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Prescriber Adherence to Antihypertensive Prescription Guidelines and the Impact of Patient Socioeconomic Factors: A Cross-Sectional Study Using Data From the Irish Longitudinal Study on Ageing

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ABSTRACT

Purpose: Uncontrolled hypertension causes significant morbidity and mortality worldwide. Several prescribing guidelines have been created to address this, however, prescriber adherence to guidelines is influenced by various sociodemographic patient factors. This study aims to determine the effects of these patient factors on prescriber adherence to antihypertensive prescription guidelines.

Methods: A secondary analysis of data from the first wave of The Irish Longitudinal Study on Ageing (TILDA), was conducted. Participants were included if they reported previous hypertension diagnoses. Antihypertensive medication regimes were compared with the prescribing guidance in the 2011 NICE hypertension guidelines. The effects of patient sociodemographic factors on prescriber adherence to guidelines, and the effect of prescriber adherence on blood pressure control (≥ 140/90 mmHg), were determined using binomial logistic regression models.

Results: A total of 2992 participants were included in this analysis; 54.9% female with mean age 65.7 years (±9.23). Male sex and older age, and lower socioeconomic status were associated with increased prescriber guideline adherence. Prescribers were less likely to adhere to guidelines in female patients ≥ 55 years (Relative Risk [RR] 0.75 [0.62, 0.91]), and female patients across all age groups (RR 0.80 [0.67, 0.95]). Better blood pressure control was seen with medication regimes adherent to prescription guidelines (140.38 (±18.98)/83.09 (±11.02) mmHg adherent vs. 141.66 (±19.86)/84.77 (±11.71) mmHg non-adherent).

Conclusions: This study highlights the effect of patient sex on prescriber adherence to antihypertensive prescription guidelines, emphasizing a larger issue of systemic undertreatment of females observed within healthcare. Further research is needed to determine the reasons for such differences in hypertensive care.

This study was accepted for presentation at the Health Services Research and Pharmacy Practice (HSRPP) Conference, in April 2024 in Cork, Ireland. Abstracts from this conference will be published in the International Journal of Pharmacy Practice.

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Summary

- Prescriber adherence to antihypertensive prescription guidelines was associated with being < 55 years of age, male sex in those over the age of 55 years, having a diagnosis of hypertension ≥ 5 years, and having a medical card with a full cover of medical costs.
- Better blood pressure control is associated with medical regimes adherent to prescription guidelines.
- Under prescription of calcium channel blockers in females is consistent with previous literature.
- These results highlight a larger issue of the systemic undertreatment of females seen in healthcare.

1 | Introduction

Hypertension is one of the leading causes of morbidity and mortality across the world [1–4]. It serves as the largest modifiable risk factor for cardiovascular diseases (CVDs) [1, 5]. Hypertension is defined as the chronic elevation of blood pressure ≥ 140/90 mmHg [6, 7]. It is commonly associated with several risk factors and can be controlled through pharmacological and lifestyle interventions [8, 9]. To enable better management of hypertension and provide guidance on anti-hypertensive use, several national and international clinical guidelines have been developed. These include the National Institute for Health and Care Excellence (NICE) guidelines [10]. The NICE guidelines include the use of angiotensin-converting enzyme inhibitors (ACEIs), angiotensin receptor blockers (ARBs), beta-blockers, calcium channel blockers (CCBs), and thiazide diuretics in the treatment of hypertension [10]. The Systolic Blood Pressure Intervention Trial (SPRINT) has shown that the primary composite endpoint was reduced by 16% in females and by 27% in males with no interaction between treatment and sex [11]. Nevertheless, there may be variations in the preferred use of blood pressure-lowering agents between males and females [12].

Several sociodemographic patient factors, such as socio-economic status, sex, and age influence prescriber adherence to prescription guidelines [13–15]. A previous study found that higher prescriber adherence to statin guidelines was associated with patients being male, of older age, and having lower income [13]. Similar findings were reported in a study investigating the prescription of aspirin in primary prevention, with increased guideline adherence being associated with patients who were of older age and male sex, with access to free healthcare and more frequent doctor visits [15]. Furthermore, in both primary and secondary CVD prevention, several studies have found that existing CVD disparities may be due to the sub-standard care received by females in comparison to males [16–19]. Similar sex differences were reported in the prescription and use of anti-hypertensives. Meta-analyses have found that females were more likely to be prescribed diuretics, whereas males were more likely to be prescribed ACEIs, beta-blockers, and CCBs [20–22], despite the guidelines recommending the same treatment, regardless of sex [23].

