A Pharmacoepidemiologic Study of Community-Dwelling, Disabled Older Women: Factors Associated With Medication Use

Victor Crentsil, MD, MHS[1]; Michelle O. Ricks, MS[2]; Qian-Li Xue, PhD[2,3]; and Linda P. Fried, MD, MPH[4]

[1]Division of General Internal Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland; [2]Center on Aging and Health, Johns Hopkins University School of Medicine, Baltimore, Maryland; [3]Division of Geriatric Medicine and Gerontology, Johns Hopkins University School of Medicine, Baltimore, Maryland; and [4]Mailman School of Public Health, Columbia University, New York, New York

ABSTRACT

Background: Although disabled older adults may be among the subpopulation of adults with the highest risk for adverse drug events (ADEs), reliable data on their use of medications are limited.

Objectives: The aims of this study were to describe the extent and patterns of medication use in community-dwelling, disabled older women, and to identify factors associated with medication use in this population.

Methods: Cross-sectional analyses of baseline data on medication use from the Women's Health and Aging Study I (WHAS I) were performed. WHAS I was an observational study of 1002 community-dwelling women aged ≥65 years who self-reported difficulty in at least 2 of 4 domains of physical functioning (ie, upper-extremity functions, mobility, self-care, and higher functioning tasks needed for independent living in the community). After descriptive analyses of their prescription and over-the-counter (OTC) drugs, associations between participants' characteristics and medication utilization were determined, using generalized linear models.

Results: Of the 975 participants, 580 (59.5%) used ≥5 medications and 115 (11.8%) used ≥10 medications (prescriptions and OTCs). The mean number of medications used was 3.9 for prescription drugs and 1.9 for OTC drugs. Cardiovascular drugs and analgesics were the most frequently used prescription and OTC drugs, respectively. Participants with complete outcome and covariate data (n = 803) were included in the multivariate analyses. Cancer was associated with a 13% increase in total medication use (95% CI, 1.00–1.27). Multimorbidity (1.08; 95% CI, 1.02–1.15), frailty (1.13; 95% CI, 1.02–1.26), high Mini-Mental State Examination score (1.03; 95% CI, 1.01–1.05), congestive heart failure (CHF) (1.39; 95% CI, 1.23–1.58), angina (1.27; 95% CI, 1.12–1.44), chronic obstructive pulmonary disease (COPD) (1.20; 95% CI, 1.05–1.37), diabetes mellitus (DM) (1.24; 95% CI, 1.07–1.43), difficulty with shopping for personal items such as medicines and toiletries (1.20; 95% CI, 1.06–1.35), and possession of health insurance (1.21; 95% CI, 1.04–1.40) or a prescription plan (1.16; 95% CI, 1.05–1.29) were independently associated with increased use of prescription drugs. A diagnosis of osteoarthritis of the hands (1.29; 95% CI, 1.12–1.49) and having a spouse (1.19; 95% CI, 1.01–1.40) were associated with increased use of OTC drugs. Participants with DM (0.78; 95% CI, 0.65–0.94), African Americans (0.70; 95% CI, 0.60–0.82), and those who had difficulty shopping (0.85; 95% CI, 0.72–0.99) used fewer OTCs than did participants without these characteristics.

Conclusions: Most of the disabled older women in this study took ≥5 medications at baseline, potentially putting them at high risk for ADEs. Those with multimorbidity, frailty, CHF, angina, DM, COPD, cancer, and difficulty with instrumental activities of daily living are target subpopulations for polypharmacy intervention. (*Am J Geriatr Pharmacother*. 2010;8:215–224) © 2010 Excerpta Medica Inc.

Key words: pharmacoepidemiology, elderly, disability, women, medication use.

Presented in part at the 58th Annual Scientific Meeting of the Gerontological Society of America, November 18–22, 2005, Orlando, Florida.

Accepted for publication May 11, 2010.
Published online June 17, 2010.

doi:10.1016/j.amjopharm.2010.06.003
1543-5946/$ - see front matter

INTRODUCTION

Use of multiple medications (polypharmacy) may be appropriate for many older adults with several health conditions; however, it may also be associated with increased risk for adverse drug events (ADEs), including falls, delirium,[1] functional or cognitive decline, and medication nonadherence.[2] In a 12-month cohort study[3] of >27,000 adults aged ≥65 years, the incidence of ADEs was 50.1 per 1000 person-years; 13.8 of the 50.1 events were judged to be preventable, and 38.0% (578/1523) were serious or fatal. Generally, for older adults, reliable data on medication use (prescription and over-the-counter [OTC] drugs) and factors associated with drug utilization are limited. This paucity of data makes it difficult to identify subsets of older patients at risk for adverse effects of polypharmacy and to optimize medication use in vulnerable subpopulations (eg, the frail and/or disabled).

