Preventive home visits to older home-dwelling people and different functional decline patterns

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Abstract A preventive home visitation scheme has been part of Danish legislation since 1996. The aim of this study was to describe functional trajectories of older home-dwelling people, and to identify whether education of the preventive home visitation staff and individual risk factors were related to specific functional decline patterns. The study is a secondary analysis of a population-based prospective controlled cohort study. Participation totalled 3,129 non-disabled 75- and 80-year-old men and women without mobility disability at baseline living in 34 municipalities. Self-reported functional ability was measured at baseline and after 1½, 3 and 4½ years follow-up. No functional decline was seen in 58% of the participants. A total of 17% developed catastrophic decline, 6% progressive and 7% showed a reversible decline pattern. The

remaining 12% showed mixed patterns. Education of the preventive home visitation staff was associated with a reduced risk of progressive decline, RR = 0.66 (CI 95% 0.50–0.86, $p = 0.002$). Not receiving home visits and living alone were associated with increased risk of catastrophic decline. Younger age (75 at baseline) was less associated with all decline patterns compared with older age (80 at baseline). Men had less risk of developing progressive, reversible and mixed decline patterns than women, but an increased risk of developing catastrophic decline. A feasible educational preventive staff intervention was associated with a reduced risk of progressive functional decline but not with other functional decline patterns. Early signs of functional decline may serve as an important trigger for when to intensify the search for and actively seek to ameliorate preventable conditions.

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Introduction

The ultimate goal of preventive home visits and other kinds of preventive intervention in older persons is to optimize their health, well-being and functional status. Loss of mobility is an important functional outcome since it is part of western individualised culture to wish to remain independent as long as possible (Guralnik et al. 2001; Gill and Kurland 2003). Rather than focusing on bio-medical risk factors alone, preventive efforts should include several strategies to prevent disability (Ferrucci et al. 2001). Predictors of functional decline potentially amenable to intervention with documented effects may therefore facilitate the implementation of health promotion and prevention programmes for older people.

Preventive home visits to older people conducted by municipality-employed home visitors was introduced without specific guidelines by Danish legislation in 1996. They serve the dual purpose of supporting personal resources and offering social support aimed at preserving functional ability. After the law had been in force for a few years, many municipalities had come to recognize a need for more knowledge about the best way to carry out the visits and organise the programme.

Preventive home visits in Denmark are most often carried out by district nurses, who are educated and trained according to the disablement process model (Verbrugge and Jette 1994) in the assessment situation.

The disablement process is a model building on four mutually dependent critical age-related changes. This model defines *disease* as recognised biochemical and cell-function abnormalities ascribable to a medical diagnosis. *Organ impairment* is defined as measurable, impaired functions of organs and the organ system that lead to specific symptoms and/or laboratory results. *Functional limitations* are restrictions in an individual's basic physical and mental behavioural patterns necessary to uphold daily life. *Disability* reflects the consequences of physical and/or mental function limitation and may result in problems performing activities related to all aspects of life. Disability must incorporate expectations that depend on the individual's economy, age and social situation (i.e. intra- and extra-individual modulating factors). In the preventive home visit situation, health, social and mental factors all need to be considered simultaneously to understand the disablement process of the particular individual. To supply this multi-faceted approach, recognition of 'disability patterns' may add important information to build into the preventive home visits and help target older people most in need of such an offer.

A distinction between progressive and catastrophic (rapid-onset) decline has been proposed (Guralnik et al. 2001; Ferrucci et al. 1996; Onder et al. 2001; Ayis et al. 2006). Both kinds of decline are associated with increased mortality, but risk factors differ and it may therefore be useful to take the pace of disability into account, both in proactive and traditional clinical assessment schemes (Ferrucci et al. 2001).

To our knowledge, no studies have described an association between different functional decline patterns and the education of primary care professionals engaged in preventive home visits. We therefore studied major patterns of functional ability over a 4½-year period on the basis of comprehensive longitudinal data on two age cohorts (75 and 80 years at baseline).