The aim of this study is to add to the existing discourse surrounding challenges in adherence to prescription guidelines by examining the effects of sex and other patient factors, such as age, geographical location, educational attainment, duration of disease, socio-economic status, smoking status, and previous history of CVDs, on prescriber adherence to hypertension prescription guidelines. The association between achievement of blood pressure goals and adherence to prescription guidelines was also assessed.

2 | Materials and Methods

This is a secondary data analysis of the first wave (2009–2011) of The Irish Longitudinal Study on Ageing (TILDA), with a cross-sectional study design in accordance with the STrengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist [24].

2.1 | Data Source

TILDA is a nationally representative cohort study of adults aged 50 years and older living in Ireland [15, 25, 26]. The first wave of the study collected data from 8175 adults who were selected using a multi-stage stratified clustered sampling method (RANSAM sampling procedure) [25, 26]. Data collection in the TILDA study involved several components. First, an at-home computer-assisted personal interview (CAPI) was carried out and collected information on social and economic characteristics including educational attainment, health insurance cover, and participant health. Information on medical conditions was based on the participant's report of the doctor diagnosis. Second, a health assessment was carried out by trained research nurses. Finally, participants were asked to fill out a self-completion questionnaire (SCQ) on topics considered to be sensitive, such as depression and loneliness [15].

2.2 | Ethical Approval

Ethical approval for the current analysis was obtained from the University College Cork School of Public Health Social Research Ethics Committee, approval number: 82.MPH_20212022.

2.3 | Hypertension Classification

As part of the CAPI, all TILDA participants were asked "Has a doctor ever told you that you have any of the conditions on this card?" followed by a list of cardiovascular conditions presented to the participant among which, "hypertension or high blood pressure" was listed. In the current analysis, participants were categorized as hypertensive if they answered yes to this question. Participants were excluded if they had missing data pertaining to hypertension status or answered no to this question.

2.4 | Outcome Variables-Medication Regimes Classification

Information relating to medication was recorded using the CAPI, with all participants being asked to show the interviewer the

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medications that they took on a regular basis. The medications were categorized based on the World Health Organization Anatomical Therapeutic Chemical classification. In the current study, the antihypertensive medication regimes of participants were further categorized based on age categories (<55 years, ≥55 years, and all age groups), and compared with the 2011 NICE Guidelines for Hypertension Management in Primary Care (Figure 1) [27]. This guideline differentiates treatment in those aged <55 years and ≥55 years old. The 2011 NICE guidelines were used, as the data analyzed in this study was collected between 2009 and 2011. For the purposes of this study, adherence to prescription guidelines was determined based on Step 1 of the NICE antihypertensive prescription guidelines, as this is the entry point to the guidelines and all further steps follow from this. Effects of adherence to NICE antihypertensive prescription guidelines on blood pressure control, defined as blood pressure <140/90 mmHg, was determined.

2.5 | Covariates

The CAPI also collected sociodemographic and health information. This included age, sex, geographical location (Dublin, other city, and rural), as well as level of education attained (primary, secondary, and higher). In the present study, socioeconomic status was determined based on medical cost cover, that is, private health insurance, state-issued full-cover medical card or general practitioner visit cards (allowing access to a range of healthcare services, issued based on household income, and age), or no health insurance or cost cover. Data about smoking status (previous smoker, current smoker, or never), self-reported history of cardio- and cerebro-vascular disease and number of years since diagnosis of hypertension (duration of disease) were also collected.

2.6 | Blood Pressure Measurement

As part of the health assessment section of the TILDA study, the mean of two consecutive blood pressure readings taken 1 min apart while the participant was seated, was calculated. The mean blood pressure readings were compared between those with medication regimes adhering to prescription guidelines, and those who were prescribed medication not adhering to prescription guidelines. This comparison was carried out in those <55 years of age, those who were ≥55 years of age, and the overall hypertensive participant population.

