OXFORD

Health Service Research

Overall mortality in older people receiving physician-led home visits: a multicentre prospective study in Japan

Makoto Kaneko[a,b,c,d,†], Takamasa Watanabe[a,b,†], Yasuki Fujinuma[b], Kenichi Yokobayashi[e] and Masato Matsushima[a,*,†,©]

[a]Division of Clinical Epidemiology, Research Center for Medical Sciences, The Jikei University School of Medicine, Tokyo, [b]Centre for Family Medicine Development, Japanese Health and Welfare Co-operative Federation, Tokyo, [c]Department of Family and Community Medicine, Hamamatsu University School of Medicine, Shizuoka, [d]Primary Care Research Unit, Graduate School of Health Data Science, Yokohama City University, Yokohama and [e]Home Care Clinic, Hiroshima, Japan

*Correspondence to Masato Matsushima, Division of Clinical Epidemiology, Research Center for Medical Sciences, The Jikei University School of Medicine, 3-25-8 Nishishimbashi Minato-ku, Tokyo 105–8461, Japan; E-mail: masato@jikei.ac.jp
[†]These authors contributed equally to this article.

Abstract

Background: Japan has the most rapidly ageing population in the world. The Japanese government has, therefore, promoted physician-led home health care for frail and disabled people.
Objectives: To describe mortality among older people receiving physician-led health care at home or at a nursing home in Japan and to identify risk factors.
Methods: This was a multicentre prospective cohort study. Participants were aged ≥65 years and had started to receive regular physician-led health care at home or at nursing homes from 13 facilities between 1 February 2013 and 31 January 2016. The observation period ended on 31 January 2017. We used a biopsychosocial approach for exploratory analysis of 13 variables to identify mortality risk factors.
Results: The median (25th to 75th percentile) observation time was 417 (121–744) days. Of 825 participants, 380 died. The total cumulative survival for 180, 360, 720 and 1440 days was 73.4% (95% confidence interval: 70.2–76.3), 64.2% (60.8–67.5), 52.6% (48.8–56.3) and 34.6% (23.5–46.0). The Kaplan–Meier cumulative survival curve showed a steep drop during the first 6 months of observation. A multivariate Cox proportional hazard model showed that sex (male), high Charlson Comorbidity Index score, low serum albumin level, low Barthel Index score, receipt of oxygen therapy, high Cornell Scale for Depression in Dementia score and non-receipt of public assistance were associated with mortality.
Conclusions: Overall mortality in physician-led home visits in Japan was described and mortality risk factors identified. Public assistance receipt was associated with lower mortality.

Key words: Aged, cohort study, home care services, mortality, prospective studies, social welfare.

Background

Population ageing is a global issue that affects the provision of health care and long-term care (1,2). The population of Japan is ageing at an unprecedented rate and more rapidly than the population of any other country (3,4). Health care providers and policymakers must, therefore, address the problem of care for older adults (4). To facilitate this, the Japanese government has promoted physician-led home-visit care for frail and disabled people (5).

Key Messages

- We report mortality in older people receiving physician-led home visits in Japan.
- The cohort included patients with severe illnesses.
- There was a steep drop in survival in the home medical care introductory phase.
- Comorbidities and receiving oxygen therapy were linked to mortality.
- Nutritional status and physical function were also linked to mortality.
- Unexpectedly, patients who received public assistance were less likely to die.

Previous meta-analyses indicate that preventive home visits (mainly conducted by nurses rather than physicians) for older adults reduce mortality and admission to long-term care facilities (6,7). However, the use of regular physician-led home visits is declining in many developed countries (8–11) to save time and ensure health provider safety (10,11). Physicians play a major role in home visits in some countries, such as Germany, Belgium (12) and Japan, because task sharing to facilitate home visits is not well established (12). Physician-led home visits in Japan provide medical care for chronic illness and acute non-severe conditions and are, therefore, intermediate between home care services and home hospitalization (13). Following the Japanese government's promotion of physician-led home visits (5), basic information (e.g. mortality and related risk factors) about patients receiving home-visit care is needed to evaluate the policy's effectiveness. However, there is little information (14) on prognosis and risk factors following the introduction of home medical care in Japan.

The Elderly Mortality Patients Observed Within the Existing Residence (EMPOWER) study in Japan is a multicentre prospective cohort study with multiple outcomes. It started in 2013 and aimed to identify the descriptive epidemiology, such as overall mortality (Aim 1), examine mortality at home and its risk factors (Aim 2) and examine the goals of diabetes treatment in home medical care (Aim 3). This article addresses Aim 1: in particular, it describes overall mortality and its risk factors among patients receiving physician-led home health care visits in Japan. It is the first report from the EMPOWER Japan study.

Methods

Design

This was a multicentre prospective cohort study conducted by a practice-based research network in Japanese primary care.

