Journal of Gerontology: MEDICAL SCIENCES
2008, Vol. 63A, No. 3, 298–307

Multidimensional Geriatric Assessment: Back to the Future

Multidimensional Preventive Home Visit Programs for Community-Dwelling Older Adults: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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Background. Multidimensional preventive home visit programs aim at maintaining health and autonomy of older adults and preventing disability and subsequent nursing home admission, but results of randomized controlled trials (RCTs) have been inconsistent. Our objective was to systematically review RCTs examining the effect of home visit programs on mortality, nursing home admissions, and functional status decline.

Methods. Data sources were MEDLINE, EMBASE, Cochrane CENTRAL database, and references. Studies were reviewed to identify RCTs that compared outcome data of older participants in preventive home visit programs with control group outcome data. Publications reporting 21 trials were included. Data on study population, intervention characteristics, outcomes, and trial quality were double-extracted. We conducted random effects meta-analyses.

Results. Pooled effects estimates revealed statistically nonsignificant favorable, and heterogeneous effects on mortality (odds ratio [OR] 0.92, 95% confidence interval [CI], 0.80–1.05), functional status decline (OR 0.89, 95% CI, 0.77–1.03), and nursing home admission (OR 0.86, 95% CI, 0.68–1.10). A beneficial effect on mortality was seen in younger study populations (OR 0.74, 95% CI, 0.58–0.94) but not in older populations (OR 1.14, 95% CI, 0.90–1.43). Functional decline was reduced in programs including a clinical examination in the initial assessment (OR 0.64, 95% CI, 0.48–0.87) but not in other trials (OR 1.00, 95% CI, 0.88–1.14). There was no single factor explaining the heterogenous effects of trials on nursing home admissions.

Conclusion. Multidimensional preventive home visits have the potential to reduce disability burden among older adults when based on multidimensional assessment with clinical examination. Effects on nursing home admissions are heterogeneous and likely depend on multiple factors including population factors, program characteristics, and health care setting.

Key Words: Aged—Geriatric assessment—Home visit—In-home—Multidimensional geriatric assessment—Older adults—Preventive home visit.

PREVENTIVE home visit programs have received much attention in the past two decades and are part of national policy in several countries, including Denmark and Australia (1,2). The overarching goal of such programs is to maintain the health and autonomy of older adults and to prevent disability and subsequent nursing home admission. Successful preventive home visit programs may have important implications for outcomes as well as for resource use and costs. However, the value of home visitation programs is controversial (2–8). Although some individual trials and several meta-analyses (2,3,5) suggest that these programs work, there is uncertainty to what extent they can prevent adverse outcomes (i.e., nursing home admission, functional status decline, or mortality), which program components are effective, and which populations are most likely to benefit (4,6–9).

The most recent meta-analysis of multidimensional preventive home visit programs published in 2002 suggests that the variation in findings likely stem from varying study population and individual program characteristics (2). This previous meta-analysis found that programs were more effective when study populations had a lower mean age, when interventions were based on multidimensional geriatric assessment that included a clinical examination, and when multiple follow-up home visits were offered (2). Yet an earlier systematic review using different trial inclusion criteria concluded that there was no clear evidence in favor of the effectiveness of preventive home visit programs (8). Adding to this controversy are several new studies published since 2002 showing variable effects of home visit

programs on both outcomes and costs (10–18). Although meta-analyses and systematic reviews attempt to contribute to our field of knowledge by synthesizing the literature, vast differences in trial inclusion/exclusion criteria and disparities in the characteristics of included trials make results difficult to interpret.

We performed a systematic review and meta-analysis using stringent trial inclusion/exclusion criteria, including recently published trials of preventive home visits, and taking into account individual trial characteristics (i.e., dose of intervention, type of personnel, population health status). We aimed to summarize the effects of preventive home visit programs on the key outcomes of nursing home admissions, functional status decline, and mortality, and to identify characteristics differentiating successful from unsuccessful programs. Based on findings of the 2002 meta-analysis, we hypothesized that programs are more likely to be beneficial on all three outcomes if they include a clinical examination as part of the initial multidimensional evaluation, are directed to younger study populations, and have more intensive interventions.

Methods

Literature Search and Eligibility Criteria

We searched for randomized controlled trials (RCTs) of the effects of multidimensional preventive home visit programs in older adults (mean age >70 years) living in the community. Trials had to report at least one of these outcomes: nursing home admission, functional status decline, or mortality. We evaluated studies included in the most recently published meta-analyses (2–5). Published studies were also identified through searches of EMBASE and MEDLINE (January 2001 through October 2007) and the Cochrane Database for Systematic Reviews (issue 4, 2007), using key words: *aged, home* or *in-home, prevention, multidimensional, screening,* and *geriatric* in combination with *functional, nursing home,* or *mortality*). We also searched the Cochrane Central Register of Controlled Trials with the same search terms. No language restrictions were applied. Three reviewers (A.H., A.E.S., and K.M.C.-G.) independently screened titles, abstracts, and full texts. Discrepancies were resolved by consensus with a fourth reviewer (L.Z.R.). We excluded studies that reported post–hospital discharge programs or home-based care-management programs, or did not offer broad preventive intervention programs but instead had a specific therapeutic or rehabilitative purpose such as cardiac rehabilitation or treatment of depression. Only studies designed with follow-up that included regular contact with intervention participants were included (i.e., multiple home visits, or home visits with regular telephone follow-up) (2,19).

Data Extraction and Outcome Definition

We extracted the following information on the study population and the characteristics of the intervention program: mean age of study population, dose of intervention (measured by the mean number of preventive home visits performed per year), if the initial multidimensional geriatric assessment included a clinical examination (e.g., physical examination, blood pressure measurement, foot examination [for diabetics], or laboratory tests for all intervention participants), and whether or not a geriatrician was part of the intervention team.