The aim of this study was to describe functional trajectories in home-dwelling older people, and to identify whether education of the preventive home visitation staff

and individual risk factors were related to specific functional decline patterns.

Methods

The study is based on a secondary analysis of a population-based prospective controlled cohort study with randomisation and educational intervention of home visitors and GPs at municipality level and outcome measured among the old persons living in the municipalities after 1½, 3, and 4½ years of follow-up. Detailed information about the study design has been published elsewhere (Vass et al. 2002).

Participants

Altogether, 5,788 non-institutionalized citizens living in the 34 municipalities born in 1918 or 1923/1924 were invited. Addresses were drawn from the Civil Registration Office. Written consent was obtained from 4,060 persons (participation rate 70.1%). Twenty-two persons died and four were institutionalized before the intervention started ($n = 4,034$). To select an initially nondisabled cohort, we excluded 902 persons reporting need of help at baseline for at least one of the following activities: transfer, getting outdoors, walking indoors, walking outdoors in nice and poor weather and walking on stairs. Three persons dropped-out, leaving 3,129 non-disabled participants for evaluation of functional patterns during 4½ years of follow-up.

Municipalities

For inclusion in the study, municipalities had to offer preventive home visits according to the Danish legislation from 1998 which stipulates that all 75+-year-old should be offered in-home assessment twice a year. Not all municipalities had implemented this scheme at the beginning of the study in 1998. The municipalities also had to have and to offer fair or good rehabilitation and GPs should be able to collaborate within the scheme by contract.

Consent to participation was obtained from 34 out of 50 eligible municipalities in four counties. No demographic differences were seen between these and the remaining 16 municipalities. Randomisation was carried out following paired matching of intra-county municipalities, urban/rural type, size and geriatric services (Vass et al. 2002). After randomisation there were no differences in baseline characteristics between intervention and control municipalities in terms of municipality size, population density, expenses per 75+ inhabitant, preventive home visitor staffing and the

general collaboration between general practice and the home care systems.

Educational intervention among the health professionals in the municipalities

Based on updated geriatric and gerontological documentation, all intervention municipality visitors received education and training focusing on assessment of functional ability at every home visit and coordinated interdisciplinary follow-up (Vass et al. 2002; Williams et al. 2002; von Renteln-Kruse et al. 2001).

Outcome measures among the old individuals living in the municipalities

Need of help in daily activities according to the Mob-H Scale (Mobility-Help) (Avlund et al. 1996) was measured at baseline and at 1½, 3 and 4½ years of follow-up. The scale was formed by answers to questions about the following six activities: transfer, walking indoors, going outdoors, walking outdoors in nice weather, walking outdoors in poor weather and climbing stairs. The Mob-H Scale describes whether the participants perform the activities with or without help and counts the number of items performed without help. High scale values describe better function, six being the highest score (Fig. 1). In the present analyses the scales are trichotomized into person's

severe mobility disability (need of help for more than two activities), *moderate mobility disability* (need of help for one or two activities) and *no disability*.

Reliability tests on the Mob-H Scale showed agreement percentages from 98.1 to 100 and kappa values from 0.82 to 1.0 for the included items on intra-rater and inter-rater tests (Avlund et al. 1995). The construct validity of the included items has been tested in the Rasch model of item analysis (Avlund et al. 1996). Analysis of criterion-related validity concluded that mobility as measured by the scale was strongly associated with isometric muscle strength (Avlund et al. 1994), postural balance (Era et al. 1997) and physical performance (Avlund et al. 1994).