Participants and setting

Participants were individuals who had started to receive medical care in their home or nursing home between 1 February 2013 and 31 January 2016. Care was provided by family physicians based in 12 family medicine clinics and one regional hospital.

The inclusion criteria were patients aged 65 years or more who started receiving medical care at home or in a nursing home through regular, physician-led visits during the recruitment period. The exclusion criterion was declining to participate in the study. Participants were followed up until 31 January 2017.

The family medicine clinics and regional hospital were affiliated with the Centre for Family Medicine Development Practice-Based Research Network (CFMD-PBRN) (15). The CFMD was established by the Japanese Health and Welfare Co-operative Federation and has been training family physicians by connecting clinics and community hospitals to create a network. This network has also been used for research under the umbrella of PBRN. All the facilities participating in this study are in urban residential areas in greater Tokyo, Japan.

The participating clinics and hospital were 'in-home treatment support clinics or hospitals'. These facilities must meet the requirements set by the Japanese payment system for medical services (e.g. they must provide 24-hour medical services upon patient request).

In Japan, physician-led home visits target patients who are not able to visit a medical institution by themselves because of illness or injury, where a physician recognizes that they need ongoing care. Physicians visit patients' homes regularly, usually fortnightly (16), in line with a physician–patient contract. Patients pay 10–30% of all health care costs according to age and financial status (17). The insurer covers the remaining costs (17).

Measures

All variables except laboratory data (e.g. serum albumin level) were evaluated using a questionnaire completed by family physicians from the participating facilities.

Outcome measure: total mortality
The outcome measure for the part of the cohort study discussed here was total mortality.

Explanatory variables and covariates
One systematic review described health-related characteristics associated with short-term mortality in older hospitalized patients and nursing home residents (18). The review classified these characteristics into the following domains: 'cognitive function', 'disease diagnosis', 'physical function', 'laboratory values', 'nutrition', 'pressure sores' and 'shortness of breath'. We used variables drawn from the biopsychosocial perspective. Biomedical-related variables were sex (female/male = 1/0), age (years), Charlson Comorbidity Index
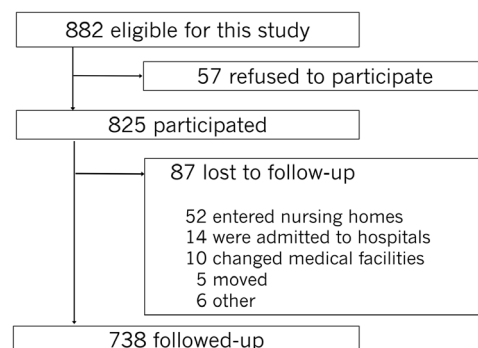

Figure 1. Follow-up process for study participants receiving physician-led home visits in Japan, 2013–17.

(CCI) score (19), serum albumin level (g/dl), Barthel Index (BI) score (20), pressure ulcer treatment (recipient/non-recipient = 1/0) and domiciliary oxygen therapy/respiratory device use (recipient/ non-recipient = 1/0). Psychological-related variables were assessed using the Japanese revised version of the Cornell Scale for Depression in Dementia (CSDD) (21,22) and the Mini-Mental

Table 1. Demographic and clinical characteristics of older people receiving physician-led visits in Japan, 2013–16