For each study, two of us (A.H. and K.M.C.-G.) independently extracted information on the endpoints nursing home admissions, functional status, and mortality. We recorded the number of participants admitted to nursing homes (excluding when identified short-term nursing home admissions and admissions to residential or board and care units). We abstracted the number of persons with functional status decline at follow-up. The definition of functional status was based on activities of daily living (ADL) or other specific measures of functional abilities as individually reported [i.e., Groningen Activity Restriction Scale-3 (11)]. If several outcome measures were reported, we used the measure based on ADLs. Six trials used continuous rather than discrete outcomes and provided means and standard deviations of these outcomes (11–13,20–22). These results were converted to odds ratios (OR) by use of the method described by Chinn (23) and Hasselblad and Hedges (24). This method is based on the fact that, when assuming logistic distributions and equal variances in the two treatment groups, the log OR corresponds to a constant multiplied by the standardized difference between means. For mortality, the number of deaths from all causes and participants with known vital status were recorded for intervention and control groups.

Original investigators were contacted if published data on study characteristics were incomplete or if data on any key outcome (nursing home admissions, functional status, and mortality) were missing or incomplete. Additional unpublished information was obtained from nine studies (10–13,20,21,25–27).

Assessment of Methodological Quality

Two of us (A.H. and K.M.C.-G.) assessed trial quality by examining the method of randomization and concealment of allocation, as well as blinding of staff ascertaining outcomes (28,29).

Statistical Analysis

We used a version of the ''metan'' command for Stata statistical software (Stata Corporation, College Station, TX) to conduct DerSimonian and Laird random effects meta-analyses (30). Between-trial heterogeneity was quantified using the I^2 statistic, which can be understood as the proportion of the total variation in estimated ORs that is due to between-trial heterogeneity rather than chance (31).

The extent to which one or more study characteristic explained between-trial heterogeneity was explored using meta-regression. The following variables were considered: mean age (in tertiles ≤77 years, 78– <80 years, ≥80 years), control group mortality rate (per year in tertiles <0.067, 0.067–0.081, >0.081; indicator of baseline risk of death and proxy for population health status), dose of intervention (mean number of visits <3, ≥3 per year dichotomized by median), clinical examination (yes/no), and whether a geriatrician was involved in the intervention.

In addition, we assessed effects of methodological quality characteristics such as concealment of allocation (adequate vs unclear) and blinding (outcome assessors reported to be blinded vs unclear). For all outcomes, we included the variables above one-by-one in meta-regression models, and conducted random effects meta-analyses within each subgroup. Systematic differences between small and large trials were assessed using funnel plots, and a statistical test for small study effects (funnel plot asymmetry) (32).

Results

Identification of Eligible Trials

We identified 4770 publications in our literature search, of which 20 publications describing 21 RCTs met our inclusion criteria and were included in our meta-analysis (Figure 1).

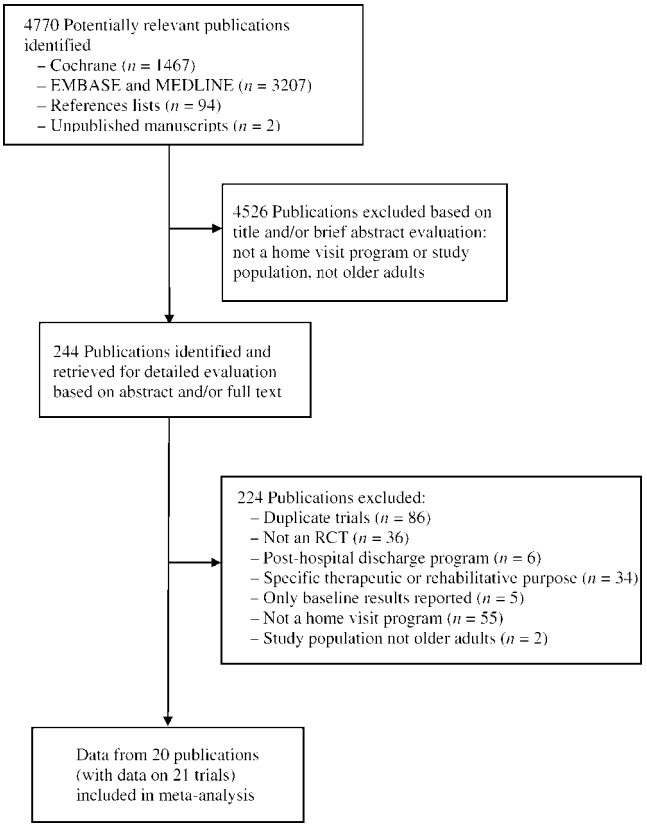

Figure 1. Identification of 21 eligible randomized control trials (RCTs) on multidimensional preventive home visit programs in community-dwelling older adults.

Characteristics of Trials, Participants, and Intervention Programs

An overview of study characteristics is given in Table 1. In the 21 included trials, 14,603 persons were allocated to either intervention (7355) or control (7248) groups. All RCTs reported mortality by intervention groups, 16 (76%) reported nursing home admissions, and 16 (76%) reported functional decline in a way that we could extract and compare results between trials. Mean age of the participants ranged from 73 to 83 years, with a median of 78.0. The number of home visits ranged up to 12, with a median of 4.3. Duration of the intervention period was reported to be between 4 months and 4 years. Seven trials (33%) reported an intervention period of 1 year or less, 14 (67%) reported a longer period. Six of the 21 trials (29%) reported having involved a geriatrician in the intervention, and seven trials (33%) reported an initial multidimensional geriatric assessment that included a clinical examination. Most studies reported that controls received ''usual care,'' but 4 of the 21 (19%) trials also reported interventions in controls. These were telephone follow-ups (20), a home safety visit (14), a single counselling session (16), or a social worker visit (27).

Effects on Nursing Home Admission

Trial results of nursing home admissions were heterogeneous (I^2 42.5%, $p = .04$). The overall reduction in the risk of admission was modest and not statistically significant, with a combined OR of 0.86 (95% confidence interval [CI], 0.68–1.10) (Table 2). For none of the study characteristics hypothesized to influence effects, meta-regression showed evidence of an association (Table 3). For example, multidimensional preventive home visit programs with <3 home visits per year had a similar effect on nursing home admissions as compared to programs with ≥ 3 visits per year (Figure 2).

