The influence of patient-reported shared decision-making on the deprescribing of fall-risk-increasing drugs in older adults

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ABSTRACT

Background Falls in older adults are a common problem with major consequences. The use of fall-risk-increasing drugs (FRIDs) is one of the risk factors and deprescribing could therefore, hypothetically, reduce the risk of falls in older adults. Based on previous qualitative studies, shared decision-making (SDM) appears to be important in order to obtain effective deprescribing. However, this association has not yet been established using quantitative data. Therefore, this quantitative study aimed to investigate the influence of patient-reported SDM on the deprescribing of FRIDs in older adults. In addition, we were interested to see whether this effect differed between patients with and without polypharmacy.

Methods A prospective cohort study was conducted using data from 31 patients visiting the falls or geriatric clinic of the Academic Medical Center of Amsterdam (AMC). To measure the degree of SDM, the iSHAREpatient questionnaire was used. Deprescribing was identified by using the letter corresponding to the consultation at the falls clinic which was stored in the medical software application of the hospital. Binary logistic regression, adjusted for age, gender and satisfaction with physician, was conducted to investigate the association between the mean patient-reported SDM score and deprescribing. In addition, an interaction term was created to analyze the potential moderator effect of polypharmacy.

Results Binary logistic regression showed a significant association between overall patient-reported SDM and deprescribing (adjusted odds ratio (aOR) 3.04 [95% confidence interval (CI) 1.05-8.75]). Of the six dimensions of the iSHAREpatient questionnaire, choice awareness and deliberation also showed significant associations with deprescribing (aOR 2.16 [95% CI 1.04-4.46] and 2.44 [95% CI 1.05-5.70]; respectively). These associations did not significantly differ between patients with and without polypharmacy (*P*-value >0.1).

Conclusion This study showed a significant association between higher mean patient-reported SDM scores and the possibility to deprescribe. Since this was the first quantitative study investigating this association

with a relatively small study population, further research needs to establish these findings and their clinical relevance on, eventually, decreasing the risk of falls in older adults.

INTRODUCTION

Falls are a major cause of morbidity and mortality worldwide (1). Especially in older adults, the impact of falling on their independence, self-reliance, and quality of life is enormous due to consequences of falls such as fear of falling, functional impairment, and activity avoidance (2–5). Therefore, preventing falls in older adults should be a high priority and should be offered by fall risk assessment and targeted interventions focusing on the fall risk factors.

An important fall risk factor is the use of fall-risk-increasing drugs (FRIDs; e.g. loop diuretics, antidepressants, benzodiazepines, digoxin; 6–8). Older patients may be more prone to the fall risk associated with FRIDs due to changes in pharmacokinetics (e.g. reduced renal function) and pharmacodynamics (e.g. altered drug-receptor affinity; 9). As a result of these alterations, the risk of experiencing adverse drug reactions (ADRs) such as dizziness, sedation and blurred vision increases. These ADRs are all risk factors for falls (6,9). Polypharmacy, defined as the concurrent use of five or more drugs, is also associated with a higher risk of falls (10,11). However, multiple studies showed that this association is not directly caused by polypharmacy itself but can be explained by the fact that patients with polypharmacy are more likely to use a FRID than patients without polypharmacy (10,12). Therefore, the deprescribing of FRIDs could potentially reduce the risk of falls in older adults (9,13).

Deprescribing is defined as "*the process of withdrawal of an inappropriate medication, supervised by a health care professional with the goal of managing polypharmacy and improving outcomes*" (14). In a previous systematic review, van der Cammen et al. described for example that withdrawal of psychotropic drugs in older adults reduced the rate of falls and improved cognition (9). Despite the advantages, deprescribing can be challenging due to the fact that physicians are often taught to prescribe, but there is limited training on stopping medication (15). One thing that appears to be very important in obtaining effective deprescribing is the involvement of the patient in the decision-making process (16). Therefore, the interest in how to implement shared decision-making (SDM) in deprescribing has risen over the past years.

SDM has been described as "*an approach where clinicians and patients make decisions together using the best available evidence*" (17). SDM encourages patients to think about, among other things, treatment options and the benefits and harms of each option after which they can discuss their preferences with the physician (17). As a result, patients perceive greater satisfaction and may tend towards more conservative treatment options, which could potentially facilitate deprescribing (15,18). However, the implementation of SDM can be difficult due to a needed change in the structure of the consult from disease-oriented towards goal-oriented to ensure focus on the patients most pressing issues (19). In addition, a shift from physicians as the single authority towards a more coaching role is needed (20).

In the field of geriatric, where older patients often present with multimorbidity, this implementation may even be more complex. In older adults, treatment preferences are found to be inconsistent depending on factors such as mood and health status (21). This challenges the physician to also understands how the patient

formulates the given preferences and to identify inconsistencies (21). Due to this, and since coordination between different physicians is required in care for patients with multimorbidity, physicians often feel overwhelmed by the complexity of care in older adults (19,22). In addition, there is little research on effectively involving frail older adults with multimorbidity in SDM (19). However, it is important to involve this population in the decision-making process since they might have a stronger opinion about what is important to them due to years of healthcare experience (15). To facilitate SDM in all stages of a consultation with frail older adults with multimorbidity, van de Pol et al. created a six-step SDM model ('preparation', 'goal talk', 'choice talk', 'option talk', 'decision talk' and 'evaluation') by combining the three-step SDM model of Elwyn et al. ('choice talk', 'option talk' and 'decision talk') with literature and experiences of geriatrics and home-dwelling and older care home patients over 65 years (19).

Because of the major impact of falls in older adults together with the challenges of implementing SDM and deprescribing in daily practice, researchers of the AD*F*ICE_IT randomized controlled trial (RCT) developed a clinical decision support system (CDSS) based on the model of van de Pol et al. to facilitate SDM in frail older adults with multimorbidity. This way, the overwhelmed physician will obtain a structured overview of options available for the complex older adult which potentially supports them to engage in a SDM consultation (23).

Although qualitative studies have shown that SDM may facilitate deprescribing in older adults, the exact effect of the patient's perspective of SDM on deprescribing FRIDs has not yet been quantitatively established in this population. Therefore, this observational quantitative cohort study, as part of the AD*F*ICE_IT trial, aimed to investigate the influence of patient-reported SDM on the deprescribing of FRIDs in older adults. In addition, this study aimed to investigate whether this potential association differs between patients with and without polypharmacy.