	Total	Followed up	Lost to follow-up
	n = 825	*n* = 738	*n* = 87
Biomedical variables			
Sex, *n* (%)			
Female	456 (55)	406 (55)	50 (57)
Male	369 (45)	332 (45)	37 (43)
Age, years, mean (SD)	83.4 (7.9)	83.2 (7.9)	84.4 (7.3)
CCI, mean (SD)	2.7 (2.3)	2.8 (2.3)	1.8 (1.6)
CCI, *n* (%)			
0–1	317 (39)	272 (37)	45 (52)
2	167 (20)	151 (21)	16 (19)
3–4	180 (22)	158 (22)	22 (26)
≥ 5	151 (19)	148 (20)	3 (3)
Data missing	10	9	1
Serum albumin level, mean (SD)	3.5 (0.7)	3.5 (0.7)	3.7 (0.5)
Serum albumin level, *n* (%)			
0–3	207 (27)	198 (29)	9 (11)
3.1–3.5	202 (26)	177 (26)	25 (30)
3.6–3.9	154 (20)	137 (20)	17 (21)
≥ 4	207 (27)	176 (26)	31 (38)
Data missing	55	50	5
BI, mean (SD)	55.4 (32.6)	54.7 (32.8)	62.0 (29.6)
BI, *n* (%)			
0–24	178 (22)	166 (23)	12 (14)
25–59	205 (25)	183 (25)	22 (25)
60–84	216 (26)	191 (26)	25 (29)
≥ 85	220 (27)	192 (26)	28 (32)
Data missing	6	6	0
Number of medications, mean (SD)	5.5 (3.7)	5.5 (3.7)	5.2 (3.7)
Opioids, *n* (%)	28 (3)	28 (4)	0 (0)
Gastrostoma, *n* (%)	10 (1)	10 (1)	0 (0)
Respiratory devices, *n* (%)	4 (0)	4 (1)	0 (0)
Domiciliary oxygen therapy, *n* (%)	50 (6)	46 (6)	4 (5)
Urinary catheter, *n* (%)	39 (5)	38 (5)	1 (1)
Dialysis, *n* (%)	3 (0)	3 (0)	0 (0)
Pressure ulcer treatment recipient, *n* (%)	21 (3)	17 (2)	4 (5)
Psychological variables			
CSDD, mean (SD)	2.5 (2.8)	2.6 (2.9)	1.6 (2.1)
CSDD, *n* (%)			
0	313 (39)	267 (37)	46 (53)
1–2	181 (23)	164 (23)	17 (20)
3–4	130 (16)	117 (16)	13 (15)
≥ 5	177 (22)	167 (23)	10 (12)
Data missing	24	23	1
MMSE-J, mean (SD)	18.6 (7.7)	18.5 (7.9)	19.1 (5.7)
MMSE-J, *n* (%)			
0–14	173 (25)	159 (26)	14 (18)
15–19	154 (22)	133 (21)	21 (27)
20–23	167 (24)	139 (22)	28 (36)
≥ 24	205 (29)	190 (31)	15 (19)
Data missing	126	117	9
Social variables			
Nursing home, *n* (%)	63 (8)	56 (8)	7 (8)
Public assistance recipient, *n* (%)	115 (14)	92 (12)	23 (26)
Full-time caregiver, *n* (%)	537 (65)	501 (68)	36 (41)
Living alone, *n* (%)	193 (23)	153 (21)	40 (46)

BI, Barthel index; CCI, Charlson comorbidity index; CSDD, cornell scale for depression in dementia; MMSE-J, mini-mental state examination-Japanese; SD, standard deviation.

State Examination-Japanese (MMSE-J) (23,24). Social-related variables assessed were 'nursing home resident' (yes/no = 1/0), existence of a 'full-time caregiver' (present/not present = 1/0), 'living alone' (yes/no = 1/0) and 'public assistance recipient' (recipient/non-recipient = 1/0).

We used the receipt of public assistance (government welfare) as an indicator of socio-economic status. The public assistance program is the main government income support program in Japan (25). Public assistance offers basic life support, including medical assistance, long-term care assistance and livelihood assistance (25), so patients receiving public assistance receive medical care without copayments. Eligibility and overall assistance vary across municipalities in Japan (25).

Follow-up of living status

Observations for each participant were terminated upon the participant's death or the end of the observation period.

Statistical analysis

The frequency of continuous variables, except age, was represented by dividing the data as closely as possible into four almost equal parts using quartiles. Cumulative survival rate functions were obtained using the Kaplan–Meier method. Periods of hospital admission after the introduction of home care were included in the observation period because we focussed the prognosis on people who started home care.

We used a multivariate Cox proportional hazard model to detect correlations of each explanatory variable as a predictor with mortality independently of other covariates. We used multiple imputations for variables with missing values. Before multiple imputation, Little's missing completely at random test was used. The imputation algorithm used was multivariate imputation using chained equations (26). The ordered logit link function was used for imputation. The observed covariates used for multiple imputation were survival status, indicator variables of clinics, opioid use, gastrostoma, urinary catheter use and dialysis, as well as the covariates described above. The results of 100 imputed data sets were combined for further analyses.

All statistical analyses used STATA 16 (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC). $P < 0.05$ was considered statistically significant.

Study size

For a Cox proportional hazard regression analysis, >10 or >20 events per explanatory variable are recommended (27). The number of events was considered to be within the acceptable range.

Results

Figure 1 shows that 882 individuals were eligible, of whom 825 consented to participate. Of these, 87 participants were lost to follow-up because of admission to a hospital or nursing home that was not affiliated with the participating facilities or relocation etc., which made it impossible to obtain information. However, these participants were included as censored cases in the survival analyses.

Across the total observation period (1080.0 person-years, with median [25th–75th percentile] observation time of 417 [121–744] days), 380 participants died. Of these, 221 (58%) died in hospital, 135 (36%) at home and 22 (6%) in nursing homes. The location of death was unknown for two participants (1%). Overall mortality

was 35.2/100 person-years (95% confidence interval [CI]: 31.8–38.9). Table 1 shows the characteristics and follow-up status of all participants. Only 8% of participants received medical care from a physician in a nursing home.

Figure 2 shows the cumulative survival functions of participants overall and by CCI score categories. The median survival time was 823 days (95% CI: 688–1012). There, a steep drop in the survival curve was observed for the first 6 months of follow-up. In particular, the survival curves by CCI score indicated that the initial steep drop was remarkable among participants with a CCI score of 5 or more.

