

RESEARCH PAPER

Total cost of care increases significantly from early to mild Alzheimer's disease: 5-year ALSOVA follow-up

VIIVI JETSONEN¹, VIRPI KUVAJA-KÖLLNER², TARJA VÄLIMÄKI³, TUOMAS SELANDER⁴, JANNE MARTIKAINEN⁵, ANNE M. KOIVISTO^{1,6,7,8}

¹Department of Neurology, University of Eastern Finland, Kuopio, Finland

²Department of Health and Social Management, University of Eastern Finland, Kuopio, Finland

³Department of Nursing Science, University of Eastern Finland, Kuopio, Finland

⁴Science Service Center, Kuopio University Hospital, Kuopio, Finland

⁵School of Pharmacy, University of Eastern Finland, Kuopio, Finland

⁶Kuopio University Hospital, Kuopio, Finland

⁷Department of Neurosciences, University of Helsinki, Helsinki, Finland

⁸Department of Geriatrics, Helsinki University Hospital, Helsinki, Finland

Address correspondence to: Viivi Jetsonen. Tel: +358 407385000. E-mail: viivi.tolvanen@gmail.com

Abstract

Introduction: We studied the costs of formal and informal care in relation to Alzheimer's disease (AD) progression.

Methods: 231 persons with AD with a family caregiver were followed up for 5 years. The Clinical Dementia Rating Scale—Sum of Boxes (CDR-SB) was used to measure AD progression. Health and social care unit costs were used for formal care costs. An opportunity cost method for lost leisure time was applied to analyse the cost of informal care.

Results: Total cost of care in early stage AD (CDR-SB ≤ 4) was 16,448€ (95% CI 13,722–19,716) annually. In mild (CDR-SB 4.5–9), moderate (CDR-SB 9.5–15.5) and severe (CDR-SB ≥ 16) AD, the total costs were 2.3, 3.4 and 4.4 times higher, respectively. A one-unit increase in CDR-SB increased the total, formal and informal costs by 15, 11 and 18%, respectively.

Conclusions: Compared to early AD, the costs of total, formal and informal care are remarkably higher already in mild AD. This finding emphasises early diagnosis, interventions and family support for persons with AD and their caregivers.

Keywords: Alzheimer's disease, formal care, informal care, cost of care, The Clinical Dementia Rating Scale—Sum of Boxes (CDR-SB), ALSOVA, follow-up study, dementia, older people

Key Points

- The cost of formal and informal care increases significantly already in the transition from early to mild Alzheimer's Disease (AD).
- A 1-unit increase in The Clinical Dementia Rating Scale—Sum of Boxes (CDR-SB) increases total, formal and informal cost by 11–18%.
- Increase in the cost of informal care is steeper than the cost of formal care.
- Based on our findings, early interventions and family support should be regarded.

Introduction

Alzheimer's disease (AD) has various effects on a person's cognition, behaviour and functional abilities. Disease severity, problems with activities of daily living (ADL), and memory and behavioural symptoms are predictors of service use among persons with dementia [1–6]. A significant portion of the cost of care is composed of informal care provided by family caregivers (FCs) [7, 8]. In addition to the help with personal and instrumental daily activities, the time spent on general supervision is significant [2]. The use of formal services increases due to disease progression but is minor compared to informal service use [9]. Thus far, few studies have explored service use in a longitudinal dataset [5, 10–12]. Longitudinal study gives deeper insight to service use and costs of AD care during the disease progression, and it allows discovery of trends and relationships within the data collected. Cross-sectional studies fail to examine long-term relationships.

The Clinical Dementia Rating Scale (CDR) is a valid method for staging AD. It assesses both cognitive and functional dimensions of AD, especially in early stages of AD [13]. CDR Sum of Boxes (CDR-SB) is a precise tool in determining the progression and severity of AD, and compared to the CDR global score, it distinguishes changes in severity of AD more accurately within and between different stages of AD [14–16].

