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ORIGINAL RESEARCH

Statin prescription patterns, adherence, and attainment of cholesterol treatment goals in routine clinical care: a Danish population-based study

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Purpose: To examine the annual rate and cumulative prevalence of statin use in Denmark 2004–10, including adherence of use and attainment of cholesterol targets.

Methods: We included all individuals aged 18–86 years with a first statin prescription in Northern Denmark in 2004–10. We calculated the annual rate and cumulative prevalence of statin use. We examined cholesterol values before and after start of statins and the proportion reaching targets according to European guidelines and cardiovascular risk group.

Results: The study population consisted of 161,646 new statin users (51% men; median age 62 years). The peak rate of new statin initiators occurred in 2008, and a cumulative prevalence of 94 users per 1,000 population was reached in 2010. In total, 98% of new users started with simvastatin. Eighty-eight percent (142,897) did not switch statin type during follow-up. Overall persistence was 84%. The reduction in median total cholesterol in new statin users was 28% (from 6.3 mmol/L to 4.5 mmol/L), while it was 43% (from 4.0 mmol/L to 2.3 mmol/L) for low-density lipoprotein cholesterol. Among patients with very high cardiovascular risk, 66% attained the recommended total cholesterol target; corresponding figures were 74% among high-risk patients and 80% among low- to moderate-risk patients. Corresponding figures for low-density lipoprotein cholesterol were 54%, 82%, and 88%, respectively.

Conclusions: Statin use has become very prevalent in Danish adults, with high adherence. Cholesterol reduction after statin initiation is similar to that found in clinical trials, yet a substantial proportion of patients does not reach target cholesterol levels.

Keywords: statin, cholesterol attainment, Denmark, persistence

Introduction

Statins (3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitors) were introduced in Denmark in 1990 and are currently recommended as a preventive treatment for men and women of all ages at high risk of cardiovascular events.[1] During the past two decades, statins have become one of the most commonly used groups of drugs worldwide. Between 1995 and 2012, 842,484 Danish individuals (the current population of Denmark is ~5.6 million) filled at least one statin prescription at a community pharmacy, according to data from the Danish National Board of Health.[2] In the 1990s, there was a four- to fivefold increase in numbers of new patients who received statins.[3] The prevalence of statin use in Denmark was predicted to increase by over 300% between 2006 and 2012,[4] based on a continuous rise in new users after 2005. Compliance with statin treatment was rated high in Denmark in the 1990s,[5] but

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others have raised concerns regarding persistence of use, with reports of a large number of dropouts in short-term studies.[6] While clinical studies often focus on middle- and low-risk populations, population-based studies may focus on real-life data, including high-risk populations.[7–10]

Clinical trials have demonstrated that the most widely prescribed statins (ie, simvastatin, atorvastatin, rosuvastatin, and pravastatin) for both primary and secondary prevention purposes reduce total plasma cholesterol and low-density lipoprotein (LDL) cholesterol; reductions of 0.5–2.26 mmol/L and 0.39–1.74 mmol/L for total and LDL cholesterol levels, respectively, were reported in a meta-analysis of 181 randomized controlled trials of statin.[11] On the other hand, the cholesterol level target attainment in routine clinical care is less well described, with somewhat inconsistent results. Among 2,227 elderly Medicare Advantage members in the US, 67%–94% reached the LDL cholesterol goal, depending on statin type prescribed.[7] In their study of 2,303 patients starting statins in the Netherlands, Heintjes et al[8] stratified cholesterol target attainment by patients' risk for cardiovascular disease; among high-risk patients, target attainment varied from 40% for patients on pravastatin to 81% for patients on rosuvastatin. In a population-based cohort study in Spain, 74% of patients did not attain their LDL cholesterol treatment goal after 3 years of follow-up.[9] In contrast, among 1,103 patients from community-based practices in Canada who filled prescriptions for statins, 73% achieved the target LDL cholesterol level.[10]

In the current population-based study, we examined the rate of patients initiating statin use and the prevalence of use in Northern Denmark during 2004–10, a setting in which national guidelines recommend using simvastatin as first-line drug. We also aimed to investigate the adherence of use. In addition, we aim to examine changes in lipid values over time after statin initiation and determined the percentage of patients attaining treatment goals for cholesterol levels, stratified by risk groups, and whether statin type was switched.

