

Lifestyle factors as predictors of nonadherence to statin therapy among patients with and without cardiovascular comorbidities

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ABSTRACT

Background: Easily detectable predictors of nonadherence to long-term drug treatment are lacking. We investigated the association between lifestyle factors and nonadherence to statin therapy among patients with and without cardiovascular comorbidities.

Methods: We included 9285 participants from the Finnish Public Sector Study who began statin therapy after completing the survey. We linked their survey data with data in national health registers. We used prescription dispensing data to determine participants' nonadherence to statin therapy during the first year of treatment (defined as < 80% of days covered by filled prescriptions). We used logistic regression to estimate the association of several lifestyle factors with nonadherence, after adjusting for sex, age and year of statin initiation.

Results: Of the participants without cardiovascular comorbidities ($n = 6458$), 3171 (49.1%) were nonadherent with their statin therapy. Obesity (adjusted odds ratio [OR] 0.86, 95% confidence interval [CI] 0.74–0.99), overweight (adjusted OR

0.88, 95% CI 0.79–0.98) and former smoking (adjusted OR 0.82, 95% CI 0.74–0.92) predicted a reduced risk of nonadherence in this group after adjustment for sex, age and year of statin initiation. Of the participants with cardiovascular comorbidities ($n = 2827$), 1155 (40.9%) were nonadherent. In this group, high alcohol consumption (adjusted OR 1.55, 95% CI 1.12–2.15), extreme drinking occasions (adjusted OR 1.48, 95% CI 1.11–1.97) and a cluster of 3–4 lifestyle risks (adjusted OR 1.61, 95% CI 1.15–2.27) predicted increased odds of nonadherence after adjustment for sex, age and year of statin initiation.

Interpretation: People with cardiovascular comorbidities who had risky drinking behaviours or a cluster of lifestyle risks were at increased risk of nonadherence. Among individuals without cardiovascular comorbidities, information on lifestyle factors was unhelpful in identifying those at increased risk of nonadherence; that overweight, obesity and former smoking were predictors of better adherence in this group provides insight into mechanisms of adherence to preventive medication that deserve further study.

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A recent meta-analysis of 44 epidemiologic studies suggested that almost 1 in 10 cardiovascular events can be attributed to medication nonadherence.¹ For statins, the average prevalence of nonadherence, defined as taking less than 80% of the prescribed medication, was as high as 46%.¹ Multiple patient-, physician- and health system-related factors are known to affect adherence to long-term drug treatment;² however, easily detectable predictors of nonadherence are lacking.

Previous research has consistently shown that patients with a history of cardiovascular events, hypertension or diabetes have better adherence to statin therapy than individuals without these conditions.^{3–5} Patients who adhere to preventive drug treatment are often assumed to also have an otherwise healthier lifestyle than those with poor

adherence.^{6–8} Accordingly, some studies have found current smoking status^{9–14} and high alcohol consumption^{14,15} to be associated with nonadherence to lipid-lowering therapy. In a Canadian study involving patients in primary care practices, those who reported regular exercise or a healthy diet had high scores of self-reported statin adherence.¹⁶ Also, obesity has been linked with good adherence to statin therapy.^{10,14} However, results have been inconsistent, with some studies showing no association between adherence and obesity^{12,17} or physical activity,^{12,14} or even an association between adherence to statins and smoking history.¹⁷ Furthermore, few studies have provided information on the association between lifestyle factors and statin adherence stratified by cardiovascular comorbidity, which may modify these associations.

Dyslipidemia guidelines usually recommend that patient management be focused on total cardiovascular risk, rather than solely on the presence or absence of cardiovascular disease, and emphasize the promotion of a healthy lifestyle to prevent cardiovascular disease.^{18,19} Therefore, a decision to prescribe a statin typically involves assessment of the patient's lifestyle.

We investigated the association between lifestyle factors readily available to prescribers (body mass index [BMI], smoking status, alcohol use and physical activity) and nonadherence to statin therapy separately among patients with and without cardiovascular comorbidities in a large cohort of Finnish employees in the public sector.

