International Journal of Clinical Pharmacy (2019) 41:207–214
https://doi.org/10.1007/s11096-018-0770-1

RESEARCH ARTICLE

Potential inappropriate prescribing and associated factors among older persons in Nigeria and South Africa

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Received: 14 July 2018 / Accepted: 14 December 2018 / Published online: 4 January 2019

Abstract

Background Potential inappropriate prescribing (PIP) among older persons is a global public health issue. However, trans-country data that can influence interventions on a global or regional level is scarce. *Objectives* To compare the prevalence of PIP and to determine the associated factors among older Nigerians and South Africans. *Settings* Nigerian and South African teaching hospitals. *Method* A retrospective evaluation of randomly selected medical charts of older persons was carried out in outpatient clinics of one University teaching hospital in both Nigeria and South Africa. Older persons aged ≥ 60 years who attended the hospitals' clinics between 1st January and 31st December 2016 and received medicine prescriptions were included. The PIP was evaluated using the 2015 American Geriatrics Society-Beers Criteria. The prevalence of PIP in both countries was compared and the associated factors for their occurrence determined using a binary logistic regression. *Main outcome measure* Prevalence of PIP and associated factors among older outpatients. *Results* A total of 680 participants were evaluated, 352 in Nigeria, mean age 69.03 (7.35) years, and 328 in South Africa, mean age 68.21 (7.42) years (95% CI −0.28 to 1.94, $p=0.14$). The PIP among Nigerian and South African participants were (124/352; 35.2%) versus (97/328; 29.6%) respectively (OR 0.77, 95% CI 0.56–1.06, $p=0.12$). Hypertension was significantly associated with PIP among the Nigerians (OR 2.56, 95% CI 1.57–4.17, $p=<0.001$) and South Africans (OR 3.11, 95% CI 1.17–8.24, $p=0.02$) in a logistic regression. *Conclusions* The prevalence and pattern of PIP among Nigerian and South African participants were similar. Hypertension was an associated factor for PIP among the participants in both countries.

Keywords Beers Criteria · Inappropriate prescribing · Nigeria · Older persons · Potentially inappropriate prescribing · South Africa

Impacts on practice

- Pharmacists knowledge of inappropriate medicines will assist in reducing negative health outcomes in older persons.
- Awareness of the associated factors for potential inappropriate prescribing can assist with developing an intervention strategy to limit its occurrence among older populations.
- Information from trans-national data that compares the Beers Criteria ability to screen for potential inappropriate prescribing in different countries, can help to develop regional criteria with clinical relevance to African older persons.

Introduction

Potential inappropriate prescribing (PIP) among older persons has received much attention globally [1–3], due to its association with the negative health outcomes among this segment of the population [4, 5]. Many prescribing guidelines providing lists of potentially inappropriate medicines (PIM) have been developed to monitor the quality of prescriptions for older persons in different countries [5–7].

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s11096-018-0770-1) contains supplementary material, which is available to authorized users.

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The Beers Criteria, which was initially developed among nursing home residents in the United States of America (USA), have been widely applied in various healthcare settings worldwide [1–4, 8, 9], and have undergone revisions based on the latest available evidence. The 2015 American Geriatrics Society Beers Criteria (AGS-Beers' Criteria) appear to address most of the criticisms against the earlier versions with the inclusion of classes of PIM to be avoided based on drug-drug interaction (DDI), drug-disease interactions, and patients' kidney functions [5].

Previous studies that evaluated PIP using the Beers Criteria among older persons, including Africans, revealed that it was a common occurrence among this segment of the population, and was associated with patients' age, gender, polypharmacy, number of diseases, and diagnoses of hypertension, cerebrovascular accident and heart failure [1–3, 8–10]. Although many of the studies among older Africans applied the earlier versions of the Criteria, which have been criticized for lacking in transferability, they nonetheless showed that first-generation antihistamines, amitriptyline and non-steroidal anti-inflammatory drugs (NSAIDs) were among the most inappropriately prescribed medications in this population. With a few exceptions [3, 11], previous PIP studies utilized either outpatients' prescriptions from hospital pharmacy or large databases, which may under or overestimate it, because the diagnoses in the database may not reflect the true diagnoses. The records may also not have adequately captured the patients' clinical data that are necessary for evaluating PIP due to drug-diseases interactions and kidney functions [1].