METHODS

Study design and population

This was a quantitative observational cohort study within the ongoing multicenter randomized controlled AD*F*ICE_IT trial. Data obtained from questionnaires of patients visiting the falls or geriatric clinic at the Academic Medical Center of Amsterdam (AMC) was used in combination with medication data from the medical software application of the hospital (Epic). The falls clinic is an out-patients clinic where a supervised resident or nurse practitioner investigates the possible causes of falls, their consequences and discusses possible factors to potentially reduce the risk of falls. Data was collected from August 2022 to the beginning of May 2023.

Patients were eligible if they were ≥65 years old, visited the falls or geriatric clinic for a fall risk assessment due to one or more fall incident(s) in the past year, had a Mini-Mental State Examination Score (MMSE) of ≥21 or a Montreal Cognitive Assessment (MOCA) ≥16, had sufficient understanding of the Dutch language, used a minimum of one FRID and were mentally competent. Patients were excluded if they had a life expectancy of less than a year, were immobile and if they participated in another intervention study.

The study was approved by the Medical Ethical Committee of the AMC and all patients gave written informed consent.

Data collection

Patients who visited the falls clinic of the AMC were seen by a nurse practitioner or resident who also screened them for eligibility. Eligible and willing patients were then approached by a researcher who handed out a first set of questionnaires. After filling in these questionnaires, the resident or nurse practitioner returned to the patient to discuss the results of the fall risk assessment. In addition, decisions about, among other things, FRIDs (e.g. continue, switch, stop) were made using the CDSS. Finally, the researcher asked the patient to complete a second set of questionnaires and the physician reported which decisions were made during the consultation in an electronic letter for the general practitioner (GP). This letter was stored in Epic.

Epic

Epic is a medical record software application used in multiple medical facilities (e.g. hospitals, hospices, dental clinics; 24). This application has a variety of functions, one of which is writing and storing electronic medical letters.

For this study, the letter belonging to the appointment at the falls or geriatric clinic and written as a summary for the GP was scanned for medication related information. Data containing information about the number of current drugs was extracted from these letters to see whether polypharmacy was the case or not. In addition, these letters were used to obtain information about FRIDs and whether deprescribing was initiated or not.

CDSS

The CDSS is a digital system that supports and guides physicians and patients in making decisions about, among other things, the deprescribing of FRIDs. To do so, the CDSS combines individual patient characteristics (e.g. medical history, sodium and potassium concentration) and current medication from Epic with the newest guidelines about falls prevention and deprescribing to support a multifactorial personalized falls prevention strategy (25). Based on these resources, the CDSS provides patient-specific advice on whether and how to deprescribe FRIDs.

Based on medication data from Epic, registered by the physician, the CDSS identifies which FRIDs a patient used at the time of the appointment at the falls clinic. Medication was identified as a FRID by the CDSS according to the Screening Tool of Older Persons Prescriptions in older adults with high fall risk (STOPPFall) and the Dutch guidelines database (23,27; *supplementary S1*). The physician can then select to 'continue', 'switch', 'taper-reduce', 'taper-stop' or 'stop' the specific drug according to the patient's preferences, the information provided by the CDSS and their own expertise.

Questionnaires

The first set of questionnaires consisted of The Older Persons and Informal Caregivers Survey Short Form (TOPICS_SF; 26), the Institute for Medical Technology Assessment Productivity Cost Questionnaire/Medical Consumption Questionnaire (iPCQ/iMCQ; 27) and the EuroQol-5 Dimensions-5

Levels (EQ-5D-5L; 28). The second set of questionnaires consisted of the iSHAREpatient and the Decisional Conflict Scale (DCS; 29,30). For the current study, the TOPICS_SF was used for baseline patient characteristics and the iSHAREpatient was used to measure patient-reported SDM. Data from the questionnaires was entered in Castor.

The TOPICS_SF aims to measure physical and mental health in older adults and is designed to evaluate the quality of geriatric care by measuring health-related quality of life (HRQOL). The topics of the questions include general health, cognitive function, pain, mood, social activities, and activities of daily living (26).

The iSHAREpatient questionnaire consists of 15 statements with a six-point scale ranging from 'not done at all' to 'completely done'. These questions can be divided into six dimensions: 1) choice awareness; 2) medical information; 3) preferences; 4) deliberation; 5) time for deliberation and; 6) decision. These dimensions were designed to assess the complete process of SDM in which the iSHAREpatient questionnaire reflects the perspective of the patient on the degree of SDM during a specific consultation (31). Statements answered with 'not applicable' were seen as missing values.

Outcome definitions

The primary outcome was the deprescribing of one or more FRID(s). Deprescribing was identified if the electronic letter from the physician indicated that a FRID was either stopped or taper-stopped after consultation at the falls or geriatric clinic of the AMC. In addition, deprescribing was coded as a dichotomous variable for the analysis in which '0' indicated no deprescribing and '1' indicated deprescribing.

Exposure definitions

The exposure was defined as the mean score of patient-reported SDM according to the statements of the iSHAREpatient questionnaire. The mean patient-reported SDM score was calculated in seven different ways: mean overall score (all 15 statements), mean of dimension I (choice awareness; statement 8 and 9), mean of dimension II (medical information; statement 1 - 7), mean of dimension III (preferences; statement 10 and 13), mean of dimension IV (deliberation; statement 11 and 14), mean of dimension V (time for deliberation; statement 12) and mean of dimension VI (decision; statement 15 or 16).

Covariates

Based on previous studies, age, gender, education level (less than 6 grades of primary school, primary school, trade school, mavo/mulo/mms, high school or university), quality of life (11-point scale), multimorbidity (i.e. ≥2 long-term conditions; yes or no), satisfaction with physician (11-point scale) and complaints about memory (yes or no) were included in the logistic regression analysis as covariates to test for potential confounding (15,32–40).

Polypharmacy (i.e. ≥ 5 medication) was coded as a dichotomous variable (yes or no) based on medication information from the letter to the GP in Epic. Then, the variable was added to the analysis to test for a potential moderator effect.

Statistical analysis

Baseline patient characteristics (e.g. age, gender, education level) were summarized as mean ± standard deviation (SD) or number with percentages. The mean overall score for patient-reported SDM and the mean SDM score per dimension, as described previously, were calculated per patient. Then, the assumption of multicollinearity was checked in which tolerance >0.1 indicates that the assumption of no multicollinearity was met. The effect of patient-reported SDM on deprescribing was analyzed using a binary logistic regression analysis. In the binary logistic regression analysis, age, gender, education level, quality of life, multimorbidity, satisfaction with physician and complaints about memory were included to test for potential confounding. If the difference between the crude and adjusted association was greater than 10%, the covariate was included in the final analysis as a confounder (41). In addition, polypharmacy was included as a covariate to test for a potential moderator effect. To do so, an interaction term between polypharmacy and patient-reported SDM (i.e. for the overall score and all six dimensions) was generated and added to the logistic regression model. *P*-value <0.1 was considered statistically significant and indicates whether stratification based on polypharmacy (yes or no) could be applied for further analysis.