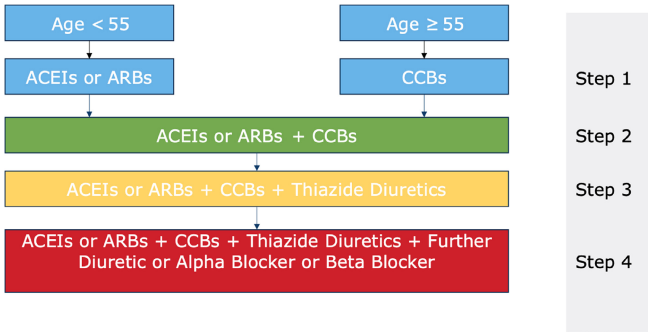

FIGURE 1 | Antihypertensive prescription guidelines in 2011 NICE Guidelines for Hypertension Management in Primary Care, amended from [27, 36].

2.7 | Statistical Analysis

Data were analyzed using Stata/SE 17.0 with statistical significance determined as $p < 0.05$. Categorical variables were stratified by sex using descriptive statistics, with frequencies and Chi-squared values being reported. Means, standard deviations, and *t*-tests were reported for continuous data. The association between the factors of interest and adherence of medication regimes to Step 1 of NICE prescription guidelines was analyzed using binomial logistic regression models, in which relative risk ratios (RR) were reported. The result of this analysis is presented as crude and adjusted RR with 95% confidence intervals and *p* values. This analysis was conducted in three different subgroups as per prescription guidelines recommendations, based on age and was stratified accordingly. The first analysis examined factors affecting adherence in those <55 years of age, the second analysis investigated factors affecting adherence in those ≥55 years of age, and the third analysis examined factors affecting adherence in all age groups. Each analysis included three separate models. The first model included sociodemographic information such as sex, age, level of education, and duration of hypertension. The second model included sociodemographic information, as well as social and behavioral information, such as geographical location, medical cost cover, and smoking status. The third model included sociodemographic and behavioral information, as well as previous history of cardio- and cerebrovascular disease.

3 | Results

A total of 8175 people participated in wave 1 of TILDA, of whom, 3088 (37.78%) reported a previous doctor diagnosis of high blood pressure or hypertension. Of those, 96 were excluded due to missing data, yielding a total of 2992 (96.89%) participants included in this study. No significant demographic differences existed between the included and excluded population. Among the 2992 participants included, 45.1% were males. The mean age of the included participants was 65.69 (±9.23) years.

A summary of the demographics of the population with hypertension, stratified by sex is shown in Table 1. Approximately half of the participants lived in rural areas (47.46% [45.66%, 49.27%]), and more than half (63.70% [61.95%, 65.43%]) have received secondary or third-level education or higher. Most participants (57.60% [55.82%, 59.40%]) have state-issued full-cover medical cards or equivalent. The mean time since diagnosis of disease is 9.96 (±9.16) years in males, and 11.69 (SD = 10.95) years in females, with 50.84% [49.03%, 52.64%] having received their diagnosis of hypertension between the ages of 55 and 79 years. A previous heart attack was reported by 7.02% (6.13%, 7.99%) of participants, 1.84% (1.39%, 2.39%) reported a history of congestive heart failure, 2.57% (2.03%, 3.21%) reported a previous of stroke, and 3.58% (2.94%, 4.31%) reported a previous transient ischemic attack (TIA). The mean seated systolic blood pressure in all participants was 141.31 (±19.62) mmHg, and the mean seated diastolic blood pressure was 84.31 (±11.54) mmHg.

Agents acting on Renin Angiotensin Aldosterone System (RAAS) were taken by 57.45% (55.66%, 59.23%) of participants, 22.89% (21.40%, 24.43%) of participants were taking CCBs, 17.98% (16.62%,

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19.41%) were taking diuretics, and 27.74% (26.14%, 29.38%) were taking beta-blockers. In terms of adherence of participants' medication regimes to prescription guidelines, 46.19% (41.27%, 51.17%) of those <55 years, 24.01% (22.46%, 25.80%) of those ≥55 years and 27.11% (25.52%, 28.74%) across all age groups, were prescribed medication adherent to 2011 NICE guidelines.

The results of binomial logistic regression analyses for participants aged <55 years ($n=407$) are presented in Table 2. Factors associated with increased adherence to prescription guidelines included, having a previous history of heart attack (RR 17.55 [2.12, 145.37]), and having a state-issued full-cover medical card or equivalent (RR 3.05 [1.58, 5.89]). Males and females had the same likelihood (RR 0.99 [0.66, 1.48]), of being prescribed antihypertensives adherent to prescription guidelines.