The number of people ageing in Africa continues to increase, with an estimated 68.7 million persons aged ≥ 60 years in 2017, and with a projected increase to 228.5 million in 2050 [12]. Nigeria and South Africa are at the forefront of this increasing age group, with an estimated 7.0% of the Nigerians and 8.0% of the South Africans already in the older persons' age bracket in 2014 [13, 14]. This growth of the ageing population is likely to be associated with an increase in PIP and the resulting health consequences for individual older persons, as well as resource implications for the healthcare systems in the countries. Despite PIP being a global issue, transnational studies presenting cross-country data that are necessary to develop interventions on a regional level are rare.

Aim of the study

This study aimed to compare the prevalence of PIP among older persons in Nigeria and South Africa using the 2015 AGS-Beers Criteria and to determine the associated factors in both countries.

Ethics approval

Ethical approval was obtained from the Biomedical Research Ethics Committee (BREC) of the University of KwaZulu-Natal, South Africa under reference number BE 591/16. The hospitals' local Ethical Review Committees also gave their approval and, due to the retrospective nature of the study, participants consent forms were not required.

Method

Study design and settings

This study was a cross-sectional, retrospective, medical chart review of older persons at the outpatients' clinics of one public University teaching hospital in both Nigeria and South Africa. The participants' medical charts were randomly selected and evaluated for PIP. The selected hospitals were in predominantly indigenous Black African cities, provide tertiary healthcare services, and were referral centers for many facilities in their regions. The outpatient departments in the two hospitals were structurally similar in terms of the composition of the clinics and there were geriatricians consulting in both.

Study population, inclusion and exclusion criteria

The participants in Nigeria were entirely Black Africans, the country being a homogenous country of Black people, while the South Africans consisted of the indigenous Black Africans, Colored (mixed race), Asians, and Whites; the races that inhabited the country, although the Black Africans are in the majority [15]. The participants in Nigeria access healthcare through out-of-pocket payment, unlike the South Africans, whose governments pay for older people healthcare in public healthcare facilities [16]. The official age of ≥ 60 years which is used to define older persons in Africa was used for the eligibility in this study [13, 14, 17]. Older persons who attended the outpatients' clinics of the two hospitals between 1st January and 31st December 2016 were eligible for inclusion in this study. Eligible participants were excluded if they did not receive medicine prescriptions, had incomplete medical information in their records, were evaluated during the pilot stage of the study, or their records were unavailable at the medical office at the time of the study. Kidney function test was not an *exclusion* criterion in this study.

Sample size estimation

The sample size was calculated using a formula previously described [18]. A total of 1392 medical records of eligible participants in Nigeria and 1693 in South Africa were available for selection based on the inclusion criteria. Using these

available populations, a 50% response distribution, a margin of error of 5% and a power of 95%, minimum sample sizes of 302 and 314 were calculated for Nigeria and South Africa respectively. An additional 20% was included for attrition yielding a maximum sample size of 363 and 377 for Nigeria and South Africa respectively.

Data collection technique and instrument

Eligible patients' medical record numbers were listed and records were selected using a simple randomization technique with the aid of computer-generated random numbers until the sample size was complete. The medical chart review was conducted by a clinical pharmacist using a validated checklist designed by the primary researcher and pretested using 10 randomly selected medical records of older patients in each of the two facilities. The checklist captured information including participants' socio-demographics, medical and medication histories, current diagnosis, current medication and renal status (where available). The participants' kidney function tests obtained not later than 6 months prior to the time of the study were considered valid.

