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Original Study

The Association of Long-Term Opioid Use With Health Care and Home Care Service Use Among Aged Home Care Clients

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A B S T R A C T

Keywords:

Aged
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Objectives: To compare health care and home care service utilization, mortality, and long-term care admissions between long-term opioid users and nonusers among aged home care clients.

Design: A retrospective cohort study based on the Resident Assessment Instrument–Home Care (RAI-HC) assessments and electronic medical records.

Setting and Participants: The study sample included all regular home care clients aged ≥ 65 years ($n = 2475$), of whom 220 were long-term opioid users, in one city in Finland (population base 222,000 inhabitants).

Methods: Health care utilization, mortality, and long-term care admissions over a 1-year follow-up were recorded from electronic medical records, and home care service use from the RAI-HC. Negative binomial and multivariable logistic regression, adjusted for several socioeconomic and health characteristics, were used to analyze the associations between opioid use and health and home care service use.

Results: Compared with nonusers, long-term opioid users had more outpatient consultations (incidence rate ratio 1.26; 95% CI 1.08–1.48), home visits (1.23; 1.01–1.49), phone contacts (1.38; 1.13–1.68), and consultations without a patient attending a practice (1.22; 1.04–1.43) after adjustments. A greater proportion of long-term opioid users than nonusers had at least 1 hospitalization (49% vs 41%) but the number of inpatient days did not differ after adjustments. The home care nurses' median work hours per week were 4.3 (Q₁–Q₃ 1.5–7.7) among opioid users and 2.8 (1.0–6.1) among nonusers. Mortality and long-term care admissions were not associated with opioid use.

Conclusions and Implications: Long-term opioid use in home care clients is associated with increased health care utilization regardless of the severity of pain and other sociodemographic and health characteristics. This may indicate the inability of health care organizations to produce alternative treatment strategies for pain management when opioids do not meet patients' needs. The exact reasons for opioid users' greater health care utilization should be examined in future.

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Almost one-tenth of home-dwelling older adults are long-term opioid users.^{1–3} Most opioid users in home care use opioids for musculoskeletal pain,³ although the current evidence is not particularly encouraging to use opioids for chronic noncancer pain.^{4–6}

In fact, about every fourth medium- to long-term opioid user experiences adverse drug effects, such as dizziness, fatigue, and nausea, compared with placebo users.⁷ Opioid use has also been associated with more serious risks, such as myocardial infarction,⁸ falls and fractures,^{9–11} and increased mortality.¹²

Adverse effects and events of opioid use might affect the need for health care services. On the other hand, pain itself is a reason to seek out physicians' consultations and it increases the risk of disability,^{13,14} which is likely to increase health care and home care utilization. In a Danish study of a representative sample of the adult population, opioid users with noncancer pain were more likely to use health care services compared with nonusers.¹⁵ However, the analyses were not adjusted for comorbid diseases. Among adults using opioids for musculoskeletal pain, increased health care utilization and higher expenditures of health care services have been demonstrated in several studies.^{16,17} Opioid users also have higher readmission risk and health care resource use after surgery.^{18,19} The effects of long-term opioid use on service use in a home care setting have not been studied before.

The objective of this study was to compare health care and home care service utilization, long-term care admissions, and mortality between long-term opioid users and nonusers among aged home care clients.

Methods

Sample and Data Source

This retrospective cohort study was based on Resident Assessment Instrument–Home Care (RAI-HC) assessments^{20,21} (www.interrai.org) and electronic medical records covering home care, primary health care centers, and secondary and post-acute care hospitals in the city of Tampere (population approximately 222,000, of which 18% are aged ≥ 65 years), Finland. Municipalities are responsible for providing health care for their residents in Finland, and the data sources cover these publicly funded services. The sample includes all clients aged ≥ 65 years who had regular home care services and at least 1 RAI-HC assessment during 2014 (Figure 1). Home care services are also run by municipalities, and include, based on a client's personal needs, assistance with activities of daily living, medical care at home, administering of medication, and support services. According to national guidelines, RAI-HC assessments should be made by educated nurses every 6 months or whenever a client's health status changes notably. In this study, each client was followed for 1 year, or until death, from their first RAI-HC assessment in 2014.