The results of binomial logistic regression analyses for participants aged ≥55 years are presented in Table 3. Increased

TABLE 1 | Descriptive characteristics of the participants aged ≥50 years with diagnosed hypertension in the first-wave (2009–2011) TILDA sample.

Variable	Male *n* (%)	Female *n* (%)	*p*	Total %
Hypertension ($N=2992$)				
Age (years)				
Years (mean, SD)	65.63 (8.91)	65.72 (9.48)	0.56	65.69 (9.23)
Geographical Location				
Dublin	322 (23.87)	396 (24.10)	0.61	24.00
Another city	397 (29.43)	457 (27.81)		28.54
Rural	630 (46.70)	790 (48.08)		47.46
Educational Attainment				
Primary/none	501 (37.14)	585 (35.61)	0.10	36.30
Secondary	476 (35.29)	641 (39.01)		37.33
Third Level/Higher	372 (27.58)	417 (25.38)		26.37
Healthcare Cover				
Not Covered	129 (9.56)	118 (7.18)	<0.01	8.26
Full Cover Medical Card	709 (52.56)	1015 (61.78)		57.60
GP Visit Card	27 (2.00)	27 (1.64)		1.80
Private Health Insurance	484 (35.88)	483 (29.40)		32.32
Smoking Status				
Never	452 (33.51)	825 (50.21)	<0.01	42.68
Past	708 (51.91)	536 (32.62)		41.38
Current	195 (14.46)	282 (17.16)		15.94
Age of Diagnosis of Hypertension (years)				
<30	29 (2.15)	78 (4.75)	<0.01	3.58
30–54	570 (42.25)	748 (45.53)		44.05
55–79	724 (53.67)	797 (48.51)		50.84
80 ≤	26 (1.93)	20 (1.22)		1.54
Duration of Disease				
(Mean, SD)	9.96 (9.16)	11.69 (10.95)	<0.01	10.91 (10.22)
Blood pressure mean seated				
Blood Pressure Mean Seated Systolic				
(Mean, SD)	144.25 (18.87)	138.82 (19.83)	<0.01	141.31 (19.62)

(Continues)

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TABLE 1 | (Continued)

Blood pressure mean seated				
Blood Pressure Mean Seated Diastolic				
(Mean, SD)	84.77 (11.65)	83.92 (11.44)	0.09	84.31 (11.54)
Prescriber adherence to guidelines				
Step 1 in < 55 years				
Yes	77 (46.39)	111 (46.06)	0.95	46.19
No	89 (53.61)	130 (53.94)		53.81
Step 1 in ≥ 55 years				
Yes	306 (25.87)	317 (22.61)	0.05	24.01
No	877 (74.13)	1085 (77.39)		75.89
Step 1 in All Ages				
Yes	383 (28.39)	428 (26.05)	0.15	27.11
No	966 (71.61)	1215 (73. 95)		72.89
Prescription of antihypertensive agents				
Agents Acting on the Renin–Angiotensin System (ATC C09)				
Yes	790 (58.56)	929 (56.54)	0.27	57.45
No	559 (41.44)	714 (43.46)		42.55
Calcium Channel Blockers (ATC C08)				
Yes	330 (24.46)	355 (21.61)	0.065	22.89
No	1019 (75.54)	1288 (78.39)		77.11
Diuretics (ATC C03)				
Yes	215 (15.94)	323 (19.66)	< 0.01	17.98
No	1134 (84.06)	1320 (80.34)		82.02
Beta-blockers (ATC C07)				
Yes	380 (28.17)	450 (27.39)	0.64	27.74
No	969 (71.83)	1193 (72.61)		72.26
Previous history of disease				
Heart Attack				
Yes	144 (10.67)	66 (4.02)	< 0.01	7.02
No	1205 (89.33)	1577 (95.98)		92.98
Congestive Heart Failure				
Yes	38 (2.82)	17 (1.03)	< 0.01	1.84
No	1311 (97.18)	1626 (98.97)		98.17
Stroke				
Yes	40 (2.97)	37 (2.25)	0.22	2.57
No	1309 (97.03)	1606 (97.75)		97.43
Transient Ischemic Attack				
Yes	47 (3.48)	60 (3.65)	0.81	3.58
No	1302 (96.52)	1583 (96.35)		96.42

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adherence to prescription guidelines was associated with being male, being 80-years of age or older (RR 1.49 [1.13, 1.96]) and having a diagnosis of hypertension ≥5 years. Decreased adherence to prescription guidelines was seen in females 0.75 (0.62, 0.91). Participants who received their hypertension diagnosis 5–9 years ago had RR 1.44 (1.11, 1.89) and those who received their hypertension diagnosis >10 years ago had RR 1.87 (1.49, 2.35) to have medication regimes adherent to guidelines, compared with those with a diagnosis of <5 years.

