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# Associations between patients' adherence and GPs' attitudes towards risk, statin therapy and management of non-adherence—a survey and register-based study

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## Abstract

**Background.** Previous studies suggest that doctors' personal lifestyle, risk taking personality and beliefs about risk reducing therapies may affect their clinical decision-making. Whether such factors are further associated with patients' adherence with medication is largely unknown.

**Objective.** To estimate associations between GPs' attitudes towards risk, statin therapy and management of non-adherence and their patients' adherence, and to identify subgroups of GPs with poor patient adherence.

**Methods.** All Danish GPs were invited to participate in an online survey. We asked whether they regarded statin treatment as important, how they managed non-adherence and whether non-adherence annoyed them. The Jackson Personality Inventory–revised was used to measure risk attitude. The GPs' responses were linked to register data on their patients' redeemed statin prescriptions. Mixed effect logistic regression was used to estimate associations between patient adherence and GPs' attitudes. Adherence was estimated by the proportion of days covered in a 1-year period using an 80% cut-off.

**Results.** We received responses from 1398 GPs (42.2%) who initiated statin therapy in 12 192 patients during the study period. In total 6590 (54.1%) of these patients were adherent. Patients who had GPs rarely assessing their treatment adherence were less likely to be adherent than those who had GPs assessing their patients' treatment adherence now and then, odds ratio (OR) 0.86 [confidence interval (CI) 0.77–0.96]. No other associations were found between patients' adherence and GPs' attitudes.

**Conclusions.** Our findings suggest that GPs' attitudes to risk, statin therapy or management of non-adherence are not significantly associated with their patients' adherence.

**Key words.** Cholesterol/lipids, doctor-patient relationship, patient adherence, primary care, risk assessment.

## Introduction

Cardiovascular diseases (CVDs) are the leading cause of death in the western part of the world accounting for about one in three overall deaths (1). As the patient's personal doctor, the GP has an important position for reducing cardiovascular death and morbidity by motivating patients to lifestyle modifications and by supporting adherence to an agreed and relevant medical treatment. Doctors' personal health habits have been shown to be associated with their counselling behaviour, exercising and non-smoking doctors being more prone to recommending lifestyle interventions to their patients than their non-exercising and smoking colleagues (2). It has also been shown that doctors' risk taking personality may affect their decisions regarding triage of emergency patients (3) and laboratory testing, and that GPs' personal attitude towards a given treatment may have an impact on their patients' decisions about adherence to screening programmes (4). The mechanisms of how GPs' personal attitudes are reflected in patients' decisions about treatment and adherence are not clear, but it could be through the impact on health beliefs (5) or intentions (6). When a GP prescribes a medical treatment for a patient, it is not certain that the patient decides to redeem the prescription or take the medicine as agreed (7). It is estimated that adherence to long-term therapies in general is about 50% in developed countries, and the poor adherence has a major impact on both patients' health (8) and societal healthcare resources. Previous research concerning predictors for poor adherence has mainly focused on patients' socio-economy and personality, co-medication and comorbidity. In contrast predictors within the health-system have received less attention (7). In particular empirical knowledge on associations between GP factors and adherence is lacking. The aims of the present study were to estimate associations between GPs' attitudes towards risk, statin therapy and management of non-adherence and their patients' adherence and to identify subgroups of GPs with poor patient adherence.

## Methods

### Questionnaire data

On the basis of a qualitative interview study (9) and a literature review, we developed a web-based questionnaire with the overall aim of gaining knowledge of GPs' professional and personal risk attitudes and approach to decision-making and non-adherence. Prior to sending out the questionnaire, it was pilot tested in its entirety for content validity, relevance, acceptability and feasibility. The data quality, response rate, floor and ceiling effects, score ranges of single items and scores were subsequently assessed by a field test in the population. In November 2014, we sent e-mails with links to the questionnaire to all 3550 active members of the Organisation of General Practitioners in Denmark. It took approximately 15 minutes to complete the questionnaire, and responding GPs were paid DKK 135 (GBP 13). We sent two reminders after 2 and 4 weeks, respectively.