Materials and methods

Setting

We conducted this study in Northern Denmark, encompassing approximately 1.8 million inhabitants. Denmark provides tax-funded universal access to primary and secondary health care, with no substantial out-of-pocket expenses and with partial reimbursement for most prescribed medications, including statins. Individual-level data from all Danish registries can be linked via the unique personal identifier (CPR number) assigned at birth by the Danish Civil Registration System (CRS).[12]

Statin use

In Denmark, statins are available to outpatients only by prescriptions filled at community pharmacies. We retrieved all entries for redemption of a first prescription (index date) of a statin (ATC classification system: C10AA statins, C10BA statin + ezetimibe) in the Aarhus University Prescription Database. This is a research database of all reimbursed prescriptions filled at community pharmacies in Northern Denmark since 1998.[13]

The study included all patients initiated on statins in 2004–10, excluding patients with a statin treatment 15 months prior to 2004, who were aged between 18 and 86 years and who filled a first statin prescription between January 2004 and December 2010 at any pharmacy in Northern Denmark. We excluded patients with a previous cancer diagnosis (International Classification of Diseases [ICD], eighth edition: 140–208, excluding 172–173 and ICD-10: C00–C99) through linkage with the Danish National Registry of Patients. This registry contains discharge diagnoses from all inpatient admissions to Danish hospitals since 1977 and hospital outpatient clinic diagnoses since 1995.[14]

We obtained information about doses, such as the defined daily dose (DDD), and adherence to statin treatment, including medication possession ratio (MPR), switches among statin types, and persistence. DDD is given to each ATC code and is the assumed daily average maintenance dose when used for a main indication. Nonpersistence was defined as no reimbursements for new statin prescriptions during the time corresponding to all DDDs in the last prescribed package plus the following 6 months (180 days).

Demographic and clinical characteristics

The CRS contains electronic records of age, sex, vital status, and place of residence (address) for the entire Danish population since 1968, updated daily.[12] From the CRS, we retrieved information on sex, age, place of residence (urban/rural), marital status (married, never married, widowed/divorced), and vital status (alive, dead, emigrated).

From the Danish National Registry of Patients we obtained information on each patient's comorbidities, assessing the presence of major conditions based on the complete hospital contact history before start of statin use. From the Aarhus University Prescription Database we obtained information on comedications, including oral glucose-lowering drugs, antithrombotics, and oral anticoagulants.

Lipid measurement

The clinical laboratory information system (LABKA) research database contains information on blood samples obtained by primary care and hospital physicians and analyzed at hospitals in Northern Denmark since 2000.[15] From the LABKA database we collected information on total cholesterol, LDL cholesterol, high-density lipoprotein (HDL) cholesterol, sample dates, and results during 2004–10. In total, 76% (123,743/161,646) of patients had one or more cholesterol measurements before and one after statin initiation.

Cholesterol target attainment and risk groups

Based on international and national guidelines[16–19] we defined three risk groups, based on availability of information in the hospital contact and prescription registries, and determined the achievement of target cholesterol levels in each group. The first group contained a very high-risk group of patients with a hospital-based diagnosis of cardiovascular disease, whose targets were <1.8 mmol/L for LDL cholesterol and <4 mmol/L for total cholesterol. The second group consisted of a high-risk group of patients with diabetes (receiving antidiabetic medications or with a history of hospitalization or outpatient care for diabetes), hypertension, or a diagnosis of familial dyslipidemia, whose targets were <2.5 mmol/L for LDL cholesterol and <4.5 mmol/L for total cholesterol. The third group contained the remaining patients with low to moderate risk, whose targets were <3 mmol/L for LDL cholesterol and <5 mmol/L for total cholesterol.

This study was approved by the Danish Data Protection Agency (record number 2009-41-3866).

Statistical analysis

We examined the rate and prevalence of statin use annually during 2004–10 and overall; annual person-years at risk in Northern Denmark for individuals aged 18–86 years (denominator) were obtained from Statistics Denmark. We examined the starting dose (mg) among new statin users by calendar year and type of statin. To measure adherence, we calculated average daily use in DDDs and MPR. We calculated the MPR as the ratio of days statin pills are supplied to days in the time interval to the next statin prescription (eg, 30 pills prescribed/40 days – MPR of 0.75)[20] and the persistence of use (see previous definition of nonpersistence).

We calculated the proportion of patients with different demographic and clinical characteristics at the time they filled their first statin prescription (index date). We created similar contingency tables for the subgroup of patients who switched to another statin type, at the time of their switch.

We also compared the characteristics of statin initiators with and without cholesterol measurements recorded in the Aarhus University Prescription Database.