The PIP was evaluated using the 2015 AGS-Beers Criteria. The PIM recommended to be avoided independent of diagnosis, due to drug-disease or drug-syndrome interactions or non-anti-infective DDI, or to have their dosage reduced due to level of kidney functions, were evaluated. The prevalence of PIP, independent of diagnosis and DDI according to the 2015 AGS-Beers Criteria, and polypharmacy in Nigeria and South Africa, were compared. In this study, polypharmacy was defined as the concurrent prescription of ≥ 5 different medications in a prescription in accordance with a study that associated this threshold with a significant increase in PIP among older persons [11]. Medicines in a combination medication (2 or more medicines in one tablet/capsule) were counted as the total number of medicines. The associated factors for PIP "independent of diagnosis category" were further assessed in both countries.

Data management and statistical analyses

Data were entered into an Excel worksheet from the checklist by a trained graduate research assistant, who also cleaned the data manually, after which the second author double checked the entries for errors. The cleaned data were entered into Statistical Packages for the Social Sciences version 25 (SPSS, IBM Corporation, Armonk, NY, USA) for statistical analysis. Subjects who had missing data were removed before analysis. The primary analysis of the data was conducted using descriptive statistics. The characteristics of the study participants in the two countries were compared using the independent sample Student *t* test for continuous variables and Chi-squared or Fisher' exact test, where applicable, for categorical variables.

A bivariate analysis was conducted to determine the associations between the independent variables and PIP. A binary logistic regression model was built to determine the factors associated with PIP among the participants. In the regression model, independent variables of reported clinical significance in previous studies including age, gender, polypharmacy, number of medications, number of chronic diseases, as well as diagnoses of hypertension, heart failure and cerebrovascular accident were included. A Backward stepwise (Likelihood Ratio) process was used to select the best model while the Hosmer–Lemeshow goodness of fit was used to assess the adequacy of the final models. The results were presented using the odds ratio with a 95% confidence interval, with $P < 0.05$ being considered significant.

Results

Of the 363 Nigerian and 377 South African records, 97.0% (352/363) in Nigeria and 87.0% (328/377) in South Africa were analyzed, the remainder being excluded due to missing data. Table 1 presents the demographic and clinical characteristics of the study participants in both countries. A total of 680 participants were evaluated, 352 in Nigeria, mean age 69.03 (7.35) years, and 328 in South Africa, mean age 68.21 (7.42) years (95% CI − 0.28 to 1.94, $p = 0.14$). All the participants in Nigeria were indigenous Black Africans. The majority of the South African participants were indigenous Black Africans (289/328, 88.1%), followed by the Asians (25/328, 7.6%), Colored (8/328, 2.4%) and Whites (6/328, 1.8%). In Nigeria, hypertension (141/352. 40.1%) and cardiovascular accident (24/352, 6.8%) were the most commonly diagnosed diseases, while in South Africa, cancers (42/328, 12.8%) and hypertension (23/328, 7.0%) were the main conditions reported among the participants. The mean number of medicines prescribed per participant in Nigeria was 4.60 (1.65) (range 1–12) and in South Africa was 4.38 (2.29), (range 1–16) respectively (95% CI − 0.08 to 0.52, $p = 0.15$).

Table 2 presents the classes of PIM among both sets of the participants. Of the 149 medicines listed in the 2015 AGS-Beers' Criteria, 63.1% (94/149) were listed in the drug catalogues in Nigeria and 68.5% (102/149) were listed in South Africa at the time of the study. The majority of the available medicines in Nigeria (56/94, 59.6%) and South Africa (71/102, 69.6%) were prescribed for the study participants. The PIP among Nigerian and South African participants were (124/352; 35.2%) versus (97/328; 29.6%) respectively (OR 0.77, 95% CI 0.56–1.06, $p = 0.12$). PIP was not associated with races in South Africa ($p = 0.55$). Many participants in Nigeria (192/352; 54.5%) and South Africa (132/328; 40.2%, $p < 0.001$) received polypharmacy