The results of the binomial logistic regression analyses in the total hypertensive population are presented in Table 4. This analysis indicated that the prescription of medications adherent to guidelines was associated with being male, being <55 years of age, having a hypertension diagnosis for ≥5 years, and having a full-cover medical card or equivalent. Decreased adherence to guidelines was seen in females RR 0.80 (0.67, 0.95). In comparison to those <55 years, participants between the ages of 55–79 years had RR 0.27 (0.21, 0.34), and those ≥80 years of age had RR 0.40 (0.28, 0.56) to be prescribed medication adherent to guidelines. In terms of healthcare cover, those with a medical card with full-cover or equivalent had increased association with being prescribed medication adherent to guidelines RR 1.60 (1.14, 2.24).

Table 5 compares the mean seated systolic and diastolic blood pressure readings in guideline adherent and guideline non-adherent participants according to sex and stratified by age <55 years, ≥55 years and all ages. In male and female participants aged <55 years, ≥55 years, and all ages, there was a significant difference in systolic blood pressure among those who were guideline adherent compared with those who were guideline non-adherent. There was no significant difference in mean diastolic blood pressure level in male or female participants across age groups whether guideline adherent or guideline non-adherent.

4 | Discussion

This study of 2992 participants in the first wave of TILDA showed that prescriber adherence to antihypertensive prescription guidelines was associated with being <55 years of age, being male in those ≥55 years, having a diagnosis of hypertension for ≥5 years, and having a state-issued full-cover medical card. Better blood pressure control, that is, <140/90 mmHg, was found to be associated with medication regimes adherent to prescription guidelines.

Consistent with previous studies conducted on patient factors affecting statin and aspirin prescription [14–16] in both primary and secondary prevention of CVDs, being male, of older age with mid-low income are all associated with increased prescriber adherence to prescription guidelines. In particular, the results of this study demonstrated that the discrepancy between the patient's sex and prescriber adherence to prescription guidelines became more apparent in those ≥55 years of age, in whom, the NICE 2011 guideline recommended the use of CCBs as first-line treatment. These finding also align with previous studies that found that males were more likely to be prescribed guideline adherent antihypertensives such as ACEIs, beta-blockers, and CCBs [21, 22], even when adjusted for indications and contraindications of the antihypertensive medications [22]. Previous studies also found that females were more likely to be prescribed diuretics [21, 22], as per NICE antihypertensive prescription guidelines, aligning with the finding of this study. The most prescribed antihypertensive medication in this study in females, and across both sexes, however, were agents acting on RAAS, followed by beta-blockers.

These findings highlight an area of concern for hypertensive care in females. Similar to previous literature, the results of this study demonstrate that CCBs are under prescribed in females [21, 22], despite being more effective than thiazide diuretics [21]. This study also found that better blood pressure control is observed in females ≥55 years on CCBs, compared with males. Furthermore, studies report that the efficacy of the different antihypertensives in CVD prevention does not differ across sex [22] thus, suggesting that there is no reason, in terms of CVD prevention, for prescribing of antihypertensives to differ across sex. Some studies, however, have suggested that side-effect profiles may influence differences in prescription of antihypertensive medication, with females tending to experience more antihypertensive side-effects when indicated for mild hypertension [21, 28, 29]. For example, females are more likely to experience dry cough associated with ACEIs [21, 30]. With diuretics, females are more likely to experience hypokalemia and hyponatremia as a side effect [21, 31], and with CCBs, females are more likely to experience edema [21, 32, 33] all of which may affect prescribing decisions.