Clients using opioids were identified based on medications listed in the RAI-HC assessments (opioids available in Finland during the study period are presented in the [Supplementary Table 1](#)). Long-term opioid use, defined as daily use of any opioid throughout the follow-up year, was confirmed from the electronic medical records, which include each client's medications, daily doses, and all prescriptions. An interruption of ≤ 3 weeks in 1 or several periods during the follow-up was accepted for the daily long-term use of opioids. Clients who (1) used opioids as needed (and hence, whose opioid use could not be verified retrospectively), or (2) stopped opioid use during the follow-up, were excluded. The median oral morphine equivalent daily dose,²² including all opioids used during the follow-up, was calculated for each opioid user.

Data on clients' sociodemographic status, comorbidities, disabilities, and use of psychotropic medication were gathered from the baseline RAI-HC assessments. Several standardized sum scales of the RAI-HC describing clients' disabilities and symptoms were used: the Pain Scale,²³ the Activities of Daily Living (ADL),²⁴ the Instrumental Activities of Daily Living (IADL),²⁰ the CHES (Changes in Health, End-Stage Disease, Signs and Symptoms Scale),²⁵ the Depression Rating Scale (DRS),²⁶ and the Cognitive Performance Scale (CPS).²⁷ Higher scores refer to greater disability or more severe symptoms on all the previously mentioned scales (sum scales in more detail in [Supplementary Table 2](#)). The MAPLe²⁸ was not included due to collinearity with the CPS and the ADL.

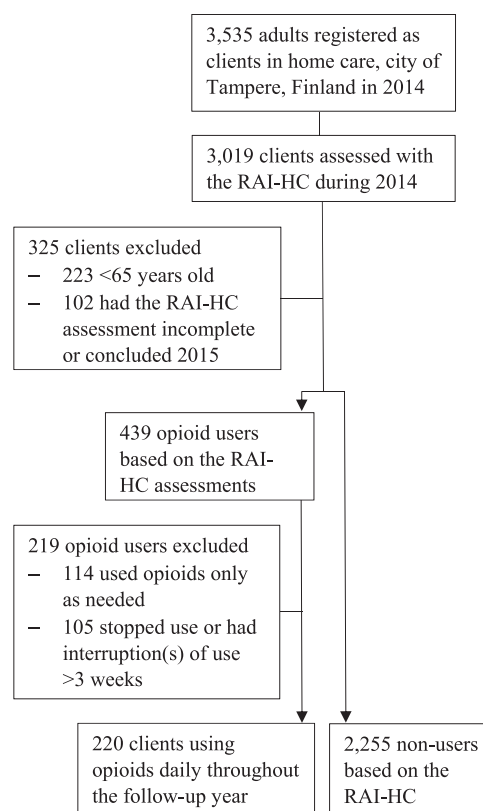


Fig. 1. Sample selection.

The study protocol was approved by the city of Tampere, which, according to Finnish and European Union legislation, has the legal authority to provide retrospectively access to health care data it maintains. In addition, ethics committee approval or informed patient consent was not required, as the retrospective study protocol neither influenced the patients' treatment nor the patients were contacted.

Outcomes

Data on health care utilization, long-term care admissions, and mortality were gathered from the electronic medical records. Health care use included all outpatient consultations in primary health care centers and secondary care hospital, stays and inpatient days in secondary and post-acute care hospitals and rehabilitation facility, home visits, phone contacts, and consultations without a patient attending a practice (eg, nurse-physician consultations, medical certificates). Data on stays in the university hospital (tertiary care), visits to its emergency department, and visits to private physicians were not available due to different service providers and patient record systems.

Use of home care services, including nurses' working hours spend with a client, home visits by registered nurses and physical therapists, service center visits, meals on wheels service, and medical alert system (24-hour emergency assistance by pressing a button on a wristband), were derived from the baseline RAI-HC assessments.