Functional decline patterns during 4½ years

Functional decline patterns were derived after an algorithm based on functional ability measured at baseline, after 1½, 3, and 4½ years (Fig. 1). Non-decline was defined as no disability at all four assessments (Fig. 1a). *Progressive disability* was defined as a pattern of decline going from no disability at baseline via moderate disability to severe disability (Fig. 1b). *Catastrophic disability* was defined as a pattern of decline going from no disability to severe disability or death without moderate disability at any measurement (Fig. 1c). *Reversible decline* was defined as no disability at baseline, moderate or severe disability at 1½ and/or 3 years of follow-up and no disability at 4½ years follow-up (Fig. 1d). If disability trajectories could not be categorised according to these definitions, patterns were classified as mixed, which most often included both progressive and catastrophic decline patterns (Fig. 1e).

Fig. 1 Functional decline patterns. A theoretical model aggregating 3129 older persons into five functional trajectories during 4.5 years relating to the Mob-H scale

Covariates

Covariates were: *sex* (specified from the Civil Registration Office), *age* (born in 1918 or 1923/1924). The 17 pairs of municipalities were based on the matched randomisation (1–17). *Living alone* was measured with a ‘yes’ or ‘no’ answer to a question asked at baseline, and persons *accepting and receiving at least one preventive home visit* during the 3 years of intervention were compared with persons not receiving preventive home visits (standardized municipality software).

Ethics

The study complies with the Declaration of Helsinki and was approved by the relevant Regional Research Ethics Committees.

Statistical analysis

We used a generalized linear model for multinomial data to obtain the adjusted relative risk estimates. Adjustment for the cluster sampling was performed by including information on municipality pairs as a categorical variable in the model. All analyses were based on the intention to treat principle. Data were analysed using Stata Statistical Software: Release 9.0 (Stata Corporation 1999).

Results

Among the initially non-disabled 3,129 older person's no functional decline was seen in 58%. Seventeen percent developed catastrophic decline, 6% progressive decline and 7% showed a reversible decline pattern (Table 1). A total of 12% did not fell into these four categories and were categorised as mixed pattern.

Univariate comparison of the different functional decline patterns with selected covariates during the 4½ years of follow-up is shown in Table 2.

Older adults living in intervention municipalities where the preventive home visitation staff received education and training had a reduced risk of progressive decline compared with older adults living in control municipalities (Table 3). Not receiving home visits was associated with increased risk of a catastrophic decline pattern and borderline significant associated with less development of progressive functional decline pattern compared with receiving at least one preventive home visit (Table 3). As expected, younger age (75 years of age) was less associated with all decline patterns compared with older age (80 years of age). Men had less risk of developing progressive, reversible and mixed decline patterns than women, but an increased risk of developing catastrophic decline. No major sex differences were seen between older persons with no functional decline (Table 3). Living alone was associated with increased risk of a catastrophic decline pattern.

Table 1 Frequencies of functional decline patterns in the 75-year and the 80-year cohort

	All	75-year-olds			80-year-olds		
	<i>n</i> = 3,129	Men <i>n</i> = 1,102	Women <i>n</i> = 1,216	Men and women <i>n</i> = 2318	Men <i>n</i> = 370	Women <i>n</i> = 441	Men and women <i>n</i> = 811
Pattern	%	%	%	%	%	%	%
Non-decline	58.1	64.0	61.9	62.9	46.5	42.4	44.3
Reversible decline	7.0	4.5	8.1	6.4	7.6	9.5	8.6
Mixed pattern	11.7	9.1	11.4	10.3	13.7	17.0	15.5
Progressive decline	6.6	2.8	8.0	5.5	5.4	13.4	9.7
Catastrophic decline	16.7	19.6	10.6	14.9	26.8	17.7	21.8

Table 2 Univariate comparison of different functional decline patterns during 4½ years with selected covariates