Data on characteristics of older adults at high risk for polypharmacy are limited. As of 2007, <10 studies had reported risk factors for polypharmacy.[4] Information on polypharmacy in geriatric subpopulations such as the disabled is particularly sparse. Studies to date were limited in sample size[5–8] or were performed from data that were not originally collected for research[9]; the latter issue limits effective control of confounders. The importance of understanding medication use in disabled populations has been further increased by reports of excess ADE risks with worsening mobility impairment purported to be mediated through increased medication utilization.[10]

This study sought to describe the extent and patterns of medication use in a representative sample of community-dwelling women ≥65 years of age who self-reported difficulty in at least 2 of 4 domains of physical functioning (ie, upper-extremity functions, mobility, self-care, and higher functioning tasks needed for independent living in the community) and to identify factors associated with medication use overall, as well as factors specific to prescription and OTC drugs. The hypothesis was that there would be a direct relationship between multimorbidity and the total number of medications used. It was also hypothesized that factors associated with prescription and OTC use would differ because they may have different indications. The findings of this study will be important for devising solutions for polypharmacy, especially for disabled older women.

METHODS

Baseline data from the Women's Health and Aging Study I (WHAS I)[11,12] collected between 1992 and 1995 were analyzed. WHAS I was a prospective observational study of 1002 women aged ≥65 years who, at baseline, were representative of the most disabled community-dwelling women.

The methods of WHAS I have been described previously.[11,12] In summary, female participants were recruited from an age-stratified, random sample of Medicare-eligible individuals. Eligibility was based on a Mini-Mental State Examination[13] (MMSE) score ≥18 and self-reported difficulty in ≥2 of 4 functional domains (upper-extremity strength, mobility, basic self-care, and higher-function tasks). Participants gave written informed consent, and all study procedures were approved by the institutional review board of the Johns Hopkins Medical Institutions.

Data Collection

Data on sociodemographic characteristics, health status, and 14 chronic diseases were obtained through a home-based interview and performance assessments.[12] Explanatory variables used in these analyses were based on factors likely to precipitate the need for medications (eg, diseases, health characteristics), characteristics enabling acquisition of medications (sociodemographic factors), and variables associated with access to medications (eg, insurance, physical functioning). The chosen explanatory variables were as follows:

1. *Adjudicated diseases*: congestive heart failure (CHF); myocardial infarction; angina; osteoarthritis (OA) of the hands, hips, and knees; diabetes mellitus (DM); stroke; chronic obstructive pulmonary disease (COPD); peripheral arterial disease; and cancer.[12]
2. *Health characteristics*: number of diseases, frailty status (nonfrail or frail; "prefrail" participants [ie, with <3 frailty indicators[14]] were classified as nonfrail), self-reported difficulty with activities of daily living (ADLs) (ie, eating, toileting, bathing, transferring, dressing) and/or instrumental ADLs (IADLs) (ie, shopping [difficulty shopping for personal items such as medicine or toiletries], meal preparation, telephone use, light housework, heavy housework), MMSE score, homebound status, and physical performance summary score.[15] The physical performance score was an aggregate of the scores for performance-based measures of physical functioning of the upper and lower extremities[12,15]; higher scores were indicative of superior performance. Upper-extremity functions were evaluated by the Grip Strength Test, Purdue Pegboard Test (a test of manual dexterity), putting-on-blouse test, and the lock-and-key test. Lower-

extremity functions were assessed by walking speed, standing-balance test, and the chair-stand test.
3. *Sociodemographic factors*: age, highest level of education completed, income, marital status, number of people in the household, and race (black or nonblack [ie, white and others combined]).
4. *Health insurance coverage*: whether or not, in addition to Medicare, a participant had health insurance coverage or a private prescription plan.

Domains of disability were based on self-reported difficulty in 4 categories of physical functioning: upper-extremity functions, mobility, self-care, and higher-function tasks.[12]

Medication containers of participants who reported taking any medication within 2 weeks of the baseline interviews were examined by an interviewer. In the absence of the medication container, the name, amount used, and classification (prescribed or OTC) reported by the participants were recorded.[16] A computerized medication database was created in which drugs were identified by name, drug code, ingredient code (using Iowa Drug Information Service code), and form code (eg, pill, capsule, topical). In this database, drugs were classified at 4 levels: major categories (eg, cardiovascular agents), first subcategories (eg, vasodilating agents), second subcategories (eg, calcium channel blockers), and ingredients (eg, amlodipine).

Statistical Analysis

The cross-sectional analyses were based on data from the participants included in the descriptive analysis; the multivariate regression analysis was based on participants with complete outcome and covariate data. For the descriptive analysis, the percentage of participants taking any medication, the mean (SD) number of total medications, prescriptions, and OTCs used, and the percentage of participants who had used various numbers of medications were determined. The participants taking various prescription and OTC ingredients were then ranked by percentage.