Effects on Functional Status

Trial results of functional decline were also heterogeneous (I^2 52.4%, $p = .01$). Trials overall had little effect on functional decline, with a combined OR of 0.89 (95% CI, 0.76–1.03). Of the characteristics hypothesized to be associated with functional decline, studies including a clinical examination showed a beneficial effect on functional status with an OR of 0.64 (95% CI, 0.48–0.87), but the other studies did not (OR 1.00, 95% CI, 0.88–1.14) (Figure 3). In meta-regression, this factor was statistically significant ($p = .02$), and the inclusion of this term to the meta-analysis reduced I^2 from 52.4% to 31.0%.

Effects on Mortality

As with the previous outcomes, results of mortality were heterogeneous (I^2 35.6%, $p = .055$) with a combined OR of 0.92 (95% CI, 0.80–1.05). Trials with participants with a mean age in the lowest tertile showed a protective effect of the intervention on mortality with an OR of 0.74 (95% CI, 0.58–0.94) compared to the trials with mean age in the upper tertile with an OR of 1.14 (95% CI, 0.90–1.43) (Figure 4). Age was borderline statistically significant in a meta-regression analysis ($p < .06$), and reduced I^2 from 35.6% to 12.6%.

Methodological Quality of Trials

Eleven of 21 (52%) trials reported adequate blinding in assessing nursing home admissions, and 10 of 21 (48%) adequate blinding in assessing functional decline. All-cause mortality is an unambiguous outcome, and blinding of assessors was not extracted. Concealment of allocation was

Table 1. Characteristics of 21 Studies (Listed Alphabetically) Included in Meta-Analysis of Multidimensional Preventive Home Visit Programs for Community-Dwelling Older Adults

Study (Author, Y, Ref)	Country	Inclusion Criteria	No. of Participants in Intervention/ Control Groups	Intervention Personnel	Study Population Mean Age	Control Mortality Rate (per y)	Mean No. Visits	Duration of Intervention (y)	Multidimensional Assessment with Clinical Examination (Yes/No):* Domains Assessed
Bouman et al., 2007 (12)	The Netherlands	70–84 y, self-reported poor health status and no home nursing care	160/170	Trained‡ community nurse with supervision of public health nurse	76	0.090	6.9	1.5	No: Health, function, psychosocial, environment
Byles et al., 2004 (10)	Australia	≥70 y	942/627	Nurse, social worker, psychologists, physiotherapists, occupational therapists	77.3	0.032	4.5	3.0	No: Health, function, psychosocial, environment
Carpenter and Demopoulos, 1990 (25)	U.K.	≥75 y	272/267	Volunteer	80	0.067	8.5	3.0	No: Function, psychosocial, environment
Fabacher et al., 1994 (20)	United States	≥70 y, no terminal illness or dementia	131/123	Physician assistant and nurse trained in geriatrics	73	0.033	4.0	1.0	Yes: Health, function, psychosocial, environment
Gunner-Svensson et al., 1984 (46)	Denmark	≥75 y	2055/2073	Geriatric nurse	79	0.067	5.0	3.25	No: Health, function, psychosocial, environment
Hebert et al., 2001 (47)	Canada	≥70 y, at risk for functional decline	250/253	Trained nurse‡	80	0.071	1.0†	1.0	Yes: Health, function, psychosocial, environment
Hendriksen et al., 1984 (26)	Denmark	≥75 y	300/300	Home care nurse or physician	79	0.083	12.0	3.0	No: Health, psychosocial
Kono et al., 2004 (13)	Japan	≥65 y, went outdoors <3 times/wk	59/60	Trained public health nurse‡	83	0.067	4.3	1.5	No: Function, psychosocial, environment
Mahoney et al., 2007 (14)	United States	≥65 y, previous falls or gait or balance problems	174/175	Trained nurse or physical therapist§	80	0.046	2.0†	1.0	Yes: Health, function, psychosocial, environment
Melis et al., 2008 (11)	The Netherlands	≥70 y, ≥1 limitation in cognition, IADLs, or mental well-being	85/66	Geriatric nurse	82	0.20	3.8	0.25	No: Health, function, psychosocial
Pathy et al., 1992 (48)	U.K.	≥65 y	369/356	Health visitor	73	0.081	9.0	3.0	No: Health, function, psychosocial, environment
Sahlen et al., 2006 (15)	Sweden	≥75 y, without home help	249/346	Nurse and care manager	79	0.12	4.0	2.0	No: Health, function, psychosocial, environment
Sjosten et al., 2007 (16)	Finland	≥65 y, previous falls	293/298	Geriatrician, trained‡ public health nurse, trained‡ student nurse	74	0.013	2.0	1.0	Yes: Health, function, psychosocial, environment
Stuck et al., 1995 (35)	United States	≥75 y, not severely impaired	215/119	Geriatrician, geriatric nurse practitioner	81	0.073	12.0	3.0	Yes: Health, function, psychosocial, environment
Stuck et al., 2000 (36)	Switzerland	≥75 y, not severely impaired	264/527	Geriatrician, public health nurse	82	0.064	7.5	2.0	Yes: Health, function, psychosocial, environment
Tinetti et al., 1994 (27)	United States	≥70 y, at risk for falls	153/148	Nurse practitioner, physical therapist	78	0.068	7.8	0.5	Yes: Health, function, psychosocial, environment
van Haastregt et al., 2000 (21)	The Netherlands	≥70 y, previous falls or impaired mobility	159/157	Community nurse	77	0.089	4.0	1.0	No: Health, function, psychosocial, environment
van Rossum et al., 1993 (22)	The Netherlands	75–84 y, not receiving home care	292/288	Home care nurse	78	0.058	12.0	3.0	No: Health, function, psychosocial, environment
Vetter et al. (Gwent), 1984 (49)	U.K.	≥70 y	296/298	Health visitor	77	0.10	2.9	2.0	No: Health, function, psychosocial
Vetter et al. (Powys), 1984 (49)	U.K.	≥70 y	281/273	Health visitor	78	0.082	1.9	2.0	No: Health, function, psychosocial
Vetter et al., 1992 (50)	U.K.	≥70 y	350/324	Health visitor	77	0.082	4.0	4.0	No: Health, function, environment

Notes: *Intervention included at least one clinical examination or measurement such as blood pressure measurement, or laboratory tests.