Methods

Study population and design

We obtained data from the Finnish Public Sector Study,²⁰ a prospective study involving all 151 901 public sector employees in 10 municipalities and 21 hospitals from 1991 to 2005. The employees cover a wide range of occupational groups, from city mayors to semiskilled cleaners, the largest groups being nurses and teachers.

We initially included the 80 459 participants who responded to 1 or more of the surveys in 1997, 2000, 2004 and 2008 (average response rate 70%). The questionnaire was designed to collect information on demographic characteristics, lifestyle factors and health status. We linked the survey data to data from national health registers^{21,22} using the participants' unique personal identification numbers. For the final study cohort, we included the 9285 participants who began statin therapy between Jan. 1, 1998, and Dec. 31, 2010, after completing the survey and had not been dispensed statins in the previous 2 years. Follow-up data for adherence to statin therapy were available to Dec. 31, 2011.

Assessment of adherence to statins

In Finland, statins are available by prescription only. National Health Insurance provides coverage for prescription drugs to all (about 5.4 million) residents living in the community. All reimbursed prescriptions are registered in the Finnish Prescription Register managed by the Social Insurance Institution.²¹ For each drug, the dispensing date, the World Health Organization Anatomic Therapeutic Chemical code²³ and the quantity dispensed are recorded.

The outcome of interest was nonadherence to statins (code C10AA) during the first year after initiation. We measured adherence according to the proportion of days covered by prescriptions dispensed during the 365-day period multiplied

by 100, assuming a daily dose of 1 tablet.²⁴ We took hospital admissions into account by subtracting the number of inpatient days from the denominator 365. We defined nonadherence as less than 80% of days covered by filled prescriptions.¹

Assessment of lifestyle factors

We assessed lifestyle factors using standard questionnaire measurements.^{25,26} We calculated each participant's BMI using self-reported weight and height and divided the cohort into 3 groups: normal weight (BMI < 25), overweight (BMI 25–29.9) and obese (BMI ≥ 30). Smoking status was reported as none, former or current. From responses to questions about alcohol use, we determined the number of units of alcohol per week (1 unit = 120 mL of wine, 40 mL of spirits or 330 mL of beer). The cut-off for high consumption was 16 drinks per week for women and 24 per week for men.^{26,27} Participants who reported having passed out owing to heavy alcohol consumption at least once during the 12 months before the survey were determined to have extreme drinking occasions. We measured physical activity using the metabolic equivalent of task (MET) index; the sum score of MET hours was used to identify active (> 4 h), moderate (2–4 h) or low (< 2 h) physical activity.

In addition, we defined a summary variable reflecting total lifestyle-related cardiovascular risk.²⁵ The unhealthiest level of each factor (current smoking, obesity, high alcohol consumption or extreme drinking occasions or both, and low physical activity) was coded as being present or absent. The number of lifestyle risks was grouped into 3 categories (0, 1–2 or 3–4 risks).

For participants who responded to more than one survey before starting statin therapy, we selected the most recent survey. The mean lag between the survey and statin initiation (\pm standard deviation) was 3.4 ± 2.4 years.

Other variables

We considered cardiovascular comorbidities, including cardiovascular diseases and diabetes, as modifiers of the associations between lifestyle factors and nonadherence. We identified these comorbidities using linked data from special reimbursement and hospital discharge registers (entitlements to special reimbursement for drug treatment of chronic hypertension, heart failure, coronary artery disease or diabetes at statin initiation, or hospital admission for these conditions, stroke or arrhythmias during the 36 months before statin initiation).²⁸

We treated other comorbidities (e.g., cancer, depression and self-rated health)^{14,29–32} and socio-demographic characteristics (sex, age, education,

marital status and residential region)³ as potential confounders. Information on cancer diagnosis within 5 years before statin initiation came from the Finnish Cancer Registry.²² Prescriptions for antidepressants (code N06A) during the 36 months before statin initiation, captured from the Prescription Register, served as a proxy for depression. We obtained information on self-rated health (classified as suboptimal if average or worse v. not suboptimal if good or very good) and marital status (married or cohabiting v. single, divorced or widowed) from the survey responses. Data on sex, age and residential region came from the employers' administrative registers. Statistics Finland provided information on education that was classified as high (tertiary level), intermediate (upper secondary level) or basic (lower secondary level or less).³³