Subsequently, factors associated with increases or decreases in the total number of medications, the number of prescription drugs, and the number of OTC drugs taken were determined using regression methods. The total number of medications taken was used as an outcome variable to determine factors that may be important in generating polypharmacy, because the definition of polypharmacy (≥5 concurrent medications) considers the total number of medications used, regardless of whether they were prescription or OTC. To properly model the skewed distributions of the outcome variables, analyses were performed using generalized linear models with a log link and γ distribution.[17] For each model, the estimate for the outcome variable was computed as an exponent of the coefficient of the regression models (expβ). For continuous explanatory variables, the estimate for the outcome variable represents the ratio of the number of medications used associated with a 1-unit increase in the explanatory variables. For example, for the number of diseases explanatory variable, the ratio 1.08 estimate of the outcome variable for total medications means for each 1-unit increase in number of diseases, the total number of medications used increases by a factor of 1.08, or 8%. For the dichotomous explanatory variables, we compared the presence of the explanatory variable to its absence to describe the associations between the explanatory variables and medication use.[18] For example, for the CHF explanatory variable, a diagnosis of CHF is associated with a factor of 1.24, or a 24% increase in total medications used compared with the absence of CHF.

Three multivariate models were developed, one for each of the outcomes: number of total medications, prescriptions, and OTCs used. Nonparametric trend tests were performed to analyze the trend between the number of medications used and the number of domains of disability. Analyses were performed using Stata 8 (StataCorp LP, College Station, Texas) and SAS PROC GENMOD (SAS 8.1, SAS Institute Inc., Cary, North Carolina).

RESULTS

Participant Characteristics

Of the random sample of women identified to be eligible to be screened for WHAS I (n = 5316), 4137 were screened; 1409 met the eligibility criteria, and 1002 agreed to participate in the study. Of the 1002 participants, medications data were missing for 27 partcipants; therefore, 975 were included in the descriptive analysis and 803 for whom complete outcome and covariate data were available were included in the multivariate regression analysis.

The baseline sociodemographic and health characteristics of WHAS I participants are summarized in **Table I**. The mean (SD) age was 78.3 (8.1) years (range, 65–100 years). Most (599/975, 61.4%) of the participants were aged ≥75 years, and most (696/975, 71.4%) were white; 43.3% (421/973) had completed ≤8th grade of education, and 18.1% (176/973) had completed >12th grade of education; 48.3% (471/975) lived alone; 21.1% (206/975) were married; and 87.1%

Table I. Baseline sociodemographic and health characteristics of the study population, Women's Health and Aging Study I[11,12] (N = 975).

Characteristic	Value
Age, y	
Mean (SD)	78.3 (8.1)
Range	65–100
65–74	38.6%
75–84	31.4%
≥85	30.0%
Race, %	
White	71.4
African American	28.1
Other	0.5
Income (US $)*	
Mean (SD)	$15,939.44 ($18,695.74)
Range	$0–$300,000
Years of education, %†	
0–8	43.3
9–11	21.5
12	17.1
>12	18.1
Number of people in household, %	
1	48.3
2	32.5
3	11.1
≥4	8.1
Married (yes), %	21.1
Have health/medical insurance plan (yes), %	87.1
Have private prescription plan (yes), %	34.0
Number of chronic diseases, %	
0	5.6
1	22.0
2	29.3
3	21.4
≥4	21.7

Characteristic	Value
Specific chronic diseases, %‡	
Osteoarthritis	57.5
Congestive heart failure	25.8
Angina	25.2
Diabetes mellitus	16.3
Chronic obstructive pulmonary disease	16.3
Cancer	11.3
Stroke	7.2
Frailty status, %	
Frail	35.1
Nonfrail	64.9
PPSS§	
Mean (SD)	5.9 (3.3)
Range	0–12
Difficulty with ADLs, %‖	
None	35.0
A little/some	33.3
A lot/unable to perform	31.7
Difficulty with IADLs, %‡¶	
Heavy housework	68.9
Shopping	37.1
Light housework	16.0
Meal preparation	15.9
Money management	13.1
Telephone use	4.1
Homebound	30.5
MMSE score[13]	
Mean (SD)	26.4 (3.0)
Range	18–30
Score ≥24	82.2%

PPSS = physical performance summary score; ADLs = activities of daily living; IADLs = instrumental ADLs; MMSE = Mini-Mental State Examination.

* Question asked: "What was your household's total income from all sources, before taxes in [insert previous year]?" Social security, retirement income, public assistance, job earnings, rent from property, help from relatives, and other income should be included. If the participant did not know or refused to provide the needed information, she was shown income ranges on a card and asked to choose a range.

† Question asked: "What is the highest grade in school or year of college that you completed?"

‡ Some participants may have been included in >1 category.

§ Continuous aggregate scores for upper- and lower-extremity physical performance measures (higher scores indicative of superior performance).[15]

‖ Eating, toileting, bathing, transferring, dressing.[11,12]

¶ Shopping, meal preparation, telephone use, light housework, heavy housework.[11,12]

(846/971) had health insurance in addition to Medicare, but only 34.0% (329/968) had a private prescription plan.

Most (703/971, 72.4%) of the participants had ≥2 chronic diseases. The most frequently reported chronic disease was OA (561/975, 57.5%). CHF was present in 25.8% (252/975) of participants; DM and COPD were present in 16.3% (159/975) each. One third (339/966, 35.1%) of the participants were frail, and 35.0% (341/974) reported no difficulty with ADLs. The most common difficulty with IADLs was performing heavy housework (669/971, 68.9%); 37.1% (361/974) of the participants had difficulty shopping, and 30.5% (297/974) were homebound. MMSE score was <24 for 17.8% (174/975) of the participants.