For the 123,743 patients with at least one cholesterol measurement recorded prior to and at least one after their first statin prescription, we examined cholesterol values before and after start of statin treatment, graphically examined cholesterol values over time, and calculated percentage reduction. We examined median and quartiles of total, LDL, and HDL cholesterol at each measurement, focusing particularly on changes between the last cholesterol measurement before commencement of statin treatment and the first measurement after treatment initiation, and on cholesterol level treatment goals. These analyses were conducted for all new statin users, stratified by switching (yes/no). We also examined the proportion of patients reaching their target levels for LDL and total cholesterol at any time within the study period, stratified by level of risk for cardiovascular events (very high, high, and low to moderate). A sensitivity analysis was conducted to examine cholesterol target attainment at the very first measurement after the date of statin initiation.

Results

Rates of statin treatment

In total, there were 161,646 statin patients initiated on statins in Northern Denmark between 2004 and 2010. In 2004, there were 16.3 new users per 1,000 person-years (Figure 1A). The annual number of patients initiated on statins increased until 2008 (19.9 per 1,000 person-years) and then decreased until 2010 (14.1 per 1,000 person-years). Figure 1B shows the resulting cumulative prevalence of statin use up to 2010. In 2010, there were 133,979 adults, corresponding to 93.8 per 1,000 adults (aged between 18 and 86 years), in Northern Denmark who still used statins and who had initiated their statin use between 2004 and 2010.

Baseline characteristics of patients at statin initiation

At statin initiation among the 161,646 patients, 98% started with simvastatin. Tables 1 and 2 show the demographic and clinical characteristics at statin initiation. The median age was 62 years. Demographic characteristics varied little between users of different statin types. Sixty percent of patients were aged between 55 and 75 years at statin initiation, and 51% were men (Table 1). As expected, many patients had previous hospital-based diagnoses of heart disease and other