†Intervention included 11 monthly follow-up telephone calls.

‡Type of training unspecified.

§Study specific brief (<4 days) training by geriatrician.

IADLs = Instrumental Activities of Daily Living.

Table 2. Odds Ratios for Nursing Home Admission, Functional Status Decline, and Mortality in 21 Trials (Listed Alphabetically) of Multidimensional Preventive Home Visit Programs for Community-Dwelling Older Adults

Study (Author, Y, Ref)	Nursing Home Admission OR (95% CI)	Functional Status Decline OR (95% CI)	Mortality OR (95% CI)
Bouman et al., 2007 (12)	0.96 (0.40–2.33)	0.97 (0.66–1.44)	1.41 (0.78–2.57)
Byles et al., 2004 (10)	2.81 (1.22–6.46)	1.10 (0.92–1.32)	1.29 (0.93–1.79)
Carpenter and Demopoulos, 1990 (25)	0.67 (0.28–1.59)	1.02 (0.68–1.55)	1.26 (0.84–1.90)
Fabacher et al., 1994 (20)	—*	0.56 (0.34–0.94)	0.95 (0.23–3.91)
Gunner-Svensson et al., 1984 (46)	0.81 (0.65–1.01)	—*	1.03 (0.89–1.19)
Hebert et al., 2001 (47)	1.02 (0.29–3.56)	0.96 (0.62–1.51)	0.66 (0.31–1.40)
Hendriksen et al., 1984 (26)	0.67 (0.37–1.22)	—*	0.73 (0.50–1.08)
Kono et al., 2004 (13)	0.60 (0.18–1.96)	0.83 (0.54–1.29)	0.65 (0.17–2.45)
Mahoney et al., 2007 (14)	0.55 (0.36–0.86)	—*	1.14 (0.43–3.02)
Melis et al., 2008 (11)	0.83 (0.39–1.76)	1.24 (0.69–2.23)	0.97 (0.25–3.76)
Pathy et al., 1992 (48)	0.67 (0.37–1.22)	1.24 (0.76–2.03)	0.70 (0.49–1.00)
Sahlen et al., 2006 (15)	—*	—*	0.81 (0.54–1.20)
Sjosten et al., 2007 (16)	—*	—*	1.28 (0.34–4.80)
Stuck et al., 1995 (35)	0.39 (0.17–0.88)	0.48 (0.26–0.88)	0.84 (0.46–1.51)
Stuck et al., 2000 (36)	1.58 (0.99–2.54)	0.80 (0.53–1.19)	1.49 (0.99–2.23)
Tinetti et al., 1994 (27)	0.48 (0.04–5.35)	0.42 (0.23–0.76)	1.37 (0.43–4.42)
van Haastregt et al., 2000 (21)	0.97 (0.06–15.62)	0.68 (0.43–1.06)	0.67 (0.29–1.56)
van Rossum et al., 1993 (22)	1.39 (0.44–4.43)	1.16 (0.86–1.56)	0.80 (0.51–1.25)
Vetter et al. (Gwent), 1984 (49)	—*	1.32 (0.92–1.91)	0.53 (0.34–0.83)
Vetter et al. (Powys), 1984 (49)	—*	0.69 (0.47–1.02)	0.96 (0.61–1.51)
Vetter et al., 1992 (50)	1.44 (0.58–3.57)	0.87 (0.60–1.26)	0.69 (0.49–0.97)
Combined odds ratio (random effects)	0.86 (0.68–1.10)	0.89 (0.77–1.03)	0.92 (0.80–1.05)
I^2, p value, test of heterogeneity	42.5%, $p = .037$	52.4%, $p = .008$	35.6%, $p = .055$

Notes: *Outcome not assessed.
OR = odds ratio; CI = confidence interval.

assessed to be adequate in 6 of 21 RCTs (29%). In meta-regression analysis and stratified subgroup analyses (Table 3), there was little evidence that blinding or allocation concealment influenced results. The funnel plots and statistical tests for small study effects that were conducted for all outcomes did not reveal evidence of funnel plot asymmetry (all $p > .2$).

Discussion

This systematic review and meta-analysis of multidimensional preventive home visit programs in community-dwelling older adults using stringent inclusion criteria showed heterogeneous results for all outcomes. Meta-regression analyses confirmed our hypotheses related to functional status and mortality outcomes. Preventive home visit programs focusing on younger study populations produced significant beneficial effects on mortality, and programs prevented or significantly delayed functional status decline if they included a clinical examination as part of the initial assessment. However, this meta-analysis did not confirm our hypotheses related to nursing home admissions, and no effect on any outcome was seen in programs with more intensive interventions.

In the nearly 6 years since the most recent meta-analysis on preventive home visit programs was conducted (2), several new studies have been published, adding to the evidence base (10–16,33,34). We included these new RCTs, evaluated additional study characteristics, and used more stringent study inclusion criteria. Our methods confirmed some previous findings and provided some surprising new ones. We confirmed that the use of multidimensional geriatric assessment that included a clinical examination and regular follow-up was an important determinant of program effects on functional status outcomes. This finding is compatible with the concept that functional status decline can be delayed or prevented by periodic multidimensional evaluation for detection of modifiable risk factors and subsequent long-term intervention to modify these risk factors as well as to identify new risks. Also consistent with previous research, the effect of preventive home visit programs on mortality was most pronounced in younger populations.

Our results showed no program effects on nursing home admissions among older adults, even in trials with intensive interventions. Heterogeneity between trials was large, with results ranging from a statistically significant reduction in nursing home admissions (OR 0.39, 95% CI, 0.17–0.88) (35) to a significant increase in nursing home admissions as a result of the preventive home visits (OR 2.81, 95% CI, 1.22–6.46) (10). The fact that nursing home admissions might even be increased as a result of preventive home visits in some trials might be explained by regional health care factors, perhaps related to an underlying under provision of nursing home care, with appropriate placements of older persons to nursing homes as a result of the intervention. Alternatively, other factors such as unmeasured intervention quality factors might be responsible for these variable effects (36).