	Non decline <i>n</i> = 1,817	Reversible decline <i>n</i> = 218	Mixed pattern <i>n</i> = 365	Progressive decline <i>n</i> = 207	Catastrophic decline <i>n</i> = 522	All <i>n</i> = 3,129
Living in intervention municipality	953 (58.1)	118 (7.2)	201 (12.3)	89 (5.4)	278 (17.0)	1,639
Living in control municipality	864 (58.0)	100 (6.7)	164 (11.0)	118 (7.9)	244 (16.4)	1,490
Not received visits	705 (57.1)	77 (6.2)	130 (10.5)	65 (5.3)	258 (20.9)	1,235
Received at least one visit	1112 (58.7)	141 (7.4)	235 (12.5)	142 (7.5)	264 (13.9)	1,894
75-year-olds	1458 (62.9)	148 (6.4)	239 (10.3)	128 (5.5)	345 (14.9)	2,318
80-year-olds	359 (44.3)	70 (8.6)	126 (15.6)	79 (9.7)	177 (21.8)	811
Men	877 (59.6)	78 (5.3)	151 (10.2)	51 (3.5)	315 (21.4)	1,472
Women	940 (56.7)	140 (8.4)	214 (12.9)	156 (9.5)	207 (12.5)	1,657
Living alone	730 (54.9)	96 (7.2)	165 (12.4)	115 (8.6)	224 (16.9)	1,330
Not living alone	1087 (60.4)	122 (6.8)	200 (11.1)	92 (5.1)	298 (16.6)	1,799

Values are given *n*(%)

Table 3 Adjusted relative risks for different functional decline patterns during 4½ years in 75- and 80-year-old men and women

	Non decline		Reversible decline		Mixed pattern		Progressive decline		Catastrophic decline	
	RR (CI 95%)	P	RR (CI 95%)	P	RR (CI 95%)	P	RR (CI 95%)	P	RR (CI 95%)	P
Living in intervention versus living in control municipalities	1.01 (0.95; 1.07)	0.81	1.08 (0.83; 1.40)	0.56	1.13 (0.93; 1.38)	0.22	0.66 (0.50; 0.86)	0.002	0.97 (0.83; 1.13)	0.67
Not accepting visits versus receiving at least one preventive home visit	0.96 (0.91; 1.03)	0.25	0.80 (0.60; 1.05)	0.11	0.83 (0.68; 1.03)	0.087	0.77 (0.57; 1.03)	0.074	1.49 (1.27; 1.74)	<0.001
75-year-olds versus 80-year-olds	1.40 (1.29; 1.53)	<0.001	0.74 (0.56; 0.97)	0.031	0.67 (0.54; 0.82)	<0.001	0.59 (0.45; 0.77)	<0.001	0.69 (0.59; 0.82)	<0.001
Men versus women	1.03 (0.97; 1.10)	0.31	0.60 (0.45; 0.80)	<0.001	0.80 (0.65; 0.99)	0.038	0.40 (0.29; 0.55)	<0.001	1.84 (1.55; 2.18)	<0.001
Living alone versus not living alone	0.95 (0.89; 1.01)	0.10	0.86 (0.66; 1.13)	0.29	0.97 (0.79; 1.19)	0.75	1.22 (0.92; 1.61)	0.17	1.25 (1.06; 1.49)	0.008

Generalized linear model for multinomial data. All analyses were adjusted for cluster effect (municipality pairs)

Discussion

The first main result was that four clear patterns of functional decline in older people could be described in 88% of all the participants. The remaining 12% were primarily identified as combinations of catastrophic, reversible and progressive decline elements. A total of 58% of older adults (75- and 80-year-old) experienced no disability during 4½ years. The 75-year-olds experienced lower risk of functional decline compared with 80-year-olds in all decline patterns. Men had a higher risk of developing catastrophic decline compared with women, and women developed more progressive decline than men, which is in accordance with known epidemiological research (Ferrucci et al. 1996; Guralnik et al. 2001).

The second main result was that older adults living in the intervention municipalities experienced less progressive functional decline than older persons living in the control municipalities where no education took place. The education of the preventive home visitation staff and the GPs working in the intervention municipalities was not associated with other functional decline patterns. This has, to our knowledge, never previously been described.