Statistical analysis

We used a logistic regression model to estimate the association between each lifestyle factor and nonadherence. According to the study aim, the main analyses were done separately for respondents with and without cardiovascular comorbidities. Each model was first adjusted for sex, age (24–50, 51–60 and 61–75 yr) and, because of changes in prescribing practices and statin costs over time,³⁴ the year of statin initiation. The final model was further adjusted for other confounders (education, marital status, residential region, suboptimal self-rated health, use of antidepressants and cancer) and mutually for other lifestyle factors); it included only respondents with complete data on all confounders. The associations between the number of lifestyle risks and nonadherence were analyzed correspondingly.

In a sensitivity analysis, we used a continuous proportion (percentage) of days covered by filled prescriptions as the outcome. We tested the mean difference (95% confidence interval [CI]) in proportion of days covered across the levels of each lifestyle factor using analysis of variance and adjusting for sex, age and year of statin initiation.

We analyzed data using SAS software, version 9.2 (SAS Institute Inc., Cary, NC).

Ethics approval

The study was approved by the ethics committee of the Hospital District of Helsinki and Uusimaa.

Results

From the eligible population of public sector employees, we identified 11 949 who began statin therapy between Jan. 1, 1998, and Dec. 31, 2010. Of these, 9285 (77.7%) had completed 1 or more of the surveys. Compared with the respondents, the 2664 nonrespondents were

more likely to be male (39.8% v. 23.8%), to be less educated (basic education 24.4% v. 16.5%) and to have cardiovascular comorbidities (36.3% v. 30.4%) at statin initiation; the 2 groups did not differ in mean age (55.2 ± 7.8 yr and 55.7 ± 7.2 yr, respectively).

Among the respondents, those without cardiovascular comorbidities ($n = 6458$) were more likely to be female, younger, more educated and from southern Finland and less likely to rate their health as suboptimal than those with cardiovascular comorbidities ($n = 2827$) (Table 1). More than half (53.5%) of those without cardiovascular comorbidities had 1 or more lifestyle risks:

Table 1: Characteristics of 9285 participants in the Finnish Public Sector Study who began statin therapy after completing the survey

Characteristic	No. (%) of participants		
	All <i>n</i> = 9285	Without cardiovascular comorbidities* <i>n</i> = 6458	With cardiovascular comorbidities* <i>n</i> = 2827
Sex			
Male	2211 (23.8)	1430 (22.1)	781 (27.6)
Female	7074 (76.2)	5028 (77.9)	2046 (72.4)
Age group, yr			
24–50	1971 (21.2)	1444 (22.4)	527 (18.6)
51–60	4811 (51.8)	3344 (51.8)	1467 (51.9)
61–75	2503 (27.0)	1670 (25.9)	833 (29.5)
Education			
High	4363 (47.0)	3185 (49.3)	1178 (41.7)
Intermediate	3390 (36.5)	2311 (35.8)	1079 (38.2)
Basic	1532 (16.5)	962 (14.9)	570 (20.2)
Marital status	<i>n</i> = 9144	<i>n</i> = 6365	<i>n</i> = 2779
Married	6976 (76.3)	4835 (76.0)	2141 (77.0)
Single	2168 (23.7)	1530 (24.0)	638 (23.0)
Residential region in Finland	<i>n</i> = 9260	<i>n</i> = 6438	<i>n</i> = 2822
Southern	5587 (60.3)	4014 (62.3)	1573 (55.7)
Central	1947 (21.0)	1344 (20.9)	603 (21.4)
Northern	1726 (18.6)	1080 (16.8)	646 (22.9)
Suboptimal self-rated health	<i>n</i> = 9184	<i>n</i> = 6394	<i>n</i> = 2790
No	5315 (57.9)	3983 (62.3)	1332 (47.7)
Yes	3869 (42.1)	2411 (37.7)	1458 (52.3)
Cancer	<i>n</i> = 9285	<i>n</i> = 6458	<i>n</i> = 2827
No	9110 (98.1)	6329 (98.0)	2781 (98.4)
Yes	175 (1.9)	129 (2.0)	46 (1.6)
Use of antidepressants			
No	7547 (81.3)	5253 (81.3)	2294 (81.1)
Yes	1738 (18.7)	1205 (18.7)	533 (18.9)

*Hypertension, heart failure, coronary artery disease, diabetes, stroke or arrhythmias.