Table 1 The characteristics of the study participants

Variable	Grouping	Nigerian n (%)	South African n (%)	*p* value
Age				
	60–69 years	208 (59.1)	212 (64.6)	
	70–79 years	102 (29.0)	87 (26.5)	
	80–89 years	40 (11.4)	23 (7.0)	0.18
	≥ 90 years	2 (0.6)	6 (1.8)	
Gender				
	Male	149(42.3)	134 (40.9)	
	Female	203 (57.7)	194 (59.1)	0.71
Number of chronic diseases				
	0	24(6.8)	91(27.7)	
	1	324 (92.1)	204 (62.2)	
	>1	4(1.1)	33 (10.1)	< 0.001
Number of medicines received				
	1–5	234 (66.5)	242 (73.8)	
	6–9	115 (32.7)	80 (24.4)	0.001
	≥ 10	3 (0.9)	6 (1.8)	
Consultation period				
	January–March	98 (27.8)	57 (17.4)	
	April–May	100 (28.4)	106 (32.3)	
	June–August	43 (12.2)	97 (29.6)	< 0.001
	September–December	111 (31.5)	68 (20.7)	
Clinics attended				
	Surgery[a]	84 (23.9)	121 (36.9)	
	Medical[b]	267 (75.8)	188 (57.3)	< 0.001
	Others[c]	1 (0.3)	19 (5.8)	

[a]Includes dermatology, neurology, orthopaedic, surgery and urology and maxillofacial clinics

[b]Includes cardiology, chest, ear, nose and throat, endocrine, family medicine, gynaecology, haematology, hepatobiliary, nephrology, ophthalmology, psychiatry, rheumatology

[c]Includes accident and emergency, and oncology

Table 2 The classes of PIM among the study participants

Class of medications	Nigeria n (%)	South Africa n (%)
Antidepressants	29 (23.4)	17 (17.5)
Antidepressants and combinations	11 (8.9)	13 (13.4)
NSAIDs	26 (21.0)	28 (28.9)
NSAIDs in combination	2 (1.6)	4 (4.1)
Anti-hypertensives	13 (10.5)	1 (1.0)
Antihistamine preparations	4 (3.2)	11 (11.3)
Cardiovascular agents	6 (4.8)	2 (2.1)
Antispasmodic	0 (0.0)	16 (16.5)
Antidiabetics	1 (0.8)	3 (3.1)
Antiparkinsonian drugs	9 (7.3)	0 (0.0)
Antipsychotics	3 (2.4)	1 (1.0)
Others[a]	20 (16.1)	1 (1.0)

[a]Others include antiemetics, opioids, antiepileptics, benzodiazepines, muscle relaxants in Nigeria and estrogen in South Africa

during the study period. Amitriptyline in Nigeria (28/352, 7.9%) and Ibuprofen in South Africa (19/328, 5.8%) were the most inappropriately prescribed medicines independent of diagnosis (Additional data are given in Online Resource 1).

Few cases of PIP due to DDI were encountered among the Nigerians (20/352, 5.7%) and South Africans (10/328, 3.0%). Amitriptyline was responsible for 40.0% (8/20) and 50.0% (5/10) of DDI in Nigeria and South Africa respectively (Additional data are given in Online Resource 2). Non-steroidal anti-inflammatory drugs were prescribed for a participant with heart failure in Nigeria (1/352, 0.3%) and in South Africa (2/328, 0.6%). In Nigeria, one participant (0.3%) with a medical history of falls received amitriptyline prescription, while spironolactone was prescribed for one renal impaired study participant (Cr Cl < 30 ml/min).

Table 3 presents the bivariate analysis of variables with PIP among the Nigerian and South African participants. PIP was associated with a diagnosis of hypertension among Nigerian ($p = 0.001$) and South African

participants ($p = 0.02$). Polypharmacy was associated with PIP only among Nigerian participants ($p = 0.01$).

Table 4 presents the factors associated with PIP among the Nigerian and South African participants. Hypertension was significantly associated with PIP among the Nigerians (OR 2.56, 95% CI 1.57–4.17, $p = < 0.001$) and South Africans (OR 3.11, 95% CI 1.17–8.24, $p = 0.02$) in a logistic regression.

Discussion

This study presents transnational data on PIP in older outpatients in Nigeria and South Africa and showed no significant difference in the pattern and prevalence of PIP among the study participants between both countries. While PIP was associated with the number of medications, diagnoses of hypertension and heart failure among Nigerians, it was only associated with hypertension among South Africans.