Statistical Analyses

Health and home care service use during the follow-up are described as percentages of home care clients having at least 1 event (eg, a consultation, a contact), and medians and quartiles (Q_1 – Q_3) of the total number of events among clients who used the service. The negative binomial regression analysis was used to examine the

associations between long-term opioid use and count outcome variables (ie, the number of events in health or home care service use such as inpatient days) and multivariable logistic regression analysis to analyze such associations with binomial outcome variables (ie, long-term care admissions, use of medical alert system and service center visits). Because of skewed distribution, nurses' working hours were analyzed using logistic regression, categorized as regular use (<8.5 h/wk) or extensive use of service (≥ 8.5 h/wk) based on mean + 1 SD. The results of negative binomial regression are expressed as incidence rate ratios (IRRs) with 95% CIs, and the results of logistic regression as odds ratios (ORs) with 95% CIs.

The regression analyses were adjusted for various sociodemographic and health-related factors in the RAI-HC assessments (Table 1) noted to be statistically different between opioid users and nonusers, and to associate with any outcome variable in unadjusted analyses. In

addition, the factors near statistically significant difference ($P < .25$) were tested in the models by adding them one at a time. Parkinson disease and congestive heart failure were included in the final models, as they affected (based on change in the point estimate of OR/IRR) some associations between long-term opioid use and outcome variables. The analysis about mortality was adjusted for all variables associated with mortality ($P < .05$) in univariate analyses and variables associated with both opioid use and mortality at the $P < .25$ level. The CPS was used in analyses instead of dementia diagnoses, as it was assumed that some clients have cognitive impairment but lack specific diagnostic examinations, and the severity of cognitive impairment, rather than diagnosis as such, affects the analyzed outcomes.

Missing values were not included in the analyses. A maximum of 47 people (of whom a maximum of 2 were opioid users) were missing from the regression analyses, with the exception of

Table 1
Characteristics of Home Care Clients According to Their Opioid Use

Characteristics	Long-term Opioid Users, n = 220		Nonusers, n = 2255		P Value*
	n	%	n	%	
Age, y, mean (SD)		83.0 (7.5)		82.7 (7.3)	.48
Gender, female	175	79.5	1616	71.7	.013
Education					.25
Primary education or less	130	65.7	1410	69.0	
Secondary education	61	30.8	529	25.9	
University degree	7	3.5	103	5.0	
A family member takes part in care	166	75.5	1614	71.7	.24
Walking aid at home	170	77.3	1160	51.6	<.001
Disability in Activities of Daily Living (ADL ≥ 1)	64	29.1	574	25.7	.28
Performance in Instrumental ADLs					.024
0–7	57	25.9	765	34.3	
8–14	102	46.4	856	38.4	
15–21	61	27.7	611	27.4	
Cognitive performance scale (CPS) ≥ 2	79	35.9	1160	52.0	<.001
Unstable health state (CHESS ≥ 3)	33	15.0	226	10.2	.028
Pain scale					<.001
No	20	9.1	906	40.8	
Less than daily	38	17.3	579	26.1	
Daily, mild to moderate	88	40.0	585	26.3	
Daily, severe	74	33.6	152	6.8	
Depression rating scale (DRS) ≥ 3	49	22.3	314	14.0	.001
Poor self-rated health	101	45.9	584	26.0	<.001
Alcohol abuse	6	2.7	107	4.8	.17
Smoker	17	7.7	189	8.4	.72
Body mass index, mean (SD)		26.8 (6.1)		26.4 (5.7)	.36
Chronic conditions					
Hypertension	168	76.7	1622	72.2	.15
Diagnosed dementia, any	53	24.2	942	41.9	<.001
Cardiac arrhythmias	62	28.3	663	29.5	.71
Diabetes	67	30.6	660	29.4	.71
Ischemic heart disease	55	25.1	576	25.6	.87
Congestive heart failure	57	26.0	500	22.3	.20
Psychiatric disorder, any	39	17.8	423	18.8	.72
Osteoporosis	81	37.0	370	16.5	<.001
Chronic obstructive pulmonary disease	24	11.0	235	10.5	.82
Peripheral arterial disease or venous insufficiency	27	12.3	228	10.1	.31
History of stroke	16	7.3	204	9.1	.38
Chronic renal failure	22	10.0	194	8.6	.48
Arthritis	32	14.6	182	8.1	.001
Cancer (in previous 5 y)	26	11.9	176	7.8	.038
History of any fracture affecting the present health status	24	11.0	150	6.7	.018
Pressure ulcer	19	8.6	86	3.8	<.001
Parkinson's disease	9	4.1	56	2.5	.15
Benzodiazepines and related drugs	113	51.4	829	37.0	<.001
Antidepressant use	77	35.0	542	24.2	<.001
Antipsychotic use	14	6.4	351	15.6	<.001
Mortality (follow-up year)	29	13.2	267	11.8	.56

*The independent samples *t*-test was used for continuous variables and the χ^2 test for nominal variables.