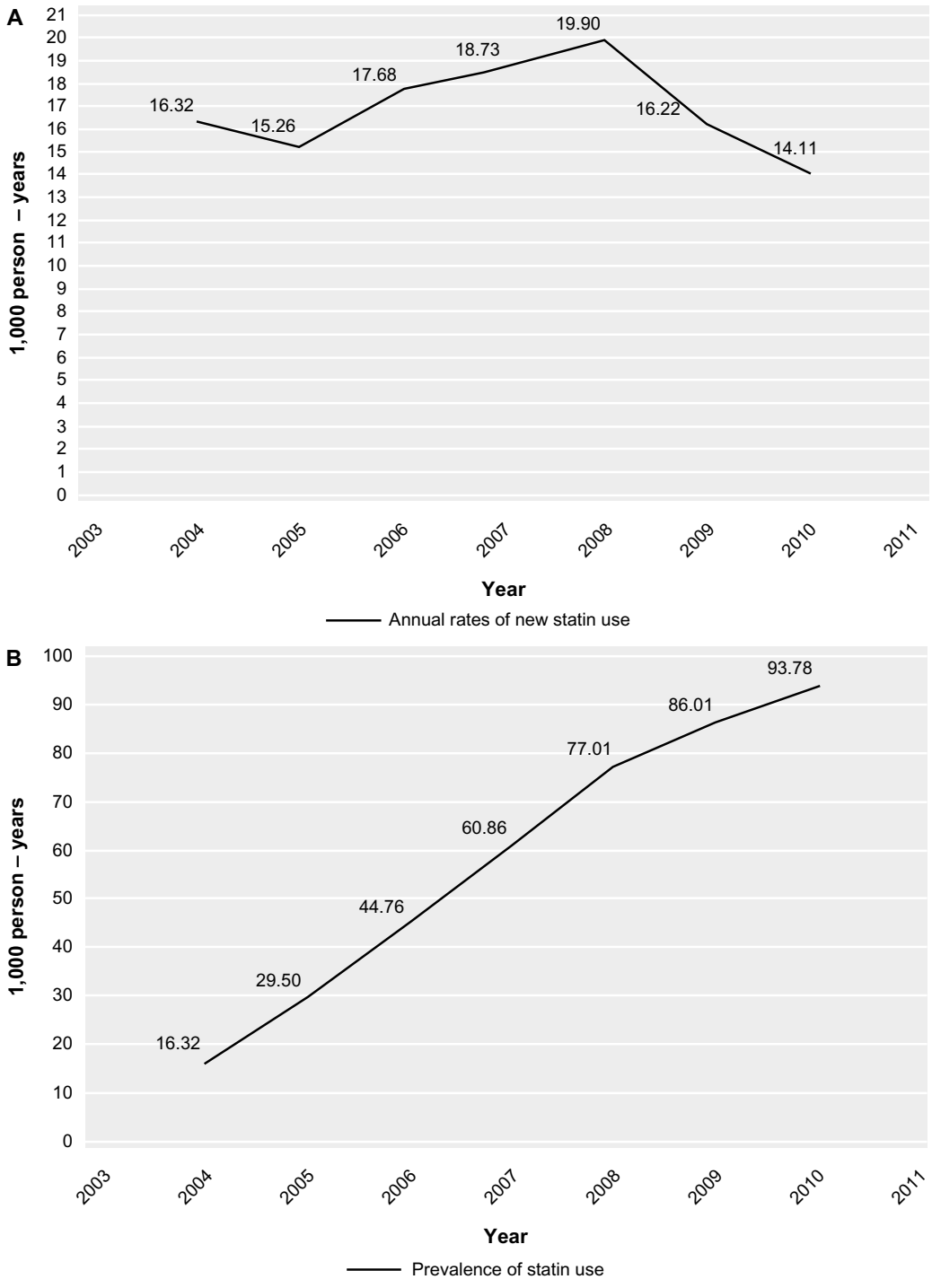

Figure 1 (**A**) Annual rates of new statin use in Northern Denmark, 2004–10. (**B**) Cumulative prevalence of new statin use in Northern Denmark, 2004–10.

chronic conditions (Table 2). In general, initial use of statins other than simvastatin was associated with higher baseline comorbidity.

Patterns of statin use

Patients initiated on statins during 2004–10 were on statin treatment for a median of 1,075 days, or close to 3 years. In this period, 920 DDDs were dispensed (average daily number one statin DDD/day). The proportion of persons who received high starting doses increased during the study period. For example, the proportion of simvastatin users who started with 40 mg tablets increased from 40% in 2004 to 75% in 2010, and the proportion of rosuvastatin users who started with high doses (20 mg or 40 mg) increased from

Table 1 Demographic characteristics of 161,646 statin-naïve patients who started treatment in Northern Denmark between 2004 and 2010

	Statin type															
	Simvastatin N=158,157		Lovastatin N=43		Pravastatin N=486		Fluvastatin N=92		Atorvastatin N=1,777		Rosuvastatin N=1,077		Ezetimibe N=14		Total N=161,646	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Sex																
Female	77,441	49	24	56	215	44	47	51	774	44	552	51	4	29	79,057	49
Male	80,716	51	19	44	271	56	45	49	1,003	56	525	49	10	71	82,589	51
Age, years																
18–44	12,885	8	9	21	57	12	17	18	246	14	101	9	2	14	13,317	8
45–54	29,711	19	2	5	89	19	25	27	359	20	220	20	4	29	30,410	19
55–64	52,614	33	16	37	142	29	28	30	592	33	373	35	3	21	53,768	33
65–74	41,824	26	12	28	124	26	20	22	385	22	270	25	5	36	42,640	26
75–85	21,123	13	4	9	74	15	2	2	195	11	113	10			21,511	13
Urbanization (population)																
<10,000	30,692	19	9	21	98	20	16	17	298	17	186	17	3	21	31,302	19
10,000–99,999	89,361	57	26	60	280	58	58	63	950	53	641	60	5	36	91,321	57
>100,000	38,104	24	8	19	108	22	18	20	529	30	250	23	6	43	39,023	24
Marital status																
Married	102,517	65	31	72	310	64	57	62	1,128	63	757	70	11	79	104,811	65
Never married	16,429	10	3	7	61	13	14	15	229	13	99	9	2	14	16,837	10
Divorced or widowed	38,570	24	9	21	109	22	20	22	408	23	216	20	1	7	39,333	24
Unknown	641	0			6	1	1	1	12	1	5	0			665	0
Year of index date																
2004	21,289	13	14	33	138	28	34	37	310	17	249	23			22,034	14
2005	20,013	13	11	26	72	15	23	25	373	21	135	13			20,627	13
2006	23,513	15	6	14	65	13	6	6	254	14	146	14			23,990	15
2007	25,004	16	9	21	67	14	11	12	271	15	166	15	1	7	25,529	16
2008	26,838	17	2	4	78	16	6	6	248	14	151	14	8	57	27,331	17
2009	22,141	14	1	2	38	8	6	6	170	10	123	11	2	14	22,481	14
2010	19,359	12			28	6	6	6	151	9	107	10	3	22	19,654	12

Table 2 Clinical characteristics of 161,646 statin-naïve patients who started treatment in Northern Denmark between 2004 and 2010