The prevalence of PIP in Nigeria and South Africa was similar despite the differences in the disease patterns, the

Table 3 A bivariate analysis of variables with PIP among Nigerian and South Africa participants

Location	Variables	Group	No PIM	PIM	*p* value
Nigeria	Age	Mean (SD)	68.72 (7.14) years	69.59 (7.71) years	0.29
		60–69 years	140 (39.8)	68(19.3)	
		70–79 years	59 (16.8)	43 (12.2)	0.28
		80–89 years	27 (7.7)	13 (3.7)	
		≥ 90 years	2 (0.6)	0 (0.0)	
	Gender	Female	126 (35.8)	77 (21.9)	
		Male	102 (29.0)	47 (13.4)	0.22
	Chronic diseases	Mean (SD)	1.32 (0.49)	1.52 (0.61)	0.001
	Diagnosis				
	Cerebrovascular	Yes	14 (4.0)	10 (2.8)	
	Accident	No	214 (60.8)	114 (32.4)	0.49
	Heart failure	Yes	22 (6.3)	8 (2.3)	
		No	206 (58.5)	116 (33.0)	0.3
	Hypertension	Yes	109 (31.0)	36 (10.2)	
		No	119 (33.8)	88 (25.0)	0.001
	Number of drugs	Mean (SD)	4.61 (1.69)	5.23 (1.92)	0.002
	Polypharmacy	Yes	113 (32.1)	79 (22.4)	
		No	115 (32.7)	45 (12.8)	0.01
South Africa	Age	Mean (SD)	68.54 (7.46) years	67.24 (6.75) years	0.14
		60–69 years	145 (44.2)	67 (20.4)	
		70–79 years	64 (19.5)	23 (7.0)	0.77
		80–89 years	17 (5.2)	6 (1.8)	
		≥ 90 years	5 (1.5)	1 (0.3)	
	Gender	Female	138 (42.1)	56 (17.1)	
		Male	93 (28.4)	41 (12.5)	0.23
	Chronic diseases	Mean value	1.9 (0.99)	1.80 (0.9)	0.43
	Diagnosis				
	Cerebrovascular	Yes	6 (1.8)	1 (0.3)	
	Accident	No	225 (68.6)	96 (29.3)	0.45
	Heart failure	Yes	20 (6.1)	3 (0.9)	
		No	211 (64.3)	94 (28.7)	0.1
	Hypertension	Yes	34 (10.4)	5 (1.5)	
		No	197 (60.1)	92 (28.0)	0.02
	Number of drugs	Mean (SD)	4.56 (2.79)	4.38 (2.53)	0.59
	Polypharmacy	Yes	90 (27.4)	42 (12.8)	
		No	141 (43.0)	55 (16.8)	0.47

PIM potential inappropriate medicine

Table 4 Factors associated with PIP among Nigerian and South African participants in a logistic regression

Variables	Nigeria		South Africa	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Number of drugs	1.25 (1.10–1.43)	0.001	–	–
Hypertension	2.56 (1.57–4.17)	< 0.001	3.11 (1.17–8.24)	0.02
Heart failure	2.71 (1.12–6.54)	0.027	2.86 (0.83–9.95)	0.097

OR odd-ratio, *CI* confidence interval

Significant *p* value < 0.05. Hosmer–Lemeshow test for goodness of fit. $X^2 = 6.92$ df = 8, $p = 0.55$ (Nigeria) $X^2 = 0.02$, $df = 1$, $p = 0.89$ (South Africa)

periods and the clinics attended, and the number of co-morbidities between the groups; an indication of its pervasiveness in clinical practice. This result also indicates a similarity in the clinical guidelines and the prescribing habits of physicians in both countries and suggests the feasibility of regional criteria for the screening of PIP among older persons in Africa [19]. The prevalence of PIP in the two countries was within the global average of 27% and 40% reported by studies that applied the 2012 AGS-Beers' Criteria [3, 9, 20, 21]. However, the PIP among the South Africans in this present study (29.6%) was higher than previously reported (13.0%) in the country [2]. This was probably because the earlier study utilized a medicine claim database, which did not contain detailed clinical information needed for an individualized case assessment and this could have led to its under-reporting of the PIP. A study that applied the 2012 AGS-Beers Criteria and a medical chart review to evaluate PIP among older Nigerians reported a similar prevalence (30.03%) to this present study [3].