17.1% were obese, 16.8% were current smokers, 8.8% had high alcohol consumption, 5.9% had extreme drinking occasions, and 29.8% had a low level of physical activity (Table 2). Among the respondents with cardiovascular comorbidities, 62.9% had 1 or more lifestyle risks: 31.1% were obese, 18.2% were current smokers, 8.9% had high alcohol consumption, 8.0% had extreme drinking occasions, and 35.3% had a low level of physical activity (Table 3).

Nonadherence to statins during the first year of treatment was slightly more common among the nonrespondents than the respondents (52.4% v. 46.7%). The corresponding figures were 55.0% and 49.1% among those without cardiovascular comorbidities at statin initiation, and 47.9% and 40.9% among those with such comorbidities. Among all

respondents, nonadherence was more common among women, people younger than 61 years, and those who were single (Table 4). No difference in nonadherence was observed among those with complete data compared with those with missing data on at least 1 lifestyle factor (data not shown).

Among the participants without cardiovascular comorbidities, obesity (odds ratio [OR] 0.86, 95% CI 0.74–0.99), overweight (OR 0.88, 95% CI 0.79–0.98) and former smoking (OR 0.82, 95% CI 0.74–0.92) predicted reduced odds of nonadherence after adjustment for sex, age and year of statin initiation. Further adjustment for other confounders and lifestyle factors had little effect on these associations (Table 2).

Among the participants with cardiovascular comorbidities, high mean alcohol consumption

Table 2: Association between lifestyle factors and nonadherence to statin therapy* among the participants without cardiovascular comorbidities†

Lifestyle factor	No. (%) of participants <i>n</i> = 6458	No. (%) who were nonadherent <i>n</i> = 3171‡	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	
				Partial adjustment§	Full adjustment¶
Body mass index	<i>n</i> = 6301				
< 25 (ref)	2550 (40.5)	1300 (51.0)	1.00	1.00	1.00
25–29.9	2675 (42.5)	1276 (47.7)	0.88 (0.79–0.98)	0.88 (0.79–0.98)	0.88 (0.79–0.99)
≥ 30	1076 (17.1)	518 (48.1)	0.87 (0.75–1.00)	0.86 (0.74–0.99)	0.85 (0.73–0.99)
Smoking status	<i>n</i> = 6138				
None (ref)	2813 (45.8)	1422 (50.6)	1.00	1.00	1.00
Former	2293 (37.4)	1051 (45.8)	0.83 (0.74–0.93)	0.82 (0.74–0.92)	0.83 (0.74–0.93)
Current	1032 (16.8)	534 (51.7)	1.05 (0.91–1.22)	1.02 (0.88–1.18)	0.99 (0.85–1.16)
Mean alcohol consumption	<i>n</i> = 6297				
None (ref)	937 (14.9)	435 (46.4)	1.00	1.00	1.00
Moderate	4809 (76.4)	2371 (49.3)	1.11 (0.97–1.29)	1.10 (0.95–1.27)	1.09 (0.94–1.27)
High	551 (8.8)	277 (50.3)	1.13 (0.91–1.40)	1.11 (0.89–1.38)	1.13 (0.90–1.42)
Extreme drinking occasions	<i>n</i> = 6278				
No (ref)	5905 (94.1)	2881 (48.8)	1.00	1.00	1.00
Yes	373 (5.9)	193 (51.7)	1.10 (0.89–1.36)	1.07 (0.86–1.33)	1.01 (0.81–1.27)
Physical activity	<i>n</i> = 6274				
Active (ref)	2301 (36.7)	1124 (48.8)	1.00	1.00	1.00
Moderate	2105 (33.6)	1034 (49.1)	1.01 (0.90–1.14)	1.02 (0.91–1.15)	1.04 (0.92–1.18)
Low	1868 (29.8)	913 (48.9)	1.01 (0.89–1.14)	1.01 (0.90–1.15)	1.03 (0.90–1.18)
No. of lifestyle risks	<i>n</i> = 6439				
0 (ref)	2996 (46.5)	1438 (48.0)	1.00	1.00	1.00
1–2	3216 (49.9)	1618 (50.3)	1.10 (0.99–1.21)	1.07 (0.97–1.19)	1.07 (0.96–1.18)
3–4	227 (3.5)	105 (46.3)	0.93 (0.71–1.22)	0.89 (0.67–1.17)	0.87 (0.66–1.15)

Note: CI = confidence interval, OR = odds ratio, ref = reference group.