First, we assessed GPs' attitudes towards lipid-lowering drug and patient adherence. We developed five items specifically for this study since no validated items were found (Table 1). The first item

**Table 1.** Items and response categories from the GP questionnaire sent to all 3550 Danish GPs in November 2014

| Item wording | | | | | |
|---|---|---|---|---|---|
| Attitude towards lipid-lowering drugs<br>The effect of lipid-lowering drugs is important for patients without known cardiovascular disease but with one or more risk factors (*Abbreviated: 'Effect of statins is important'*). | Agree<br>*Strongly agree* | *Tend to agree* | Neutral<br>*Neither agree nor disagree* | Disagree<br>*Tend to disagree* | *Strongly disagree* |
| Management of medical treatment | *Often* | | *Now and then* | *Rarely* | |
| Do you check if your patients chose to redeem their prescriptions for lipid-lowering drugs? (*Abbreviated: 'Adherence assessment'*) | *Yes, always* | *Often* | *Now and then* | *Rarely* | *Never* |
| *Do you discuss lack of prescription redemption with your patients?* (*Abbreviated: 'Discussion of prescription redemption'*) | *Yes, always* | *Often* | *Now and then* | *Rarely* | *Never* |
| *Do you discuss lack of medication intake with your patients?* (*Abbreviated: 'Discussion of medication intake'*) | *Yes, always* | *Often* | *Now and then* | *Rarely* | *Never* |
| Does it annoy you if you discover that your patients do not take their medication as agreed? (*Abbreviated: 'Annoyance by poor adherence'*) | *Yes, always* | *Often* | *Now and then* | *Rarely* | *Never* |
| Risk taking personality, Jackson Personality Inventory (JPI) | 6-point Likert-scale ranging from '*Strongly disagree*' to '*Strongly agree*' | | | | |
| a. I enjoy taking risks. | | | | | |
| b. I try to avoid situations that have uncertain outcomes.[a] | | | | | |
| c. Taking risks does not bother me if the gains involved are high. | | | | | |
| d. I consider security an important aspect of my life.[a] | | | | | |
| e. People have told me that I seem to enjoy taking chances. | | | | | |
| f. I rarely, if ever, take risks when there is another alternative.[a] | | | | | |

[a]In construction of the JPI-R-score, statements b, d and f were reversely scored.

estimated the GPs' attitudes towards the effect of statins on patients without known cardiovascular disease, but with one or more cardiovascular risk factors. The other items estimated different aspects of GPs attitudes towards the importance of their patients' adherence to lipid-lowering drugs and towards the management of non-adherence in daily clinical work.

Second, we assessed GPs' personal risk attitudes by using six items from the Jackson Personality Inventory-Revised (JPI-R), originally adapted and validated by Pearson *et al*. (10) to estimate risk attitude. These items have been used in several studies of medical decision-making among doctors (3). The six items were translated and adapted to a Danish setting by forward and backward translation according to standards for cultural adaptation of questionnaires (11).

## Register data

The questionnaire data were linked with register data from the Danish National Prescription Register (DNPR), The National Patient Register (NPR), The Health Insurance Register (HIR), Statistics Denmark Demographic Database, the Organisation of General Practitioners in Denmark, MedCom (12) and the Danish Register of Authorisation.

### GP characteristics

Since 2005 all Danish medical doctors including GPs have a unique authorization ID, which is used for identification of prescriptions. Further, each practice has a unique provider ID used for reimbursement. The authorization ID and the provider ID enabled accurate linkage between the registers containing GPs' characteristics. The Organisation of General Practitioners in Denmark provided the following data on the GPs: email addresses, authorization ID and provider ID of their practice. The Danish Register of Authorisation provided data on gender, age and years as an MD. MedCom provided data on practice form and municipality code. Further, the municipality code was merged with data on degree of urbanization provided by Statistics Denmark.