Medication Use

Medication use at baseline is shown in **Table II**. Almost all (972/975, 99.7%) of the participants used ≥1 medication at baseline. Prescription use (893/975, 91.6%) was more prevalent than OTC use (801/975, 82.2%). The distribution of medications used was positively skewed (**Figure 1**). The mean (SD) numbers of total medications, prescriptions, and OTCs used were 5.8 (3.3), 3.9 (2.7), and 1.9 (1.8), respectively (**Table II**). The most frequent number of medications used by the participants was 4; the maximum number was 23. Most (580/975, 59.5%) of the participants used ≥5 medi-

Table II. Medication use at baseline, Women's Health and Aging Study I[11,12] (N = 975).

Category	Value
No. of medications used, % of participants	
≥1	99.7
≥2	93.5
≥3	84.5
≥4	75.1
≥5	59.5
≥6	47.3
≥7	35.5
≥8	26.8
≥9	18.8
≥10	11.8
Medications used, % of participants	
Prescriptions	91.6
OTCs	82.2
Medications used, mean (SD)	
Total medications	5.8 (3.3)
Prescriptions	3.9 (2.7)
OTCs	1.9 (1.8)

OTCs = over-the-counter medications.

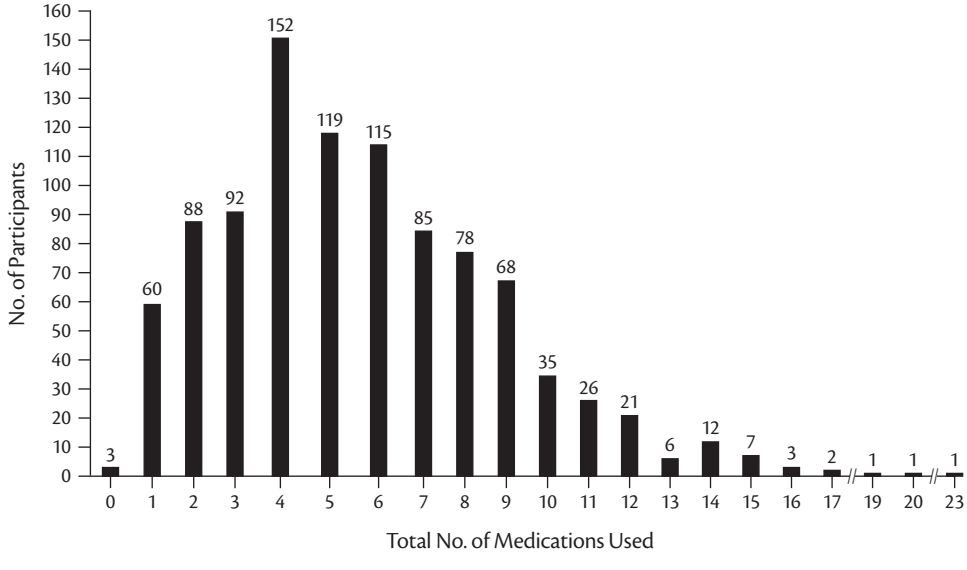

Figure 1. Frequency distribution of total number of medications used by participants in the Women's Health and Aging Study I[11,12] (N = 975).

cations (prescriptions and OTCs combined), and 11.8% (115/975) used ≥10 medications (prescriptions and OTCs combined).

A direct relationship was found between the number of adjudicated diseases and the number of medications used (**Figure 2**). In the absence of any of the adjudicated diseases, the mean number of medications used was 3.7. A stepwise relationship was found between the number of domains of disability and the total medications or prescriptions used (**Figure 3**). The mean number of total medications used by those with 2, 3, and 4 domains of disability were 5.2, 5.7, and 6.3, respectively (test of trend, $P < 0.01$). The mean number of prescriptions used was 3.5, 3.8, and 4.4 for 2, 3, and 4 domains of disability, respectively (test of trend, $P < 0.01$). OTC use did not change significantly as disability increased.

The most frequently used medication ingredients are summarized in **Table III**. Cardiovascular medication ingredients were the most frequently used in the prescription drug category, with hydrochlorothiazide and nitroglycerin the most-used prescription ingredients (17.6% each). Acetaminophen was the most frequently used OTC ingredient (35.2%). Anti-inflammatory analgesics (eg, aspirin [31.5%]), supplements (eg, multivitamins [8.4%]), and gastrointestinal drugs (eg, ranitidine [8.5%]) were also widely used.

Factors Associated With Medication Use

Factors that were independently associated with an increased number of total medications used included increased number of diseases (multimorbidity) (total medication use increased by 8% for each additional disease [95% CI, 3%–13%]), frailty, CHF, angina, cancer, and OA of the hands (**Table IV**, second column). African Americans, participants who lacked health insurance or a private prescription plan, the cognitively impaired, and unmarried women used fewer total medications than did participants without these characteristics.