The pattern of PIM utilization was similar in Nigeria and South Africa, with amitriptyline and NSAIDs being the most common in both countries. This observation is consistent with studies among older Africans and New Zealanders [2, 3, 8, 21]. In this present study, amitriptyline contributed largely to the high prevalence of PIP independent of diagnosis and the AGS-Beers Criteria DDI in both countries, similar to a previous study among older South Africans [2]. In this study, amitriptyline was prescribed mostly for neuropathic pain in accordance with the clinical practice guidelines for managing pain [22, 23], and in contradiction of the 2015 AGS-Beers Criteria, which recommends that it should be avoided among older persons independent of diagnosis due to its strong anticholinergic effects [5]. This observation may indicate that the physicians considered the AGS-Beers Criteria as only a guide toward medication safety and not a substitute for established clinical practice guidelines. Although other recommended alternatives such as gabapentin and lidocaine patch were available in Nigeria and South Africa at the time of this study [24], physicians may not be favorably disposed to them due to the financial implication, as they may be beyond the reach of the healthcare systems in both countries. The practice guideline for prescribing these alternatives especially in South Africa may also limit their use.

Diclofenac (Nigeria) and Ibuprofen (South Africa) were mostly inappropriately prescribed among the NSAIDs in this study, in line with other studies in Nigeria, South Africa and South Korea [1–3, 8]. The NSAIDs are categorized as PIM in older persons when used as a first-line for pain management, or for a prolonged period without gastroprotective agents and in underlying comorbidities such as congestive heart failure, chronic kidney disease, and peptic ulcer disease [5, 24]. Although topical NSAIDs, capsaicin and lidocaine patch have been recommended as alternatives to oral NSAIDs, there is currently little evidence to support their effectiveness in managing neuropathic and musculoskeletal pains including osteoarthritis and spondylosis despite their huge costs [24]. Physicians in resource-limited countries, such as Nigeria and South Africa are therefore restricted in their choice of effective and safe medicines for pain among older persons, and this may have accounted for the high use of oral NSAIDs in this study.

Hypertension was consistently associated with PIP among the participants in Nigeria and South Africa, similar to a study among older Brazilians [25]. After adjusting for confounders, participants with a diagnosis of heart failure were thrice likely to have a PIP in Nigeria, consistent with a study among older Americans [10], but in contradiction with a similar study in Brazil [25]. The finding of this present study suggests the need for a proper medication review among older persons with cardiovascular diseases. Consistent with many studies, the number of medications received by participants in Nigeria was associated with PIP in this current study [1, 3, 26].

Although multiple factors including patients' age, gender, polypharmacy and comorbidities have been associated with PIP among older persons [1–3, 9, 11, 21], the present study showed no significant association with age and gender among both sets of participants. This result is consistent with Indian and Japanese studies [27, 28] but contradicts similar studies among Koreans, Nigerians and Brazilians [1, 3, 29]. However, polypharmacy and number of chronic diseases were associated with PIP among Nigerian participants in a bivariate analysis consistent with previous studies [1, 11]. The associations were however lost after adjusting for confounders in this study.

Despite the challenges associated with prescribing in older patients, certain approaches including healthcare providers education, detailed medication review by a multidisciplinary team involving clinical pharmacists, and

deprescribing of medications when necessary have been shown to be effective in preventing or reducing PIP in older persons [30, 31]. These interventions, in combination with the use of computerized order entry and decision support, should be considered in Nigeria and South Africa [32].