The bivariate Cox proportional hazard model in Table 2 revealed a significant association of mortality with sex, CCI score, serum albumin level, BI score, receipt of oxygen therapy, CSDD score, MMSE-J score, nursing home resident, receipt of public assistance, full-time caregiver and living alone.

Table 3 shows seven variables retained as significant predictors in the results of the multivariate model with multiple imputation. Of the biomedical-related variables, based on hazard ratios, a CCI score of 5 or higher, serum albumin levels and oxygen therapy tend to be
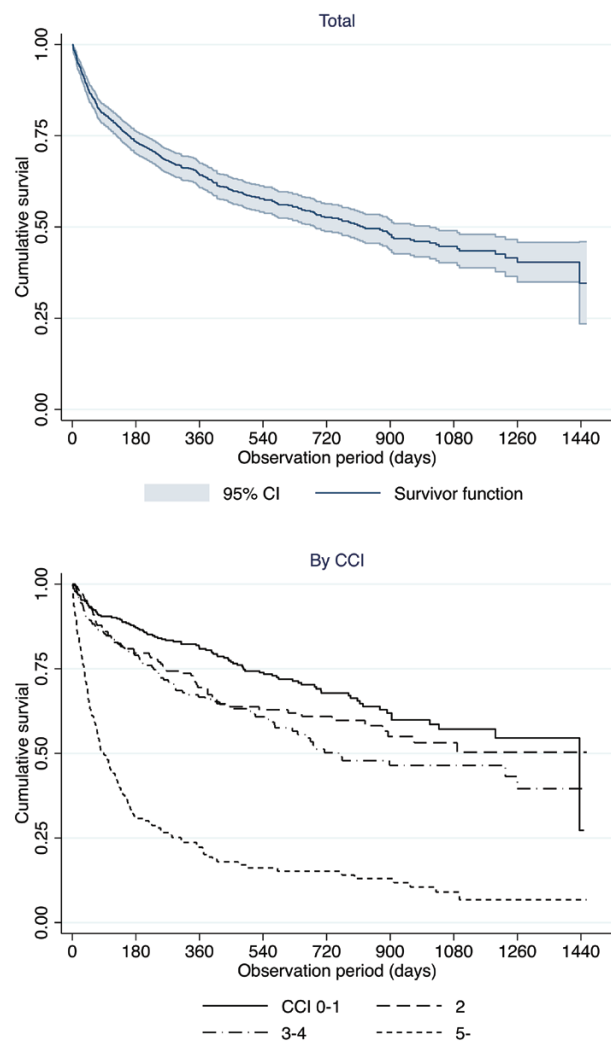

Figure 2. Kaplan–Meier survival functions: total and by CCI category in older people receiving physician-led home visits in Japan, 2013–17. The total cumulative survival for 180, 360, 720 and 1440 days was 73.4% (95% CI: 70.2–76.3), 64.2% (60.8–67.5), 52.6% (48.8–56.3) and 34.6% (23.5–46.0).

more strongly associated with mortality than BI scores. Of the psychological variables, CSDD was the only significant predictor with a relatively small hazard ratio. MMSE-J score was no longer significant. Of the social variables, receipt of public assistance was the only significant predictor.

Discussion

In this prospective cohort study of 825 older adults receiving medical care in their homes from family physicians in urban residential areas in Japan between 2013 and 2017, we found that the cumulative survival curve showed a steep drop for the first 6 months after participants had received home medical care. A Cox proportional hazard model showed that sex (male), high CCI score, low serum albumin level, low BI score, receiving oxygen therapy, high CSDD score and not receiving public assistance independently increased mortality risk.

As shown in Figure 2, the cumulative survival curve showed a steep drop for the first 6 months of observation. In contrast, cumulative survival rates of previous studies of nursing home residents dropped linearly, at a constant rate (29,30). The difference may be our inclusion of more severely ill participants, such as patients with cancer receiving palliative care at home and critically ill patients who opted to spend the end stage of life at home. This is supported by the fact that the survival curve of participants with CCI of 5 or more showed a steep drop during the first 6 months and 81% of participants with these CCI scores had cancer. These survival curve characteristics probably reflect one function of Japanese physician-led home visits: to care for patients who wish to stay at home during the end stage of life. Additionally, despite the steep drop in the survival curve for the first 6 months of follow-up in our study, the cumulative survival rate after 2 years of follow-up using a Kaplan–Meier curve and

Table 2. Bivariate Cox proportional hazard model: relationship between overall mortality and explanatory variables in older people receiving physician-led home visits in Japan, 2013–17