For the primary analysis, participants with missing data in the iSHAREpatient questionnaire were not included to conduct a complete case analysis (CCA). To account for possible introduced bias due to the CCA, Little's Missing Completely At Random (MCAR) test was used to analyze the type of missing values (42). *P*-value >0.05 indicated that data was missing completely at random.

In addition to the primary analysis, sensitivity analyses were conducted to test the robustness of the primary CCA. Statistically significant differences between patients with and without missing values were assessed using Chi-square test or Mann-Whitney U test. To account for extreme rating of SDM, missing values were then substituted by the lowest score for SDM. Second, missing values were substituted by the highest score of SDM. Finally, missings were replaced with the mean score of the corresponding variable. The primary analysis including the check for multicollinearity was then repeated for each of the three substitutions. The adjusted odds ratios (aOR) of the sensitivity analyses were visually compared with the aOR of the primary CCA. In the CCA and sensitivity analyses, *P*-value <0.05 was considered statistically significant.

All data was analyzed using SPSS Statistics for Windows, version 28 (IBM Corp., Armonk, N.Y., USA).

RESULTS

As shown in *figure 1*, 105 patients visited the falls or geriatric clinic of the AMC between August 2022 and May 2023. Of these patients, 23 patients were excluded based on the exclusion criteria. The researcher approached the 82 eligible patients of whom 15 were not willing to participate. Of the 67 patients who were willing to participate, 36 patients were excluded due to incomplete questionnaire completion or missing values in iSHAREpatient questionnaire. This resulted in a total of 31 patients for the CCA.

Participant characteristics

The characteristics of the study population are shown in *table 1*. Of the 31 participants, 20 (64.5%) were female and the mean age was 76.4 (standard deviation (SD) 6.91). The majority of the participants had

multimorbidity and polypharmacy (77.4% and 64.5%, respectively). During the final conversation with the resident or nurse practitioner at the falls clinic, deprescribing was initiated in 38.7% of the participants. The mean score of overall patient-reported shared decision making was 4.9 (SD 1.26) and the patients rated their physician with a mean score of 8.8 (SD 0.98).

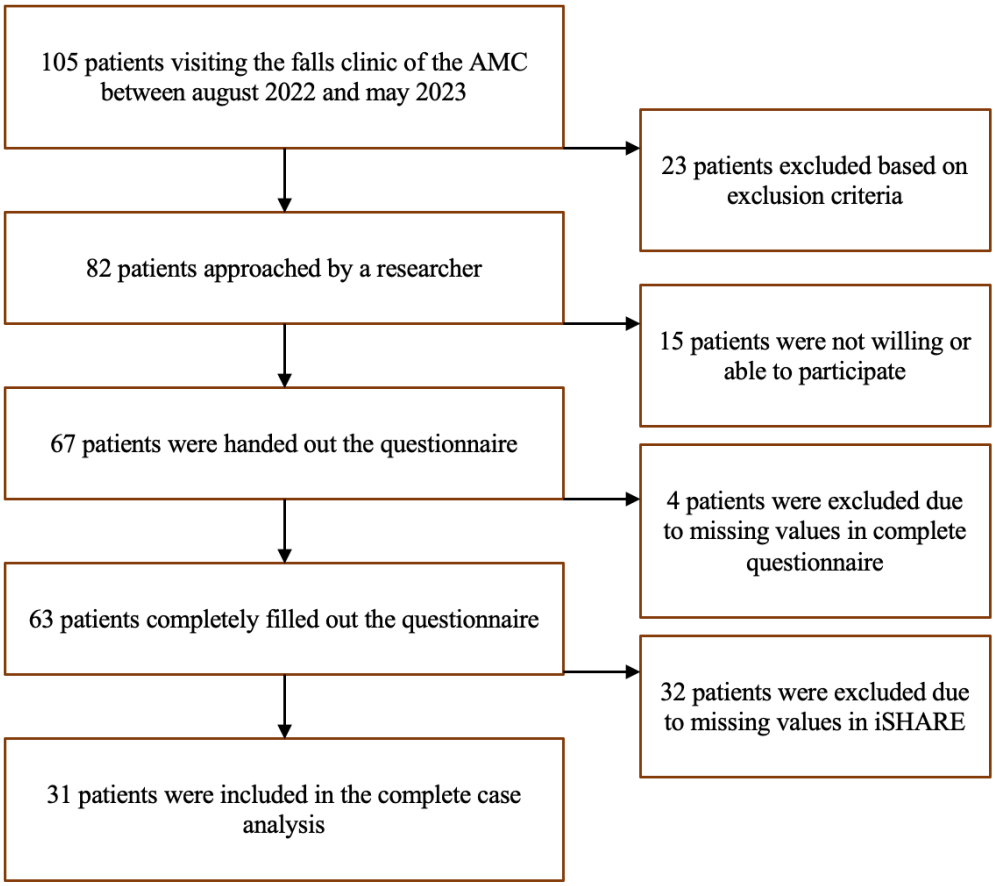

Figure 1. Flowchart of participant recruitment in CCA

Logistic regression

For the binary logistic regression, a preliminary analysis suggested that the assumption of no multicollinearity was met (tolerance = >0.81). Age, gender, and satisfaction with physician were included in the final analysis as confounders.

Table 2 shows the unadjusted and adjusted odds ratios (OR) with 95% confidence interval (CI) for the tested association between deprescribing and patient-reported SDM. As shown in *table 2*, overall patient-reported SDM was significantly associated with deprescribing (aOR 3.04 [95% CI 1.05-8.75]). In addition, the dimensions 'choice awareness' and 'deliberation' were also significantly associated with deprescribing (aOR 2.16 [95% CI 1.04-4.46] and 2.44 [95% CI 1.05-5.70]; respectively). The other dimensions were not significantly associated with deprescribing (*P*-value >0.05).

Results from the logistic regression analysis including the interaction term for polypharmacy showed that polypharmacy did not significantly interact with the association between patient-reported SDM and deprescribing (*P*-value >0.1). This was true for overall patient-reported SDM and the six dimensions.

Sensitivity analyses

Since approximately 51% of the participants had missing values in the iSHAREpatient questionnaire, who were all excluded from the primary analysis, sensitivity analyses were carried out to test the robustness of the results of the CCA. The results of these analyses can be found in *table 4*. Participant inclusion and characteristics are summarized in *supplementary S2*.