Characteristics that were associated with increased prescription use (**Table IV**, third column) included increased number of diseases (multimorbidity) (prescription use increased by 8% with each additional disease [95% CI, 2%–15%]), frailty, CHF, angina, COPD, DM, and difficulty with shopping. Cognitive impairment and lack of health insurance or a private prescription plan were associated with reduced prescription use. No significant association was found between race and prescription use.

The main factors significantly associated with increased OTC use (**Table IV**, fourth column) were marital status (married; 19% increase in OTC use) and a diagnosis of OA of the hands (29% increase in OTC use). African-American race was associated with a 30% decrease in OTC use, and DM was associated with a 22% decrease. OTC use decreased by 6% with each additional person in the household, and difficulty with

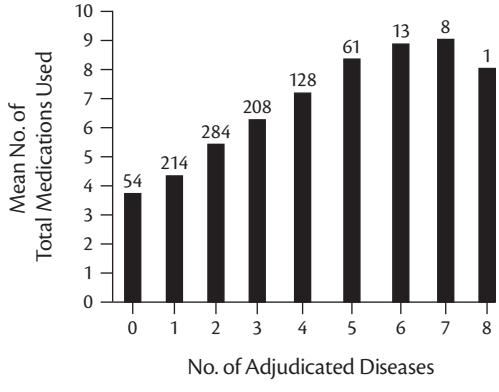

Figure 2. Mean number of total medications used by participants in the Women's Health and Aging Study I[11,12] (N = 975) versus the number of adjudicated diseases (n = 971). The numbers on the bars indicate the number of participants in that stratum of adjudicated diseases.

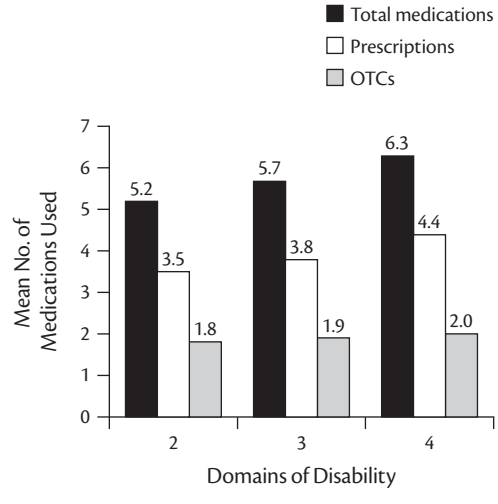

Figure 3. Mean number of total medications, prescriptions, or over-the-counter medications (OTCs) used by participants in the Women's Health and Aging Study I[11,12] (N = 975) versus the number of domains of disability (n = 975). Nonparametric tests of trend: total medications, $P < 0.01$; prescriptions, $P < 0.01$; OTCs, $P = 0.07$.

Table III. Most widely used prescription and OTC ingredients, Women's Health and Aging Study I[11,12] (N = 975).

Ingredient	% of Participants
Prescriptions	
Hydrochlorothiazide	17.6
Nitroglycerin	17.6
Furosemide	17.5
Potassium chloride	14.3
Digoxin	14.0
Nifedipine	10.0
Levothyroxine	8.8
Ranitidine	8.5
Diltiazem	8.4
Triamterene	8.0
OTCs	
Acetaminophen	35.2
Aspirin	31.5
Iron	9.0
Calcium carbonate	8.8
Multivitamins	8.4
Trace elements	8.2
Ibuprofen	7.7
Magnesium oxide	7.5
Ascorbic acid	7.2
Aluminum hydroxide	6.2

OTCs = over-the-counter medications.

shopping was associated with a 15% decrease in OTC use. Age, education, and income were not significantly associated with the total number of medications, prescriptions, or OTCs used.

DISCUSSION

This study confirms that medication use is substantial among community-dwelling, disabled older women; >50% of the study participants were taking ≥5 medications at baseline. These findings are consistent with those of Kaufman et al,[8] who reported a 57% prevalence for use of ≥5 medications by women aged ≥65 years in a US population-based telephone survey of 2590 adults (≥18 years of age). Possible explanations for the high prevalence of medication use in the present study are accumulation of medications for treatment of multiple comorbidities and, probably, health providers' adherence to treatment guidelines without individualizing treatments.[19]

Regardless of the etiology of multiple medication use, the finding that >50% of the study participants were taking ≥5 medications at baseline suggests the need for urgent attention because polypharmacy increases the risk for ADEs, financial burden, medication nonadherence, and mortality.[20] On the other hand, the need for multiple medications for appropriate management of multiple illnesses in older adults may be unavoidable in certain situations, and clinicians should distinguish between appropriate needs and other conditions under which polypharmacy is more harmful than beneficial.

