Drugs - Real World Outcomes (2023) 10:159–166
https://doi.org/10.1007/s40801-022-00335-1

ORIGINAL RESEARCH ARTICLE

Statin Prescription Patterns Among Elderly Patients with Type 2 Diabetes: A Cross-Sectional Study in Lebanon

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Accepted: 18 September 2022 / Published online: 23 November 2022

Abstract

Background Even though statins have been proven to be effective in both primary and secondary prevention of cardiovascular disease among diabetic patients, a suboptimal use of the latter has been detected in real clinical practice, especially among older adults.

Objective This study aimed to evaluate the patterns and predictors of statin use among elderly patients with type 2 diabetes mellitus (T2DM) in Lebanon.

Methods This is a cross-sectional study that extended between April 2021 and February 2022. Our study involved elderly T2DM outpatients, aged 65–80 years, who presented to 40 community pharmacies for prescription filling. Diabetes status was ascertained via dispensed medication information, and patients were classified based on the American Diabetes Association preset risk scores for cardiovascular diseases in diabetics: low, moderate, or high risk. The questionnaire included patients' demographics, clinical information, and status of statin use.

Results A total of 420 diabetic geriatric patients were observed in this study; their mean age was 70 years (±7), and there was a predominance of males, 270 (64.3%). Almost all patients were classified as being at high risk, 396 (94.3%), while the rest were at moderate risk; thus, all were recommended to receive statins; however, statin prescription was only reported among 197 (46.9%), with atorvastatin and rosuvastatin being the most used: 102 (51.8%) and 62 (31.5%), respectively. Of patients prescribed statins, 60 (14.3%) were taking them for primary prevention and 137 (32.6%) for secondary prevention. Patients having a higher Charlson Comorbidity Index score had lesser odds of being prescribed statins (odds ratio [OR] 0.15, 95% confidence interval [CI] 0.02–0.8, $p=0.028$); however, those presenting with a history of dyslipidemia and coronary artery disease had higher odds of statin prescription (OR 10.5, 95% CI 4.2–26.1, $p<0.001$, and OR 5.0, 95% CI 2.4–10.5, $p<0.001$, respectively).

Conclusion Despite patients' eligibility to receive statins, statin undertreatment was evident among elderly outpatients with T2DM in Lebanon, which was modulated by several predictors.

Key Points

Less than half of the observed participants were receiving statin therapy, although all of them were considered to be at moderate to high risk.

Moderate-intensity statins, mainly atorvastatin, were found to be the most repeatedly prescribed statin, followed by rosuvastatin.

More patients were receiving statins for secondary prevention rather than primary prevention.

Patients with a history of coronary artery disease and dyslipidemia were more likely to be prescribed a statin compared to those with moderate risk for cardiovascular disease or a higher Charlson Comorbidity Index score.

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1 Introduction

With advancing age, patients are potentially placed at an increased risk for insulin resistance and/or a decline in pancreatic beta cell function. This physiological alteration precipitates an increased risk for type 2 diabetes mellitus (T2DM) and its associated complications among older adults [1]. Notably, diabetic patients are especially prone to atherosclerotic cardiovascular diseases (ASCVD) given the commonly observed risk factors (e.g., obesity, hypertension, and dyslipidemia) upon disease progression. ASCVD includes stroke, transient ischemic attack (TIA), coronary artery disease (CAD) with stable angina, acute coronary syndromes (ACS), peripheral vascular disease (PVD) with or without claudication, and aortic aneurysm. According to King et al.'s worldwide report, which extended between 1995 and 2025, ASCVD was reported to be the prime cause of morbidity and mortality in patients with diabetes mellitus [2]. In this sense, the American Diabetes Association (ADA) has set special risk scores for cardiovascular disease (CVD) risk assessment in diabetic patients [3]. These include three major risk-group categories: low risk (i.e., young diabetics < 40 years without additional ASCVD risk factors), moderate risk (i.e., diabetics aged ≥ 40 years without ASCVD risk factors), and high risk (i.e., diabetics with an established ASCVD irrespective of their age or diabetics older than 40 years who have two or more traditional cardiovascular risk factors) [3].

In this regard, diabetic dyslipidemia has a two- to threefold increased CVD risk and an approximate fourfold increased mortality rate that is related to post-myocardial infarction [4]. This indicates the importance of strict control over dyslipidemia in this population group and the need for primary prevention even in the case of a normal lipid profile [4].