	Statin type															
	Simvastatin N=158,157		Lovastatin N=43		Pravastatin N=486		Fluvastatin N=92		Atorvastatin N=1,777		Rosuvastatin N=1,077		Ezetimibe N=14		Total N=161,646	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Comorbidities																
Acute myocardial infarction	11,888	8	2	5	71	15	7	8	255	14	83	8	1	7	12,307	7
Unstable angina pectoris	2,617	2			23	5	2	2	85	5	33	3			2,760	2
Angina pectoris/chronic ischemic heart disease	15,824	10	4	9	97	20	21	23	347	20	150	14	1	7	16,444	10
Peripheral arterial disease	5,236	3	1	2	27	6	10	11	95	5	33	3	1	7	5,403	3
Heart failure	4,515	3	1	2	58	12	1	1	83	5	30	3			4,688	3
Atrial fibrillation/flutter	8,694	6	3	7	54	11	10	11	106	6	60	6	0		8,927	6
Renal insufficiency/end-stage renal disease	886	1			9	2	39	42	17	1	7	1	2	14	960	1
Chronic obstructive pulmonary disease	7,392	5	1	2	49	11	6	6	78	4	38	3			7,564	5
Diabetes	13,782	9	3	7	51	11	17	18	201	11	78	8			14,132	9
Hypertension	28,285	18	3	7	101	21	57	62	393	22	210	20	2	14	29,051	18
Obesity	6,876	4	4	9	32	7	2	2	94	5	48	4			7,056	4
Familial hyperlipidemia	8,207	5	10	23	54	11	11	12	305	17	145	13	1	7	8,733	5
Any muscular disorder	658	0			1	0			9	1	5	0			673	0
Comedication																
Insulin	6,473	4	1	2	28	6	13	14	102	6	42	4			6,659	4
Oral glucose-lowering drugs	17,993	11	2	5	40	8	5	5	182	10	97	9	1	7	18,320	11
Any antihypertensives	103,561	65	19	44	337	69	85	92	1,151	65	659	61	8	57	105,820	65
Short-/long-acting nitrates	11,281	7	5	12	60	12	12	13	193	11	69	6	2	14	11,622	7
Antithrombotics	51,976	33	9	21	184	38	26	28	624	35	273	25	1	7	53,093	33
Oral anticoagulants	7,631	5			47	10	3	3	107	6	48	4	1	7	7,837	5

12% in 2004 to 21% in 2010. Overall, the average MPR for the entire period was 0.93 (interquartile range [IQR] 0.77–1.0).

Of the statin initiators in this sample, 88% (142,807/161,646) did not switch statin type. Of these 142,807 nonswitchers, only 18% (24,998/142,807) altered their statin dose during the study period. Of the 18,839 (12%) persons who did switch one or more times, 13,138 (70%) switched only once. By far the most common initial switches were from simvastatin to atorvastatin (48%; 9,104/18,839), to rosuvastatin (35%; 6,644/18,839), or to pravastatin (9%; 1,603/18,839). The median time from statin initiation to first statin switch was 457 days. Statin switchers had substantially more heart disease than all statin users. For example, 21% versus 11% had chronic ischemic heart disease and 11% versus 8% had a previous myocardial infarction. In contrast, the prevalence of other important comorbidities (eg, chronic obstructive pulmonary disease) was similar to that in nonswitchers. The sex and age distributions among statin switchers and nonswitchers were similar (51% males among nonswitchers and 48% among switchers; 40% aged over 65 years among nonswitchers and 39% among switchers).

Adherence

The MPR for the nonswitchers was 0.93 (IQR 0.78–1.0), while the MPR for the patients who switched statin type was 0.90 (IQR 0.75–1.0) preswitch and 0.93 (IQR 0.70–1.0) postswitch.

Among the statin initiators, 26,314 persons (16%) completely stopped their statin treatment: ie, were nonpersistent. Compared with all patients who started statins, nonpersistent patients were more likely to be very young (aged <45 years) or very old (aged >75 years), more likely to live in small municipalities in rural areas, more likely to be divorced, and – importantly – had a slightly higher prevalence of almost all examined diagnoses of comorbidity, including cardiovascular disease (data not shown).

Changes in cholesterol and cholesterol target attainments

Among the 133,856 patients with at least one cholesterol measurement recorded prior to their first statin prescription, the most recent cholesterol measurement was, on average, 9 days (quartiles 5–28 days) before redemption of a statin prescription. Furthermore, 123,743 patients had at least one cholesterol surveillance measurement (median 80 days) after starting to use statins. The demographic and clinical characteristics of patients with and without cholesterol measurements recorded in the database were very similar, except that more patients without measurement lived in large cities (29% vs 8%), and more patients without measurement (49% vs 38%) started statin treatment early in the period (2004–06), when the laboratory database may have been less complete.