*Nonadherence = < 80% of days covered by filled prescriptions.

†Without hypertension, heart failure, coronary artery disease, diabetes, stroke or arrhythmias.

‡Percentages are based on row totals.

§Adjusted for sex, age and year of statin initiation.

¶Adjusted for factors in the first model plus education, marital status, residential region, suboptimal self-rated health, use of antidepressants, cancer and other lifestyle factors; 624 participants were excluded from this model because of missing data on at least 1 lifestyle factor (except for the no. of lifestyle risks) or covariate.

(OR 1.55, 95% CI 1.12–2.15), extreme drinking occasions (OR 1.48, 95% CI 1.11–1.97) and a cluster of 3–4 lifestyle risks (OR 1.61, 95% CI 1.15–2.27) predicted increased odds of nonadherence after adjustment for sex, age and initiation year (Table 3). Further adjustment changed these associations slightly: OR 1.58 (95% CI 1.11–2.25) among those with high alcohol consumption, 1.36 (95% CI 1.00–1.85) among those with extreme drinking occasions and 1.65 (95% CI 1.16–2.34) among those with a cluster of 3–4 lifestyle risks (Table 3).

In our sensitivity analysis with a continuous adherence measure, obesity, overweight and former smoking were associated with an increase in the mean proportion of days covered by filled prescriptions among those without cardiovascu-

lar comorbidities (Appendix 1, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.131807/-/DC1). Among those with cardiovascular comorbidities, extreme drinking occasions and a cluster of 3–4 lifestyle risks were associated with a decrease in the mean proportion of days covered.

Interpretation

In our study involving a large cohort of public sector employees, we found that overweight, obesity and former smoking were associated with reduced odds of nonadherence to statin therapy among individuals without cardiovascular diseases or diabetes. Information on lifestyle factors was unhelpful in identifying those at increased risk of nonadherence in this group. Among par-

Table 3: Association between lifestyle factors and nonadherence to statin therapy* among the participants with cardiovascular comorbidities†

Lifestyle factor	No. (%) of participants <i>n</i> = 2827	No. (%) who were nonadherent <i>n</i> = 1155‡	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	
				Partial adjustment§	Full adjustment¶
Body mass index	<i>n</i> = 2730				
< 25 (ref)	736 (27.0)	317 (43.1)	1.00	1.00	1.00
25–29.9	1145 (41.9)	451 (39.4)	0.87 (0.72–1.05)	0.90 (0.74–1.09)	0.90 (0.74–1.10)
≥ 30	849 (31.1)	352 (41.5)	0.92 (0.75–1.13)	0.93 (0.76–1.14)	0.97 (0.78–1.20)
Smoking status	<i>n</i> = 2684				
None (ref)	1161 (43.3)	480 (41.3)	1.00	1.00	1.00
Former	1034 (38.5)	408 (39.5)	0.93 (0.78–1.10)	0.97 (0.82–1.16)	0.95 (0.79–1.14)
Current	489 (18.2)	206 (42.1)	1.03 (0.83–1.28)	1.08 (0.86–1.35)	1.03 (0.82–1.31)
Mean alcohol consumption	<i>n</i> = 2765				
None (ref)	433 (15.7)	170 (39.3)	1.00	1.00	1.00
Moderate	2087 (75.5)	841 (40.3)	1.03 (0.83–1.28)	1.10 (0.88–1.36)	1.13 (0.89–1.42)
High	245 (8.9)	115 (46.9)	1.35 (0.98–1.86)	1.55 (1.12–2.15)	1.58 (1.11–2.25)
Extreme drinking occasion	<i>n</i> = 2756				
No (ref)	2535 (92.0)	1018 (40.2)	1.00	1.00	1.00
Yes	221 (8.0)	103 (46.6)	1.32 (1.00–1.75)	1.48 (1.11–1.97)	1.36 (1.00–1.85)
Physical activity	<i>n</i> = 2753				
Active (ref)	858 (31.2)	350 (40.8)	1.00	1.00	1.00
Moderate	923 (33.5)	379 (41.1)	1.03 (0.85–1.24)	1.02 (0.84–1.24)	1.04 (0.85–1.27)
Low	972 (35.3)	393 (40.4)	0.99 (0.82–1.20)	1.00 (0.83–1.21)	0.98 (0.80–1.21)
No. of lifestyle risks	<i>n</i> = 2815				
0 (ref)	1043 (37.1)	413 (39.6)	1.00	1.00	1.00
1–2	1606 (57.1)	655 (40.8)	1.05 (0.90–1.23)	1.05 (0.89–1.24)	1.07 (0.91–1.27)
3–4	166 (5.9)	81 (48.8)	1.45 (1.05–2.02)	1.61 (1.15–2.27)	1.65 (1.16–2.34)