### Patient sampling and register data

DNPR contains data on all sales of redeemed prescriptions since 1994. Data on each prescription include identification of the dispensed product according to the Anatomical Therapeutic Chemical Classification System (ATC), number of packages and pack size dispensed, prescribers' authorization IDs, patients' personal registration number and dates of prescription redemptions. The register was used to identify all new users of statins prescribed by GPs who answered the web-based questionnaire. We included DNPR data on prescriptions for statin treatment from 1 July 2011 to 30 June 2014.

From demographic databases from Statistics Denmark, we included data on highest attained educational level, income, ethnicity, cohabitation status and labour market status in 2012. As comorbidity may be related to both GPs' risk attitudes and adherence, it was considered a potential confounder. We measured comorbidity in two different ways: general comorbidity using the Charlson Comorbidity Score and specific manifest CVD (13,14). Using DNPR and NPR, patients were categorized as having manifest CVD if, within a period of 15 years prior to the index date, they (i) had been admitted with diagnoses of stroke, acute coronary syndrome and/or complications and angina and/or (ii) had undergone coronary bypass graft or percutaneous coronary intervention and/or (iii) had redeemed a prescription for clopidogrel, prasugrel and ticagrelor, platelet aggregation inhibitors used as secondary prevention to prevent new myocardiac infarction.

## Adherence

We measured adherence as the proportion of days covered (PDC) (15), which measures how many daily doses of medication a patient has purchased relative to the length of a defined study period, in this case 1 year (16) (Fig. 1). Since statin tablets exist in all clinically relevant doses, e.g. 10, 20, 40 and 80 mg, we find it reasonable to assume that one tablet a day equals one daily dose, rather than patients taking e.g. two tablets or half a tablet a day. New users of statins were patients redeeming a prescription in the period from 1 July 2012 to 30 June 2013. For each patient, the index date was defined as the date of the first redeemed prescription of a statin in the period from 1 July 2012 to 30 June 2013. We used a 12 months run-in period to define new users of statins (15). The end date was 1 year after the index date (Fig. 1). A patient's PDC was calculated by dividing the total number of tablets from all redeemed prescriptions during the study period into the 365 days in the study period. If a patients' supply from a redemption stretched beyond the 1-year study period, the number of days beyond the study period were subtracted from the days covered. PDC above 0.8 were categorized as adherent and equal to or below 0.8 as non-adherent. Patients were excluded in the event of death or migration in the run-in period or the study period.

## Statistical analyses

We tested the hypothesis that risk-neutral GPs and GPs with a neutral approach to non-adherence had more adherent patients. For each of the five items on GPs' attitudes towards lipid-lowering drugs and patient adherence, responses were categorized into 3 groups: 'often', 'now and then' and 'rarely' representing risk averse, risk neutral and risk seeking, respectively, according to the terminology used in standard economic theory (17), see Table 1. The six items from the JPI-R were scored on a 6-point Likert scale, and the scores were

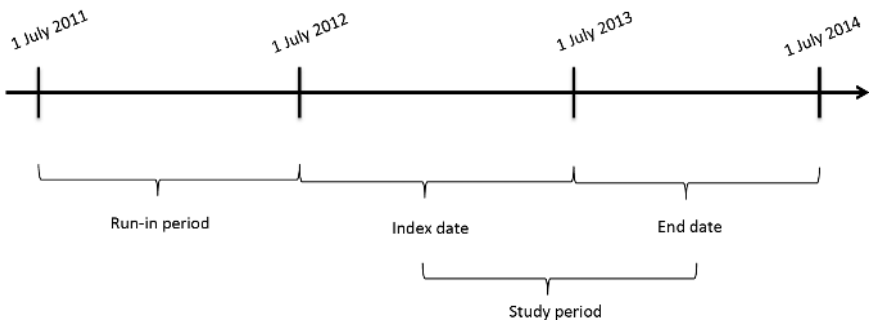


**Figure 1.** Timeline of run-in-period and study period for estimation of patient adherence.

added into an index ranging from 6 (very risk averse) to 36 (very risk seeking). GPs who scored lower than 1 SD below the mean were classified as risk averse whereas those who scored 1 SD above mean were classified as risk seeking. The others were classified as risk neutral (10).