A major strength of this research is that we conducted an extensive and thorough literature search: We are confident that we identified all published RCTs meeting our inclusion

Table 3. Random Effects Meta-Analyses for Outcomes Nursing Home Admission, Adverse Functional Status, and Mortality Stratified by Study Characteristics in 21 Trials of Multidimensional Preventive Home Visit Programs for Community-Dwelling Older Adults

Characteristics	Nursing Home Admission OR (95% CI)	Functional Status Decline OR (95% CI)	Mortality OR (95% CI)
Study characteristics*			
Population			
Mean age of study population (in tertiles)			
≤77 y	0.87 (0.57–1.34)	0.91 (0.71–1.18)	0.74 (0.58–0.94)‖
78–<80 y	1.03 (0.62–1.71)	0.85 (0.60–1.56)	0.97 (0.84–1.12)
≥80 y	0.75 (0.49–1.16)	0.87 (0.70–1.08)	1.14 (0.90–1.43)
Mortality rate in controls (per y in tertiles)			
<0.067	1.15 (0.59–2.25)	0.92 (0.74–1.55)	—‡
0.067–0.081	0.78 (0.64–0.94)	0.81 (0.60–1.10)	—‡
>0.081	0.78 (0.52–1.17)	0.94 (0.71–1.24)	—‡
Intervention program			
Multidimensional assessment with clinical examination			
No	0.88 (0.70–1.11)	1.00 (0.88–1.14)†	0.88 (0.76–1.03)
Yes	0.75 (0.39–1.44)	0.64 (0.48–0.87)	1.13 (0.86–1.48)
Geriatrician involved in intervention			
No	0.88 (0.70–1.09)	0.94 (0.81–1.09)	0.88 (0.76–1.02)
Yes	0.75 (0.40–1.42)	0.72 (0.50–1.05)	1.20 (0.90–1.61)
Dose of intervention (dichotomized by median)			
<3 visits per y	0.90 (0.62–1.32)	0.98 (0.84–1.15)	0.91 (0.76–1.09)
≥3 visits per y	0.85 (0.60–1.19)	0.81 (0.63–1.03)	0.92 (0.74–1.14)
Methodological quality characteristics			
Concealment of allocation			
Adequate	0.71 (0.35–1.42)	0.69 (0.54–0.88)	1.18 (0.88–1.58)
Unclear	0.88 (0.71–1.08)	0.96 (0.83–1.12)	0.88 (0.76–1.02)
Blinding of staff ascertaining outcomes			
Blinded	0.97 (0.67–1.42)	0.87 (0.72–1.05)	—§
Unclear	0.75 (0.61–0.92)	0.92 (0.71–1.19)	—§

Notes: *For definition of characteristics, see Methods section.
†Variable statistically significant ($p < .05$) in meta-regression analysis.
‡Outcome not analyzed, stratified variable same as outcome variable.
§Stratification variable not assessed.
‖Variable borderline statistically significant ($p < .06$) in meta-regression analysis.
OR = odds ratio; CI = confidence interval.

criteria. We collected detailed information on study characteristics (e.g., population health status, dose of intervention, assessment domains, intervention personnel), which allowed a more extensive evaluation of the effect of study population and program characteristics on outcomes. We also purposely used stringent inclusion criteria based on previous research, thereby attempting to reduce some of the variation in program characteristics (2). This meant that we excluded some studies that had been included in the previous meta-analysis as well as some larger newer trials (33,34,37–40). A recent study in Denmark was excluded because it was primarily a study of provider education (34). Moreover, we excluded the large Medical Research Council (MRC) trial (33), because intervention assessments were not only offered to persons in the intervention group (''universal assessment group''), but also to persons in the control group (''targeted assessment group''), and the intervention did not include home visits with regular follow-up. The results of the MRC trial were disappointing, with few differences at the 3-year follow-up. One hypothesis is that the intervention in the control group might have diluted intervention effects. A second hypothesis is that, although the MRC trial is the largest trial of geriatric assessment ever done, the randomization of general practices rather than individuals means that it may not have had sufficient statistical power to detect or exclude clinically important effects (41).

There is widespread confusion regarding terminology. We suggest the use of the term ''multidimensional preventive home visit program'' for home visit programs offered to community-dwelling older adults (rather than selected groups of older people, such as to those recently discharged from the hospital), with follow-up through home visits or telephone contacts (rather than screening-only programs or home-based care-management programs) that include multidimensional assessment. Lack of uniform terminology has led to confusion over program definition and probably contributed to the heterogeneity in results. The use of clearly defined terminology will help to develop