The aim of this study was to examine home-dwelling persons with AD and the use of formal and informal care as AD progresses during a 5-year follow-up and cost of care in different stages of AD measured with CDR-SB. These study results reflect directly service use and cost of care in home-dwelling persons with AD.

Methods

Study design

This multidisciplinary study is a part of the Psychological Rehabilitation Study of Persons with Alzheimer's Disease-project, a 5-year randomised, controlled AD study conducted by the University of Eastern Finland (UEF), Department of Neurology in collaboration with the Departments of Health and Social Management, Nursing Sciences and Pharmacy at UEF. A detailed description of the study protocol has been reported previously [17,18].

Study population

A total of 231 of 242 recruited home-dwelling persons with early or mild AD (care recipient, CR) and their FCs were eligible for this part of the study project. The dyads were recruited from the memory clinics of three hospital districts, an average of 5 months after AD diagnosis, between 2002 and 2006 and followed up until 2011. Register data were obtained in 2015. CRs were examined and diagnosed with AD by a neurologist or geriatrician using International Diagnostic Criteria (ICD-10/DSM-IV) and confirmed by

the study neurologist [17–19]. Inclusion criteria for the CRs were early (CDR-SB 0.5–4) or mild AD (CDR-SB 4.5–9) at baseline, home-dwelling and presence of a FC. The endpoint for the study was the CR's permanent institutionalisation or death. The dyads were followed up to 5 years or when the endpoint was met. Ninety dyads met the endpoint during follow-up: 64 CRs were permanently institutionalised and 26 died. Furthermore, 73 dropped out. Throughout the project, CRs were offered a standard treatment for AD according to Finnish national guidelines. As a part of the ALSOVA project, one-third of the dyads were randomised into psychological intervention group and given education, counselling and social support. The other group received treatment according to national guidelines. The study found no difference in the institutionalisation rate between the two groups [19]. Participants from both groups were pooled into one sample for this study.

Data collection and measurements

Demographic data (age, gender, education and comorbidities), years lived together, living situation (i.e. living together), relationship (spouse or other) and hours spent on informal care were obtained by interviewing FCs by a study nurse. CDR-SB was conducted by a psychologist.

Service use and cost

Hospital visits and hospitalisation periods were gathered from hospital records and the national health care HILMO register [20]. HILMO is the Finnish National Care Register for Social Welfare and Health Care that gathers information on hospital visits and hospital stays. For simplicity, the average duration of hospitalisation in 2016 was applied. The use of primary care services (i.e. doctor and nurse visits, ward stays, visits to the emergency room, physiotherapeutic and occupational therapeutic rehabilitation, and visits to a psychologist) was extracted manually from electronic patient medical records (EMRs) by study nurses for each study participant. The use and cost of medication were obtained from The Social Insurance Institute of Finland, KELA [21].

Utilisation of social care services was obtained from EMRs and interviews with FCs by a study nurse. The use of home care, i.e. care provided by a visiting nurse, daycare and interval nursing/respite care, was extracted from the EMRs.

Hours spent on informal care were obtained by personal interview of the FCs by a study nurse. FCs kept a journal on informal care 3 months prior to each study visit. Assistance in personal (PADL) and instrumental activities of daily living (IADL) and general supervision were asked separately, as were hours spent on each dimension of informal care. When data were analysed, the maximum hours spent on informal care per day was set to 24 hours.

The CDR [22] global score (range 0, no dementia to 3, severe dementia) and CDR-SB (range 0, no dementia to 18, very severe dementia) were scored using standardised methodology based on the interviews with the FCs. CDR-SB collects the information of the six domains (each domain

0–3, 0 with no and 3 with severe symptoms) of global CDR. CDR-SB was then divided into five groups based on the severity of AD: early with CDR-SB ≤ 4 , mild with CDR-SB 4.5–6.5 or 7–9, moderate with CDR-SB 9.5–15.5 and severe with CDR-SB ≥ 16 . The reason for dividing mild AD into two subgroups was the significant change in service use within the group and the high number of observations in this group.