Mixed effect logistic regression was used to estimate associations between adherence and each of the five items and the JPI-R-score, respectively, adjusting for clustering of patients to their GP. We present two models: Model 1 adjusting for confounders on GP-level: gender, years as an MD, practice form and degree of urbanization in practice localization; Model 2 adjusting for both confounders on GP-level and confounders on patient-level: gender, age-group (20–39 years, 40–59 years, 60–79 years), highest attained educational level (<10 years, 10–12 years, >12 years), cohabitation (single, married/cohabiting), labour market status (working, retirement pension, not on the workforce), duration of treatment (>1 year, 1–2 years, 2–5 years, 5–10 years, <10 years) and comorbidity (the Charlson comorbidity index and CVD) and ethnicity (Danes, immigrants from western countries, immigrants from non-western-countries). Missing values were considered missing at random. Kendall's tau correlation between CVD comorbidity and the Charlson Comorbidity Index was calculated as low to moderate ($\tau = 0.35$). STATA release 14.0 (StatCorp, College Station, TX) was used for all statistical analyses.

## Results

Of the 3550 GPs, 238 were not eligible due to unknown email, unknown authorization ID, retirement or leave. Of the 3312 eligible GPs, 1398 responded yielding a response rate of 42.2% (Fig. 2). In total 12 192 patients were defined as new users of statins. Some 6590 patients (54.1%) were adherent to their medication with statins.

As to the risk attitude item 'Effect of statins is important,' 220 (15.7%) of the GPs were neutral and neither agreed or disagreed. The majority of GPs considered the effect of statin therapy as important and often discussed the intake of medicine with their patients. However, less than 50% said that they often discussed or monitored their patients' prescription redemptions. About one in four admitted that poor adherence annoyed them (Table 2). Overall we found no significant associations between GPs' attitudes towards risk and management of non-adherence and their patients' adherence to statin treatment. Only for the items regarding adherence assessment, we found a significant association with the patients' adherence: GPs rarely assessing their patients' adherence had less adherent patients than those assessing their patients now and then, [odds ratio (OR) 0.86 (confidence interval (CI) 0.77–0.96), based on Model 2 adjusted for GPs' gender, years as an MD, practice form, and patients' gender, age group, cohabitation status, educational level, ethnicity and comorbidity; Table 3]. We could not identify GP subgroups with poor patient adherence. Only the practice form was associated with adherence as patients attending multi-handed practices were more adherent, OR 1.10 (CI 1.00–1.20), based on Model 2 (Table 4).

No considerable differences were seen between characteristics of the respondents and the background population of GPs (see Supplementary data). Patients' sociodemographic characteristics and comorbidity are available as Supplementary data.

## Discussion

### Summary of main findings

In the present study, we estimated associations between GPs' attitudes towards risk, management of non-adherence, medical and organizational characteristics and their patients' adherence to statin treatment. We found substantial variation in the GPs' attitudes towards management of non-adherence and risk. Only adherence assessment and practice form were significantly associated with patient adherence to statin treatment. Rather surprisingly, no significant associations were found between patients' adherence and their GPs' attitudes towards risk, the majority of the items regarding management of non-adherence and GPs' characteristics.