The third main result was an association between declining the home visits offered and an increased risk of developing catastrophic functional decline compared with accepting the visits. This has never been reported before, although we have found that older persons refusing the offered home visits were at higher risk of developing general functional decline (Vass et al. 2005). Catastrophic events may be associated with disease, which could have been prevented in a long-time perspective. We do not know to which extent self-selection for participation in a preventive programme is a critical factor in comprehension of messages and acceptance of actions plan leading to proven beneficial impacts of proactive assessments. It is possible that persons refusing free, publicly offered preventive home visits also may have been reluctant to take up other public health offers and incorporate healthier life style messages in earlier life.

The incentive to participate in a health promotion offer, however, should also refer to the problems of time dependent confounding. Non-disabled older people may be reluctant to let preventive home visitors come into their home. Momentary or insidious functional limitations (progressive, reversible, and mixed decline pattern) may trigger the use of the preventive home visit offer, which eventually should lead to higher acceptance rates in these subgroups. This was, although not significantly, actually seen.

Reversible decline was not associated with intervention. We would have expected that intervention was effective in this context, but the group is small and the

time span between assessments may have been too long. Intervention often demands the introduction of rehabilitation strategies over a long period of time. Presumably differences were not big enough to demonstrate a positive effect, although the rehabilitative domain was very much underlined in the educational intervention. We may argue that the included cases were truly reversible and not at higher risk of disability, even though they did experience an episode of disability. Intensifying the efforts to recognize early functional decline as part of an interdisciplinary proactive approach where all domains were assessed improved functional ability (Vass et al. 2004, 2005). The absence of these effects in the reversible decline pattern group may reflect that the message of reacting quickly to very early sign of functional decline was the cue halting the onset of a progressive decline pattern. Further longitudinal analyses will be needed to explore this hypothesis.

Disability in essential activities of daily living often occurs insidiously, particularly among older persons who are physically frail or who have had prior episodes of disability (Gill et al. 2004a, b). The results may therefore imply that insidious decline is preventable rather than catastrophic. Catastrophic decline patterns are often related to stroke or cancer, which are sometimes preventable, but mainly in a longer lifetime perspective (Onder et al. 2001). Progressive decline patterns are associated with chronic diseases, diabetes, heart failure and vascular diseases and sensory impairments and they often have a higher rate of comorbidity (Deeg 2005; Guralnik et al. 2001). Hip fractures can be related to both patterns, but the fraction of 'preventable hip fractures' may be quite different in catastrophic and progressive decline patterns, depending on pre-existing comorbidity.

Preliminary analyses of hospitalised participants during the intervention period showed associations between different functional decline patterns and specific clinical diagnosis according to the ICD10 classification. However, no differences in the ten most prevalent diagnoses among hospitalised persons living in the intervention municipalities were seen compared with hospitalised persons living in the control municipalities. Further analyses incorporating follow-up data after the intervention period will be done to explore these associations in detail.

The benefits of intervention associated with the progressive decline pattern may also reflect that optimal preventive intervention should focus on frailty. Our interventional education underlined the awareness of frailty. Frail older person were defined as persons with disability or persons experiencing functional decline. We emphasised the importance of identifying even sub-clinical disability through alertness to 'tiredness in daily activities' (Avlund et al. 2002, 2003). Furthermore, poor self-rated health,

mental problems, having had a fall episode within the previous half year and taking more than four prescription medicines were considered indicators of frailty. Any unclarified question on medication or health related problem should result in referral to the GP. Efforts should also be made to identify *situations* implying a higher risk for development of frailty from arising. Such efforts could consist in actively contacting older people experiencing bereavement and older people newly discharged from hospitals where clinical judgement predicted need of coordination.