Cost estimation

Unit costs for healthcare service use were obtained from the report on Health and Social Care Unit costs in Finland in 2011 [23]. For comparative reasons, all costs were transformed into 2016 monetary values using the national consumer price index [24]. Unit costs are presented in Appendix 1, available in *Age and Ageing* online.

Informal care costs can be considered direct non-medical costs as a proxy of home care, or as indirect costs if the opportunity cost approach is used [25]. In this study, the time spent on informal care was assessed by the opportunity cost approach in means of loss of leisure time, as no data were available on productivity losses, i.e. whether employed FCs had to be absent from work to care for CRs. 35% of the average Finnish gross wage per hour for lost leisure time was applied as in many previous studies [4,26]. Due to the complexity in valuing informal care, an opportunity cost method in means of both lost leisure time and lost productivity was applied in the sensitivity analysis. For lost productivity, the average Finnish gross wage of 20.91€ per hour was applied for informal care supplied by employed FCs.

Statistical analysis

The data were analysed using generalised estimating equations (GEE) model for repeated measures with gamma distribution and log-link function. Three different types of costs were used as dependent variables: formal costs, informal costs and a combination of these costs as an all cost variable. CDR-SB was used in two different ways as an independent variable: as a continuous variable and as an ordinal variable. All information used in analyses (i.e. CDR-SB, and use of formal and informal care) were asked five times during the 5-year follow-up. The results of the GEE model were reported as rate ratios (Exp(B)) and estimated cost of care with 95% confidence intervals (CIs). Data were analysed using SPSS Statistics for Windows, Version 25.0 (IBM, Armonk, NY). *P*-values < 0.05 were set to indicate significant results.

Ethical considerations

The Ethics Committee of Kuopio University Hospital issued a favourable opinion to conduct the study (64/00). Both oral permission and written informed consent were obtained from CRs and FCs. In addition, the Finnish Social and Health Ministry (STM) and the Finnish Institute for Health and Welfare (THL) gave permission for this study to be

Table 1. Demographic data at baseline ($n = 231$)

	CRs	FCs
Age, years (SD)	75.1 (6.5)	65.7 (12.0)
Male gender (%)	111 (48.1)	79 (34.2)
Education, years (SD)	7.5 (3.2)	9.9 (3.7)
Caregiver working/yes (%)		51 (22.1)
Spouse as a FC (%)		163 (70.6)
Years of living together (SD)	33.1 (21.7)	
Mean CDR-SB (SD)	4.1 (1.5)	
CDR-SB		
≤ 4 (%)	129 (55.8)	
4.5–6.5 (%)	88 (38.1)	
7–9 (%)	14 (6.1)	
9.5–15.5	0	
16–18	0	

Results are presented as number (%) or mean (SD). SD, standard deviation.

carried out (original permission STM/62/07/2000, updated regularly, last time by THL on 25 February 2020 Dnro THL/1576/5.05.00/2014).

Results

Main findings

The demographic data for the 231 CRs and FCs are presented in Table 1 as means and standard deviations or frequencies and percentages. Seventy-three dyads dropped out during 5-year follow-up. Reasons for dropping out were decline in CRs' general health ($n = 33$), caregiver-related reasons ($n = 22$) and other reasons ($n = 18$). Drop-out analysis showed that CRs who completed the study had slightly better CDR-SB (3.8 versus 4.3, $P = 0.02$) and lower age (73.4 versus 75.8, $P = 0.01$) at baseline than those who dropped out.

In this model, the average annual total cost of care of CRs with early AD was 16,448€ (95% CI 13,722–19,716). A 1-unit increase in CDR-SB increased the annual total cost by 15% (1,875€, 95% CI 1,625–2,125). A significant increase in the annual total cost of care was already seen in the transition from early to mild AD ($P < 0.001$ between all AD severity groups). The influence of AD severity on the total cost of care is presented in Table 2. Since the disease progression is individual, CDR-SBs are not related to or presented at specific time points. The results reflect cost of care at different stages of AD, as in real life.