Approaches that health care providers may adopt to minimize unnecessary polypharmacy include use of medications that are likely to simultaneously treat multiple diseases or symptoms in the same patient. In addition, prioritization of medications and individualization of treatment plans could minimize use of unnecessary drugs. However, in attempts to minimize unnecessary medication use in older adults, health care providers should guard against overzealous discontinuation of medications and inappropriate restriction of needed medications due to concerns about the adverse effects of polypharmacy. The optimal approach to minimizing unnecessary polypharmacy is to periodically reevaluate the benefits and risks of a patient's medications to ensure that the benefits of polypharmacy outweigh the risks.

The association between frailty and increased medication use is important for 3 reasons. First, frailty is thought to be associated with decreases in drug metabolism and conjugation,[21,22] which may delay drug elimination and increase the potential for ADEs. Second, frailty is associated with a decrease in physiologic reserves[23] that could theoretically contribute to increasing the propensity for ADEs. Lastly, frailty has been linked to poor health outcomes.[14] To minimize ADEs in frail older adults, the global clinical and functional status of patients should be considered before recommending medications, balancing the risks for ADEs with the benefits of pharmacotherapy.

Diseases that are more likely to adversely affect quality of life in older adults (eg, CHF, COPD, DM, angina) were associated with increased medication use. Patients with these diseases use multiple prescriptions to relieve symptoms, minimize disease severity, or treat complications; the need for prescriptions increases their risk for polypharmacy and ADEs. Thus, older adults with these diseases could benefit from frequent medication reviews to prevent use of unnecessary medications.

Associations of marital status and OA of the hands with OTC use are noteworthy. Increased OTC use by disabled

Table IV. Factors associated with medication use, Women's Health and Aging Study[11,12]: Multivariate regression analyses showing ratios of medications used (95% CI) with each unit increase in continuous variables or comparing presence to absence of dichotomous variables* (n = 803†).

Factor	Total Medications	Prescriptions	OTCs
Age	1.00 (0.99–1.00)	1.00 (0.99–1.00)	1.00 (0.99–1.01)
Married	1.11 (1.01–1.22)	1.09 (0.96–1.24)	1.19 (1.01–1.40)
Education	1.00 (0.99–1.01)	0.99 (0.98–1.01)	1.01 (0.99–1.03)
African American race	0.88 (0.81–0.97)	0.99 (0.88–1.12)	0.70 (0.60–0.82)
No. in household	0.99 (0.96–1.03)	1.01 (0.97–1.05)	0.94 (0.89–1.00)
No. of diseases	1.08 (1.03–1.13)	1.08 (1.02–1.15)	1.07 (0.98–1.16)
CHF	1.24 (1.12–1.37)	1.39 (1.23–1.58)	0.92 (0.77–1.09)
Angina	1.14 (1.03–1.26)	1.27 (1.12–1.44)	0.94 (0.79–1.11)
COPD	1.08 (0.97–1.20)	1.20 (1.05–1.37)	0.90 (0.76–1.08)
Cancer	1.13 (1.00–1.27)	1.15 (0.99–1.34)	1.09 (0.89–1.33)
DM	1.08 (0.96–1.21)	1.24 (1.07–1.43)	0.78 (0.65–0.94)
OA of hands	1.12 (1.03–1.22)	1.04 (0.93–1.16)	1.29 (1.12–1.49)
Frailty	1.10 (1.01–1.20)	1.13 (1.02–1.26)	1.06 (0.92–1.23)
Difficulty shopping	1.07 (0.98–1.18)	1.20 (1.06–1.35)	0.85 (0.72–0.99)
MMSE score	1.02 (1.01–1.04)	1.03 (1.01–1.05)	1.01 (0.98–1.03)
Health insurance	1.12 (1.00–1.25)	1.21 (1.04–1.40)	1.02 (0.84–1.24)
Prescription plan	1.12 (1.04–1.22)	1.16 (1.05–1.29)	1.08 (0.94–1.24)

OTCs = over-the-counter medications; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; DM = diabetes mellitus; OA = osteoarthritis; MMSE = Mini-Mental State Examination.

* All 3 models were adjusted for income, homebound status, difficulty with activities of daily living, physical performance summary score, ability to use a telephone, history of stroke, presence or absence of peripheral arterial disease, and myocardial infarction (all, *P* = NS). Interpretation of ratio of medications used: for example, for CHF, the ratio of total medications used is 1.24, meaning that CHF was associated with a 24% increased total medication use compared with those without CHF; similarly, each 1-unit increase in the number of diseases was associated with an 8% increase in total medication use. Furthermore, black race, with a 0.88 total medication used ratio, indicates a 12% decrease in medications used by blacks compared with nonblacks.

† For valid comparison across types of medication use, the analyses were restricted to the common set of study subjects with complete outcome and covariate information.

married participants may be explained by the observation that, in this study, the married women had less difficulty shopping for personal items than did unmarried women (24.3% vs 40.5%, respectively). Hence, comparatively, married participants had greater access to OTC drugs for personal use. A high prevalence of advanced age (≥85 years: unmarried, 35.9%; married, 8.3%) and frailty (unmarried, 38.5%; married, 22.2%) may have contributed to the relatively high prevalence of difficulty with shopping among the unmarried participants. OA of the hands is a painful disorder; hence, its link with increased OTC use (eg, analgesics) is not surprising.