A strength enjoyed by the study is that the analyses are based on well-validated measures of disability (Avlund et al. 1995, 1996) based on six mobility activities. The scale has been tested with the Rasch item analytical model which showed that the included items all reflect the same dimension. Other studies of functional decline patterns have defined moderate and severe disability as being unable to perform daily activities (Guralnik et al. 2001; Ferrucci et al. 1996; Covinsky et al. 2003). Our descriptive results of the two cohorts were in accordance with reported findings in other populations supporting we are reporting the same concept. Our assessments were done in the Nordic/Scandinavian health and social care context and we do not know whether our findings may be generalised to other contexts.

We experienced an extremely low drop-out due to vigorous follow-up. Three persons were excluded, leaving all participants with no missing values on functional ability. The Danish registers provided high standards of precise data. All other data reflect high internal validity since registration of home visits in the 34 municipalities was standardized in easily implemented software and because employees in intervention as well as in control municipalities showed high motivation.

Functional decline patterns have been defined in different ways with respect to time intervals between assessments. Although disability is a highly dynamic process with considerable diversity, analytical strategies for estimating active and disabled life expectancy have assumed stability in activities of daily life function between periodic surveys spanning 12–24 months (Gill et al. 2005). We measured functional mobility every 1.5 years. Some decline or recurrent episodes, however, may be reversed within this time interval, which will imply that persons are categorised as non-decliners, although they may belong to a frailer subgroup (Gill et al. 2004a, b). This possible misclassification will not influence the claim that preventive intervention should target the group of older people with the lowest mortality (Stuck et al. 2002a, b) and focus on early signs of functional limitations and disability (Hardy and Gill 2004; Dapp et al. 2005).

Conclusion

Early signs of functional decline may serve as a trigger for when to intensify the search for and actively seek to ameliorate preventable conditions. Such intervention may be more successful in halting progressive decline than in preventing catastrophic decline. The importance of using functional ability as the key outcome and instrument to monitor ongoing assessments is crucial in the future concept of enabling active life expectancy. Education of the staff is a key issue to obtaining better practice settings. Targeting the non-disabled with preventive home visits and follow them up in an integrated preventive primary care scheme may be an efficient way of organising the prevention of functional progressive decline.

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Conflict of interest None. The corresponding author has full access to all the data in the study, and has taken final responsibility for the decision to submit for publication.