All CRs received formal care in every stage of AD. For CRs with early AD, the annual cost of formal care was 8,498€ (95% CI 6,480–11,143). A 1-unit increase in CDR-SB increased the formal cost by 11% (788€, 95% CI 501–1,002). The cost of formal care according to CDR-SB is described in Table 3.

The cost of informal care in persons with early AD was lower than the cost of formal care. However, the increase in cost of informal care was more drastic when the disease progressed, and in the mild stage, the cost of informal care surpassed that of formal care. For CRs with early AD, the

Table 2. Effect of AD severity measured by CDR-SB on total cost of care

	Exp(B) (95% CI)	Cost of total care (95% CI) (€)	P-value
Mean cost of all stages in AD		34,284 (31,269–37,590)	
CDR-SB, continuous	1.15 (1.13–1.17)		<0.001
CDR-SB, classified			
≤4	1	16,448 (13,722–19,716)	
4.5–6.5	1.77 (1.45–2.15)	29,053 (25,091–33,642)	<0.001
7–9	2.76 (2.25–3.37)	45,314 (38,806–52,913)	<0.001
9.5–15.5	3.42 (2.77–4.22)	56,252 (49,451–63,990)	<0.001
≥16	4.41 (3.42–5.70)	72,600 (59,717–88,262)	<0.001

Table 3. Effect of AD severity measured by CDR-SB on the formal cost of care

	Exp(B) (95% CI)	Cost of formal care (95% CI) (€)	P-value
Mean cost in all stages of AD		14,499 (12,005–17,511)	
CDR-SB, continuous	1.11 (1.07–1.14)		<0.001
CDR-SB, classified			
≤4	1	8,498 (6,480–11,143)	
4.5–6.5	1.57 (1.17–2.10)	13,300 (10,145–17,437)	0.003
7–9	2.34 (1.67–3.27)	19,870 (14,103–27,994)	<0.001
9.5–15.5	2.42 (1.69–3.47)	20,559 (15,461–27,338)	<0.001
≥16	3.16 (1.86–5.39)	26,887 (16,593–43,566)	<0.001

Table 4. Effect of AD severity measured by CDR-SB on informal cost of care

	Exp(B) (95% CI)	Cost of informal care (95% CI) (€)	P-value
Mean cost in all stages of AD		19,527 (17,686–21,559)	
CDR-SB, continuous	1.18 (1.16–1.20)		<0.001
CDR-SB, classified			
≤4	1	8,032 (6,312–10,221)	
4.5–6.5	1.95 (1.48–2.56)	15,654 (13,355–18,350)	<0.001
7–9	3.15 (2.41–4.13)	25,330 (21,954–29,225)	<0.001
9.5–15.5	4.36 (3.34–5.68)	34,979 (30,903–39,593)	<0.001
≥16	5.62 (4.22–7.50)	45,169 (38,276–53,303)	<0.001

cost of informal care was 8,032€ annually (CI 95% 6,312–10,221). A 1-unit increase in CDR-SB increased the cost of informal care by 18% (1,006€, 95% CI 894–1,118). The cost of informal care is presented in Table 4.

Figure 1 summarises the yearly costs of formal and informal care in relation to CDR-SB.

The figure shows increase in both formal and informal care in relation to disease severity. However, increase in informal care is significantly steeper already in transition from early (CDR-SB 0.5–4) to mild (4.5–9) AD.

Sensitivity analysis

One-fifth ($n = 51$) of the FCs were employed, and this was considered in the sensitivity analysis of the cost of informal care using different approaches for cost estimation. In addition to the opportunity cost method in means of lost leisure time, the opportunity cost method in means of lost productivity was applied for the employed FCs. When the Finnish gross wage was used for the working FCs, total and informal care costs relatively increased. Between the two methods, the increase in relation to CDR-SB was similar,

except in the case of severe AD, when costs were higher with the opportunity cost method in means of lost leisure time compared to early AD. Results from the sensitivity analysis are presented in Appendix 2, available in *Age and Ageing* online.