186 persons (of whom 19 were opioid users) from the analysis of mortality due to missing body mass indexes. SPSS version 27 was used in all statistical analyses.

Results

Altogether, 2475 home care clients, of whom 220 were long-term opioid users, were included in the present study (Figure 1). Their mean age was 82.7 (SD 7.3, range 65–104) years. Long-term opioid users were more often women (80% vs 72%), used walking aids (77% vs 52%), and had an unstable health state (15% vs 10%) and depressive symptoms (22% vs 14%), compared with nonusers (Table 1). Their IADL performance was also poorer. Fewer opioid users than nonusers had cognitive impairment (36% vs 52%) but they had osteoporosis, arthritis, pressure ulcers, and history of fractures or cancer more frequently. Although there was no difference in diagnosed psychiatric disorders, opioid users more frequently used antidepressants, and benzodiazepines and related drugs but less frequently antipsychotics compared with nonusers. Opioid users were also more likely to experience daily pain. The mean follow-up (340 vs 345 days) as well as mortality during the follow-up year (13% vs 12%) were about the same among long-term opioid users and nonusers (adjusted OR 0.88; 95% CI 0.55–1.42).

During the follow-up, transdermal buprenorphine was the most commonly used opioid (65.0% of clients), followed by oxycodone (29.5%), codeine (combined with acetaminophen; 18.6%), tramadol (8.6%), transdermal fentanyl (7.7%), and morphine (5.0%). One-third (31%) of opioid users switched from one opioid to another during the follow-up, and 16 persons (7%) used 3 or more different opioids. The median oral morphine equivalent daily dose was 22 mg (Q_1 – Q_3 11–34 mg).

Health Care and Home Care Service Use

A greater proportion of long-term opioid users than nonusers had at least 1 stay in hospital (49% vs 41%) or in a rehabilitation facility (11% vs 7%), home visit (68% vs 54%), and phone contact (47% vs 38%)

(Table 2). They also had a greater number of outpatient consultations and consultations without a patient attending a practice. In practice, during the follow-up year, long-term opioid users had on average 2.0 outpatient consultations, 0.5 home visits, 0.6 phone contacts, and 2.1 other consultations more than nonusers.

The nurses' median work hours per week were 4.3 (Q_1 – Q_3 1.5–7.7) among long-term opioid users and 2.8 (1.0–6.1) among nonusers ($P < .001$). A higher proportion of long-term opioid users had physical therapist visits (12% vs 7%) and used a medical alert system (66% vs 47%) but fewer had service center visits (13% vs 18%), compared with nonusers (Table 2).

When adjusted for sociodemographic and health characteristics, the number of inpatient days in hospital or rehabilitation facility during the follow-up year did not differ between long-term opioid users and nonusers, whereas opioid users had more outpatient consultations (IRR 1.26; 95% CI 1.08–1.48), home visits (1.23; 1.01–1.49), phone contacts (1.38; 1.13–1.68), and consultations without a patient attending a practice (1.22; 1.04–1.43) than nonusers (Table 3). After adjustments, opioid users' odds for using home care nurses extensively (≥ 8.5 h/wk) were 1.52 (95% CI 1.00–2.31), but otherwise home care service use did not differ between long-term opioid users and nonusers. During the follow-up year, 12% of long-term opioid users and 15% of nonusers were admitted to a long-term care facility (adjusted OR 0.87; 95% CI 0.54–1.42).