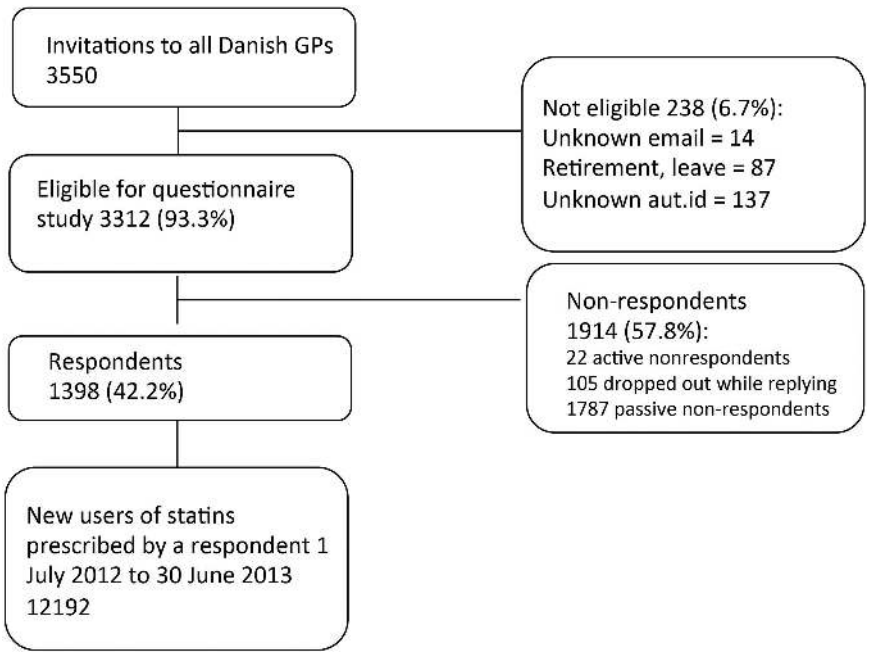


**Figure 2.** Flow chart of GPs responding to the GP-questionnaire in November 2014 and sampling of their patients in registers.

**Table 2.** Distribution of the 1398 responding GPs' attitudes towards risk, statin therapy and management of non-adherence according to their answers to the GP questionnaire

| | No. | % |
|---|---|---|
| Effect of statin is important | | |
| Agree | 1022 | 73.1 |
| Neutral | 220 | 15.7 |
| Disagree | 156 | 11.2 |
| Adherence assessment | | |
| Often | 528 | 37.8 |
| Now and then | 252 | 18.0 |
| Rarely | 618 | 44.2 |
| Discussion of prescription redemption | | |
| Often | 687 | 49.1 |
| Now and then | 338 | 24.2 |
| Rarely | 373 | 26.7 |
| Discussion of medication intake | | |
| Often | 1103 | 78.9 |
| Now and then | 254 | 18.2 |
| Rarely | 41 | 2.9 |
| Annoyance in case of poor adherence | | |
| Often | 371 | 26.5 |
| Now and then | 520 | 37.2 |
| Rarely | 507 | 36.3 |
| Risk taking personality, JPI | | |
| Risk averse | 245 | 17.5 |
| Risk neutral | 953 | 68.2 |
| Risk seeking | 200 | 14.3 |

## Strengths and limitations

The main strengths of this study are the large and representative samples of Danish GPs and their patients in treatment with statins. We estimated adherence using valid registers of on-going prescription redemption, which is considered a fairly accurate way of estimating actual medication use in large populations (14). A broad range of measures of adherence using prescription databases exists. The method of PDC has several advantages: It includes a dimension of long-term use in the analysis by defining the proportion of days the patient has tablets available over a long period. It measures the degree of perseverance and consistency in daily medication taking behaviour. By using adherence and PDC with a fixed cut-off point, we elucidate contrasts between the patients who are adherent on a daily basis and those who are not.

Another strength was that the chosen method of PDC permitted to include all incident users, not only those with two or more statin prescriptions. In that way, the study also addressed early discontinuation of statins known to be a problem of significant magnitude. A minor limitation to this approach is the possible bias of a slight overestimate of patient adherence when supplies stretching beyond the end-date were subtracted. An important limitation is the modest response rate from the GPs (42%) though this is comparable with other online surveys of busy clinicians (18). We cannot rule out that the responding GPs could be more interested in cardiovascular prevention and decision-making than the non-responding GPs, thereby introducing a selection-bias. We tried to reduce that by not revealing the research question or hypothesis of the study in the introduction of the questionnaire and by omitting the word 'adherence'. Furthermore, we found no significant differences between respondents and non-respondents with regard to demographic and organizational characteristics; see supplementary data.

Since no validated measure suited our purposes, we developed a new questionnaire. A general limitation of questionnaire-based studies is that respondents may understand or interpret the items differently than intended. We sought to minimize this type of bias by the two-stepped qualitative pilot-testing to ensure content validity. Further, we performed a field test to determine and confirm acceptability, validity and general applicability.