One of the strengths of this study is the utilization of a large nationally representative cohort study that collected data on factors of interest to this study and used a standardized protocol of data collection through interviews and objective health measures, within the Irish population. Potential limitations of this study include introduction of bias through self-reporting of doctor diagnosed hypertension, smoking status, and medication use. This may have led to some degree of misclassification due to recall and reporting bias however, this is the case in all survey study designs [34]. Furthermore, previous validation of TILDA demonstrated reporting of medications to accurately reflect the medication that was dispensed to patients [35]. Additionally, in the total hypertensive population, 58% had public medical cover, meaning that they received their medicines for free with a dispensing fee per item of €1.50 and that 32% of hypertensives in the study had private medical cover, indicating a willingness to pay for healthcare. These factors reduce the risk of medication non-persistence in this population. Recall bias may have also played a role in determining the duration of disease among participants, as those with a more recent diagnosis may be better able to recall age of diagnosis. Bias may have also been introduced through the exclusion of those with missing data. However, as only 3.14% (2.55%, 3.82%) of participants with doctor diagnosed hypertension were excluded, and no significant sociodemographic differences existed between those included and excluded, the effects of the missing data should be negligible. Another potential limitation of this study is the results of the blood pressure readings, as elevation of blood pressure may have occurred due to white coat hypertension. However, the effect of this is expected to be equal across all groups and may have been reduced due to the average of two readings taken 1 min apart, being used as the final blood pressure measurement. Finally, the age-stratified results suggest a possible interaction between age and gender in relation to guideline adherence. Although the confidence intervals overlap, the difference observed in the older age group may indicate that age modifies the relationship between gender and guideline

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TABLE 2 | Binomial regression models exploring associations between prescriber adherence to antihypertensive prescription guidelines and predictor variables in those < 55 years.

	Model 1		Model 2		Model 3	
Predictor	**RR (95% CI)**	***p***	**RR (95% CI)**	***p***	**RR (95% CI)**	***p***
Sex						
Male	1	0.96	1	0.79	1	0.88
Female	0.99 (0.66, 1.48)		0.94 (0.63, 1.43)		1.03 (0.68, 1.58)	
Educational Attainment						
Primary/None	1		1		1	
Secondary	0.97 (0.52, 1.83)	0.93	1.17 (0.60, 2.28)	0.64	1.39 (0.68, 2.83)	0.36
Third Level/Higher	0.88 (0.46, 1.70)	0.71	1.23 (0.60, 2.52)	0.57	1.49 (0.70, 3.19)	0.30
Duration of Disease						
0–4 years	1		1		1	
5–9 years	1.58 (0.96, 2.61)	0.07	1.58 (0.95, 2.64)	*0.08*	1.58 (0.94, 2.67)	0.08
10+ years	1.33 (0.83, 2.11)	0.23	1.22 (0.75, 1.96)	*0.42*	1.16 (0.71, 1.91)	*0.55*
Geographical Location						
Dublin			1		1	
Another City			0.84 (0.47, 1.51)	0.56	0.81 (0.44, 1.47)	0.49
Rural			0.91 (0.53, 1.56)	0.73	0.89 (0.51, 1.56)	0.69
Healthcare Cover						
Not Covered			1		1	
Full Cover Medical Card			3.01 (1.60, 5.70)	< 0.01	3.05 (1.58, 5.89)	< 0.01
GP Visit Card			2.45 (0.62, 9.64)	0.20	2.46 (0.58, 10.32)	0.22
Private Health Insurance			1.57 (0.89, 2.77)	0.12	1.72 (0.96, 3.08)	0.07
Smoking Status						
Never			1		1	
Previous			0.85 (0.53, 1.37)	0.51	0.82 (0.50, 1.34)	0.43
Current			1.02 (0.60, 1.73)	*0.95*	0.96 (0.56, 1.65)	0.88
Previous Heart Attack						
No					1	< 0.01
Yes					17.55 (2.12, 145.37)	
Previous Congestive Heart Failure						
No					1	0.54
Yes					2.10 (0.20, 22.14)	
Previous Stroke						
No					1	0.74
Yes					0.65 (0.05, 8.03)	
Previous Transient Ischemic Attack						
No					1	0.57
Yes					1.73 (0.26, 11.30)	

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TABLE 3 | Binomial regression models exploring associations between prescriber adherence to antihypertensive prescription guidelines and predictor variables in those ≥ 55 years.