Few interactions were noted in the analyses. Among home care clients with cognitive impairment, long-term opioid users had fewer inpatient days in a rehabilitation facility (adjusted IRR_a 0.55; 95% CI 0.38–0.79), but among clients without cognitive impairment, opioid users had greater number of inpatient days (IRR_a 1.47; 1.14–1.89), compared with nonusers. Among clients with daily pain, long-term opioid users had a greater number of inpatient days in rehabilitation facility (IRR_a 1.24; 0.99–1.56), whereas among clients without daily pain, opioid users had fewer inpatient days (IRR_a 0.62; 0.41–0.94) than nonusers. Among home care clients with cognitive impairment, long-term opioid use was associated with lower likelihood of long-term care admissions (opioid users 15.2% vs nonusers 23.3%; OR_a 0.51; 0.25–1.03), but among clients without cognitive impairment, the

Table 2
Health Care and Home Care Service Use of Home Care Clients According to Opioid Use

Health Care Services Per Year	Long-term Opioid Users, n = 220		Nonusers, n = 2255		P Value [‡]
	n (%) [*]	Median [†] (Q_1 – Q_3)	n (%) [*]	Median [†] (Q_1 – Q_3)	
Stays in hospital	107 (48.6)		915 (40.6)		.020
Inpatient days		21 (10–58)		21 (9–65)	.97
Stays in rehabilitation facility	24 (10.9)		147 (6.5)		.014
Inpatient days		21 (14–39)		20 (14–36)	.89
Health center or hospital outpatient consultations	200 (90.9)		2001 (88.7)		.33
Number of consultations		5 (3–10)		5 (2–8)	<.001
Medical consultations without a patient attending a practice	200 (90.9)		1958 (86.8)		.08
Number of consultations		7 (3–11)		5 (3–9)	<.001
Home visits	149 (67.7)		1209 (53.6)		<.001
Number of visits		2 (1–3)		2 (1–3)	.33
Phone contacts	104 (47.3)		856 (38.0)		.007
Number of contacts		2 (1–4)		2 (1–3)	.010
Home Care Services Per Week					
Nurse or home carer, hours per week		4.3 (1.5–7.7)		2.8 (1.0–6.1)	<.001
Registered nurse visits	23 (10.5)		202 (9.0)		.47
Number of visits		1 (1–1)		1 (1–1)	.76
Physical therapist visits	26 (11.8)		155 (6.9)		.008
Number of visits		1 (1–1)		1 (1–1)	.33
Service center visit	28 (12.7)		411 (18.3)		.039
Meals on wheels	89 (40.6)		905 (40.4)		.94
Number of service days		4 (2–7)		5 (2–7)	.17
Medical alert system	144 (65.5)		1057 (47.1)		<.001
Admitted to long-term care (follow-up year)	26 (11.8)		342 (15.2)		.18

^{*}Proportion of clients who used the service.

[†]Median and interquartile range of service use among those clients who used the service.

[‡]The Mann-Whitney test was used to compare medians and the χ^2 test to compare percentages between long-term opioid users and nonusers.

Table 3
Long-term Opioid Users' IRRs or ORs for Health Care and Home Care Service Use

Health Care Services Per Year	Unadjusted		Adjusted Models*	
	IRR	95% CI	IRR	95% CI
Inpatient days in hospital	1.21	1.05–1.40	1.11	0.95–1.29
Inpatient days in rehabilitation facility	1.84	1.57–2.16	1.06	0.87–1.29
Health center or hospital outpatient consultations	1.38	1.19–1.60	1.26	1.08–1.48
Medical consultations without a patient attending a practice	1.38	1.19–1.60	1.22	1.04–1.43
Home visits	1.38	1.16–1.64	1.23	1.01–1.49
Phone contacts	1.61	1.34–1.92	1.38	1.13–1.68
Home Care Services Per Week				
Registered nurse visits	1.11	0.72–1.70	0.85	0.53–1.36
Physical therapist visits	1.56	1.02–2.38	0.99	0.62–1.59
Meals service days	0.93	0.78–1.10	0.96	0.79–1.16
	OR	95% CI	OR	95% CI
Nurse or home carer, ≥ 8.5 hours per week	1.80	1.28–2.53	1.52	1.00–2.31
Service center visit	0.65	0.43–0.98	0.78	0.50–1.20
Medical alert system	2.13	1.59–2.84	1.33	0.96–1.86
Admitted long-term care	0.75	0.49–1.15	0.87	0.54–1.42
Mortality [†]	1.13	0.75–1.71	0.88	0.55–1.42

*Models adjusted for gender, the CPS (\geq or <2), the IADL, need of walking aid, the CHESS (\geq or <3), the DRS (\geq or <3), poor self-rated health, the Pain scale, osteoporosis, arthritis, a history of fracture affecting the present health status, pressure ulcers, cancer in previous 5 years, Parkinson's disease, congestive heart failure, and use of anti-psychootics, antidepressants, and benzodiazepines and related drugs.