A preliminary analysis suggested that the assumption of no multicollinearity was met (tolerance = >0.70). According to the results shown in *table 3*, participants with missing values in the iSHAREpatient questionnaire did not significantly differ from participants without missing values. In addition, MCAR showed that data was missing completely at random (*P*-value = 0.653). For overall patient-reported SDM, the association with deprescribing remained positive across all substitution methods (i.e. highest, lowest, and mean score). When replacing missing values with the highest or the mean SDM score, the association also remained significant (aOR 2.11 [95% CI 1.06 – 4.23] and 2.34 [95% CI 1.08 – 5.04]; respectively). In contrast, this association did not remain significant when missing values were replaced with the lowest SDM score (aOR 1.26 [95% CI 0.85 – 1.86]).

For the six dimensions, the association with deprescribing also remained positive across all substitution methods. However, this association was not found to be significant for dimension II and VI (*P*-value >0.05). In contrast, replacing missing values in dimension V with the highest or the mean SDM score showed a significant association with deprescribing (aOR 1.72 [95% CI 1.03 – 2.87] and 1.73 [95% CI 1.02 – 2.93]; respectively). In dimension III and IV, only replacing missing values with the highest SDM score showed a significant association with deprescribing (aOR 2.10 [95% CI 1.01 – 4.29] and 1.95 [95% CI 1.04 – 3.65]; respectively). Finally, the association between dimension I and deprescribing was found to be significant when replacing missing values with the mean SDM score (aOR 1.71 [95% CI 1.01 – 2.89]).

Table 1. Characteristics study population of complete case analysis

	Overall
Female, n (%) (n = 31)	20 (64.5%)
Age, mean (SD) (n = 31)	76.4 (6.91)
Education, n (%) (n = 31)	
(Less than 6 grades of) primary school	3 (9.7%)
Trade school	5 (16.1%)
Mavo, mulo, mms	13 (41.9%)
High school	2 (6.5%)
University	8 (25.8%)
Country of birth, n (%) (n = 31)	
The Netherlands	23 (74.2%)
Living situation, n (%) (n = 31)	
Alone	15 (48.4%)
With someone (e.g. partner, children, etc.)	15 (48.8%)
Nursing home	1 (3.2%)
Quality of life, mean (SD) (n = 31)	7.5 (1.41)
Satisfaction with physician, mean (SD) (n = 31)	8.8 (0.98)
Chronic conditions, mean (SD) (n = 31)	2.5 (1.46)
Diabetes, n (%) (n = 31)	10 (32.3%)
Heart failure or other heart condition, n (%) (n = 31)	7 (22.6%)
Cancer, n (%) (n = 31)	5 (16.1%)
Asthma, chronic bronchitis, emphysema, or COPD, n (%) (n = 30)	6 (19.4%)
Joint wear, n (%) (n = 29)	13 (41.9%)
Chronic joint inflammation, n (%) (n = 28)	3 (9.7%)
Osteoporosis, n (%) (n = 28)	8 (25.8%)
Disease of the nervous system (e.g. Parkinson's disease, MS, epilepsy), n (%) (n = 31)	1 (3.2%)
Fear- and/or panic-disorder, n (%) (n = 31)	6 (19.4%)
Dementia, n (%) (n = 31)	1 (3.2%)
Hearing problems, n (%) (n = 31)	8 (25.8%)
Problems with vision, n (%) (n = 31)	9 (29.0%)
Multimorbidity, n (%) (n = 31)	24 (77.4%)
Complaints about memory, n (%) (n = 31)	11 (35.5%)
Polypharmacy, n (%) (n = 31)	20 (64.5%)
Mean SDM score, n (%) (n = 31)	4.9 (1.26)
Deprescribing, n (%) (n = 31)	12 (38.7%)

Abbreviations: FRIDs, fall-risk-increasing drugs; havo, hoger algemeen voortgezet onderwijs (higher general continued education); mulo, meer uitgebreid lager onderwijs (more extensive primary education); mavo, middelbaar algemeen voortgezet onderwijs (general secondary education); mms, middelbare meisjesschool (girls secondary school); MS, multiple sclerosis; SD, standard deviation

Table 2. Associations between patient-reported shared decision-making and deprescribing of FRIDs

Variable	OR*	95% CI		*P* value	aOR**	95% CI		*P* value
		Lower	Upper			Lower	Upper	
Overall patient-reported SDM	2.46	0.99	6.07	0.05	3.04	1.05	8.75	0.04***
I Choice awareness	2.04	1.02	4.09	0.04***	2.16	1.04	4.46	0.04***
II Medical information	1.93	0.88	4.24	0.10	2.14	0.90	5.10	0.09
III Preferences	2.28	0.94	5.52	0.07	2.76	0.99	7.73	0.05
IV Deliberation	2.03	0.99	4.15	0.05	2.44	1.05	5.70	0.04***
V Time for deliberation	2.96	0.92	9.51	0.07	3.22	0.91	11.43	0.07
VI Decision	1.50	0.86	2.65	0.16	1.80	0.88	3.65	0.11

*Odds ratio adjusted for age and gender

**Odds ratio adjusted for age, gender, and satisfaction with physician

****P*-value < 0.05

Abbreviations: FRID, fall-risk-increasing drugs; aOR, adjusted odds ratio; 95% CI, confidence interval; OR, odds ratio; SDM, shared decision-making

Table 3. Characteristics of patients with and without missing values in iSHAREpatient questionnaire