To the best of the authors' knowledge, this was the first study that compared the prevalence of PIP among older persons in two African countries; however, it has some limitations. South Africa is a multiracial country however, the majority of the study participants were Black Africans. Caution is advised in the generalization of the results to the entire racial groups in the country. In addition, this study evaluated PIP but did not assess physicians' justification for it. Nevertheless, this present study provided information about the disease conditions in which detailed medication review and interventions may be needed among older patients. Larger studies are needed to corroborate the finding of this study and to further investigate the health outcomes of PIP among these cohorts of patients in both countries.

Conclusions

The prevalence and pattern of PIP among Nigerian and South African participants were similar, possibly suggesting the feasibility of regional criteria for the screening of PIP among older persons in both countries. Hypertension was an associated factor for PIP among the participants in both countries, while the number of medications and a diagnosis of heart failure were associated with it only among the Nigerian participants. While the 2015 AGS-Beers Criteria may improve the quality of prescribing among older persons in both countries, they will need to be validated among medical experts in Nigeria and South Africa to determine their fitness to meet the needs of the countries' healthcare systems.

Acknowledgements We would like to thank the management and staff of the study sites for their cooperation.

Funding This study received no funding from any source.

Conflicts of interest The authors declare that no conflict of interest exists in the study.

References

1. Nam YS, Han JS, Kim JY, Bae WK, Lee K. Prescription of potentially inappropriate medication in Korean older adults based on 2012 Beers Criteria: a cross-sectional population based study. BMC Geriatr. 2016;16:118.
2. van Heerden JA, Burger JR, Gerber JJ. Inappropriate medicine prescribing in older South Africans: a cross-sectional analysis of medicine claims data. S Afr Med J. 2016;106(10):1010–6.
3. Fadare JO, Desalu OO, Obimakinde AM, Adeoti AO, Agboola SM, Aina FO. Prevalence of inappropriate medication prescription in the elderly in Nigeria: a comparison of Beers and STOPP criteria. Int J Risk Saf Med. 2015;27(4):177–89.
4. van der Stelt CAK, Vermeulen Windsant-van den Tweel AMA, Egberts ACG, van den Bemt PMLA, Leendertse AJ, Hermens WAJJ, et al. The association between potentially inappropriate prescribing and medication-related hospital admissions in older patients: a nested case control study. Drug Saf. 2016;39(1):79–87.
5. American Geriatrics Society Beers Criteria Update Expert Panel. American Geriatrics Society 2015 updated Beers Criteria for potentially inappropriate medication use in older adults. J Am Geriatr Soc. 2015;63(11):2227–46.
6. Gallagher P, Ryan C, Byrne S, Kennedy J, Oahony D. STOPP (screening tool of older person's prescriptions) and START (screening tool to alert doctors to right treatment). Consensus validation. Int J Clin Pharmacol Ther. 2008;46(2):72–83.
7. Holt S, Schmiedl S, Thürmann PA. Potentially inappropriate medications in the elderly: the PRISCUS list. Dtsch Arztebl Int. 2010;107(31–32):543–51.
8. Eze UIH, Olowu AO. Prescribing patterns and inappropriate use of medications in elderly outpatients in a tertiary hospital in Nigeria. Trop J Pharm Res. 2011;10(1):19–25.
9. Mekonnen AB, Bhagavathula AS. Inappropriate medication use in the elderly population attending Gondar University Hospital: a preliminary assessment. Int J Pharm Pharm Sci. 2014;6(10):540–3.
10. Sheikh-Taha M, Dimassi H. Potentially inappropriate home medications among older patients with cardiovascular disease admitted to a cardiology service in USA. BMC Cardiovasc Disord. 2017;17:189.
11. Rakesh KB, Chowta MN, Shenoy AK, Shastry R, Pai SB. Evaluation of polypharmacy and appropriateness of prescription in geriatric patients: a cross-sectional study at a tertiary care hospital. Indian J Pharmacol. 2017;49(1):16–20.
12. United Nations. World population ageing 2017—highlights (ST/ESA/SERA/397). http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2017_Highlights.pdf. Accessed 5 June 2018.
13. National Bureau of Statistics. 2015 statistical report on women and men in Nigeria. http://www.nigerianstat.gov.ng/download/49. Accessed 7 June 2018.
14. Statistics South Africa. Census 2011: profile of older persons in South Africa. http://www.statssa.gov.za/publications/Report-03-01-60/Report-03-01-602011.pdf. Accessed 13 June 2018.
15. Coovadia H, Jewkes R, Barron P, Sanders D, McIntyre D. The health and health system of South Africa: historical roots of current public health challenges. Lancet. 2009;374(9692):817–34.
16. Kalusopa TDR, Osei-Boateng C. Social protection schemes in Africa. Windhoek: African Labour Research Network; 2012.
17. African Union. Protocol to the African charter on human and peoples' rights on the rights of older persons. https://www.auint/en/treaties/protocol-african-charter-human-and-peoples%E2%80%99-rights-rights-older-persons. Accessed 28 Mar 2018.
18. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Indian J Psychol Med. 2013;35(2):121–6.
19. Levy H, Marcus E, Christen C. Beyond the Beers Criteria: a comparative overview of explicit criteria. Ann Pharmacother. 2010;44(12):1968–75.
20. Lim YJ, Kim HY, Choi J, Lee JS, Ahn AL, Oh EJ, et al. Potentially inappropriate medications by Beers Criteria in older outpatients: prevalence and risk factors. Korean J Fam Med. 2016;37(6):329–33.
21. Narayan SW, Nishtala PS. Prevalence of potentially inappropriate medicine use in older New Zealanders: a population-level