Statins, a class of HMG-CoA reductase inhibitors, are often used in the management and prophylaxis of dyslipidemia, which can ultimately lower the probability of CVD (by 27%), stroke (by 36%), and their associated mortality (by 15%), especially among diabetic patients [5].

However, the use of statins in geriatric patients has been debated, given their strong association with an increased risk for adverse effects, namely poor glycemic control, which substantially complicates treatment options [6].

Based on the ADA's recent recommendations in 2022, the use of a moderate-intensity statin has been encouraged for diabetic patients without a history of ASCVD and aged 40–75 years, irrespective of the baseline cholesterol levels [3]. The use of high-intensity statins may also be reasonable among diabetic individuals at a higher risk for CVD (i.e., multiple CVD risk factors) or those aged 50–70 years. On the other hand, diabetic patients with an established history of ASCVD, irrespective of age, are advised to receive a high-intensity statin in addition to lifestyle modifications for secondary prophylaxis. Whilst statin use among patients older than 75 years may be questionable, it may be reasonable to support the continuity of treatment if initiated before the age of 75 years and careful consideration of the imposed risks and offered benefits.

Despite the fact that statins have been proven to be effective in both primary and secondary prevention of CVD, several studies have revealed a discrepancy between guideline recommendations and statin use in actual clinical practice, where a suboptimal use of the latter has been detected, especially in older adults [7–10].

To our knowledge, there have been no contemporary data on statin prescriptions among Lebanese elderly with T2DM, despite the remarkably high prevalence of modifiable cardiovascular risk factors among the general population. Therefore, we aimed in this study to evaluate the patterns and predictors of statin use among elderly patients with T2DM in Lebanon.

2 Methods

2.1 Study Design and Settings

This is a cross-sectional study that spanned a period of 11 months, from April 2021 to February 2022. The ethical approval was provided by the institutional review board of the Lebanese International University (Ref: 2021RC-039-LIU-SOP). An oral informed consent was obtained from all study participants prior to face-to-face interview initiation.

2.2 Participants

Our study involved the observation of elderly T2DM outpatients aged 65–80 years, who consciously presented to the community pharmacy to fill their own prescriptions. Diabetes status was ascertained via dispensed medication information, whereall patients presenting with a prescription of an antidiabetic medication (Anatomical Therapeutic Chemical [ATC] code: A10) were deemed eligible to participate [11].

2.3 Data Collection

Using the order of Lebanese pharmacists' records, a proportionate random sample of 40 pharmacies was selected. The chief pharmacist's permission was obtained from each pharmacy to conduct on-site interviews. The 40 pharmacies were equally divided and assigned to two researchers, who attended each pharmacy for 1 week following a 2-day on-site assessment of the average pharmacy load of elderly patients. Patients were interviewed in Arabic by a

well-trained pharmacist in a private place in the pharmacy to minimize information bias [12].

A questionnaire was developed for this study and comprised four sections. A pilot study was performed on 20 diabetic patients to determine the relevance, clarity, and applicability of the survey instrument; no changes were deemed necessary. Face-to-face interviews using the pretested patient interview questionnaire were conducted (supplementary material). On average, each patient interview took 7 min (range 5–12 min). The first section of the questionnaire included screening questions from the Short Orientation Memory Concentration (SOMC) questionnaire (e.g., person, place, and time) to assess patients' proper orientation and concentration, and a score of 20 or more proved the proper mental capabilities of the participant and, hence, they were considered eligible. The second section included questions about patients' demographics (i.e., age, weight, height, place of residence, monthly income, and alcohol consumption, in addition to smoking, marital, and educational status). Clinical variables were sought in the third section (i.e., patient's medical condition). The fourth section surveyed the status of statin and antidiabetics use and questions related to the currently used medications (i.e., agent and dose). Statins were then classified into low, moderate, and high intensity according to the dose used [3].

All enrolled participants were classified according to the ADA's recent recommendation in 2022 into moderate- or high-risk categories and primary- or secondary-prevention groups [3]. Moderate-high-risk diabetic patients who were free of atherosclerotic complications were considered for primary prevention, while diabetic patients with a history of coronary heart disease (CHD), stroke, or peripheral arterial occlusive disease were directed towards secondary prevention. Polypharmacy was checked for in accordance with the World Health Organization (WHO) definition of the latter term as the routine use of five or more medications, which include prescription, over-the-counter, complementary, and traditional products [13].