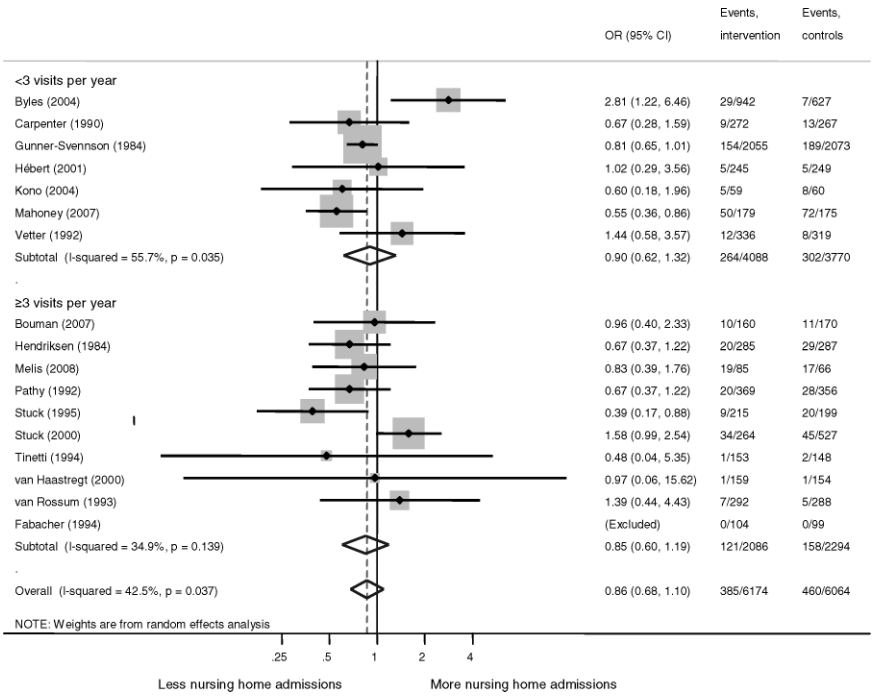

Figure 2. Effect of multidimensional preventative home visit programs on nursing home admissions, trials stratified by number of visits per year (<3 visits per year, ≥3 visits per year), random effects model.

a consensus and standardize program characteristics in the field. This definition differentiates preventive home visit programs from other potentially promising intervention programs that are offered in the home setting for older adults. For instance, a recently published RCT in the United States described beneficial effects of a home-based geriatric care-management program offered to a population of low-income older adults (42).

Based on RCTs, the comparisons made in meta-regression analyses are observational, and factors included in the meta-regression analyses might not be independent. Meta-analytic subgroup analyses, like subgroup analyses

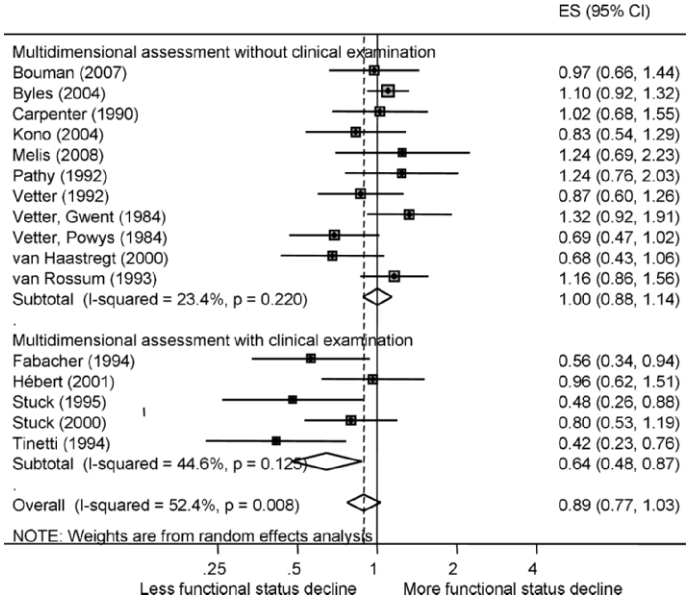

Figure 3. Effect of multidimensional preventative home visit programs on functional status decline, trials stratified by multidimensional assessment with clinical examination, random effects model.

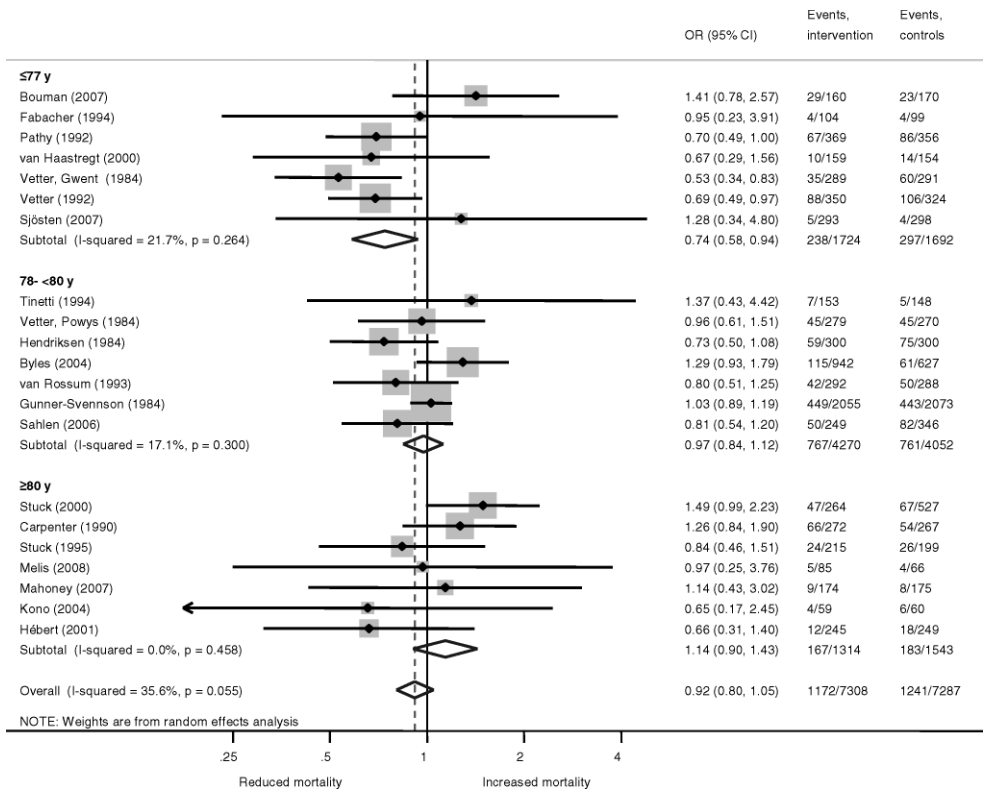

Figure 4. Effect of multidimensional preventative home visit programs on mortality, trials stratified by three age groups (years in tertiles), random effects model.

within trials, are prone to bias and confounding and therefore should be interpreted with caution (43–45). There is also inaccuracy in meta-analysis results due to poor individual trial reporting and imprecision in measurement, which might result in nondifferential misclassification and potential underestimates of true effects. This might be an issue for the functional decline outcomes that were measured using different methods and may have been affected by attrition bias. Although we assessed population and intervention characteristics, these measures were limited. For example, we were unable to find a precise measure of the intervention dose and therefore had to use a crude proxy measure (number of visits per year) that does not take into account actual content and extent of participant contacts (i.e., many interventions included inconsistently described phone contacts). Lastly, we acknowledge that the effects of other unmeasured program characteristics, such as the intervention teams' case loads, scope of practice during follow-up, interactions with primary care physicians, and authority to take diagnostic and therapeutic action, could not be addressed.