[†]Model adjusted for age, gender, need of walking aid, the IADL, the CHESS (\geq or <3), body mass index, cancer in previous 5 years, ischemic heart disease, cardiac arrhythmias, congestive heart failure, chronic obstructive pulmonary disease, chronic renal failure, Parkinson's disease, arthritis, psychiatric disorders, pressure ulcers, and use of antidepressants.

association was the opposite (9.9% vs 6.2%). Because of too few admissions to long-term care, adjusted analysis was not possible in the latter comparison.

Discussion

Despite the high proportion of opioid users in home care clients, health care, and home care use related to opioid use in this group have not been studied before. In this regionally representative retrospective study of home care clients, long-term opioid users had more outpatient and other consultations, home visits, and phone contacts than nonusers. However, the total number of inpatient days in hospitals or rehabilitation facilities during the follow-up year was similar to nonusers. Home care nurses' work hours per week were higher among long-term opioid users than nonusers but otherwise there were no differences in home care services. Long-term opioid use was not associated with mortality or long-term care admissions during the follow-up year.

The association between opioid use, including higher opioid dose and greater duration of use, and higher health care utilization or costs has been demonstrated in several studies mostly among middle-aged community-dwelling adults with musculoskeletal pain.^{16,17,29,30} In the only earlier study among patients ≥ 65 years, opioid use in patients with low back pain was associated with emergency department visits but not with hospitalizations over a 2-year follow-up.³¹ The present study expands earlier findings to more disabled and older home care clients with a wider range of indications for opioid use (mainly musculoskeletal pain but including also, e.g., pain related to neurologic and cardiovascular diseases and cancer),³ and with confirmed 1-year daily use of opioids.

Importantly, long-term opioid users' more frequent use of health care services was not explained by the severity of pain, nor by socio-demographic characteristics, comorbid diseases, cognitive status, disabilities, or other health characteristics. This finding raises the question of whether adverse effects or events of opioid use could explain a part of the more frequent use of health or home care services. In an earlier study among the same home care clients, constipation was the only adverse effect of opioid use that could be demonstrated using the RAI-HC data.³² Although opioid-induced

constipation has been associated with higher health care resource utilization,^{33,34} its prevalence is so low³² that it cannot explain the higher health care use. Besides constipation, other symptoms such as dizziness and nausea⁷ could increase the frequency of physicians' consultations. These symptoms may also lead to more severe physical limitations in frail older adults and increase the need for home care nurses' help. Other examples of adverse effects associated with opioid use for chronic noncancer pain include increased risk of falls,⁹ myocardial infarctions,⁸ and increased mortality.¹² However, latter findings are from populations mostly younger than home care clients in this study.

Against our hypothesis, we found no association between long-term opioid use and long-term care admissions, longer hospitalizations, or mortality. This does not support the idea that opioid use would inevitably lead to serious adverse effects. Moreover, increased use of other health care services could indicate an appropriate response to opioid users' care needs rather than being a marker of drug-related problems. One explanation for the findings could also be the common use of transdermal buprenorphine, which, compared with most other opioids and nonsteroidal anti-inflammatory drugs, has certain benefits, such as safety in persons with renal impairment, stable serum concentrations, and ease of use in persons with cognitive impairment.³⁵ However, the lack of association may also be due to a relatively small number of selected opioid users, who tolerate opioids, and just 1-year follow-up. Altogether, the reasons explaining greater service use remain unclear, and we cannot preclude the possibility of residual confounding (eg, related to severity of comorbid diseases or frailty) that could affect physicians' prescription practices of opioids as well as the studied outcomes.

Strengths and Limitations

Opioid use during the follow-up was verified from electronic medical records including a list of medication of each day and all prescriptions and renewals. So, it is unlikely that some opioid users would actually not have been long-term users. It was impossible to verify to what extent there was short-term opioid use among nonusers between the RAI-HC assessments. However, exclusion of all short-term or random use of opioids among nonusers would have led

to exclusion of many events in which opioids are often needed, for example, injuries or illnesses needing surgery, or end-of-life care. The fact that few nonusers probably used opioids to some extent during the follow-up may have diluted the observed associations but cannot make false associations.