Median total cholesterol in new statin users decreased from 6.3 (quartiles 5.5–7.0) mmol/L at the most recent measurement before statin initiation to 4.5 (quartiles 3.9–5.1) mmol/L at the first measurement after initiation, and remained remarkably stable thereafter (Figure 2A), corresponding to a reduction of 28%. Median LDL cholesterol decreased rapidly from 4.0 (quartiles 3.3–4.6) mmol/L to 2.3 (quartiles 1.9–2.8) mmol/L, corresponding to a reduction of 43%. Median HDL cholesterol remained stable at 1.4 mmol/L before and after statin initiation. Among patients who later switched statin type, there was a smaller initial decrease in cholesterol values compared with nonswitchers, and some increase in cholesterol levels after the first surveillance measurement (Figure 2B). Among patients who switched statin type, we observed a modest reduction in cholesterol level after their switch (Figure 2C).

Table 3 shows attainment of target cholesterol levels by risk group. Among all statin users, 66% of patients in the very high-risk group reached their target value for total cholesterol, while corresponding figures were 74% and 80% for patients in the high-risk and low- to moderate-risk groups, respectively. When stratified by switching of statin type (yes/no), results for statin nonswitchers were comparable with the overall results. Among patients who switched statin type, the percentages attaining target cholesterol levels after the first switch and before the second were 46%, 56%, and 64% for the three risk groups, respectively. When focusing on target attainment at the very first measurement after statin initiation (averaging 3 months after statin start), 43% in the very high-risk, 49% in the high-risk, and 55% in the low- to moderate-risk groups reached total cholesterol target.

Discussion

Our population-based data show that the rate of new statin use in Northern Denmark seemed to reach a plateau and begin to decline starting in 2008, and the initiators were adherent in their use. The cumulative prevalence was 94 per 1,000 person-years at risk. The reduction in median total cholesterol and LDL cholesterol was similar to that observed in clinical trials. Following European guideline lipid goals, 66% in the very high-risk group reached target levels for overall cholesterol and 54% for LDL cholesterol.