The Charlson Comorbidity Index (CCI) was used to quantify comorbidities, where a severe CCI score signified a worse compilation of co-existing conditions. Only medical conditions previously diagnosed by a physician were included. Researchers involved in data collection were well trained prior to engaging with patients to minimize interview bias. Patients were also shown a list of pictures of all statins available in the market to enhance their recall of possibly attempted trials of statin therapy.

2.4 Study Size

Meanwhile, the WHO database shows that 11% of the approximate 6 million Lebanese population are older than 65 years, and findings from a national population-based study highlighted the prevalence of T2DM among 8.5% of Lebanese adults aged ≥ 25 years [14, 15]. Additionally, according to the India Heart Watch-2, statins were only prescribed in 55.2% of diabetic patients [7]. Thus, using the aforementioned information, a minimum sample size of 378 was calculated using the Epi Info™, for a 5% level of significance.

2.5 Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (version 25). While frequencies were utilized to address qualitative variables, numerical variables were described using means and standard deviations. Bivariate analyses were conducted to identify the demographics and clinical variables associated with statin prescriptions, as well as to investigate the factors associated with statin prescription in patients stratified into primary- and secondary-prevention groups. Variables with a p value less than 0.2 in the bivariate analysis were included in a multivariate logistic analysis model. Statistical significance was set at a p value of < 0.05.

3 Results

In our 11-month study that extended between April 2021 and February 2022, a total of 600 T2DM patients were approached, of whom 420 (70%) agreed to take part in the study. Patient characteristics are presented in Table 1.

The mean age of enrolled participants was 70 years (± 7), and 270 (64.3%) were males. Overweight and obesity had the highest percentages within the body mass index (BMI) categories, 203 (48.3%) and 134 (31.9%), respectively. More than half of the patients were smokers, 218 (51.9%), and 61 (14.5%) consumed alcohol. Hypertension was the most commonly reported comorbidity, 314 (74.5%), followed by CAD, 201 (47.8%), and dyslipidemia, 110 (26.2%). The CCI showed the severe category to be most prevalent among the patients, 272 (64.8%). The mean number of medications received per patient was 5.95 ± 2.755, with a range of 1–18, in which 292 patients (69.5%) were on polypharmacy.

Almost all of the patients were considered to be high risk, 396 (94.3%), and the rest were classified as moderate, where all of them should be on statin (Fig. 1); however, statin prescription among patients was only 197 (46.9%), with atorvastatin and rosuvastatin being the most used, 102 (51.8%) and 62 (31.5%), respectively. Medium-intensity statins were the most used, 106 (53.8%), followed by high intensity, 85 (43.1%). Of patients prescribed statins, 60 (14.3%) were taking it for primary prevention and 137 (32.6%) for secondary prevention.

Table 1 Patients' socio-demographic characteristics ($n=420$)

Characteristics	*n* (%)
Age (years)	Mean (SD): 70 (7) Range: 65–80
Gender (male)	270 (64.3)
BMI[a]	
Normal	83 (19.8)
Overweight	203 (48.3)
Obese	134 (31.9)
Smoker[b]	218 (51.9)
Alcohol consumption[b]	61 (14.5)
Place of residency	
Mount Lebanon	184 (43.6)
Beirut	80 (19)
Baalbek-Hermel	76 (18)
South Lebanon	37 (8.9)
North Lebanon	20 (4.7)
Nabatiye	16 (3.8)
Bekaa	7 (1.7)
Marital status (married)	353 (84.0)
Education	
No schooling	112 (26.7)
High school	185 (44.0)
University degree	123 (29.0)
Monthly income	
< 1 million LBP	103 (24.5)
1–3 million LBP	180 (42.9)
3.1–5 million LBP	97 (23.0)
> 5 million LBP	50 (9.5)
Comorbidities	
Hypertension	314 (74.5)
Coronary artery disease	201 (47.8)
Dyslipidemia	110 (26.2)
Stroke	36 (8.6)
Peripheral artery disease	32 (7.6)
Charlson Comorbidity Index (severe)	272 (64.8)
Number of medications received	Mean (SD): 5.95 (2.755) Range: 1–18
Polypharmacy	292 (69.5)
Statin prescription	197 (46.9)
Statin used ($n=197$)	
Atorvastatin, 102 (51.8)	
Moderate intensity (10–20 mg)	50 (25.4)
High intensity (40–80 mg)	52 (26.4)
Rosuvastatin, 62 (31.5)	
Moderate intensity (5–10 mg)	29 (14.7)
High intensity (20–40 mg)	33 (16.7)
Simvastatin, 25 (12.7)	
Low intensity (10 mg)	–
Moderate intensity (20–40 mg)	25 (12.7)
Pitavastatin, 8 (4.0)	
Low intensity (1 mg)	6 (3.0)
Moderate intensity (2–4 mg)	2 (1.0)
Statin intensity ($n=197$)	
Low	6 (3.0)
Moderate	106 (53.8)
High	85 (43.1)
Reason of use	
Primary prevention	60 (14.3)
Secondary prevention	137 (32.6)
Risk category[c]	
Moderate risk	24 (5.7)
High risk	396 (94.3)