	No missing values (n = 31)	With missing values (n = 32)	*P*-value
Female, n (%)*	20 (64.5%)	19 (59.4%)	0.674
Age, mean (SD)**	76.4 (6.91)	78.4 (6.84)	0.173
Education, n (%)*			0.676
(Less than 6 grades of) primary school	3 (9.7%)	4 (12.5%)	
Trade school	5 (16.1%)	2 (6.3%)	
Mavo, mulo, mms	13 (41.9%)	10 (31.3%)	
High school	2 (6.5%)	4 (12.5%)	
University	8 (25.8%)	11 (34.4%)	
Country of birth, n (%)*			0.774
The Netherlands	23 (74.2%)	25 (78.1%)	
Living situation, n (%)*			0.394
Alone	15 (48.4%)	15 (46.9%)	
With someone (e.g. partner, children, etc.)	15 (48.8%)	15 (46.9%)	
Nursing home	1 (3.2%)	0 (0%)	
Other	0 (0%)	2 (6.3%)	
Quality of life, mean (SD)**	7.5 (1.41)	6.9 (1.60)	0.416
Satisfaction with physician, mean (SD)**	8.8 (0.98)	8.1 (1.60)	0.068
Chronic conditions, mean (SD)**	2.5 (1.46)	2.9 (1.52)	0.187
Diabetes, n (%)*	10 (32.3%)	13 (40.6%)	0.490
Heart failure or other heart condition, n (%)*	7 (22.6%)	10 (31.3%)	0.393
Cancer, n (%)*	5 (16.1%)	4 (12.5%)	0.681
Asthma, chronic bronchitis, emphysema, or COPD, n (%)*	6 (19.4%)	6 (18.8%)	0.949
Joint wear, n (%)*	13 (41.9%)	17 (53.1%)	0.517
Chronic joint inflammation, n (%)*	3 (9.7%)	4 (12.5%)	0.795
Osteoporosis, n (%)*	8 (25.8%)	10 (31.3%)	0.666
Disease of the nervous system (e.g. Parkinson's disease, MS, epilepsy), n (%)*	1 (3.2%)	2 (6.3%)	0.573
Fear- and/or panic-disorder, n (%)*	6 (19.4%)	7 (21.9%)	0.805
Dementia, n (%)*	1 (3.2%)	2 (6.3%)	0.573
Hearing problems, n (%)*	8 (25.8%)	8 (25%)	1.000
Problems with vision, n (%)*	9 (29.0%)	11 (34.4%)	0.649
Multimorbidity, n (%)*	24 (77.4%)	26 (81.3%)	0.707
Complaints about memory, n (%)*	11 (35.5%)	13 (40.6%)	0.674
Polypharmacy, n (%)*	18 (58.1%)	22 (68.8%)	0.465
Deprescribing, n (%)*	12 (38.7%)	15 (46.9%)	0.513

*Differences analyzed using Chi square test

**Differences analyzed using Mann-Whitney U test

Abbreviations: FRIDs, fall-risk-increasing drugs; havo, hoger algemeen voortgezet onderwijs (higher general continued education); mulo, meer uitgebreid lager onderwijs (more extensive primary education); mavo, middelbaar algemeen voortgezet onderwijs (general secondary education); mms, middelbare meisjesschool (girls secondary school); MS, multiple sclerosis; SD, standard deviation

Table 4. Sensitivity analysis

	Missing value substitution	OR*	95% CI		*P* value	aOR**	95% CI		*P* value
			Lower	Upper			Lower	Upper	
Overall SDM	Highest SDM score	2.10	1.10	3.87	0.02***	2.11	1.06	4.23	0.03***
	Lowest SDM score	1.10	0.82	1.49	0.52	1.26	0.85	1.86	0.25
	Mean of corresponding variables	2.07	1.10	3.87	0.02***	2.34	1.08	5.04	0.03***
D I	Highest SDM score	1.68	1.08	2.61	0.02***	1.59	1.00	2.54	0.05
	Lowest SDM score	1.13	0.86	1.49	0.37	1.27	0.91	1.77	0.17
	Mean of corresponding variables	1.69	1.06	2.71	0.03***	1.71	1.01	2.89	0.04***
D II	Highest SDM score	1.57	0.99	2.50	0.06	1.61	0.94	2.76	0.09
	Lowest SDM score	1.12	0.84	1.49	0.45	1.25	0.87	1.79	0.23
	Mean of corresponding variables	1.59	0.97	2.61	0.07	1.73	0.96	3.12	0.07
D III	Highest SDM score	2.29	1.14	4.60	0.02***	2.10	1.01	4.39	0.04***
	Lowest SDM score	1.04	0.78	1.37	0.78	1.19	0.80	1.78	0.39
	Mean of corresponding variables	2.13	1.07	4.23	0.03***	2.16	1.00	4.68	0.05
D IV	Highest SDM score	2.10	1.16	3.80	0.01***	1.95	1.04	3.65	0.04***
	Lowest SDM score	1.03	0.80	1.33	0.81	1.07	0.79	1.44	0.65
	Mean of corresponding variables	1.91	1.07	3.41	0.03***	1.89	0.99	3.62	0.06
D V	Highest SDM score	1.84	1.10	3.08	0.02***	1.72	1.03	2.87	0.04***
	Lowest SDM score	1.08	0.84	1.38	0.57	1.16	0.88	1.54	0.30
	Mean of corresponding variables	1.81	1.07	3.06	0.03***	1.73	1.02	2.93	0.04***
D VI	Highest SDM score	1.55	0.94	2.55	0.08	1.46	0.89	2.38	0.13
	Lowest SDM score	1.01	0.80	1.26	0.96	1.04	0.80	1.35	0.77
	Mean of corresponding variables	1.46	0.90	2.36	0.12	1.45	0.87	2.40	0.16

*Odds ratio adjusted for age and gender

**Odds ratio adjusted for age, gender, and satisfaction with physician

****P*-value < 0.05

Abbreviations: aOR, adjusted odds ratio; 95% CI, confidence interval; D, dimension; OR, odds ratio; SDM, shared decision-making

DISCUSSION

In this cohort study, the influence of patient-reported SDM on deprescribing was investigated by using the iSHAREpatient questionnaire and Epic-registered medication data. The aORs and 95% CIs of the logistic regression showed that an increase in the mean overall patient-reported SDM score was significantly associated with an increased possibility of deprescribing FRIDs during a medication related consultation. The same was true for two of the six dimensions: choice awareness and deliberation. Polypharmacy did not appear to moderate these associations. These findings indicate that involving older adults in the decision-making process in clinical practice could be associated with a higher possibility of deprescribing FRIDs which, potentially, might decrease the risk of falls in older adults with and without polypharmacy.

Previous studies investigating the relationship between SDM and deprescribing also showed that SDM consultations are conducive for deprescribing. For example, multiple qualitative studies showed that the vast majority of older adults are willing to deprescribe and wished to be involved in the decision-making process (19,43–45). In addition Ostini et al. found that effective deprescribing interventions included, among other things, patient-mediated interventions (16). Finally, Kim et al. showed that older hospitalized patients are willing to deprescribe when patient-centered deprescribing consultations are initiated (46). Although these studies have found that participation of older adults in the decision-making process influences the effectiveness of deprescribing, the quantitative impact of patient-reported SDM on deprescribing has not yet been established. Therefore, the results of this quantitative study are a valuable addition to the current knowledge about the influence of SDM on deprescribing and provide more insight in the degree of this impact. Moreover, these results confirm the previously described positive effect of SDM on deprescribing.