	Pairwise deletion			Multiple imputation (*n* = 825)	
	n	Hazard ratio [95% CI]	*P*-value	Hazard ratio [95% CI]	*P*-value
Sex (female/male = 1/0)	825	0.61 [0.50–0.75]	<0.01		
Age (year)	825	0.99 [0.98–1.00]	0.18		
CCI	815				
0–1		Reference			
2		1.33 [0.97–1.82]	0.07	1.34 [0.98–1.84]	0.07
3–4		1.60 [1.19–2.15]	<0.01	1.63 [1.21–2.18]	<0.01
≥5		5.82 [4.46–7.59]	<0.01	5.83 [4.47–7.61]	<0.01
Serum albumin level (g/dl)	770				
0–3		Reference			
3.1–3.5		0.48 [0.37–0.62]	<0.01	0.48 [0.37–0.62]	<0.01
3.6–3.9		0.37 [0.27–0.50]	<0.01	0.36 [0.26–0.48]	<0.01
≥4		0.19 [0.14–0.26]	<0.01	0.19 [0.13–0.26]	<0.01
BI	819				
0–24		Reference			
25–59		0.68 [0.52–0.88]	<0.01	0.68 [0.52–0.89]	<0.01
60–84		0.43 [0.32–0.57]	<0.01	0.43 [0.32–0.57]	<0.01
≥85		0.41 [0.31–0.55]	<0.01	0.41 [0.31–0.55]	<0.01
Pressure ulcer treatment (recipient/non-recipient = 1/0)	825	1.52 [0.89–2.59]	0.12		
Oxygen therapy (recipient/non-recipient = 1/0)	825	2.91 [2.10–4.04]	<0.01		
CSDD	801				
0		Reference			
1–2		1.24 [0.93–1.64]	0.14	1.24 [0.94–1.65]	0.13
3–4		1.19 [0.87–1.64]	0.28	1.22 [0.89–1.67]	0.23
≥5		2.05 [1.58–2.67]	<0.01	2.07 [1.59–2.70]	<0.01
MMSE-J	699				
0–14		Reference			
15–19		0.81 [0.58–1.13]	0.20	0.80 [0.58–1.10]	0.17
20–23		0.70 [0.50–0.97]	0.03	0.69 [0.51–0.95]	0.02
≥24		0.79 [0.58–1.07]	0.12	0.77 [0.58–1.03]	0.08
Nursing home resident (yes/no = 1/0)	825	0.31 [0.17–0.54]	<0.01		
Public assistance recipient (yes/no = 1/0)	825	0.54 [0.38–0.76]	<0.01		
Full-time caregiver (present/not present = 1/0)	825	1.79 [1.42–2.26]	<0.01		
Living alone (yes/no = 1/0)	825	0.77 [0.60–0.99]	0.04		

The pairwise deletion column shows results of the analyses using pairwise deletion (i.e. each row represents the results from analysis of the available data for that variable). Hazard ratios for the variables with no missing values are shown only for the pairwise deletion analyses, because there were no differences in hazard ratios between the multiple imputation analyses and the pairwise deletion analyses. Little's missing completely at random test was significant at *P* < 0.01, indicating that the missing data were not missing completely at random. We, therefore, used multiple imputation for interpretation.

Table 3. Multivariate Cox proportional hazard model: relationship between overall mortality and explanatory variables in older people receiving physician-led home visits in Japan 2013–2017

	Complete case analysis (n = 663)		Multiple imputation (n = 825)	
	Adjusted HR [95% CI]	*P*-value	Adjusted HR [95% CI]	*P*-value
Sex (female/male = 1/0)	0.69 [0.53–0.90]	0.01	0.62 [0.50–0.78]	<0.01
Age (years)	1.01 [0.99–1.03]	0.32	1.01 [0.99–1.02]	0.29
CCI				
0–1	Reference		Reference	
2	1.28 [0.89–1.84]	0.19	1.19 [0.86–1.64]	0.29
3–4	1.29 [0.91–1.84]	0.16	1.19 [0.87–1.63]	0.27
≥5	4.40 [3.08–6.29]	<0.01	4.00 [2.97–5.40]	<0.01
Serum albumin level (g/dl)				
0–3	Reference		Reference	
3.1–3.5	0.62 [0.45–0.85]	<0.01	0.60 [0.46–0.79]	<0.01
3.6–3.9	0.70 [0.48–1.02]	0.07	0.68 [0.49–0.95]	0.03
≥4	0.38 [0.25–0.57]	<0.01	0.37 [0.25–0.54]	<0.01
BI				
0–24	Reference		Reference	
25–59	0.92 [0.63–1.34]	0.66	0.81 [0.60–1.10]	0.18
60–84	0.88 [0.59–1.33]	0.56	0.68 [0.48–0.97]	0.03
≥85	0.86 [0.54–1.39]	0.54	0.69 [0.47–1.03]	0.07
Pressure ulcer treatment (recipient/non-recipient = 1/0)	1.19 [0.65–2.18]	0.58	1.00 [0.58–1.73]	0.996
Oxygen therapy (recipient/non-recipient = 1/0)	2.08 [1.31–3.30]	<0.01	2.49 [1.75–3.54]	<0.01
CSDD				
0	Reference		Reference	
1–2	1.47 [1.05–2.05]	0.03	1.31 [0.97–1.75]	0.08
3–4	1.16 [0.80–1.70]	0.43	1.09 [0.79–1.51]	0.60
≥5	1.67 [1.19–2.34]	<0.01	1.71 [1.30–2.25]	<0.01
MMSE-J				
0–14	Reference		Reference	
15–19	1.04 [0.71–1.52]	0.84	1.05 [0.74–1.48]	0.80
20–23	0.84 [0.57–1.24]	0.39	0.89 [0.63–1.27]	0.53
≥24	0.89 [0.60–1.31]	0.55	0.90 [0.63–1.30]	0.59
Nursing home resident (yes/no = 1/0)	0.49 [0.24–0.996]	0.049	0.56 [0.29–1.06]	0.08
Public assistance (recipient/non-recipient = 1/0)	0.65 [0.42–1.01]	0.06	0.61 [0.41–0.90]	0.01
Full-time caregiver (present/not present = 1/0)	1.01 [0.69–1.47]	0.96	1.04 [0.75–1.46]	0.80
Living alone (yes/no = 1/0)	1.15 [0.76–1.73]	0.51	1.25 [0.87–1.79]	0.23