The inverse relationship between DM, difficulty shopping, household size, and African-American race and use of OTC medications is interesting. The decrease in OTC use among participants with DM, despite the occurrence of painful complications that may result in use of OTC analgesics, could be due to high prescription use,[24] leaving diminished funds or desire for additional medications. Therefore, DM may be associated with prescription needs that can force patients to limit use of OTCs or, conceivably, reduce use of prescriptions that the patient believes are nonessential. Difficulty with shopping may be an index of disease severity; therefore, as in DM, the reduced use of OTCs may have occurred because difficulty with shopping was associated with increased prescription use; hence, the decline in OTC use may be related to diminished funds from increased prescription

use. Furthermore, participants who had difficulty shopping may have reduced access to OTCs because they may have had to depend on others to acquire the OTCs for them. The reason for reduced OTC use with increased household size could not be determined from the data provided in this study. Although the association between African-American race and reduced OTC use is difficult to explain, it may be due to the African Americans in this study having limited financial resources, as evidenced, for instance, by the lack of health insurance. This proposition is based on the finding that 9.7% of non-African Americans in the present study lacked health insurance, whereas 20.9% of the African Americans in this study lacked health insurance. This relationship between lack of health insurance and reduced OTC use among African-American older adults has been described previously.[25]

The present study has a number of limitations. The exclusive observation of women in this study may limit generalizability of the results. On the other hand, it could be a strength because older women use more medications than do older men,[6] and disability, which is more prevalent in women than in men,[26] is among the factors associated with high medication intake.[5] Thus, hypothetically, disabled older women constitute the subpopulation at highest risk for polypharmacy and its adverse effects[27]; however, data on this subpopulation are sparse.

Another limitation is the possible changing patterns of medication use with time. A cross-sectional study[9] of 415 homebound patients (77% female; median age, 83 years [ie, similar to participants in the present study]) reported the mean number of medications prescribed as 8.2, and the uninsured used an average of 7.4 medications. Therefore, the prevalence of medication use in the present study seems conservative. Another study[28] of medication use among adults aged ≥65 years reported that cardiovascular drugs were the most widely used medications in the evaluated population and that ≥50% of these older adults used ≥5 drugs. These similarities between the present study and subsequent studies by other investigators suggest that the pattern of medication use in older adults may not have changed substantially and that the results of this study are still relevant despite the amount of time that has elapsed since the data were collected. Although the data in this study are >15 years old, the authors are not aware of any recently published findings that would refute the conclusions.

The cross-sectional design of the present study is another limitation because the relationship between medication use and the identified factors cannot be inferred to be causal in nature. The requirement of drug utilization management programs as part of the Medicare prescription benefit[29] suggests that policy makers share the authors' concerns regarding suboptimal medication use among older adults. To be able to forecast adverse utilization levels or patterns and promote risk-minimizing strategies, policy makers and health care providers need to understand the patterns and determinants of medication use preceding the Medicare prescription benefit, as detailed in this study.

CONCLUSIONS

Most of the disabled older women in this study took ≥5 medications at baseline, potentially putting them at high risk for ADEs. Those with multimorbidity, frailty, CHF, angina, DM, COPD, cancer, and difficulty with IADLs are target subpopulations for polypharmacy intervention. Evaluation of the causal relationship between these factors and use of medications, as well as polypharmacy, among older adults using prospective or longitudinal studies will be necessary.

ACKNOWLEDGMENTS

The authors are indebted to the participants and investigators of WHAS I, and they express their gratitude to Marcia Omondi (Center of Aging and Health, Johns Hopkins University) for her assistance in the preparation of this manuscript. Dr. Crentsil was supported by the following awards: (1) National Institute of Aging Supplement to the Women's Health and Aging Study III to Promote Diversity in Health-Related Research, (2) John A. Hartford Center of Excellence Award, and (3) Johns Hopkins Older American Independence Center Award (P30 AG 021334). The authors have indicated that they have no other conflicts of interest regarding the content of this article.

REFERENCES

1. Hanlon JT, Schmader KE, Ruby CM, Weinberger M. Suboptimal prescribing in older inpatients and outpatients. *J Am Geriatr Soc.* 2001;49:200–209.
2. Vik SA, Maxwell CJ, Hogan DB. Measurement, correlates, and health outcomes of medication adherence among seniors. *Ann Pharmacother.* 2004;38:303–312.
3. Gurwitz JH, Field TS, Harrold LR, et al. Incidence and preventability of adverse drug events among older persons in the ambulatory setting. *JAMA.* 2003;289:1107–1116.
4. Hajjar ER, Cafiero AC, Hanlon JT. Polypharmacy in elderly patients. *Am J Geriatr Pharmacother.* 2007;5:345–351.