	Model 1		Model 2		Model 3	
Predictor	**RR (95% CI)**	***p***	**RR (95% CI)**	***p***	**RR (95% CI)**	***p***
Sex						
Male	1	0.01	1	< 0.01	1	< 0.01
Female	0.80 (0.66, 0.96)		0.77 (0.64, 0.94)		0.75 (0.62, 0.91)	
Age (years)						
55–79	1	< 0.01	1	< 0.01	1	< 0.01
≥ 80	1.63 (1.25, 2.12)		1.49 (1.14, 1.96)		1.49 (1.13, 1.96)	
Educational Attainment						
Primary/None	1		1		1	
Secondary	1.01 (0.82, 1.25)	*0.90*	1.04 (0.84, 1.29)	0.72	1.04 (0.84, 1.29)	0.74
Third Level/Higher	0.96 (0.76, 1.21)	*0.70*	1.00 (0.78, 1.29)	0.99	0.99 (0.77, 1.27)	0.93
Duration of Disease						
0–4 years	1	*< 0.05*	1	< 0.01	1	< 0.01
5–9 years	1.45 (1.11, 1.90)		1.43 (1.10, 1.87)		1.44 (1.11, 1.89)	
10+ years	1.91 (1.53, 2.39)		1.85 (1.47, 2.31)		1.87 (1.49, 2.35)	
Geographical Location						
Dublin			1		1	
Another City			0.98 (0.76, 1.26)	0.89	0.98 (0.76, 1.26)	0.87
Rural			0.93 (0.74 1.17)	0.54	0.93 (0.74, 1.17)	0.54
Healthcare Cover						
Not Covered			1		1	
Full Cover Medical Card			1.28 (0.86, 1.91)	0.23	1.29 (0.86, 1.93)	0.21
GP Visit Card			0.74 (0.30, 1.82)	0.51	0.72 (0.29, 1.78)	0.48
Private Health Insurance			1.03 (0.67, 1.57)	0.91	1.03 (0.68, 1.58)	0.88
Smoking Status						
Never			1		1	
Previous			0.97 (0.79, 1.18)	0.75	0.97 (0.79, 1.18)	0.75
Current			0.80 (0.60, 1.08)	*0.14*	0.80 (0.59, 1.07)	0.13
Previous Heart Attack						
No					1	0.13
Yes					0.75 (0.52, 1.09)	
Previous Congestive Heart Failure						
No					1	0.36
Yes					0.71 (0.34, 1.47)	
Previous Stroke						
No					1	
Yes					1.24 (0.74, 2.07)	0.42
Previous Transient Ischemic Attack						
No					1	0.12
Yes					1.42 (0.92, 2.20)	

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TABLE 4 | Binomial regression models exploring associations between prescriber adherence to antihypertensive prescription guidelines and predictor variables across all hypertensive participants.

	Model 1		Model 2		Model 3	
Predictor	**RR (95% CI)**	***p***	**RR (95% CI)**	***p***	**RR (95% CI)**	***p***
Sex						
Male	1	0.03	1	0.01	1	0.01
Female	0.83 (0.70, 0.98)		0.80 (0.68, 0.95)		0.80 (0.67, 0.95)	
Age (years)						
< 55	1	< 0.01	1	< 0.01	1	< 0.01
55–79	0.30 (0.24, 0.38)		0.27 (0.21, 0.35)		0.27 (0.21, 0.34)	
≥ 80	0.49 (0.35, 0.68)		0.40 (0.28, 0.57)		0.40 (0.28, 0.56)	
Educational Attainment						
Primary/None	1		1		1	
Secondary	1.01 (0.83, 1.23)	*0.90*	1.06 (0.86, 1.29)	0.60	1.05 (0.86, 1.29)	0.61
Third Level/Higher	0.94 (0.76, 1.17)	*0.60*	1.02 (0.81, 1.29)	0.88	1.01 (0.80, 1.28)	0.92
Duration of disease						
0–4 years	1	*< 0.01*	1	< 0.01	1	< 0.01
5–9 years	1.46 (1.16, 1.84)		1.44 (1.14, 1.81)		1.44 (1.14, 1.82)	
10+ years	1.80 (1.47, 2.19)		1.72 (1.41, 2.11)		1.72 (1.40, 2.11)	
Geographical Location						
Dublin			1		1	
Another City			0.97 (0.77, 1.22)	0.77	0.97 (0.77, 1.22)	0.78
Rural			0.93 (0.76, 1.15)	0.53	0.94 (0.76, 1.16)	0.54
Healthcare Cover						
Not Covered			1		1	
Full Cover Medical Card			1.60 (1.15, 2.25)	< 0.01	1.60 (1.14, 2.24)	< 0.01
GP Visit Card			1.09 (0.53, 2.25)	0.82	1.08 (0.52, 2.23)	0.84
Private Health Insurance			1.21 (0.86, 1.71)	0.27	1.21 (0.86, 1.71)	0.27
Smoking Status						
Never			1		1	
Previous			0.96 (0.80, 1.16)	0.67	0.96 (0.79, 1.15)	0.64
Current			0.88 (0.69, 1.13)	*0.32*	0.88 (0.68, 1.13)	0.31
Previous Heart Attack						
No					1	0.73
Yes					0.95 (0.68, 1.32)	
Previous Congestive Heart Failure						
No					1	0.71
Yes					0.89 (0.47, 1.66)	
Previous Stroke						
No					1	