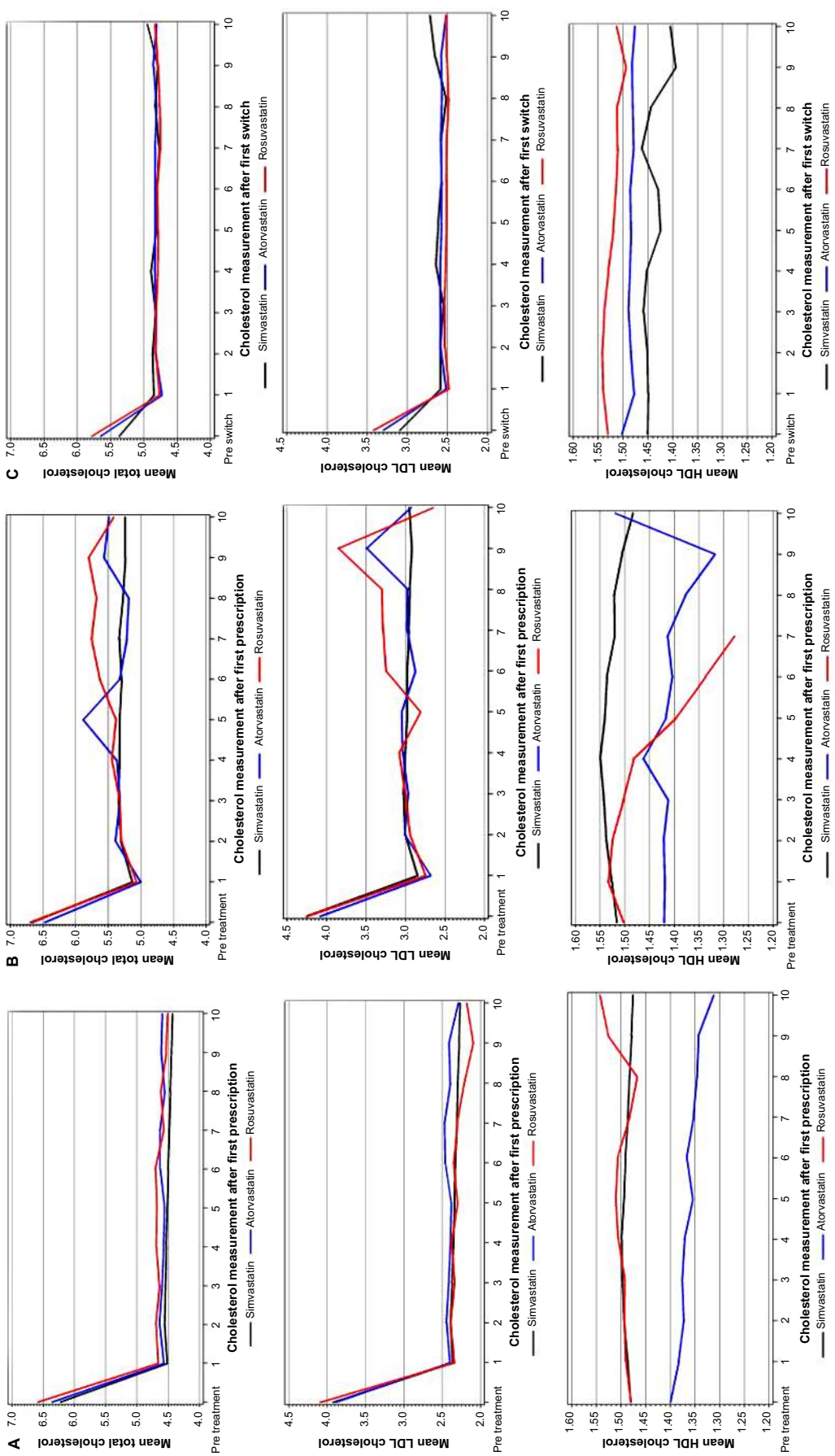

Figure 2 (**A**) Mean total, low-density lipoprotein (LDL), and high-density lipoprotein (HDL) cholesterol values over time among nonswitching patients initiated on statins in Northern Denmark. (**B**) Mean total, LDL, and HDL cholesterol values over time among patients initiated on statins who later switched statin type, from first statin prescription until switch. (**C**) Mean total, LDL, and HDL cholesterol values over time among statin switchers, starting at the time of their first switch.

Table 3 Proportion of patients attaining targets for low-density lipoprotein (LDL) and total cholesterol among 123,743 statin-naïve patients who started statin treatment between 2004 and 2010*

	Target attainment[¶]	
	LDL cholesterol N (%)	Total cholesterol N (%)
Overall		
Very high risk[+]	15,154 (54%)	19,955 (66%)
High risk[‡]	49,921 (82%)	46,864 (74%)
Low to moderate risk[§]	25,654 (88%)	24,383 (80%)
Nonswitchers		
Very high risk	13,362 (55%)	17,504 (67%)
High risk	44,445 (83%)	41,833 (74%)
Low to moderate risk	22,177 (88%)	21,091 (80%)
Switchers, after first switch		
Very high risk	1,412 (35%)	1,875 (46%)
High risk	4,672 (66%)	4,034 (56%)
Low to moderate risk	3,024 (74%)	2,660 (64%)

Notes: *Patients with one measurement after statin initiation; [+]very high risk, defined as patients with documented previous cardiovascular disease; [‡]high risk, defined as patients with diabetes, treated hypertension, or familial dyslipidaemia; [§]low to moderate risk – all remaining patients; [¶]target attainment levels: very high-risk patients: <1.8 mmol/L for LDL cholesterol and <4 mmol/L for total cholesterol; high-risk patients: 2.5 mmol/L for LDL cholesterol and <4.5 mmol/L for total cholesterol; low- to moderate-risk patients: <3 mmol/L for LDL cholesterol and <5 mmol/L for total cholesterol.

Corresponding percentages were about 80% among the high-risk and low- to moderate-risk groups.

Previous reports have shown a large increase in population-wide statin use in the 2000s. Raymond et al[21] reported a 1.7-fold increase in incident statin use based on prescription drug claims in British Colombia during 1999–2004. Our finding that new statin use levelled off starting in the late 2000s may be due to statin treatment saturation within a large pool of previously untreated individuals, or possibly more restrictive use after reports of potential adverse long-term effects of statins. As expected, many patients initiated on statins had previous hospital-based diagnoses of cardiovascular diseases and other comorbidities. The higher proportions of documented cardiovascular disease among patients initiated on the more potent statins may be related to guidelines recommending their use in patients with acute cardiovascular disease.[19] Furthermore, the increase in starting doses of statins during the observation period is also in accordance with newer treatment guidelines;[22] further examination of the impact on the changed starting doses over time is warranted, as dose is related to efficacy in lowering cholesterol.[11]