The complete case analyses column shows the results of the analyses using listwise deletion (i.e. cases with missing values on one or more variables were excluded from the analysis). All the mean variance inflation factors (28) of the independent variables after multiple imputation were below 4.0 (range 1.07–2.76), so multicollinearity was considered unlikely. HR, hazard ratio.

the median survival time were very similar to those in the nursing home study by Vossius *et al.* (29). This means that participants in our study, except severely ill individuals, had a higher survival rate than those in the nursing home study. Participants in our cohort except severely ill individuals, may simply be less severely ill than those in the previous study. Another possibility is that, from a biomedical perspective, physician-led home visits might provide better care than nursing homes for patients who are not severely ill but have chronic conditions. Direct international comparisons of mortality rates for older people are difficult to make because of differences in the biomedical status of participants and the health care system. Studies evaluating the effectiveness of older people's care or identifying risk factors for mortality often exclude terminally ill patients (31,32), so it is reasonable that their mortality rates were lower than in our study.

It was surprising that public assistance recipients were less likely to die than non-recipients. We chose the variable 'public assistance' as a proxy for socio-economic indicators and, therefore, expected that mortality rates for public assistance recipients would be higher than for non-recipients. One possibility is that public assistance recipients receive all necessary medical care, regardless of cost, because their medical costs are fully covered. In this cohort, 14% of participants were public assistance recipients. In contrast, 2.7% of people aged ≥65 years in 2012 were public assistance recipients in Japan (33). The cohort, therefore, probably included many older people with relatively low socio-economic status. It is possible that some individuals who could not afford their own health care were not receiving public assistance because the criteria are too strict. Low-income patients who did not meet the criteria for public assistance, and limited the services they used for economic reasons, may, therefore, not have received all the necessary care. This might have affected their life expectancy. Our results suggest that it may be necessary to change the criteria or system for public assistance. In contrast, the other social variables assessed were not significantly associated with mortality in the multivariate analysis, although these were significant in the bivariate analyses. It is difficult to interpret these results because variables such as 'living alone' and 'presence of a full-time caregiver' are

important factors for family physicians providing home medical care. Correlations of these variables with public assistance may constitute a confounding effect.

We had assumed that biomedical-related variables would have a direct effect on mortality. As expected, sex, CCI (34,35), serum albumin level as an indicator of nutritional status (18,36,37), BI score as an indicator of functional status (38) and receipt of oxygen therapy were significant predictors of mortality. The weak association of BI score in the multivariate analysis may be a result of the adjustment for variables that more directly affect disease severity, such as serum albumin level and oxygen therapy. The psychological-related variable CSDD was an independent predictor of mortality. Schulz *et al.* suggested several reasons why depression affects non-suicide mortality among older people, such as alienation from social networks and low compliance with medical regimens (39). Community-dwelling patients receiving home medical care may be more influenced by social networks than residents in long-term care facilities. The status of CSDD score as a predictor for mortality in this study may be because depression inhibits participation in social networks. In contrast, MMSE-J score did not have a significant effect on mortality. Greater attention from health care providers to cognitive function and adequate care may have reduced the mortality rate in this study.

An international survey for health professionals reported that there may be a huge gap between choice and reality of place for end of life care (40). The proportions of health professionals who believed that home was the ideal place for the end of life stage for patients with cancer were much higher than those who thought that patients would actually spend their final days at home (Japan: 79.2% versus 8.2%, UK: 79.7% versus 20.6%). This difference might represent a lack of patient-centred care during the end stage of life. Our study suggests that physician-led home visits can support a wide range of dependent patient conditions, from terminally ill patients to non-critically ill patients with chronic conditions. Physician-led home visits might, therefore, be a suitable form of end-of-life care to bridge this gap.