Discussion

To the best of our knowledge, this is the longest follow-up of home-dwelling persons with AD and their caregivers to analyse formal and informal cost of care. As expected, our study shows an increase in both formal and informal service use and cost in relation to AD progression. A 1-unit increase in CDR-SB increased the total cost 15%, formal cost 11% and informal cost 18%. The mean annual total, formal and informal cost of care during the 5-year period was 34,284€, 14,499€ and 19,527€, respectively. Handels *et al.* [8] reported that the annual mean total cost in eight European countries for persons with dementia and their caregivers is 17,296€ in all stages of dementia. In the baseline findings of the GERAS study by Wimo *et al.* [4],

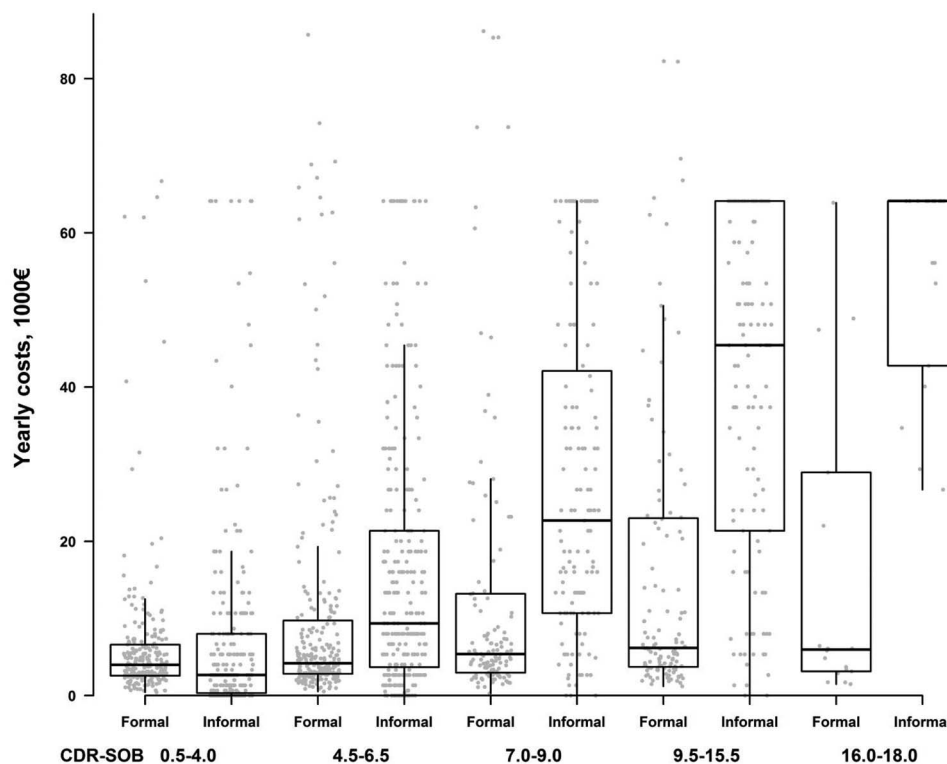


Figure 1. Cost of formal and informal care in relation to CDR-SB.

the mean monthly societal cost was estimated to be 1,312–3,722€ in France, Germany and the United Kingdom. However, comparisons to previous studies are difficult due to methodological differences. In the cross-sectional studies by Wimo *et al.* [4] and Handels *et al.* [8], supervision time was excluded from informal care time. Furthermore, unit costs in Handels' study, especially in Southern European countries, were lower than in this study, and persons with severe dementia were excluded.

Interestingly, in mild AD, the annual total, formal and informal cost already doubled compared to early stage AD. Division of mild AD into two groups (CDR-SB 4.5–6.5 and 7–9) was justified, as the cost of both formal and informal care increased significantly within the group; the total cost of care was 77% higher in CDR-SB 4.5–6.5 and 176% higher in CDR-SB 7.0–9.0 compared to early AD.