References

- Avlund K, Schroll M, Davidsen M, Løvgård B, Rantanen T (1994) Maximal isometric muscle strength and functional ability in daily activities among 75-year-old men and women. *Scand J Med Sci Sports* 4:32–40
- Avlund K, Thudium D, Davidsen M, Fuglsang-Sørensen B (1995) Are self-ratings of functional ability reliable? *Scand J Occup Ther* 2:10–16
- Avlund K, Kreiner S, Schultz-Larsen K (1996) Functional ability scales for the elderly. A validation study. *Eur J Public Health* 6:35–42
- Avlund K, Damsgaard MT, Sakari-Rantala R, Laukkanen P, Schroll M (2002) Tiredness in daily activities among non-disabled old people as determinant of onset of disability. *J Clin Epidemiol* 55:965–973
- Avlund K, Vass M, Hendriksen C (2003) Onset of mobility disability among community-dwelling old men and women. The role of tiredness in daily activities. *Age Ageing* 32:579–584
- Ayis S, Gooberman-Hill R, Bowling A, Ebrahim S (2006) Predicting catastrophic decline in mobility among older people. *Age Ageing* 35(4):382–387
- Covinsky KE, Eng C, Lui LY, Sands LP, Yaffe K (2003) The last 2 years of life: functional trajectories of frail older people. *J Am Geriatr Soc* 51(4):492–498
- Dapp U, Anders J, von Renteln-Kruse W, Meier-Baumgartner HP (2005) Active health promotion in old age: methodology of a preventive intervention programme provided by an interdisciplinary health advisory team for independent older people. *J Public Health* 13:122–127
- Deeg DJ (2005) Longitudinal characterization of course types of functional limitations. *Disabil Rehabil* 27:253–261
- Era P, Avlund K, Jokela J, Gause-Nilsson I, Heikkinen E, Steen B, Schroll M (1997) Postural balance and self-reported functional ability in 75-year-old men and women—a cross-national comparative study. *J Am Geriatr Soc* 45:21–29
- Ferrucci L, Guralnik JM, Simonsick E, Salive ME, Corti C, Langlois J (1996) Progressive versus catastrophic disability: a longitudinal view of the disablement process. *J Gerontol A Biol Sci Med Sci* 51(3):M123–M130
- Ferrucci L, Guralnik JM, Studenski S, Fried LP, Cutler GB Jr, Walston JD (2001) Interventions on Frailty Working Group. Designing randomized, controlled trials aimed at preventing or delaying functional decline and disability in frail, older persons: a consensus report. *J Am Geriatr Soc* 52(4):625–634
- Gill TM, Kurland B (2003) The burden and patterns of disability in activities of daily living among community-living older persons. *J Gerontol A Biol Sci Med Sci* 58(1):70–75
- Gill TM, Allore H, Holford TR, Guo Z (2004a) The development of insidious disability in activities of daily living among community-living older persons. *Am J Med* 117(7):484–491
- Gill TM, Allore HG, Holford TR, Guo Z (2004b) Hospitalization, restricted activity, and the development of disability among older persons. *JAMA* 292(17):2115–2124
- Gill TM, Allore H, Hardy SE, Holford TR, Han L (2005) Estimates of active and disabled life expectancy based on different assessment intervals. *J Gerontol A Biol Sci Med Sci* 60(8):1013–1016
- Guralnik JM, Ferrucci L, Balfour JL, Volpato S, Di Iorio A (2001) Progressive versus catastrophic loss of the ability to walk: implications for the prevention of mobility loss. *J Am Geriatr Soc* 49(11):1463–1470
- Hardy SE, Gill TM (2004) Recovery from disability among community-dwelling older persons. *JAMA* 291(13):1596–1602
- Onder G, Penninx BW, Ferrucci L, Fried LP, Guralnik JM, Pahor M (2001) Measures of physical performance and risk for progressive and catastrophic disability: results from the Women's Health and Aging Study. *J Gerontol A Biol Sci Med Sci* 60(1):74–79
- Stuck AE, Egger M, Hammer A, Minder CE, Beck JC (2002a) Home visits to prevent nursing home admission and functional decline in elderly people. Systematic review and meta-regression analysis. *JAMA* 287:1022–1028
- Stuck AE, Elckuch P, Dapp U, Anders J, Iliffe S, Swift CG (2002b) Pro-age pilot study group. Feasibility and yield of a self-administered questionnaire for health risk appraisal in older people in three European countries. *Age Ageing* 31(6):463–467
- Vass M, Avlund K, Hendriksen C, Andersen CK, Keiding N (2002) Preventive home visits to older people in Denmark. *Aging Clin Exp Res* 14:509–515
- Vass M, Avlund K, Kvist K, Hendriksen C, Andersen CK, Keiding N (2004) Structured home visits to older people. Are they only of benefit for women? A randomised controlled trial. *Scand J Prim Health Care* 22:106–111
- Vass M, Avlund K, Lauridsen J, Hendriksen C (2005) Feasible model for prevention of functional decline in older people. Municipality-randomized controlled trial. *J Am Geriatr Soc* 53:563–568
- Verbrugge LM, Jette AM (1994) The disablement process. *Soc Sci Med* 38(1):1–14
- von Renteln-Kruse W, Anders J, Dapp U, Meier-Baumgartner HP (2001) Preventative home visits by a specially trained nurse for 60-year olds and elderly in Hamburg. *Z Gerontol Geriatr* 36(5):378–391
- Williams IE, Fischer G, Junius U, Sandholtzer H, Jones D, Vass M (2002) An evidence-based approach to assessing older people in primary care. The Royal College of General Practitioners, Occasional Paper 82