Note: CI = confidence interval, OR = odds ratio, ref = reference group.

*Nonadherence = < 80% of days covered by filled prescriptions.

†Hypertension, heart failure, coronary artery disease, diabetes, stroke or arrhythmias.

‡Percentages are based on row totals.

§Adjusted for sex, age and year of statin initiation.

¶Adjusted for factors in the first model plus education, marital status, residential region, suboptimal self-rated health, use of antidepressants, cancer and other lifestyle factors; 308 participants were excluded from this model because of missing data on at least 1 lifestyle factor (except for the no. of lifestyle risks) or covariate.

ticipants with cardiovascular comorbidities, high alcohol consumption, extreme drinking occasions (passing out because of alcohol use) and having 3–4 lifestyle risks were predictors of nonadherence. Our sensitivity analysis, in which adherence was treated as a continuous measure, supported the robustness of these findings.

The rates of nonadherence in our study are similar to those previously reported from Finland³⁵ and elsewhere,¹⁴ including studies involving non-working and older populations. As expected,^{3–5} patients with a history of cardiovascular disease or diabetes had better adherence to statin therapy than those without these comorbidities. Because of their increased risk of cardiovascular events,¹⁹ patients with comorbidities likely have a strong perception of the need for statin treatment.³⁶ Also,

overweight and obese patients have an increased cardiovascular risk¹⁹ and may also have higher cholesterol levels; thus, a greater clinical need for statin therapy may strengthen their motivation to adhere to treatment.^{36,37} Accordingly, among participants in our study who did not have cardiovascular comorbidities, those who were obese, overweight or former smokers had better adherence than those without these risk factors.

Our findings of associations between non-adherence and high levels of alcohol consumption and clustering of unhealthy lifestyle behaviours among patients with cardiovascular comorbidities support the notion that people who adhere to long-term drug therapy follow a healthier lifestyle. Two previous studies examined the association between alcohol use and adherence to statins and

Table 4: Association between baseline characteristics of the 9285 participants and nonadherence to statin therapy*