Informal care comprised over half (57%) of the mean total cost, which is in line with previous studies [4,8]. The cost of informal care increased drastically due to disease progression already in mild AD. In our study, the cost of informal care was on average 155% in mild AD, 336% in moderate AD and 462% in severe AD compared to early AD. In many registry-based studies, informal care is a hidden expenditure, as quantification of the amount and cost of informal care is difficult. The FCs do not invoice their CRs for the service they provide and especially supervision aspect of the informal caregiving cannot be substituted by formal home care, as it can be round-the-clock task. In fact, informal care can act

as a substitute for permanent institutionalisation, especially in the most severe stages of the disease when a person with AD requires full-time assistance and supervision. In Finland, the society pays a special carer's allowance for selected FCs, but the monetary value of it is small-scale compared to work they do. Although quantification of the aspect of supervision is difficult, in our opinion it is justified to account for it when it comes to valuing informal care. Our study is in line with previous studies [4] that show supervision as a major component in informal caregiving time, especially in the most severe stages of AD. Many of the previous studies have considered caregiver supervision as a zero value [4,7,8,27]. However, neuropsychiatric symptoms of AD, which may require supervision, have a stronger impact on the burden that caregivers experience compared to the decline in ADL or cognition [28]. In our study, hours spent on informal care increased as the disease progressed in all three dimensions (PADL, IADL and supervision).

In addition to quantification of informal care and its components, the monetary value of informal care is a complex entity because there is no univocal definition [29]. We used the opportunity cost method to avoid overestimating the monetary value of lost leisure time because >70% of FCs were non-working, as in previous studies [4].

This study has several strengths and limitations. A long follow-up period is needed, as the progression of the disease itself and cost of care is different within persons with AD over time. In addition, formal care data were collected from local

registries single-handedly, not only from national records to avoid possible errors in statistics. Dyads were recruited in both urban and rural areas, which gives a broader understanding of service use and availability as, in rural areas, travel distances can be longer and service availability insufficient to meet demand. Study participants were clinically assessed and met personally by a study nurse. At baseline, the study participants were in the early or mild stages of AD, which provides an opportunity to detect changes in service use and cost from the earliest stages of the disease. All subjects were recommended to use Alzheimer-targeted medication and were treated according to national guidelines. Thus, the diagnostics and treatment protocol used are applicable to present day.

This study is clinical rather than population-based, which may overestimate formal service use in particular, as all dyads were acquainted with the service network. We did not analyse why formal services were not used, whether due to economic aspects, unmet needs or lack of knowledge. Furthermore, it was not analysed whether FCs received help from other family members for caregiving, and this might lead to underestimation of informal care. 11% of CRs deceased and 28% were permanently institutionalised during the follow-up, which is in line with previous studies [30]. A possible limitation of this study is a moderate drop-out rate, as 32% dropped out during the follow-up. However, this was foreseeable, since study participants were older with comorbidities. CRs who completed the follow-up had milder AD and were younger at baseline, suggesting that these participants had better cognitive and functional abilities in general, thus leading to underestimation of service use.

Most persons with AD live at home with the help of a FC, and the care-demanding nature of the disease creates costs. This study found a significant increase in the total, formal and informal costs already between early and mild AD, but disease progression and consequently increase of resources needed in care vary individually over time. This finding emphasises early diagnosis, preferably before the dementia stage of AD, and early available interventions, such as AD-targeted medication, exercise, individually tailored psychosocial interventions and family support [31,32]. Delaying the progression of AD reduces the economic burden of the disease [33].

As stated, a major proportion of costs is composed of informal care. Monetary and social support of FCs in early stages of AD are crucial for the well-being and quality of life of persons with AD and their FCs [18].

Conclusions

Total, informal and formal care needs and costs increase substantially from early to mild AD. This study gives perspectives on the matter of designing and organising care for individuals with AD. Based on the knowledge of the costs of formal and informal care in different stages of AD, it is

possible to create population-based predictive assessments of the cost of AD care for care providers.

Supplementary Data: Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

Acknowledgements: The authors wish to thank all study participants who contributed to the study. We thank Mari Tikkanen, the administrative assistant, and Lotta Salo, the project researcher and nutritionist. We thank study nurses Helena Mäkelä and Markku Kalinen for collecting data from the registries. We also thank Virve Kärkkäinen, PhD, research coordinator.