The RAI-HC offered the possibility to control over a comprehensive range of potential confounding factors. Missing values were rare, and even though there may be some miscoding at the level of an individual client this should not systematically bias the observations. All health care service use was confirmed using electronic medical records and there were no clients with missing information. Disappearing from follow-up was possible only by moving to another municipality, which is rare among home care clients.

Unfortunately, data on visits in the university hospital and private health care were unavailable in the present study. In actual practice, however, private health care visits are rare among home care clients, and most clients are transferred from the emergency department or wards of the university hospital after urgent examinations or surgery to the secondary and post-acute care wards of Tampere city. Presumably, the total number of inpatient days is slightly higher than observed in the present study, but missing entire stays is less likely, with the exception of, for example, few day surgery services available only at the university hospital.

Home care service use was not recorded in the electronic medical records on a day-to-day basis and there was considerable variation in the timing of later RAI-HC assessments, so home care service use during the follow-up could not be analyzed. Therefore, cross-sectional data based on baseline RAI-HC assessments were used instead. However, it should be noted that most opioid users in this study were already daily long-term users before entering the study.³

Conclusions and Implications

Home care clients' long-term opioid use is associated with increased health care and home care service use regardless of the severity of pain and other sociodemographic and health characteristics. This may indicate inability of health care organizations to produce alternative treatment strategies for pain management when opioids do not meet patients' needs. Future studies should examine to what extent opioid users' greater health care utilization is associated with adverse effects or events of opioid use, insufficient pain relief despite the use of opioids, or other health problems of opioid users, and the potential of transdermal buprenorphine to decrease adverse consequences of opioids in older adults.

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Supplementary Table 1

Opioid Analgesics (ATC N02 A) Available in Finland During the Study Period

Opioid*	ATC Code [†]	Routes of Administration
Strong opioids		
Morphine	N02AA01	Oral (both short and long-acting) [‡]
Hydromorphone	N02AA03	Not used in study population
Oxycodone	N02AA05-55	Oral (both short and long-acting) [‡] with and without naloxone
Fentanyl	N02AB03	Transdermal, sublingual, intranasal [‡]
Buprenorphine	N02AE01	Transdermal, sublingual
Weak opioids		
Codeine	N02AJ06-08	Oral (available only in combinations with acetaminophen or nonsteroidal anti-inflammatory drugs)
Tramadol	N02AX02	Oral (both short and long-acting)

*All opioids are only available on prescription in Finland.

[†]The World Health Organization Anatomical Therapeutic Chemical classification system.[‡]Also intravenous or subcutaneous use in hospital wards or during palliative care and end-of-life care.**Supplementary Table 2**

Description of the Resident Assessment Instrument Sum Scales Used in the Study

Sum Scale	Contents	Score (Range; Categorization)
Activities of daily living (ADL)	Items on eating, locomotion, bed mobility, mobility from/to bed/chair, dressing, personal hygiene, and toilet use	0–28; higher scores indicate greater disability
Instrumental activities of daily living (IADL)	Items on meal preparation, housework, phone use, managing finances and medications, shopping, transportation, and stairs	0–21; higher scores indicate greater disability
Changes in Health, End-Stage Disease, Signs and Symptoms Scale (CHESS)	Items on end-stage disease, change in decision making and ADL status, weight loss, dehydration, decreased food intake, vomiting, peripheral edema, dyspnea	0 no; 1 minimal; 2 low; 3 moderate; 4 high; 5 very high health instability
Depression Rating Scale (DRS)	Items on negative statements, sad and worried expressions, crying and tearfulness, anxious non-health-related concerns, repetitive health complaints, unrealistic fears, persistent anger with self or others	0–14; scores ≥ 3 suggest that a person has depressive symptoms
Cognitive Performance Scale (CPS)	Items on decision making, understanding, procedural memory and short-term memory, dependence in eating	0–6; scores ≥ 2 refer to at least mild cognitive impairment
Pain Scale	Pain frequency and pain intensity	0 no pain; 1 less than daily pain; 2 mild to moderate daily pain; 3 severe daily pain