In addition to investigating the influence of overall SDM on deprescribing, this study also focused to see whether certain parts of the SDM consultation (i.e. dimensions) contributed more to deprescribing than others. Based on the CCA, making the patient aware that there is a choice and that their opinion matters (dimension I: choice awareness awareness) and deliberating what is important to the patient in life and in the treatment options (dimension IV: deliberation) were the only dimensions that appeared to significantly contribute to deprescribing. There were no studies that previously examined this phenomenon. However, the importance of choice awareness could be explained by the possibility that older adults might not be aware that options exist and that they have a choice, since they believe physicians only recommend clearly indicated actions. In addition, they might feel like they have to get along with whatever the physician suggests (47). In regard to deliberation, previous studies described the importance of discussing the older patients' goals and most pressing issues in the decision making process since the goals of older adults are highly individual and diverse (19,48). This in combination with previous findings that older adults are willing to deprescribe could explain the finding that higher choice awareness and deliberation scores were association with a significantly higher probability of deprescribing.

In addition to the above-mentioned findings in the CCA, expression of the patient's values, feelings, and preferences (dimension III: preferences) and giving the patient time to contribute to SDM (dimension V: time for deliberation) showed no significant association despite a higher aOR. In contrast, we found the association between dimension III/V and deprescribing to be significant in the sensitivity analyses for at least one of the

substitution methods. Also, the effect size of dimension III remained higher than the other dimensions in the sensitivity analyses. The effect size and significance found in the CCA and sensitivity analyses may indicate that dimension III and V, followed by dimension I and IV, contribute more to initiating deprescribing than dimension II and VI in a medication-related consultation with older adults. However, the differences found in especially the significance between the CCA and sensitivity analyses could also indicate that there was a lack of power in the CCA, making the results found inconclusive. Since detailed clinical data about medication and communication was used for this study, it can be assumed that the results found are more or less an accurate representation of reality. However, further research in a larger study population is needed to draw a more convincing conclusion about the contribution of the different dimensions to deprescribing.

Finally, this study showed that polypharmacy did not moderate the association between SDM and deprescribing. This finding is consistent with the results of a previous study in which the willingness to deprescribe was not related to the number of medications (49). Another study found that older adults with polypharmacy are willing to withdraw medication (43). However, their study did not include patients without polypharmacy. These previous studies also only investigated the association between polypharmacy and the willingness to deprescribe by use of qualitative data. Therefore, this study provides new quantitative information. However, due to a relatively small study population and power, the actual moderation effect of polypharmacy may differ from the measured effect. Therefore, more research in a larger sample size is needed to confirm or refute our findings.

Limitations

The major limitation of this study was the degree of missingness in the iSHAREpatient questionnaire. To account for this limitation and to test the robustness of the findings in the CCA, sensitivity analyses were conducted. As a result, this study found that despite imputation with the lowest, highest, or mean SDM score, the association between patient-reported SDM and deprescribing remained positive, as did the CCA. This indicates that the involvement in decision making of patients with missing values (i.e. completely involved or not at all) did not affect the effect size. Although the association remained positive, replacing missing values with the lowest SDM score resulted in a non-significant association between all patient-reported SDM variables and deprescribing. A possible and speculated explanation for this finding could be found in the fact that the majority of the patients scored high on overall SDM. When replacing missing values with the lowest SDM score, the apparent difference between patients increases. In that case, more power is required to measure a significant effect. Therefore, the small sample size in this study might explain why replacing missing values with the lowest SDM score resulted in a non-significant association for all of the exposure variables.

Another limitation, which is related to the above-mentioned limitation, was the sample size. Of the 67 patients who were included in the AMC, 50% had missing values in the iSHARE patient questionnaire or the complete questionnaire was not completed. This resulted in a sample size of 31 patients for the CCA and a decrease in power. Despite this relatively small study population, we found the association between overall patient-reported SDM and deprescribing to be significant. The same was true for dimension I and IV. However, fully excluding patients with one or more missing values in the iSHAREpatient questionnaire could

have led to biased estimates. In contrast, Little's MCAR test showed that missing values were MCAR and Chi Square test and Mann-Whitney U test showed that the baseline characteristics of patients with and without missing values did not significantly differ. In addition, the effect size in the sensitivity analyses remained similar to the CCA (i.e. positive). These findings suggest that the CCA could have resulted in unbiased estimates (42). However, due to the small sample size, it may be possible that some associations in the CCA and sensitivity analyses appeared to be not significant while they would be significant in a larger sample size. In order to potentially obtain more unequivocal results by increasing the sample size, the cause of missing values must be addressed. During inclusions it was noticeable that patients did not always interpret deprescribing as a decision made. As a consequence and since the iSHAREpatient questionnaire involves statements about decisions that have been made during the consultation, patients did not know how to answer some of the iSHAREpatient statements or answered with 'not applicable'. For that reason, making patients aware that (no) deprescribing is indeed a decision that has been made could hopefully reduce the number of missing values and increase the sample size.

Despite the fact that this study was part of a multicenter RCT, we only used data from one of the included hospitals (the AMC). This center was one of the intervention hospitals in which the CDSS was applied during the consultation at the falls or geriatric clinic. The use of data from the other included centers would have expanded the sample size. However, Epic data from the other hospitals was not accessible during our study. Therefore, only patients from the AMC could be included in our study which in turn also caused a decrease in sample size and power.

The final limitation was that, based on the medication data from the electronic letter corresponding to the consultation at the falls clinic, patients were assigned to the 'deprescribing' or 'no deprescribing' group. However, in some cases, the resident or geriatrician first needed to discuss whether deprescribing could be initiated with the prescriber or treating physician (e.g. cardiologist, nephrologist). Since this study was part of an ongoing study, patients included at a later stage had a shorter follow-up period. Therefore, the decisions that needed to be discussed with the prescriber or treating physician were not yet made for all patients. This could have led to patients being assigned to the 'no deprescribing' group even though deprescribing had eventually taken place after the consultation at the falls clinic by the prescriber or treating physician. As a possible consequence, the number of patients in whom deprescribing is initiated may be underestimated and the found effect may slightly deviate from reality.