5. López-Torres HJ, Cerdá Diaz R, Fernández OC, et al. Factors associated with chronic drug consumption in the elderly [in Spanish]. *Med Clin (Barc)*. 1997;108:572–576.
6. Chrischilles EA, Foley DJ, Wallace RB, et al. Use of medications by persons 65 and over: Data from the established populations for epidemiologic studies of the elderly. *J Gerontol*. 1992;47:M137–M144.
7. Wallsten SM, Sullivan RJ Jr, Hanlon JT, et al. Medication taking behaviors in the high- and low-functioning elderly: MacArthur field studies of successful aging. *Ann Pharmacother*. 1995;29:359–364.
8. Kaufman DW, Kelly JP, Rosenberg L, et al. Recent patterns of medication use in the ambulatory adult population of the United States: The Sloan survey. *JAMA*. 2002; 287:337–344.
9. Kronish IM, Federman AD, Morrison RS, Boal J. Medication utilization in an urban homebound population. *J Gerontol A Biol Sci Med Sci*. 2006;61:411–415.
10. Chrischilles E, Rubenstein L, Van Gilder R, et al. Risk factors for adverse drug events in older adults with mobility limitations in the community setting. *J Am Geriatr Soc*. 2007;55:29–34.
11. Simonsick EM, Maffeo CE, Rogers SK, et al. Methodology and feasibility of a home-based examination in disabled older women: The Women's Health and Aging Study. *J Gerontol A Biol Sci Med Sci*. 1997;52:M264–M274.
12. Guralnik JM, Fried LP, Simonsick EM, et al, eds. *The Women's Health and Aging Study: Health and Social Characteristics of Older Women with Disability*. NIH Pub. No. 95-4009. Bethesda, Md: National Institute on Aging; 1995. http://www.nia.nih.gov/HealthInformation/Publications/Reports/WomensHealthAgingStudy.htm. Accessed June 10, 2010.
13. 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;12:189–198.
14. Fried LP, Tangen CM, Walston J, et al, for the Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: Evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001;56:M146–M156.
15. Onder G, Penninx BW, Lapuerta P, et al. Change in physical performance over time in older women: The Women's Health and Aging Study. *J Gerontol A Biol Sci Med Sci*. 2002;57:M289–M293.
16. Pahor M, Chrischilles EA, Guralnik JM, et al. Drug data coding and analysis in epidemiologic studies. *Eur J Epidemiol*. 1994;10:405–411.
17. Manning WG, Basu A, Mullahy J. Generalized modeling approaches to risk adjustment of skewed outcomes data. *J Health Econ*. 2005;24:465–488.
18. Anis AH, Lynd LD, Wang XH, et al. Double trouble: Impact of inappropriate use of asthma medication on the use of health care resources. *CMAJ*. 2001;164:625–631.
19. Boyd CM, Darer J, Boult C, et al. Clinical practice guidelines and quality of care for older patients with multiple comorbid diseases: Implications for pay for performance. *JAMA*. 2005;294:716–724.
20. Espino DV, Bazaldua OV, Palmer RF, et al. Suboptimal medication use and mortality in an older adult community-based cohort: Results from the Hispanic EPESE Study. *J Gerontol A Biol Sci Med Sci*. 2006;61: 170–175.
21. Wynne HA, Yelland C, Cope LH, et al. The association of age and frailty with pharmacokinetics and pharmacodynamics of metoclopramide. *Age Ageing*. 1993;22: 354–359.
22. Kinirons MT, O'Mahony MS. Drug metabolism and ageing. *Br J Clin Pharmacol*. 2004;57:540–544.
23. Fried LP, Hadley EC, Walston JD, et al. From bedside to bench: Research agenda for frailty [published correction appears in *Sci Aging Knowledge Environ*. 2005;2005:er3]. *Sci Aging Knowledge Environ*. 2005;2005:pe24.
24. Ryan EA, Pick ME, Marceau C. Use of alternative medicines in diabetes mellitus. *Diabet Med*. 2001;18:242–245.
25. Fillenbaum GG, Hanlon JT, Corder EH, et al. Prescription and nonprescription drug use among black and white community-residing elderly. *Am J Public Health*. 1993;83:1577–1582.
26. Orfila F, Ferrer M, Lamarca R, et al. Gender differences in health-related quality of life among the elderly: The role of objective functional capacity and chronic conditions. *Soc Sci Med*. 2006;63:2367–2380.
27. Evans RS, Lloyd JF, Stoddard GJ, et al. Risk factors for adverse drug events: A 10-year analysis. *Ann Pharmacother*. 2005;39:1161–1168.
28. Linton A, Garber M, Fagan NK, Peterson MR. Examination of multiple medication use among TRICARE beneficiaries aged 65 years and older. *J Manag Care Pharm*. 2007;13:155–162.
29. Centers for Medicare & Medicaid Services (CMS), HHS. Medicare program; Medicare prescription drug benefit; Final rule. *Fed Regist*. 2005;70:4193–4585.

Address correspondence to: Victor Crentsil, MD, MHS, Division of General Internal Medicine, Johns Hopkins University School of Medicine, 1830 East Monument Street, Baltimore, MD 21205. E-mail: vcrents2@jhmi.edu