ASCVD atherosclerotic cardiovascular disease, *BMI* body mass index, *LBP* Lebanese pound

[a]BMI normal (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), obese (> 30.0 kg/m^2)

[b]Smoking and alcohol consumption status was assessed using simple "yes or no" questions, and no specific definitions were followed

[c]Moderate risk: diabetics aged ≥ 40 years without ASCVD risk factors; high risk: diabetics with ASCVD irrespective of age or diabetics older than 40 years with multiple (≥ 2 traditional cardiovascular risk factors) [3]

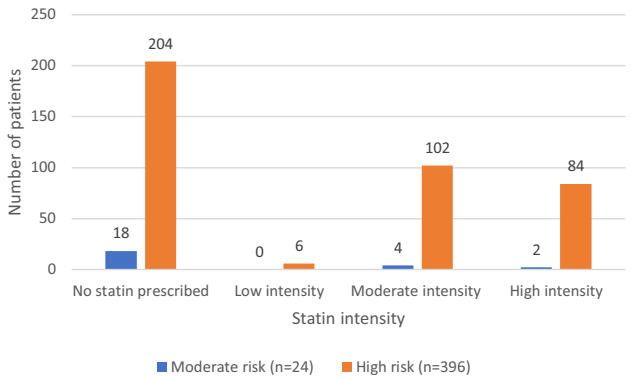

Fig. 1 Statin use among moderate- and high-risk patients

The comparison of demographics and clinical variables between patients with, 197 (46.9%), and without statin prescription, 223 (53.1%), using bivariate analysis is documented in Table 2.

The monthly income ($p=0.02$), severe CCI ($p=0.002$), CAD, ($p=0.030$), dyslipidemia ($p=0.001$), and polypharmacy ($p<0.001$) were shown to be significant. The results of the second bivariate analysis comparing demographics and clinical variables in the primary-prevention group, 60 (14.2%), and secondary-prevention group, 137 (32.6%), are documented in Table 3.

It showed that only dyslipidemia ($p<0.001$) was significant in the primary-prevention use group. On the other

Table 2 A comparison of demographics and clinical variables between patients with and without statin prescription

Characteristics	Bivariate analysis			Multivariable analysis	
	Statin prescription *n* (%) = 197 (46.9)	No statin prescription *n* (%) = 223 (53.1)	*P* value	OR (95% CI)	*P* value
Men	134 (68.0)	136 (61.0)	0.33		
Women	63 (32.0)	87 (39.0)			
Age (years)	69 ± 9	67 ± 6	0.62		
BMI (overweight)	98 (49.7)	105 (47.1)	0.93		
BMI (obese)	64 (32.5)	70 (31.4)			
Smoker	101 (51.3)	117 (52.5)	0.81		
Alcohol consumption	37 (18.8)	24 (10.8)	0.08		
Monthly income (1–3 million LBP)	93 (47.2)	87 (39.0)	0.02*	1.2 (0.3–4.4)	0.755
Educational level (high school)	93 (47.2)	92 (41.2)	0.052		
CCI (severe)	152 (77.2)	120 (53.8)	0.002*	0.15 (0.02–0.8)	0.028*
Hypertension	147 (74.6)	166 (74.4)	0.86		
CAD	110 (55.8)	91 (40.8)	0.03*	5.0 (2.4–10.5)	0.00*
Dyslipidemia	73 (37.1)	37 (16.6)	0.001*	10.5 (4.2–26.1)	0.00*
PAD	14 (7.1)	18 (8.1)	0.77		
Stroke	18 (9.1)	18 (8.1)	0.80		
Polypharmacy	166 (84.2)	124 (55.6)	< 0.001*	0.39 (0.06–2.2)	0.28
Risk (high)	192 (97.5)	202 (90.6)	0.14		