Characteristic	All <i>n</i> = 9285	No. (%) who were nonadherent†	Unadjusted OR (95% CI)	Adjusted‡ OR (95% CI)
Sex				
Male (ref)	2211 (23.8)	979 (44.3)	1.00	1.00
Female	7074 (76.2)	3347 (47.3)	1.12 (1.02–1.24)	1.16 (1.05–1.28)
Age group, yr				
24–50	1971 (21.2)	1003 (50.9)	1.40 (1.25–1.59)	1.41 (1.25–1.39)
51–60	4811 (51.8)	2267 (47.1)	1.21 (1.10–1.34)	1.19 (1.07–1.31)
61–75 (ref)	2503 (27.0)	1056 (42.2)	1.00	1.00
Education				
High (ref)	4363 (47.0)	2083 (47.7)	1.00	1.00
Intermediate	3390 (36.5)	1561 (46.0)	0.94 (0.86–1.03)	0.92 (0.84–1.01)
Basic	1532 (16.5)	682 (44.5)	0.88 (0.78–0.99)	0.90 (0.80–1.02)
Marital status <i>n</i> = 9144				
Married (ref)	6976 (76.3)	3200 (45.9)	1.00	1.00
Single	2168 (23.7)	1064 (49.1)	1.15 (1.05–1.27)	1.15 (1.05–1.27)
Residential region in Finland <i>n</i> = 9260				
Southern	5587 (60.3)	2571 (46.0)	0.97 (0.87–1.08)	0.97 (0.87–1.08)
Central	1947 (21.0)	931 (47.8)	1.05 (0.92–1.20)	1.04 (0.91–1.19)
Northern (ref)	1726 (18.6)	811 (47.0)	1.00	1.00
Suboptimal self-rated health <i>n</i> = 9184				
No (ref)	5315 (57.9)	2480 (46.7)	1.00	1.00
Yes	3869 (42.1)	1796 (46.4)	0.98 (0.90–1.07)	0.99 (0.91–1.08)
Cancer <i>n</i> = 9285				
No (ref)	9110 (98.1)	4260 (46.8)	1.00	1.00
Yes	175 (1.9)	66 (37.7)	0.69 (0.51–0.95)	0.73 (0.53–1.00)
Use of antidepressants				
No (ref)	7547 (81.3)	3499 (46.4)	1.00	1.00
Yes	1738 (18.7)	827 (47.6)	1.06 (0.96–1.18)	1.04 (0.93–1.16)

Note: CI = confidence interval, OR = odds ratio, ref = reference group.
 *Nonadherence = < 80% of days covered by filled prescriptions.
 †Percentages are based on row totals.
 ‡Adjusted for sex, age and year of statin initiation.

reported findings similar to ours,^{14,15} although they did not separate findings by cardiovascular status. Many potential explanations for this association exist. Heavy drinkers may intentionally avoid taking medication because of potential drug–alcohol interactions, they may unintentionally miss doses or even refills because of intoxication, or they may simply be less concerned about missing doses.

Limitations

Because of the universal drug reimbursement system in Finland and the availability of statins by prescription only, the Prescription Register provided comprehensive data on filled statin prescriptions. Nevertheless, we were unable to determine if, and to what extent, dispensed medications were not used. In addition, self-reporting tends to underestimate obesity and overweight,³⁸ as well as smoking and alcohol use.^{39,40} This underascertainment of nonadherence and lifestyle risks most likely had little effect on our results; if anything, it may have attenuated the observed associations.

People with the unhealthiest lifestyles and highest rates of nonadherence may be less likely to participate in a study than those with a healthier lifestyle. However, in our study, the nonadherence rate among nonrespondents was only 5 percentage points higher than the rate among respondents. Thus, major bias due to selection or missing data seems unlikely.

One reason for the lack of association between lifestyle factors and nonadherence among participants without cardiovascular comorbidity may be that the levels of risk factors observed did not accurately reflect those present at statin initiation: participants who exhibited better adherence may have changed their lifestyle before statin initiation. A Danish study involving people with high cholesterol levels reported that improvement in physical activity and dietary habits predicted initiation of statin therapy during a 5-year follow-up.⁴¹ In our study, the lag between lifestyle measurement and statin initiation was 3 years on average. We tested whether lag time modified the associations between the lifestyle factors and nonadherence by including an interaction term “lag*lifestyle factor” in each model adjusted by sex, age and year of statin initiation. We found a statistically significant interaction between lag time and extreme drinking occasions in a subpopulation with cardiovascular comorbidities (p for interaction = 0.04). The association between extreme drinking occasions and nonadherence was stronger among those with more recent responses (data not shown).

We did not assess serum lipid levels or patient’s total cardiovascular risk, which may have affected the perceived need for statin therapy and adherence to it.

Conclusion

The association between lifestyle factors and nonadherence to statin therapy varied according to cardiovascular comorbidity status. People with cardiovascular comorbidities who had risky drinking behaviours or a cluster of lifestyle risks were at increased risk of nonadherence. Among those without cardiovascular comorbidities, information on lifestyle factors was unhelpful in identifying individuals at increased risk of nonadherence. However, the observation that overweight, obesity and former smoking were predictors of better adherence in this group provides insight into mechanisms of adherence to preventive medication that deserve further study.

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