Implications

Due to major consequences of falling in older adults, there is great need to investigate approaches to reduce the risk of falls. Deprescribing FRIDs could be one of these approaches. As the first quantitative study, the results of this study showed that making the patient feel that they are involved in the decision-making process could be an important part of future medication-related consultations in order to obtain effective deprescribing. Based on differences between the CCA and sensitivity analyses, no unequivocal statements can be made about whether certain dimensions contribute more to deprescribing than others. Since there probably was a lack of power in this study due to the small sample size and since this was the first quantitative study investigating the association between patient-reported SDM and deprescribing, further research is

needed on this topic. In addition, since the lack of power could have also affected the measured moderator effect of polypharmacy, further investigating this effect in a larger sample size (i.e. more power) is also recommended. In order to diminish the number of patients with missing values and, thereby, increasing the sample size and power, it is recommended to address the cause of the missing values. An approach could be, for example, to better inform patients during the inclusion procedure about what can be seen as 'a decision' that has been made so they, hopefully, better understand the iSHAREpatient statements. Actively reaching out to patients afterwards if answers appear to be missing can also be an approach.

Furthermore, to implement SDM-driven consultations in fall-risk assessments it would also be interesting to investigate whether deprescribing actually reduces the risk of falls in older adults since this is not yet been established. Finally, previous studies investigated what leads a patient to report a decision as shared and what is important in SDM-consultations with older adults (19,50). However, further research needs to focus on how to effectively implement this in clinical practice to stimulate deprescribing and, potentially, reduce the risk of falls in older adults.

Conclusion

In this prospective cohort study higher scores of patient-reported SDM were associated with an increased possibility of deprescribing. Whether certain dimensions contribute more to the possibility of deprescribing remains uncertain. All of the associations were independent of age, gender, and satisfaction with the physician and were not moderated by the amount of medication a patient uses. Since this was the first quantitative study investigating this association with a relatively small sample size, further research in a larger study population needs to establish these findings. Furthermore, whether the deprescribing of FRIDs, as a result of an SDM-consultation, actually reduces the risk of falls and their consequences in older adults also needs further investigation.

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SUPPLEMENTARY S1: ADDITIONAL DATA

Table S1. Classification of FRIDs*

Drug class	Subgroup	Drug substance
Hypnotics, sedatives, and anxiolytics	Benzodiazepines	Alprazolam, bromazepam, brotizolam, clobazam, clorazepic acid, diazepam, flunitrazepam, flurazepam, loprazolam, lorazepam, lormetazepam, midazolam, nitrazepam, oxazepam, prazepam, remimazolam, temazepam, zolpidem, zopiclone
	Others	Agomelatine
Antipsychotics	Classic antipsychotics	Bromoperidol, chlorproxitene, flupentixol, fluspirilene, haloperidol, penfluridol, pimozide, pipamperone, zuclopenthixol
	Atypical antipsychotics	Amisulpride, aripiprazole, brexpiprazole, cariprazine, clozapine, lurasidone, olanzapine, paliperidone, quetiapine, risperidone, sertindole, sulpride
Antidepressants	Tricyclic antidepressants	Amitriptyline, clomipramine, dosulepin, doxepin, imipramine, maprotiline, nortriptyline
	SNRIs	Duloxetine, trazodone, venlafaxine
	SSRIs	(Es)citalopram, dapoxetine, fluoxetine, fluvoxamine, paroxetine, sertraline
Anti-Parkinson's drugs	Levodopa with decarboxylase inhibitor	Levodopa/benserazide, levodopa/carbidopa, levodopa/carbidopa/entacapone
	Dopamine agonists	Apomorphine, bromocriptine, pramipexole, ropinirole, rotigotine
Antiepileptics	GABA-agonists and others	Brivaracetam, carbamazepine, cenobamate, chloral hydrate, clonazepam, ethosuximide, felbamate, phenobarbital, phenytoin, gabapentin, lacosamide, lamotrigine, levetiracetam, oxacarbazepine, perampanel, pregabalin, primidone, rufinamide, stiripentol, topiramate, valproic acid, vigabatrin, zonisamide
Cholinesterase inhibitors		Donepezil, galantamine, rivastigmine, distigmine, neostigmine, neostigmine/glycopyronium, pyridostigmine
Antivertigo drugs		Betahistine, flunarizine, piracetam
Diuretics	Loop diuretics	Bumetanide, furosemide
	Thiazide diuretics	Chlorthalidone, hydrochlorothiazide, indapamide
Antiarrhythmics	Calcium channel blockers	Diltiazem, verapamil
	Glycosides	Digoxin
	Others (class I)	Disopyramide, flecainide, quinidine, lidocaine, procainamide, propafenone
	Others (class III)	Amiodarone, ibutilide
	Others (class I and III)	Vernakalant
Vaso-dilatants	Nitrates	Isosorbide nitrate, isosorbide mononitrate, nicorandil, nitroglycerin
	Alpha blockers	Alfuzosin, doxazosin, phentolamine, silodosin, tamsulosin, terazosin, urapidil
Beta blockers		Acebutolol, atenolol, bisoprolol, carvedilol, celiprolol, esmolol, labetalol, landiolol, metoprolol, nebivolol, propranolol, sotalol

Drug class	Subgroup	Drug substance
RAS inhibitors	ACE inhibitors	Benazepril, captopril, enalapril, fosinopril, lisinopril, perindopril, ramipril, zofenopril
	ARBs	Candesartan, eprosartan, irbesartan, losartan, olmesartan, telmisartan, valsartan
Statins		Atorvastatin, fluvastatin, pravastatin, rosuvastatin, simvastatin
Analgesics	Opioids	Alfentanil, buprenorphine, fentanyl, hydromorphone, morphine, nalbuphine, oxycodone, oxycodone/naloxone, pethidine, piritramide, remifentanil, sufentanil, tapentadol, tramadol
	NSAIDs	Aceclofenac, dexketoprofen, diclofenac, phenylbutazone, flurbiprofen, ibuprofen, indomethacin, meloxicam, nabumetone, naproxen, piroxicam, tiaprofenic acid
	Others (non-opioids)	Methoxyflurane, ziconotide
Muscle relaxants		Baclofen, tizanidine, tolperisone, dantrolene, hydroquinine
Antihistamines	Old generation	Chlorcyclizine/cinnarizine, cinnarizine, clemastine, cyclizine, doxylamine, dimetindene, hydroxyzine, ketotifen, meclizine/pyridoxine, oxomemazine, promethazine
Sympathomimetics		Formoterol, indacaterol, olodaterol, salbutamol, salmeterol, terbutaline
Urologic agents	Spasmolytics	Darifenacin, fesoterodine, flavoxate, mirabegron, oxybutynin, solifenacin, tolterodine
Glucose-lowering drugs	Insulins	Aspart, aspart/protamine, degludec, degludec/aspart, degludec/liraglutide, detemir, glargine, glargine/lixisenatide, glulisine, lispro, lispro/protamine, human, human/isophane, isophane
	Oral glucose-lowering drugs	Acarbose, pioglitazone, repaglinide, metformin, glibenclamide, gliclazide, glimepiride, tolbutamide, linagliptin, saxagliptin, sitagliptin, vildagliptin, dulaglutide, exenatide, liraglutide, lixisenatide, semaglutide, canagliflozin, dapagliflozin, empagliflozin, ertugliflozin
Agents for peptic disorders	H_2-blockers	Cimetidine, famotidine
	PPIs	Esomeprazole, lansoprazole, omeprazole, pantoprazole, rabeprazole