BMI body mass index, *CAD* coronary artery disease, *CCI* Charlson Comorbidity Index, *CI* confidence interval, *LBP* Lebanese pound, *OR* odds ratio, *PAD* peripheral artery disease

* Statistically significant

Table 3. Demographics and characteristics in patients receiving a statin prescription for primary or secondary prevention

Characteristics	Primary prevention *n* (%) = 60 (14.2)				Secondary prevention *n* (%) = 137 (32.6)			
	Bivariate analysis		Multivariable analysis		Bivariate analysis		Multivariable analysis	
	n (%)	*P* value	OR (95% CI)	*P* value	*n* (%)	*P* value	OR (95% CI)	*P* value
Men	42 (70.0)	0.49			92 (67.1)	0.64		
Women	18 (30.0)				45 (32.8)			
Age (years)	67 ± 6	0.33			72 ± 7	0.52		
BMI (overweight)	38 (65.5)	0.20			60 (43.7)	0.41		
Smoker	28 (46.7)	0.51			74 (54.0)	0.76		
Alcohol consumption	12 (20.0)	0.37			25 (18.2)	0.23		
Monthly income 1–3 million LBP	30 (50)	0.44	4.7 (1.1–19.4)	0.03*	62 (45.2)	0.01*	1.8 (0.60–5.95)	0.272
Educational level (high school)	32 (53.3)	0.57			61 (44.5)	0.07		
CCI (severe)	40 (66.7)	0.97	0.5 (0.8–0.9)	0.04*	112 (81.7)	0.002*	0.20 (0.04–0.9)	0.046*
Hypertension	38 (63.3)	0.13			108 (78.8)	0.37		
CAD	20 (33.3)	0.08			90 (65.7)	< 0.0001*		
Dyslipidemia	32 (53.3)	< 0.0001*			42 (30.6)	0.37	1.37 (0.4–3.6)	0.523
Polypharmacy	46 (76.7)	0.40			120 (87.6)	< 0.0001*		
Risk (high)	58 (96.7)	0.70			134 (97.8)	0.34		

BMI body mass index, *CAD* coronary artery disease, *CCI* Charlson Comorbidity Index, *CI* confidence interval, *LBP* Lebanese pound, *OR* odds ratio

* Statistically significant

hand, monthly income, severe CCI, CAD, and polypharmacy were all significant, $p = 0.016$, $p = 0.002$, $p < 0.001$, and $p < 0.001$, respectively, for those taking the statin for secondary prevention.

The results that were significant in the bivariate analysis were then run into a multivariate analysis model, as presented in Table 2. Patients with multimorbidity (i.e., severe CCI score) received significantly lower number of statins prescriptions (odds ratio [OR] 0.15, 95% confidence interval [CI] 0.02–0.8, $p = 0.028$). Statins were mainly prescribed to patients diagnosed with dyslipidemia (OR 10.5, 95% CI 4.2–26.1, $p < 0.001$) and/or CAD (OR 5.0, 95% CI 2.4–10.5, $p < 0.001$).

Similarly, patients with a severe CCI score were less likely to receive statin for primary prevention (OR 0.47, 95% CI 0.229–0.965, $p = 0.040$) and secondary prevention (OR 0.787, 95% CI 0.044–0.971, $p = 0.046$). On the contrary, a higher monthly income was positively correlated with statin use for primary prevention (OR 4.765, 95% CI 1.167–19.456, $p = 0.030$) (Table 3).

4 Discussion

Our study evaluated the patterns of statin use for the primary and secondary prevention of CVD among elderly outpatients with T2DM in Lebanon. Statin prescriptions were compared to risk stratification of study participants, and this showed that less than half of the participants were receiving statin therapy although all of them were eligible for therapy, as they were considered to belong to moderate- to high-risk groups.

Similar to Teeling et al.'s and Ko et al.'s findings, the elderly patients observed in this study showed a decreased probability of receiving a statin [16, 17]. Our study's findings were also comparable to data from other developing countries, where statin prescriptions were recorded among 33.8–55.7% of diabetic patients [7–10]. Even in the more developed countries with well-established and covered medical care, in the United States, less than half of the observed diabetic patients (40%) filled a statin prescription [18]. One reason that may justify this decreased use of statins is the inappropriate adherence to recommendations supported by international guidelines, which regarded risk with diabetes as being equivalent to CHD, therefore, recommending similar cholesterol-lowering therapy (i.e., same intensity and goal as with CHD) [19].