study using the updated 2012 Beers Criteria. J Eval Clin Pract. 2015;21(4):633–41.
22. Finnerup NB, Attal N, Haroutounian S, McNicol E, Baron P, Dworkin RH, et al. Pharmacotherapy for neuropathic pain in adults: a systematic review and meta-analysis. Lancet Neurol. 2015;14:162–73.
23. Dworkin RH, O'Connor AB, Kent J, Mackey SC, Raja SN, Stacey BR, et al. Interventional management of neuropathic pain: NeuP-SIG recommendations. Pain. 2013;154(11):2249–61.
24. Hanlon JT, Semla TP, Schmader KE. Alternative medications for medications in the use of high-risk medications in the elderly and potentially harmful drug-disease interactions in the elderly quality measures. J Am Geriatr Soc. 2015;63(12):e8–18.
25. Lopez LM, de Figueiredo TP, Costa SC, Reis AMM. Use of potentially inappropriate medications by the elderly at home. Ciênc saúde coletiva. 2016;21(11):3429–38.
26. Karandikar YS, Chaudhari SR, Dalal NP, Sharma M, Pandit VA. Inappropriate prescribing in the elderly: a comparison of two validated screening tools. J Clin Gerontol Geriatr. 2013;4(4):109–14.
27. Pradhan S, Panda A, Mohanty M, Behera JP, Ramani YR, Pradhan PK. A study of the prevalence of potentially inappropriate medication in elderly in a tertiary care teaching hospital in the state of Odisha. Int J Med Public Health. 2015;5:344–8.
28. Kondo N, Nakamura F, Yamazaki S, Yamamoto Y, Akizawa T, Akiba T, et al. Prescription of potentially inappropriate medications to elderly hemodialysis patients: prevalence and predictors. Nephrol Dial Transplant. 2015;30:498–505.
29. Lutz BH, Miranda VIA, Bertoldi AD. Potentially inappropriate medications among older adults in Pelotas, Southern Brazil. Rev Saúde Pública. 2017;51:52.
30. Alldred DP, Kennedy MC, Hughes C, Chen TF, Miller P. Interventions to optimise prescribing for older people in care homes. Cochrane Database Syst Rev. 2016;2:CD009095.
31. Keith SW, Maio V, Dudash K, Templin M, Del Canale S. A physician-focused intervention to reduce potentially inappropriate medication prescribing in older people. Drugs Aging. 2013;30(2):119–27.
32. Scott IA, Pillans PI, Barras M, Morris C. Using EMR-enabled computerized decision support systems to reduce prescribing of potentially inappropriate medications: a narrative review. Ther Adv Drug Saf. 2018;9(9):559–73.