The items regarding risk and management of non-adherence touch upon controversial issues with no obvious right and wrong answers. In accordance with our hypothesis, we chose risk-neutral GPs and GPs with a neutral approach to management of non-adherence as the reference group.

To account for confounding, we adjusted for a range of factors known to be predictors or hypothesized by us as being predictors of poor patient adherence. We developed two models, Model 1 adjusting for GP factors and Model 2 adjusting for both GP factors and patient factors. The confounding effect of comorbidity was assessed in two different approaches as proposed by Benner *et al.* (14): Patients with CVD may be more likely to take statins than patients with other comorbidities; therefore the effect of CVD may be different from that of other comorbidities.

## Comparison with existing literature

The impact of doctors' personal characteristics, attitudes or estimates on their clinical decision making has been the focal point of several previous studies. Halvorsen *et al.* (18) found that GPs' recommendations regarding statin therapy were strongly associated with their own estimates of survival gain, but insensitive to patients' preferences. Hung *et al.* (2) found that doctors' personal health habits were associated with lifestyle counselling for hypertensive patients. Morishita *et al.* (19) made similar findings with regard to doctors' counselling and recommendation habits for metabolic syndrome and cardiovascular diseases. In 2003 WHO called for further research on the impact of health system related factors on adherence to long-term therapies (7). We investigated the impact of GPs' attitudes on the patients' behaviour and intentions, which we considered to be a step beyond counselling and recommendations. This is in line with the reasoned action theory assuming that people's intentions about behaviour change are affected by attitudes and norms (6). In this case, the norms are presented to the patients by their GPs. Also the health belief model could be applied, assuming that the GPs' overt or tacit attitudes may influence their patients' health beliefs and—ultimately—adherence behaviour (5). We found a substantial variation in GPs' attitudes towards non-adherence and risk, which underlines that patients are exposed to many different beliefs and approaches. The absence of associations in our findings is not a proof of absence of the impact of GPs' attitudes on patients' adherence, but it could be a sign that patients' integrity is too strong to be affected by the GPs' attitudes. However, our findings may also suggest that GPs are conscious about not letting their personal attitudes affect the consultation with their patients. Thereby, they basically act professionally in preserving their own and their patients' personal integrity. It is striking that patients attending multi-handed practices were more adherent than patients attending solo-practices. One explanation could be that the larger multi-handed practices probably often have practices nurses with interest in cardiovascular prevention and assessment of adherence. A previous study by Mohammed *et al.* (20) found that prescribing of statins by practice nurses was more consistent with established guidelines than prescribing by GPs. The effect of practice nurses and other practice characteristics on patient adherence is worth studying further.

## Implications for practice and research

To our knowledge, no prior studies have found that multi practices have more adherent patients than solo practices. Further research in this area is needed before recommendations on practice form can be given.

**Table 3.** Mixed effects logistic regression analysis[a] of associations between patients' adherence[b] and GPs' attitudes to statin therapy, management of non-adherence and risk