In our study, atorvastatin was found to be the most repeatedly prescribed statin, followed by rosuvastatin. This finding mirrors that concluded by Bideberi and Mutagaywa in Tanzania, where atorvastatin was used by almost all patients placed on statins (95%), followed by rosuvastatin (5%) [8]. One reason that may explain this preference is the availability of atorvastatin in moderate- to high-intensity doses, the affordable cost compared to the newer statins, and physicians' long-standing experience and preference for the aforementioned agents. Although pravastatin and fluvastatin have been suggested to offer further control of glucose levels compared to atorvastatin and rosuvastatin, more research is still needed [20]. Compared to previously conducted studies [9, 18], where a larger number of patients were receiving statins for primary prevention, more patients in this study were taking statins for secondary prevention (32.7%) rather than primary prevention (14.2%), which reveals the lack of intervention prior to the occurrence of a cardiovascular incident.

Based on the ADA 2022 recommendations, secondary-prevention patients are always candidates for high-intensity statins, as opposed to primary-prevention patients, who may benefit from moderate- to high-intensity statins, according to their risk category [3]. In this sense, a larger number of patients are expected to be placed on high-intensity statins. Nevertheless, as opposed to our expectations, moderate-intensity statins were the most commonly prescribed drugs. This reflects Gupta et al.'s data from India where moderate-intensity statins were more commonly prescribed (85.4%) in comparison with other intensities [7]. This may be in part due to physicians' concerns about increased adverse effects among this fragile population (i.e., the elderly). Their fear comes in concordance with 2019 American College of Cardiology/American Heart Association (ACC/AHA) recommendations to prescribe moderate-intensity statins to patients older than 75 years even when high intensity is required [21]. Nonetheless, the age of patients observed in this study ranged between 65 and 80 years, which relatively refutes this explanation and calls for further consideration.

Moreover, patients identified as being in the moderate-risk category were more likely to miss being prescribed statins, and only one-quarter of them received statin therapy, compared to half of those classified as high risk. This is alarming as primary prevention in the case of the moderate-risk category is a must and is expected to lower mortality rates twofold better than secondary prevention, which brings to light the present gap in primary prophylaxis [22].

Further investigation into factors that may have modulated statin utilization among our study group revealed that patients were less likely to be prescribed statins. One possible reason may be the deferral of treatment due to fear of decreased medication adherence and increased risk of side effects and drug–drug interaction. A limit in statin prescription among this subgroup of patients (i.e., high CCI score) potentially detained statin's favorable impact on 1-year survival, as demonstrated in a Taiwanese study [23].

Nonetheless, the use of statins in our study was independent of the BMI level. Neutel et al. claimed that Canadian patients who were overweight or obese were more likely to

be prescribed statins [24]. This should be concerning, as a BMI exceeding 30 kg/m^2 is considered an independent CVD risk factor that necessitates statin therapy initiation for diabetic patients and may ultimately show up as a strong predictor for statin use. The pattern of statin prescription was also independent of patients being hypertensive, despite it being another major CVD risk factor. This contradicts Bideberi et al.'s findings in Tanzania [7]. Similarly, age and smoking were unraveled to be not significantly associated with statin prescription, as opposed to Neutel et al.'s findings in Canada [24]. This demonstrates that not all CVD risk factors were equally considered when checking for patients' need for statin use. Furthermore, the use of statin was non-significantly correlated with economic status. On the contrary, a declined financial status significantly limited medication purchasing power and medication adherence in González López-Valcárcel et al.'s study [25].

Notably, participants with a history of CAD and dyslipidemia were more likely to be prescribed statins compared to those who were free of comorbidities. This presents the Lebanese physicians' inclination to prescribe statins for subtle indications only (i.e., CAD and dyslipidemia) while ignoring other equally essential risk factors (i.e., smoking, high BMI) that place the patient at similarly high risk if collectively present (three or more risk factors) or a slightly lower risk that deserves to be addressed.

Lastly, in comparison with Kebede Zelalem and Feyisa's study where polypharmacy projected the initiation of statin therapy, this aforementioned variable had no impact on statin prescription in our study [26]. This sheds light on another potential concern, where patients on multiple medications are being equally treated as other patients. This group of patients is particularly vulnerable and should be thoroughly followed up.