*According to STOPPFall and the Dutch guidelines database (25,51)

Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin-receptor blocker; FRIDs, fall-risk-increasing drugs; GABA, gamma-aminobutyric acid; NSAIDs, nonsteroidal anti-inflammatory drugs; PPIs, proton-pump inhibitors; RAS, renin-angiotensin system; SNRIs, serotonin-norepinephrine reuptake inhibitors; SSRIs, selective serotonin reuptake inhibitors; STOPPFall; Screening Tool of Older Persons Prescriptions in older adults with high fall risk

SUPPLEMENTARY S2: CHARACTERISTICS PATIENTS IN SENSITIVITY ANALYSES

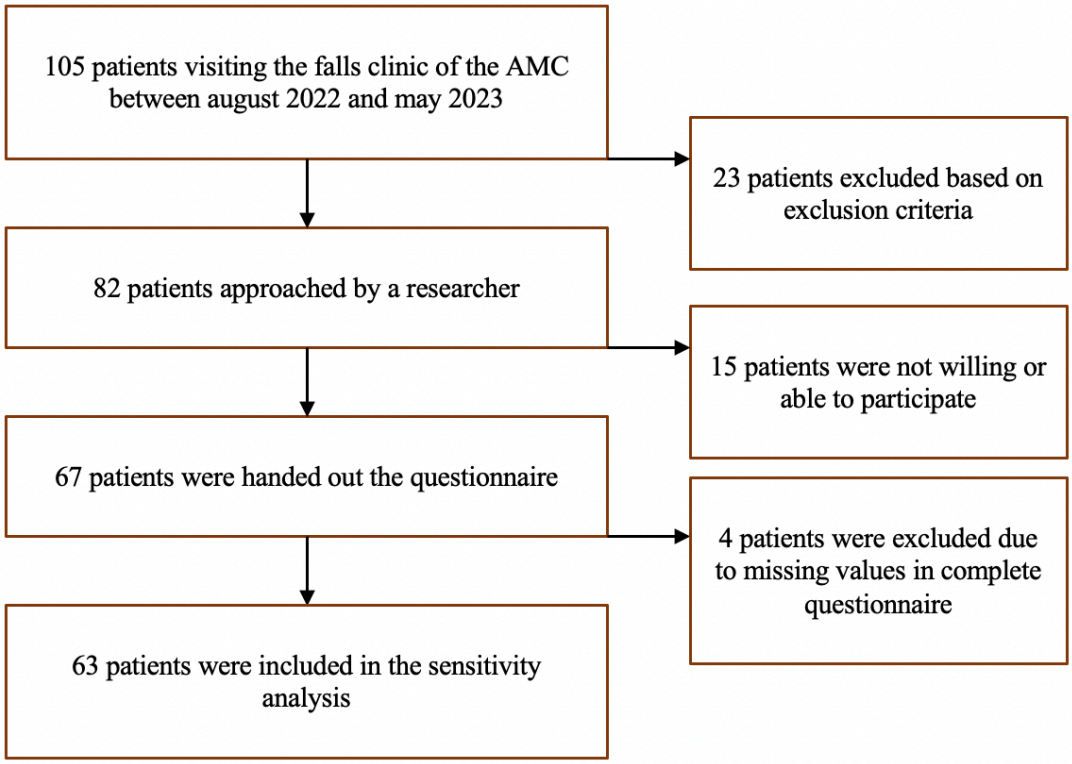

Figure S2. Flowchart of participant recruitment in sensitivity analyses

Table S2. Characteristics study population of sensitivity analyses

	Overall (n = 63)
Female, n (%) (n = 63)	39 (61.9%)
Age, mean (SD) (n = 62)	77.56 (6.730)
Education, n (%) (n = 63)	
Less than 6 grades of primary school	2 (3.2%)
Primary school	5 (9.5%)
Trade school	7 (11.1%)
Mavo, mulo, mms	23 (36.5%)
High school (i.e. havo, atheneum, gymnasium)	6 (9.5%)
University	19 (30.2%)
Country of birth, n (%) (n = 63)	
The Netherlands	48 (76.2%)
Living situation, n (%) (n = 63)	
Alone	30 (47.6%)
With someone (e.g. partner, children, etc.)	30 (47.6%)
Nursing home	1 (1.6%)
Other	2 (3.2%)
Quality of life, mean (SD) (n = 63)	7.22 (1.764)
Satisfaction with physician, mean (SD) (n = 58)	8.48 (1.328)
Chronic conditions, mean (SD (n = 63)	2.71 (1.689)
Diabetes, n (%) (n = 63)	23 (36.5%)
Heart failure or other heart condition, n (%) (n = 62)	17 (27.0%)
Cancer, n (%) (n = 63)	9 (14.3%)
Asthma, chronic bronchitis, emphysema, or COPD, n (%) (n = 61)	12 (19.0%)
Joint wear, n (%) (n = 61)	30 (47.6%)
Chronic joint inflammation, n (%) (n = 59)	7 (11.1%)
Osteoporosis, n (%) (n = 56)	18 (28.6%)
Disease of the nervous system (e.g. Parkinson's disease, MS, epilepsy), n (%) (n = 63)	3 (4.8%)
Fear- and/or panic-disorder, n (%) (n = 63)	13 (20.6%)
Dementia, n (%) (n = 63)	3 (4.8%)
Hearing problems, n (%) (n = 62)	16 (25.4%)
Problems with vision, n (%) (n = 63)	20 (31.7%)
Multimorbidity, n (%) (n = 63)	50 (79.4%)
Complaints about memory, n (%) (n = 63)	24 (38.1%)
Polypharmacy, n (%) (n = 63)	43 (68.3%)
Deprescribing, n (%) (n = 63)	27 (42.9%)

Abbreviations: FRIDs, fall-risk-increasing drugs; havo, hoger algemeen voortgezet onderwijs (higher general continued education); mulo, meer uitgebreid lager onderwijs (more extensive primary education); mavo, middelbaar algemeen voortgezet onderwijs (general secondary education); mms, middelbare meisjesschool (girls secondary school); MS, multiple sclerosis; SD, standard deviation