| | | | | Model 1[c] | | | Model 2[d] | | |
|---|---|---|---|---|---|---|---|---|---|
| | No.[e] | OR crude (95% CI) | *P*-value | No.[e] | OR adj. (95% CI) | *P*-value | No.[e] | OR adj. (95% CI) | *P*-value |
| Effect of statin is important | | | | | | | | | |
| Agree | 9465 | 0.94 (0.84–1.06) | 0.313 | 9386 | 0.95 (0.85–1.07) | 0.408 | 9103 | 0.95 (0.85–1.07) | 0.421 |
| Neutral | 1670 | Ref. | – | 1642 | Ref. | – | 1593 | Ref. | – |
| Disagree | 1057 | 0.95 (0.80–1.12) | 0.509 | 1053 | 0.94 (0.80–1.11) | 0.483 | 1023 | 0.96 (0.81–1.13) | 0.598 |
| Adherence assessment | | | | | | | | | |
| Often | 4811 | 0.91 (0.81–1.02) | 0.090 | 4790 | 0.91 (0.81–1.02) | 0.097 | 4637 | 0.90 (0.80–1.00) | 0.056 |
| Now and then | 2148 | Ref. | – | 2138 | Ref. | – | 2085 | Ref. | – |
| Rarely | 5233 | 0.88 (0.79–0.98) | **0.025** | 5153 | 0.88 (0.79–0.99) | **0.027** | 4997 | 0.86 (0.77–0.96) | **0.008** |
| Discussion of prescription redemption | | | | | | | | | |
| Often | 6377 | 1.01 (0.91–1.11) | 0.883 | 6326 | 1.00 (0.91–1.11) | 0.956 | 6127 | 1.00 (0.90–1.10) | 0.946 |
| Now and then | 2816 | Ref. | – | 2788 | Ref. | – | 2709 | Ref. | – |
| Rarely | 2999 | 0.96 (0.86–1.08) | 0.488 | 2967 | 0.96 (0.86–1.08) | 0.513 | 2883 | 0.93 (0.83–1.04) | 0.208 |
| Discussion of medication intake | | | | | | | | | |
| Often | 9993 | 1.02 (0.92–1.14) | 0.668 | 9897 | 1.02 (0.92–1.14) | 0.662 | 9601 | 1.01 (0.91–1.13) | 0.807 |
| Now and then | 1958 | Ref. | – | 1957 | Ref. | – | 1898 | Ref. | – |
| Rarely | 241 | 0.92 (0.69–1.23) | 0.570 | 227 | 0.96 (0.72–1.29) | 0.791 | 220 | 0.93 (0.69–1.26) | 0.640 |
| Annoyance by poor adherence | | | | | | | | | |
| Often | 3535 | 0.97 (0.88–1.07) | 0.597 | 3512 | 0.97 (0.88–1.07) | 0.551 | 3391 | 0.98 (0.89–1.08) | 0.725 |
| Now and then | 4528 | Ref. | – | 4468 | Ref. | – | 4342 | Ref. | – |
| Rarely | 4129 | 0.94 (0.86–1.03) | 0.182 | 4101 | 0.95 (0.86–1.04) | 0.238 | 3986 | 0.95 (0.86–1.04) | 0.285 |
| Risk taking personality, JPI | | | | | | | | | |
| Risk averse | 2160 | 0.98 (0.88–1.09) | 0.698 | 2145 | 0.98 (0.88–1.09) | 0.744 | 2071 | 1.00 (0.90–1.11) | 0.940 |
| Risk neutral | 8223 | Ref. | – | 8139 | Ref. | – | 7912 | Ref. | – |
| Risk seeking | 1809 | 0.98 (0.88–1.10) | 0.736 | 1797 | 0.97 (0.87–1.09) | 0.626 | 1736 | 0.98 (0.87–1.10) | 0.700 |

Data on GPs' attitudes are based on the 1398 GPs responding the GP questionnaire in November 2014, and data on patients' adherence are based on prescription data on the GPs' 12 192 patients collected in 2011–2014. Bold values indicate significant *P*-values.

[a]The analyses were adjusted for clustering of patients to their GP.

[b]Adherence was defined as a PDC (proportion of days covered) above 80%.

[c]Model 1: The analyses are adjusted for GPs' gender, years as an MD and practice form.

[d]Model 2: The analyses are adjusted for GPs' gender, years as an MD, practice form, and patients' gender, age group, cohabitation status, educational level, ethnicity and comorbidity.

[e]Numbers are referring to patients (12 192 in total).

**Table 4.** Mixed effects logistic regression analysis[a] of associations between patients' adherence[b] and GP-characteristics