The evidence on the effectiveness of multidimensional preventive home visit programs indicates that even under controlled experimental conditions, effects of programs vary and are affected by four major factors: (i) intervention program characteristics (i.e., nonstandardized terminology and protocols, nonspecific measures unrepresentative of actual intensity), (ii) population characteristics (i.e., what people enrolled, assessed using crude proxy measures), (iii) adherence (i.e., how participants and health professionals followed recommendations), and (iv) setting (i.e., underlying patterns of health care use). These results, although confirming some previous results (2,8), underscore the need for additional RCTs, collaborative individual person data (IPD) meta-analyses, as well as practice implementation programs. Future high-quality trials with well-documented interventions, follow-up periods, target populations, specific measures of intervention dose, and exact characterization of settings would extend our knowledge by further clarifying which populations benefit and what program characteristics are effective. Collaborative IPD meta-analyses of existing trials could also help to distinguish factors related to programs, populations, intervention dose, and settings.

Based on current evidence, multidimensional preventive home visits have the potential to reduce disability burden among older adults. The high prevalence of coexisting risk factors in community-dwelling older adults emphasizes the need for multidimensional preventive home visit programs that address multiple coexisting risk factors. Several seminal studies have documented the ability of prototype programs to produce important beneficial effects. By omitting crucial program components, subsequent replication trials may produce disappointing results. Therefore, based on the existing body of evidence, future programs should be tailored to specific regional settings, and effects of programs on health and health care use should be evaluated in the real clinical practice settings in which they function.

Acknowledgments

This research was supported by institutional funds from the University of Bern.

We thank Dr. Aijing Shang, Gerhard Gillmann, and Prof. Dr. Christoph Minder, who helped with conversions of continuous outcomes to odds ratios, and Muriel Käser for her assistance with data entry.

Author contributions: Anke Huss: study design, data collection, data analysis, data interpretation, preparation of manuscript; Andreas Stuck: study concept, study design, data collection, data interpretation, preparation of manuscript; Laurence Rubenstein: study concept, study design, manuscript preparation; Matthias Egger: data interpretation, preparation of manuscript; Kerri Clough-Gorr: study design, data collection, data analysis, data interpretation, preparation of manuscript.