Declaration of Conflicts of Interest: Janne Martikainen is a founding partner of ESiOR Oy and a board member of Siltana Oy. These companies were not involved in carrying out this research.

Declaration of Sources of Funding: The study was funded by Kuopio University Hospital (VTR grant 1V255/5772728) and the Päivikki and Sakari Sohlberg Foundation.

References

1. Hux M, O'Brien B, Iskudjian M, Goeree R, Gagnon M, Gauthier S. Relation between severity of Alzheimer's disease and cost of caring. *Can Med Assoc J* 1998; 159: 457–65.
2. Wimo A, Von Strauss E, Nordberg G, Sassi F, Johansson L. Time spent on informal and formal care giving for persons with dementia in Sweden. *Health Policy* 2002; 61: 255–68.
3. Reese J, Hemann P, Seeberg G *et al.* Cost and care of patients with Alzheimer's disease: clinical predictors in German health care settings. *J Alzheimers Dis* 2011; 27: 723–36.
4. Wimo A, Reed C, Dodel R *et al.* The GERAS study: a prospective observational study of costs and resource use in community dwellers with Alzheimer's disease in three European countries study design and baseline findings. *J Alzheimers Dis* 2013; 36: 385–99.
5. Rattinger GB, Schwartz S, Mullins CD *et al.* Dementia severity and the longitudinal costs of informal care in the cache county population. *Alzheimers Dement* 2015; 11: 946–54.
6. Robinson KM, Buckwalter KC, Reed D. Predictors of use of services among dementia caregivers. *West J Nurs Res* 2005; 27: 126–40.
7. Gustavsson A, Brinck P, Bergvall N *et al.* Predictors of costs of care in Alzheimer's disease: a multinational sample of 1222 patients. *Alzheimers Dement* 2011; 7: 318–27.
8. Handels RLH, Sköldunger A, Bieber A *et al.* Quality of life, care resource use, and costs of dementia in 8 European countries in a cross-sectional cohort of the Actifcare study. *J Alzheimers Dis* 2018;66:1027–40.
9. Bökberg C, Ahlström G, Karlsson S. Utilisation of formal and informal care and services at home among persons with dementia: a cross-sectional study. *Scand J Caring Sci* 2018; 32: 843–51.
10. Jones RW, Lebec J, Kahle-Wroblewski K *et al.* Disease progression in mild dementia due to Alzheimer's disease in an 18-month observational study (GERAS): the impact on costs and

