between the most difficult variables–housekeeping, cooking, personal hygiene and outdoor mobility–could be related to the fact that the two first are IADL variables and that very few individuals actually need to perform these tasks in a nursing home setting. We found, in Table 1, that nearly 100% of those living in nursing homes required help with these tasks.

We also observed that there were relatively large gaps between the cognitive variables for the two groups of elderly individuals. Thus, the IPLOS system does not appear to be well suited for detecting differences between users with severe cognitive impairment. One possible solution, when there are gaps, could be to split the variable in question into multiple "sub"-variables, *e.g.*, a possibility is to split indoor mobility into three separate variables.[21] In a more general analysis 166 ADL/IADL variables were analysed and identified potential variables that could be included in disability instruments to reduce information gaps.[28] After a variable is split, the system may be more capable of identifying differences between both the most and least severely disabled recipients.

In Norway today, a composite score of all 15 IPLOS variables is used to describe "severity".[56] However, our results show that this may lead to an inaccurate picture of both severity and the resulting need.

A strength of this study is that analysis are based on everyday use of a system that is mandatory. Thus, we also believe that results should be applicable in Norwegian long term care. There are, however, also some caveats in our approach. Firstly, the IPLOS system contains fewer variables than other frequently used instruments; in particular, it contains fewer IADL variables. Thus, frequently used IADL variables such as "handling money" and "using phone/internet" can be indirectly included in "shopping", and the variable "maintaining own health" has a broader definition than the frequently used IADL variable "responsibility for own medications". These variables have been reported in some studies to be included in a separate "cognitive" IADL dimension in addition to other "physical" IADL variables. In contrast, IPLOS includes variables related to cognitive and behavioural functioning, which enables us to test IADL variables against cognitive impairment. Further the IPLOS system does not have information of other potential determinants of need as *e.g.*, medication and education. Secondly, the data analysed in this study were a specific Norwegian setting; therefore, we cannot confirm their representativeness for other settings. Thirdly, Although IPLOS, as other instruments, have gaps along the continuum, comparison with other instruments was not possible with the available data. Further research should compare IPLOS against other reliable instruments.

5. CONCLUSION

Factorization suggests that all elderly (67 years and older) long term care users can be adequately described along two dimensions; one reflecting physical disability and one re-

flecting cognitive impairment. However both the number of factors and the variable contained in each factor is likely to depend on the instrument used to characterise LTC users.

The IRT analysis showed minor differences in the hierarchically structure between home dwelling elderly and nursing home residents. On the other hand IRT analysis revealed large information gaps between the different variables in the system currently used in Norway. Especially it seems less suited to discover differences in need among the less disabled home dwelling elderly. Thus, there is a need to supplement the design of the IPLOS system preferably with variables from other reliable instruments.

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CONFLICTS OF INTEREST DISCLOSURE

The authors declare that there is no conflict of interest.

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