We chose to examine attainment of cholesterol levels overall for the statins, since almost all new users start with simvastatin in Denmark, in accordance with Danish guidelines. Our finding that attainment of target cholesterol levels differs among patient risk groups is in line with previous real-world findings from the Netherlands.[8] Additionally, the cholesterol target level attainment in this routine clinical care setting was similar to findings from randomized controlled trials.[11] While Danish and European guidelines contain lipid goals stratified on risk,[17,18] the newest US guidelines have removed the use of lipid goals, and suggestions have been voiced that they ought to be refined rather than removed.[23] Given that the main desired outcome of increased statin therapy is a decrease in cardiovascular events, it is interesting to note that the incidence of new myocardial infarction has continously decreased over the past 20 years in Denmark, as reported by Schmidt et al[24] based on population-based data. They only included follow-up until 2008; thus, further observation is warranted as to whether the continuing increase in statin use and the plateau from 2008 have been accompanied by a continuing decrease in cardiovascular events in Denmark.

Adherence was high in this study; both a high medication possession (MPR) and high treatment persistence were observed during our study period. Whereas others have reported clinically important declines in persistence over time,[6] only 16% among our study participants appeared to quit statin use totally. Compared with previous studies of statin initiators, our study had the advantage of a rather long follow-up time and allowed for shorter gaps of treatment. The generally high adherence observed in this study is positive news, and further examinations of predictors of adherence are warranted.

Danish guidelines state that simvastatin should be the first-line drug of choice, and it is apparent from our findings that Danish physicians adhere to these guidelines.[17] Twelve percent of patients initiated on statins switched statin type, most often from simvastatin to a more potent statin. In clinical practice, reasons for switching may include adverse side effects and/or failure to attain target cholesterol levels. Accordingly, we observed that patients who later shifted statin type experienced less initial reduction of cholesterol levels. Unfortunately, our data did not allow us to determine whether insufficient cholesterol reduction was related to poor drug effectiveness, reduced compliance (eg, due to side effects), or choice of dose with the first statin prescribed, but we know that adherence (expressed as MPR) is comparable. Patients who later shifted statin type also had substantially more heart disease than all initiators, which may explain this group's greater difficulty in reaching their cholesterol targets.

Strengths of this study include its large size, population-based design, and access to high-quality Danish medical databases providing a complete hospital contact, prescription, and laboratory history. Our findings are based on data

from a wide range of unselected patients in the community and may be transferrable to other population-based settings. However, our registry-based population approach also has some limitations. Some statin-treated patients apparently did not present for surveillance measurements, some may have emigrated outside our data catchment area, some died, and some started statins late in the study period and were followed for only a short time. The patients without cholesterol measurement did not differ in demographic or clinical characteristics compared with the patients with cholesterol measurements. We focused on new statin users from 2004 onward, and patients who had already received statins before the start of the study were left-truncated. This may have excluded from our study early statin users in the background population with a strong medical indication for statins, and subjects who had earlier started and then entirely discontinued statins due to adverse events or lack of effect. On the other hand, having a short look-back period of only 15 months before 2004 may have artificially inflated new statin user rates in the earliest study years because of the inclusion of some previous statin users who restarted statin use during the first study years. In addition, filling a statin prescription is only a proxy for statin utilization. However, the calculated medication possession ratio in our patients was close to 1, suggesting a surprisingly high adherence to the medication in our region. Furthermore, diagnoses made in the primary care setting by patients' general practitioners were not included in our data, and our estimates of comorbidity prevalence are likely to be underestimates, as can be identified by the discrepancy between diseases and marker drugs. Another concern is that lifestyle changes such as a healthier diet and increased physical exercise are the recommended first interventions to decrease high lipid levels. Unfortunately, we had no information on such and other (eg, smoking cessation) behavioral changes. Finally, our patient risk group classification had to be modified according to data availability. In particular, we lacked data on individual risk factors necessary to evaluate the indication for statin treatment in the low- to moderate-risk group.

Conclusions

In conclusion, our population-based data from routine clinical care show that statin use is very prevalent in Northern Denmark. Cholesterol level target attainment in the community setting is similar to findings from clinical trials; however, a substantial proportion of patients, particularly those at high risk, did not reach target cholesterol levels.

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Disclosure

Pål Hasvold and Pernilla Aarskog are employed by AstraZeneca Nordic Baltic. The authors report no other conflicts of interest in this work.

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