Strengths of this study

To our knowledge, this is the first multicentre prospective study with minimal loss to follow-up to describe the prognosis of patients receiving physician-led visits for medical care in Japan. In addition to conventional risk factors for mortality among older people, social variables were evaluated to identify mortality risk factors.

Limitations of this study

The setting was limited to facilities in urban residential areas in greater Tokyo, and the cohort included older people with relatively low socio-economic status. Care should, therefore, be taken when generalizing these results to populations in other areas.

The follow-up rate was not optimum. If the reason for loss to follow-up was death-related, the results would be biased. Considering the variables that were significantly associated with mortality, those who were lost to follow-up may have a lower risk of death than those followed up. The mortality might, therefore, have been lower if follow-up had been optimum.

Conclusion

This study described the overall mortality in patients receiving physician-led home visits in Japan and identified mortality risk factors. In particular, we showed that public assistance recipients were less likely to die.

Supplementary material

Supplementary material is available at *Family Practice* online.

Data availability

The data underlying this article cannot be shared publicly because we did not receive participants' informed consent for data sharing.

References

1. Harper S. Economic and social implications of aging societies. *Science* 2014; **346**(6209)**:** 587–91.
2. Foreman KJ, Marquez N, Dolgert A *et al.* Forecasting life expectancy, years of life lost, and all-cause and cause-specific mortality for 250 causes of death: reference and alternative scenarios for 2016-40 for 195 countries and territories. *Lancet* 2018; **392**(10159)**:** 2052–90.
3. Muramatsu N, Akiyama H. Japan: super-aging society preparing for the future. *Gerontologist* 2011; **51**(4)**:** 425–32.
4. Tamiya N, Noguchi H, Nishi A *et al.* Population ageing and wellbeing: lessons from Japan's long-term care insurance policy. *Lancet* 2011; **378**(9797)**:** 1183–92.
5. Ministry of Health, Labour and Welfare. *[Promotion of long-term care and home care].* https://www.mhlw.go.jp/seisakunitsuite/bunya/kenkou_iryou/iryou/zaitaku/dl/zaitakuiryou_all.pdf (accessed 7 July 2020).

6. Elkan R, Kendrick D, Dewey M *et al*. Effectiveness of home based support for older people: systematic review and meta-analysis. *BMJ* 2001; **323**(7315)**:** 719–25.

7. 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**(8)**:** 1022–8.

8. Aylin P, Majeed FA, Cook DG. Home visiting by general practitioners in England and Wales. *BMJ* 1996; **313**(7051)**:** 207–10.

9. Meyer GS, Gibbons RV. House calls to the elderly—a vanishing practice among physicians. *N Engl J Med* 1997; **337**(25)**:** 1815–20.

10. van den Berg MJ, Cardol M, Bongers FJ, de Bakker DH. Changing patterns of home visiting in general practice: an analysis of electronic medical records. *BMC Fam Pract* 2006; **7**: 58.

11. Joyce C, Piterman L. Trends in GP home visits. *Aust Fam Physician* 2008; **37**(12)**:** 1039–42.

12. Voigt K, Bojanowski S, Taché S, Voigt R, Bergmann A. Home visits in primary care: contents and organisation in daily practice. Study protocol of a cross-sectional study. *BMJ Open* 2016; **6**(2)**:** e008209.

13. Hernández C, Aibar J, Seijas N *et al*. Implementation of home hospitalization and early discharge as an integrated care service: a ten years pragmatic assessment. *Int J Integr Care* 2018; **18**(2)**:** 12.

14. Morita M. [Factors related to the long-term prognosis of home-based medical care subjects]. *Nihon Ronen Igakkai Zasshi* 2015; **52**(4)**:** 383–90.

15. Centre for Family Medicine Development Practice Based Research Network. *PBRN Registry. Agency for Healthcare Research and Quality*. https://pbrn.ahrq.gov/pbrn-registry/centre-family-medicine-development-practice-based-research-network (accessed 28 October 2020).

16. Yokobayashi K, Matsushima M, Watanabe T, Fujinuma Y, Tazuma S. Prospective cohort study of fever incidence and risk in elderly persons living at home. *BMJ Open* 2014; **4**(7)**:** e004998.

17. Kato D, Ryu H, Matsumoto T *et al*. Building primary care in Japan: literature review. *J Gen Fam Med* 2019; **20**(5)**:** 170–9.

18. Thomas JM, Cooney LM Jr, Fried TR. Systematic review: health-related characteristics of elderly hospitalized adults and nursing home residents associated with short-term mortality. *J Am Geriatr Soc* 2013; **61**(6)**:** 902–11.

19. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987; **40**(5)**:** 373–83.

20. Mahoney FI, Barthel DW. Functional evaluation: the Barthel Index. *Md State Med J* 1965; **14**: 61–5.

21. Alexopoulos GS, Abrams RC, Young RC, Shamoian CA. Cornell Scale for Depression in Dementia. *Biol Psychiatry* 1988; **23**(3)**:** 271–84.

22. Tsutsumida R, Adachi K. Measurement property of Japanese revised version of CSDD (Cornell Scale for Depression in Dementia): an empirical study for Japanese patients with Alzheimer's disease. *Jpn J Appl Psychol Educ Welfare Disord* 2011; **10**: 13–21.

23. Folstein MF, Folstein SE, McHugh PR. 'Mini-mental state'. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res* 1975; **12**(3)**:** 189–98.

24. Sugishita M, Koshizuka Y, Sudou S *et al*. The Validity and Reliability of the Japanese Version of the Mini-Mental State Examination (MMSE-J) with the original procedure of the Attention and Calculation Task (2001). *Jpn J Cogn Neurosci* 2018; **20**(2)**:** 91–110.

25. Inaba M. Increasing Poverty in Japan: social policy and public assistance program. *Asian Soc Work Policy Rev* 2011; **5**(2)**:** 79–91.

26. van Buuren S, Boshuizen HC, Knook DL. Multiple imputation of missing blood pressure covariates in survival analysis. *Stat Med* 1999; **18**(6)**:** 681–94.

27. Motulsky H. *Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking*. 2nd ed. New York, NY: Oxford University Press; 2010.

28. Klein D. *MIVIF: Stata module to calculate variance inflation factors after mi estimate regress*. https://econpapers.repec.org/software/bocbocode/s457254.htm (accessed 6 July 2020).

29. Vossius C, Selbæk G, Šaltytė Benth J, Bergh S. Mortality in nursing home residents: A longitudinal study over three years. *PLoS One* 2018; **13**(9)**:** e0203480.

30. Reilev M, Lundby C, Jensen J, Larsen SP, Hoffmann H, Pottegård A. Morbidity and mortality among older people admitted to nursing home. *Age Ageing* 2019; **49**(1)**:** 67–73.

31. Sommers LS, Marton KI, Barbaccia JC, Randolph J. Physician, nurse, and social worker collaboration in primary care for chronically ill seniors. *Arch Intern Med* 2000; **160**(12)**:** 1825–33.

32. Gené Badia J, Borràs Santos A, Contel Segura JC *et al*.; HC>65 Research Team. Predictors of mortality among elderly dependent home care patients. *BMC Health Serv Res* 2013; **13**: 316.

33. Ministry of Health, Labour and Welfare. *[Secular trend of the number and the proportion of public assistance receipient by age category]*. https://www.mhlw.go.jp/wp/hakusyo/kousei/17/backdata/01-03-01-24.html (accessed 5 July 2020).

34. Frenkel WJ, Jongerius EJ, Mandjes-van Uitert MJ, van Munster BC, de Rooij SE. Validation of the Charlson Comorbidity Index in acutely hospitalized elderly adults: a prospective cohort study. *J Am Geriatr Soc* 2014; **62**(2)**:** 342–6.

35. Chan TC, Luk JK, Chu LW, Chan FH. Validation study of Charlson Comorbidity Index in predicting mortality in Chinese older adults. *Geriatr Gerontol Int* 2014; **14**(2)**:** 452–7.

36. Valmorbida E, Trevisan C, Imoscopi A, Mazzochin M, Manzato E, Sergi G. Malnutrition is associated with increased risk of hospital admission and death in the first 18 months of institutionalization. *Clin Nutr* 2020; **39**(12)**:** 3687–94. doi:10.1016/j.clnu.2020.03.029.

37. Moon S, Hong GS. Predictive factors of mortality in older adult residents of long-term care facilities. *J Nurs Res* 2020; **28**(2)**:** e82.

38. Lee SJ, Lindquist K, Segal MR, Covinsky KE. Development and validation of a prognostic index for 4-year mortality in older adults. *JAMA* 2006; **295**(7)**:** 801–8.

39. Schulz R, Drayer RA, Rollman BL. Depression as a risk factor for nonsuicide mortality in the elderly. *Biol Psychiatry* 2002; **52**(3)**:** 205–25.

40. Hasegawa K, Isobe F, Uchide Y *et al*. *End-of-life Care: Japan and the World, Research Report. International Comparative Study on Terminal Care System. International Comparative Study on Ideal Terminal Care and Death. Surveys with Professionals and Facilities. Interviews with Facility Representatives (Summary)*. http://www.ilcjapan.org/studyE/doc/End-of-life_Care2011.pdf. Published 2012 (accessed 11 October 2020).