- caregiver outcomes. *Dement Geriatr Cogn Dis Extra* 2017; 7: 87–100.
11. Andersen CK, Lauridsen J, Andersen K, Kragh-Sorensen P. Cost of dementia: impact of disease progression estimated in longitudinal data. *Scand J Public Health* 2003; 31: 119–25.
 12. Wimo A, Sjölund BM, Sköldunger A, Johansson L, Nordberg G, Von Strauss E. Incremental patterns in the amount of informal and formal care among non-demented and demented elderly persons: results from a 3-year follow-up population-based study. *Int J Geriatr Psychiatry* 2011; 26: 56–64.
 13. Morris JC, Ernesto C, Schafer K *et al.* Clinical dementia rating training and reliability in multicenter studies: the Alzheimer's disease cooperative study experience. *Neurology* 1997; 48: 1508–10.
 14. Coley N, Andrieu S, Jaros M, Weiner M, Cedarbaum J, Vellas B. Suitability of the clinical dementia rating-sum of boxes as a single primary endpoint for Alzheimer's disease trials. *Alzheimers Dement* 2011; 7: 602–610.e2.
 15. Cedarbaum JM, Jaros M, Hernandez C *et al.* Rationale for use of the clinical dementia rating sum of boxes as a primary outcome measure for Alzheimer's disease clinical trials. *Alzheimers Dement* 2013; 9: S45–55.
 16. O'Bryant SE, Waring SC, Cullum CM *et al.* Staging dementia using clinical dementia rating scale sum of boxes scores: a Texas Alzheimer's research consortium study. *Arch Neurol* 2008; 65: 1091–5.
 17. Välimäki TH, Vehviläinen-Julkunen KM, Pietilä AK, Pirttilä TA. Caregiver depression is associated with a low sense of coherence and health-related quality of life. *Aging Ment Health* 2009; 13: 799–807.
 18. Karttunen K, Karppi P, Hiltunen A *et al.* Neuropsychiatric symptoms and quality of life in patients with very mild and mild Alzheimer's disease. *Int J Geriatr Psychiatry* 2011; 26: 473–82.
 19. Koivisto AM, Hallikainen I, Välimäki T *et al.* Early psychosocial intervention does not delay institutionalization in persons with mild Alzheimer's disease and has impact on neither disease progression nor caregivers' well-being: ALSOVA 3-year follow-up. *Int J Geriatr Psychiatry* 2016; 31: 273–83.
 20. HILMO register: the Finnish National Register for Social Welfare and Health Care. <https://www.thl.fi/en/web/thlfi-en>.
 21. KELA: The Social Insurance Institute of Finland. <https://www.kela.fi/web/en>.
 22. Hughes CP, Berg L, Danziger WL, Coben LA, Martin RL. A new clinical scale for the staging of dementia. *Br J Psychiatry* 1982; 140: 566–72.
 23. Kapiainen. Unit Costs of Health and Social Care in Finland 2011. https://www.julkari.fi/bitstream/handle/10024/114683/THL_RAPO3_2014_web.pdf. (accessed date 29 October 2018).
 24. Consumer Price Index, Statistics of Finland. <http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/>. (accessed date 14 December 2018).
 25. Nadège C, Laura F, Hélène D-B *et al.* Comparison of informal care time and costs in different age-related dementias: a review. *J Biomed Biotechnol* 2012-10-13; 2013: 852368–15.
 26. Åkerborg Ö, Lang A, Wimo A *et al.* Cost of dementia and its correlation with dependence. *J Aging Health* 2016; 28: 1448–64.
 27. Lenox-Smith A, Reed C, Lebec J, Belger M, Jones RW. Resource utilization, costs and clinical outcomes in non-institutionalized patients with Alzheimer's disease: 18-month UK results from the GERAS observational study. *BMC Geriatr* 2016; 16: 195–10.
 28. Bergvall N, Brinck P, Eek D *et al.* Relative importance of patient disease indicators on informal care and caregiver burden in Alzheimer's disease. *Int Psychogeriatr* 2011; 23: 73–85.
 29. Wimo A, Jönsson L, Fratiglioni L *et al.* The societal costs of dementia in Sweden 2012 – relevance and methodological challenges in valuing informal care. *Alzheimers Res Ther* 2016; 8: 59. <https://doi.org/10.1186/s13195-016-0215-9>.
 30. Phung T, Waldorff F, Buss D *et al.* A three-year follow-up on the efficacy of psychological interventions for patients with mild dementia and their caregivers: the multicentre, rater-blinded, randomised Danish Alzheimer Intervention Study (DAISY). *BMJ Open* 2013; 3: e003584. <https://doi.org/10.1136/mbjopen-2013-003584>.
 31. Rosenberg A, Ngandu T, Rusanen M *et al.* Multidomain lifestyle intervention benefits a large elderly population at risk for cognitive decline and dementia regardless of baseline characteristics: the FINGER trial. *Alzheimers Dement* 2018; 14: 263–70.
 32. Pitkälä K, Pöysti M, Laakkonen M *et al.* Effects of the Finnish Alzheimer's disease exercise trial (FINALEX): a randomized controlled trial. *JAMA Intern Med* 2013; 173: 1–8.
 33. Laver K, Dyer S, Whitehead C, Clemson L, Crotty M. Interventions to delay functional decline in people with dementia: a systematic review of systematic reviews. *BMJ Open* 2016; 6: e010767. <https://doi.org/10.1136/bmjopen-2015-010767>.

Received 2 February 2021; editorial decision 4 May 2021