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References

1. Byles JE. A thorough going over: evidence for health assessments for older persons. *Aust N Z J Public Health.* 2000;24:117–123.
2. Stuck AE, Egger M, Hammer A, Minder CE, Beck JC. Home visits to prevent nursing home admission and functional decline in elderly people: systematic review and meta-regression analysis. *JAMA.* 2002; 287:1022–1028.
3. Elkan R, Kendrick D, Dewey M, et al. Effectiveness of home based support for older people: systematic review and meta-analysis. *BMJ.* 2001;323:719–725.
4. Markle-Reid M, Browne G, Weir R, et al. The effectiveness and efficiency of home-based nursing health promotion for older people: a review of the literature. *Med Care Res Rev.* 2006;63:531–569.
5. Stuck AE, Siu AL, Wieland GD, Adams J, Rubenstein LZ. Comprehensive geriatric assessment: a meta-analysis of controlled trials. *Lancet.* 1993;342:1032–1036.
6. Stuck AE, Zwahlen HG, Neuenschwander BE, et al. Methodologic challenges of randomized controlled studies on in-home comprehensive geriatric assessment: the EIGER project. Evaluation of In-Home Geriatric Health Visits in Elderly Residents. *Aging (Milano).* 1995; 7:218–223.
7. Stuck A, Kane RL. Whom do preventive home visits help? *J Am Geriatr Soc.* 2008 Jan 2; [Epub ahead of print] PMID: 18179507.
8. van Haastregt JC, Diederiks JP, van Rossum E, de Witte LP, Crebolder HF. Effects of preventive home visits to elderly people living in the community: systematic review. *BMJ.* 2000;320:754–758.
9. Egger M. Commentary: when, where, and why do preventive home visits work? *BMJ.* 2001;323:724–725.
10. Byles JE, Tavener M, O'Connell RL, et al. Randomised controlled trial of health assessments for older Australian veterans and war widows. *Med J Aust.* 2004;181:186–190.
11. Melis RJ, van Eijken MI, Teerenstra S, et al. Multidimensional Geriatric Assessment. A randomized study of a multidisciplinary program to intervene on geriatric syndromes in vulnerable older people who live at home (Dutch EASYcare Study). *J Gerontol A Biol Sci Med Sci.* 2008;63A:283–290.
12. Bouman A, van Rossum E, Ambergen T, Kempen G, Knipschild P. Effects of a home visiting program for older people with poor health status: a randomized, clinical trial in The Netherlands. *J Am Geriatr Soc.* 2007 Dec 27; [Epub ahead of print] PMID: 18179482.
13. Kono A, Kai I, Sakato C, Harker JO, Rubenstein LZ. Effect of preventive home visits for ambulatory housebound elders in Japan: a pilot study. *Aging Clin Exp Res.* 2004;16:293–299.
14. Mahoney JE, Shea TA, Przybelski R, et al. Kenosha County falls prevention study: a randomized, controlled trial of an intermediate-intensity, community-based multifactorial falls intervention. *J Am Geriatr Soc.* 2007;55:489–498.
15. Sahlen KG, Dahlgren L, Hellner BM, Stenlund H, Lindholm L. Preventive home visits postpone mortality–a controlled trial with time-limited results. *BMC Public Health.* 2006;6:220.
16. Sjosten NM, Salonoja M, Piirtola M, et al. A multifactorial fall prevention programme in home-dwelling elderly people: a randomized-controlled trial. *Public Health.* 2007;121:308–318.
17. Bouman A, van Rossum E, Evers S, et al. Multidimensional Geriatric Assessment. Effects on health care use and cost-effectiveness of a home visiting program for older people with a poor health status: a randomized clinical trial in the Netherlands. *J Gerontol A Biol Sci Med Sci.* 2008;63A:291–297.
18. Melis RJ, Adang E, Teerenstra S, et al. Multidimensional Geriatric Assessment. The cost-effectiveness of a multidisciplinary intervention model for community-dwelling frail older people. *J Gerontol A Biol Sci Med Sci.* 2008;63A:275–282.
19. Consensus development summaries: geriatric assessment methods for clinical decision making. National Institutes of Health. *Conn Med.* 1988;52:92–97.
20. Fabacher D, Josephson K, Pietruszka F, et al. An in-home preventive assessment program for independent older adults: a randomized controlled trial. *J Am Geriatr Soc.* 1994;42:630–638.
21. van Haastregt JC, Diederiks JP, van Rossum E, et al. Effects of a programme of multifactorial home visits on falls and mobility impairments in elderly people at risk: randomised controlled trial. *BMJ.* 2000;321:994–998.
22. van Rossum E, Frederiks CM, Philipsen H, et al. Effects of preventive home visits to elderly people. *BMJ.* 1993;307:27–32.
23. Chinn S. A simple method for converting an odds ratio to effect size for use in meta-analysis. *Stat Med.* 2000;19:3127–3131.
24. Hasselblad V, Hedges LV. Meta-analysis of screening and diagnostic tests. *Psychol Bull.* 1995;117:167–178.
25. Carpenter GI, Demopoulos GR. Screening the elderly in the community: controlled trial of dependency surveillance using a questionnaire administered by volunteers. *BMJ.* 1990;300:1253–1256.
26. Hendriksen C, Lund E, Stromgard E. Consequences of assessment and intervention among elderly people: a three year randomised controlled trial. *Br Med J (Clin Res Ed).* 1984;289:1522–1524.
27. Tinetti ME, Baker DI, McAvay G, et al. A multifactorial intervention to reduce the risk of falling among elderly people living in the community. *N Engl J Med.* 1994;331:821–827.
28. Jadad AR, Moore RA, Carroll D, et al. Assessing the quality of reports of randomized clinical trials: is blinding necessary? *Control Clin Trials.* 1996;17:1–12.
29. Juni P, Altman DG, Egger M. Systematic reviews in health care: assessing the quality of controlled clinical trials. *BMJ.* 2001;323: 42–46.
30. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials.* 1986;7:177–188.
31. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med.* 2002;21:1539–1558.
32. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ.* 1997;315: 629–634.
33. Fletcher AE, Price GM, Ng ES, et al. Population-based multidimensional assessment of older people in UK general practice: a cluster-randomised factorial trial. *Lancet.* 2004;364:1667–1677.
34. Vass M, Avlund K, Hendriksen C. Randomized intervention trial on preventive home visits to older people: baseline and follow-up characteristics of participants and non-participants. *Scand J Public Health.* 2007;35:410–417.
35. Stuck AE, Aronow HU, Steiner A, et al. A trial of annual in-home comprehensive geriatric assessments for elderly people living in the community. *N Engl J Med.* 1995;333:1184–1189.
36. Stuck AE, Minder CE, Peter-Wuest I, et al. A randomized trial of in-home visits for disability prevention in community-dwelling older people at low and high risk for nursing home admission. *Arch Intern Med.* 2000;160:977–986.
37. Clarke M, Clarke SJ, Jagger C. Social intervention and the elderly: a randomized controlled trial. *Am J Epidemiol.* 1992;136: 1517–1523.
38. McEwan RT, Davison N, Forster DP, Pearson P, Stirling E. Screening elderly people in primary care: a randomized controlled trial. *Br J Gen Pract.* 1990;40:94–97.
39. Newbury JW, Marley JE, Beilby JJ. A randomised controlled trial of the outcome of health assessment of people aged 75 years and over. *Med J Aust.* 2001;175:104–107.

40. Sorensen KH, Sivertsen J. Follow-up three years after intervention to relieve unmet medical and social needs of old people. *Compr Gerontol B*. 1988;2:85–91.
41. Stuck AE, Beck JC, Egger M. Preventing disability in elderly people. *Lancet*. 2004;364:1641–1642.
42. Counsell SR, Callahan CM, Clark DO, et al. Geriatric care management for low-income seniors: a randomized controlled trial. *JAMA*. 2007; 298:2623–2633.
43. Assmann SF, Pocock SJ, Enos LE, Kasten LE. Subgroup analysis and other (mis)uses of baseline data in clinical trials. *Lancet*. 2000;355: 1064–1069.
44. Lau J, Ioannidis JP, Schmid CH. Summing up evidence: one answer is not always enough. *Lancet*. 1998;351:123–127.
45. Thompson SG. Why sources of heterogeneity in meta-analysis should be investigated. *BMJ*. 1994;309:1351–1355.
46. Gunner-Svensson F, Ipsen J, Olsen J, Waldstrom B. Prevention of relocation of the aged in nursing homes. *Scand J Prim Health Care*. 1984;2:49–56.
47. Hebert R, Robichaud L, Roy PM, Bravo G, Voyer L. Efficacy of a nurse-led multidimensional preventive programme for older people at risk of functional decline. A randomized controlled trial. *Age Ageing*. 2001;30:147–153.
48. Pathy MS, Bayer A, Harding K, Dibble A. Randomised trial of case finding and surveillance of elderly people at home. *Lancet*. 1992;340: 890–893.
49. Vetter NJ, Jones DA, Victor CR. Effect of health visitors working with elderly patients in general practice: a randomised controlled trial. *Br Med J (Clin Res Ed)*. 1984;288:369–372.
50. Vetter NJ, Lewis PA, Ford D. Can health visitors prevent fractures in elderly people? *BMJ*. 1992;304:888–890.

Received December 3, 2007
Accepted January 15, 2008
Decision Editor: Luigi Ferrucci, MD, PhD