This is the first study to assess statin prescription patterns among elderly T2DM patients using a quite representative and diverse sample from all Lebanese districts, which favors the generalizability of our findings. Nonetheless, several limitations should be pointed out; the study was based on prescription data, and therefore, we lacked information on the duration of diabetes for each patient, medication adherence, and lab tests (e.g., low-density lipoprotein, cholesterol level, A1c, etc.); the possibility of recall and selection bias among enrolled participants; the lack of follow-up assessments on statin adherence, as it is well-known that statin initiation, continuation, and discontinuation are time dependent. Another significant limitation is the lack of a national guideline on diabetes management or a nationally adopted international guideline, which interferes with the homogeneity of the physicians' risk-group classification and treatment recommendations.

5 Conclusion

In conclusion, our study revealed statin undertreatment among elderly outpatients with T2DM in Lebanon, despite their indubitable eligibility, and identified the present gap in commitment to recommendations set by international guidelines. Patients described as having moderate risk or a higher CCI score had lesser odds of being prescribed statins; however, those presenting with a history of CAD and dyslipidemia had higher odds of statin prescription. Efforts should be made toward guideline implementation to improve the quality of care provided to patients with T2DM presenting with other cardiovascular risks and to minimize the risk of long-term complications.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40801-022-00335-1.

Acknowledgements We would like to acknowledge the pharmacies, on whose premises we conducted data collection, and the study participants who took part in this study.

Declarations

Conflict of interest BC and FS declare that they have no potential conflicts of interest that might be relevant to the contents of this article.

Funding No sources of funding were used in the preparation of this study.

Ethics approval Ethical approval was obtained for the study (Ref: 2021RC-039-LIUSOP).

Consent to participate Oral consent.

Availability of data and material The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Code availability SPSS version 25 institutional license.

Author contributions We confirm that the authors BC and FS contributed meaningfully and equally to this publication. BC and FS contributed to the study design and analysis plan. FS performed the statistical analyses. BC and FS drafted and revised the manuscript and are in agreement with the content of the manuscript. Both authors read and approved the final version.