(Continues)

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TABLE 4 | (Continued)

Predictor	Model 1 RR (95% CI)	*p*	Model 2 RR (95% CI)	*p*	Model 3 RR (95% CI)	*p*
Yes					1.16 (0.71, 1.92)	0.55
Previous Transient Ischemic Attack						
No					1	0.13
Yes					1.39 (0.91, 2.12)	

TABLE 5 | Effects of prescriber adherence to prescription guidelines on blood pressure control in those <55 years, ≥55 years, and overall population, according to participant sex.

Mean (SD)	Male	Female	*p*	Total
<55 years				
BP Mean Systolic				
Adherent	140.06 (17.04)	130.27 (17.36)	<0.01	134.71 (17.84)
Not adherent	145.32 (16.66)	135.71 (16.44)	<0.01	139.54 (17.14)
BP Mean Diastolic				
Adherent	88.48 (11.24)	87.16 (11.38)	0.49	87.76 (11.29)
Not adherent	92.70 (11.21)	88.87 (9.75)	0.03	90.40 (10.49)
≥55 years				
BP Mean Systolic				
Adherent	144.66 (18.88)	139.63 (18.82)	<0.01	142.16 (18.99)
Not on guide	144.43 (19.39)	139.83 (20.50)	<0.01	141.90 (20.13)
BP Mean Diastolic				
Adherent	82.36 (10.29)	80.89 (10.73)	0.14	81.63 (10.52)
Not adherent	84.48 (11.80)	83.87 (11.57)	0.34	84.14 (11.67)
Overall				
BP Mean Systolic				
Adherent	143.64 (18.56)	137.22 (18.87)	<0.01	140.38 (18.98)
Not adherent	144.51 (19.15)	139.38 (20.13)	<0.01	141.66 (19.86)
BP Mean Diastolic				
Adherent	83.70 (10.79)	82.50 (11.22)	0.19	83.09 (11.02)
Not adherent	85.77 (11.71)	84.42 (11.48)	0.18	84.77 (11.71)

adherence. Presenting the total population results alongside the stratified analyses was intended to provide context, showing how the overall trends might mask or dilute differences that become apparent when age groups are examined separately.

5 | Conclusions

This study indicates that prescriber adherence to prescription guidelines was associated with several participant factors including being male, of older age, and having a full cover medical card or equivalent, as well as having a diagnosis of hypertension for ≥5 years. Furthermore, this study highlights the sex differences in prescriber adherence to antihypertensive prescription guidelines, particularly within the age group of patients who are ≥55 years. These results emphasize a larger issue of the systemic undertreatment of females in healthcare and further research is required to determine possible reasons for such differences.

5.1 | Plain Language Summary

High blood pressure is a significant cause of death and disease across the world. Several guidelines have been created for

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healthcare providers to help combat this. Application of these guidelines by prescribers, however, has been found to be influenced by various patient factors. This study aims to determine how these patient factors affect prescribers' use of medication guidelines for high blood pressure. Data from the Irish Longitudinal Study on Ageing (TILDA) collected between 2009 and 2011, were used in the study. All study participants were 50 years of age and older. Information was available about participants' diagnosis of high blood pressure, their medications and personal information such as age, sex and health insurance and educational background, geographical location, smoking status, and time since they were diagnosed with high blood pressure. This study found that prescribers were more likely to prescribe medication in line with the guidelines in males, in those of older age, and those with less healthcare cover. When prescribers used the medications according to the guidelines, people with high blood pressure had better blood pressure control. This study highlights the effects of patient sex on how prescribers apply medication guidelines in people with high blood pressure.

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Ethics Statement

The study was approved by the University College Cork, School of Public Health Social Research Ethics Committee approval number 82.MPH_20212022.

Consent

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

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