References

1. Cerf ME. Beta cell dysfunction and insulin resistance. Front Endocrinol. 2013;4:37.
2. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995–2025: prevalence, numerical estimates, and projections. Diabetes Care. 1998;21(9):1414–31. https://doi.org/10.2337/diacare.21.9.1414.
3. American Diabetes Association Professional Practice Committee. 10. Cardiovascular disease and risk management: standards of medical care in Diabetes-2022 [published correction appears in Diabetes Care. Diabetes Care. 2022;45(Suppl 1):S144–74. https://doi.org/10.2337/dc22-S010.
4. Ramos R, Comas-Cufí M, Martí-Lluch R, et al. Statins for primary prevention of cardiovascular events and mortality in old and very old adults with and without type 2 diabetes: retrospective cohort study. BMJ. 2018;362:k3359. https://doi.org/10.1136/bmj.k3359.
5. Costa J, Borges M, David C, Vaz CA. Efficacy of lipid lowering drug treatment for diabetic and non-diabetic patients: meta-analysis of randomized controlled trials. BMJ. 2006;332(7550):1115–24. https://doi.org/10.1136/bmj.38793.468449.AE.
6. Bardini G, Giannini S, Rotella CM, Pala L, Cresci B, Mannucci E. Lower and higher-potency statins on glycemic control in type 2 diabetes: a retrospective cohort study. Diabetes Res Clin Pract. 2016;120:104–10.
7. Gupta R, Lodha S, Sharma KK, et al. Evaluation of statin prescriptions in type 2 diabetes: India Heart Watch-2. BMJ Open Diabetes Res Care. 2016;4(1): e000275. https://doi.org/10.1136/bmjdrc-2016-000275.
8. Bideberi AT, Mutagaywa R. Statin prescription patterns and associated factors among patients with type 2 diabetes mellitus attending diabetic clinic at Muhimbili National Hospital, Dar es Salaam, Tanzania. Diabetes Metab Syndr Obes. 2022;15:633–46. https://doi.org/10.2147/DMSO.S347765.
9. Lee VW, Ho IC, Chan WS, Tam KY, Lee KK. Statin utilization patterns for the primary prevention of cardiovascular events: a retrospective study in patients with diabetes mellitus in Hong Kong. Am J Cardiovasc Drugs. 2008;8(3):199–205. https://doi.org/10.2165/00129784-200808030-00006.
10. Demoz GT, Wahdey S, Kasahun GG, et al. Prescribing pattern of statins for primary prevention of cardiovascular diseases in patients with type 2 diabetes: insights from Ethiopia. BMC Res Notes. 2019;12(1):386. https://doi.org/10.1186/s13104-019-4423-9.
11. https://moph.gov.lb/userfiles/files/HealthCareSystem/Pharmaceuticals/LNDI/LNDI-2015.pdf
12. Wade DT, Vergis E. The Short Orientation Memory Concentration Test: a study of its reliability and validity. Clin Rehabil. 1999;13:164–70.
13. UN ESCWA. Retrieved April 8, 2022, from https://data.unescwa.org/portal/7bae8f12-f543-407f-9afa-29471d6b7c6d
14. Medication Safety in Polypharmacy. Geneva: World Health Organization; 2019 (WHO/UHC/SDS/2019.11).
15. Costanian C, Bennett K, Hwalla N, Assaad S, Sibai AM. Prevalence, correlates and management of type 2 diabetes mellitus in Lebanon: findings from a national population-based study. Diabetes Res Clin Pract. 2014;105(3):408–15. https://doi.org/10.1016/j.diabres.2014.06.005.
16. Teeling M, Bennett K, Feely J. The influence of guidelines on the use of statins: analysis of prescribing trends 1998–2002. Br J Clin Pharmacol. 2005;59:227-232.29.
17. Ko DT, Mamdani M, Alter DA. Lipid-lowering therapy with statins in high-risk elderly patients: the treatment-risk paradox. JAMA. 2004;291:1864–70.
18. Steen DL, Khan I, Becker L, et al. Patterns and predictors of lipid-lowering therapy in patients with atherosclerotic cardiovascular disease and/or diabetes mellitus in 2014: insights from a large US managed-care population. Clin Cardiol. 2017;40(3):155–62. https://doi.org/10.1002/clc.22641.
19. Massing MW, Foley KA, Sueta CA, et al. Trends in lipid management among patients with coronary artery disease: has diabetes received the attention it deserves? Diabetes Care. 2003;26(4):991–7. https://doi.org/10.2337/diacare.26.4.991.
20. Boppana SH, Syed HA, Antwi-Amoabeng D, Reddy P, Gullapalli N. Atorvastatin-induced necrotizing myopathy and its response to combination therapy. Cureus. 2021;13(1): e12957. https://doi.org/10.7759/cureus.12957.
21. Arnett DK, Blumenthal RS, Albert MA, et al. ACC/AHA guideline on the primary prevention of cardiovascular disease: executive summary: a report of the american college of cardiology/american heart association task force on clinical practice guidelines [published correction appears in Circulation. 2019;140(11):e647–e648] [published correction appears in Circulation. 2020;141(4):e59] [published correction appears in Circulation. 2020;141(16):e773]. Circulation. 2019;140(11):e563–e595. https://doi.org/10.1161/CIR.0000000000000677.
22. Kabir Z, Bennett K, Shelley E, et al. Comparing primary prevention with secondary prevention to explain decreasing Coronary Heart Disease death rates in Ireland, 1985–2000. BMC Public Health. 2007;7:117. https://doi.org/10.1186/1471-2458-7-117.
23. Huang CH, Yu PH, Tsai MS, et al. Relationship between statin use and outcomes in patients having cardiac arrest (from a nationwide cohort study in Taiwan). Am J Cardiol. 2019;123(10):1572–9. https://doi.org/10.1016/j.amjcard.2019.02.018.
24. Neutel CI, Morrison H, Campbell NR, de Groh M. Statin use in Canadians: trends, determinants and persistence. Can J Public Health. 2007;98(5):412–6. https://doi.org/10.1007/BF03405430.
25. González López-Valcárcel B, Librero J, García-Sempere A, et al. Effect of cost sharing on adherence to evidence-based medications in patients with acute coronary syndrome. Heart. 2017;103(14):1082–8. https://doi.org/10.1136/heartjnl-2016-310610.
26. Kebede Zelalem B, Feyisa D. Determinants of statin initiation among adult diabetic patients in Bonga, Ethiopia. Diabetes Metab Syndr Obes. 2020;13:4839–47. https://doi.org/10.2147/DMSO.S283993.