| | | | | Model 1[c] | | | Model 2[d] | | |
|---|---|---|---|---|---|---|---|---|---|
| | No.[e] | OR crude (95% CI) | *P*-value | No.[e] | OR adj. (95% CI) | *P*-value | No.[e] | OR adj. (95% CI) | *P*-value |
| GP gender | | | | | | | | | |
| Female | 4995 | Ref. | – | 4985 | Ref. | Ref. | 4845 | Ref. | Ref. |
| Male | 7097 | 1.03 (0.95–1.12) | 0.409 | 7096 | 1.05 (0.97–1.14) | 0.203 | 6874 | 1.05 (0.97–1.14) | 0.235 |
| GP age[f] | | | | | | | | | |
| <45 | 2589 | Ref. | – | 2579 | Ref. | Ref. | 2502 | Ref. | Ref. |
| 45–54 | 3424 | 0.98 (0.87–1.09) | 0.703 | 3424 | 0.98 (0.82–1.16) | 0.782 | 3318 | 0.98 (0.82–1.17) | 0.815 |
| 55–64 | 4845 | 0.97 (0.88–1.08) | 0.629 | 4844 | 0.95 (0.77–1.16) | 0.601 | 4698 | 0.95 (0.77–1.17) | 0.638 |
| ≥65 | 1234 | 1.00 (0.86–1.16) | 0.998 | 1234 | 0.99 (0.78–1.25) | 0.918 | 1201 | 0.97 (0.76–1.23) | 0.779 |
| Practice form | | | | | | | | | |
| Single-handed | 3626 | Ref. | – | 3602 | Ref. | Ref. | 3475 | Ref. | Ref. |
| Multi-handed | 8545 | 1.12 (1.03–1.23) | **0.007** | 8479 | 1.14 (1.05–1.25) | **0.003** | 8244 | 1.10 (1.00–1.20) | **0.042** |
| Region | | | | | | | | | |
| Capital | 3210 | Ref. | – | 3198 | Ref. | Ref. | 3054 | Ref. | Ref. |
| Central Denmark | 2765 | 1.03 (0.92–1.15) | 0.570 | 2746 | 1.01 (0.90–1.13) | 0.837 | 2678 | 0.95 (0.85–1.07) | 0.397 |
| North Denmark | 1326 | 1.09 (0.95–1.26) | 0.215 | 1314 | 1.07 (0.92–1.23) | 0.380 | 1277 | 0.97 (0.84–1.12) | 0.667 |
| Southern Denmark | 3079 | 1.12 (1.01–1.25) | 0.037 | 3036 | 1.08 (0.97–1.21) | 0.166 | 2960 | 1.00 (0.90–1.12) | 0.957 |
| Zealand | 1808 | 1.13 (1.00–1.28) | 0.056 | 1787 | 1.10 (0.97–1.25) | 0.124 | 1750 | 1.05 (0.92–1.19) | 0.478 |
| Degree of urbanization | | | | | | | | | |
| Densely populated | 3443 | Ref. | – | 3401 | Ref. | Ref. | 3261 | Ref. | Ref. |
| Intermediate | 2744 | 1.05 (0.94–1.17) | 0.391 | 2705 | 1.04 (0.93–1.16) | 0.526 | 2620 | 0.98 (0.88–1.10) | 0.777 |
| Thinly populated | 6005 | 1.03 (0.94–1.13) | 0.506 | 5975 | 1.00 (0.91–1.10) | 0.931 | 5838 | 0.93 (0.84–1.03) | 0.152 |

Analyses are based on register data. Data on GP-characteristics of the 1398 GPs were collected in 2014 and data on the 12 192 patients' adherence were collected in 2011–2014. Bold values indicate significant *P*-values.

[a]The analyses were adjusted for clustering of patients to their GP.

[b]Adherence was defined as a PDC (proportion of days covered) above 80%.

[c]Model 1: The analyses are adjusted for GPs' gender, years as an MD and practice form.

[d]Model 2: The analyses are adjusted for GPs' gender, years as an MD, practice form, and patients' gender, age group, cohabitation status, educational level, ethnicity and comorbidity.

[e]Numbers are referring to patients (12 192 in total).

[f]GP age was not adjusted for years as an MD due to the close correlation.

From a patient's perspective, it is rather reassuring that GPs' risk-taking personality is not associated with patients' adherence. Every patient deserves professional evidence-based consultations in which the GP and the patient base medical decisions on the available evidence rather than on the GPs' attitudes and beliefs. Our findings may contribute to underline GPs professionalism and communicative skills, but do not provide answers to how GPs should communicate in order to improve adherence. However, our findings should not remove GPs' focus from adherence issues in general practice. With the present observation of only 54.1% of the patients being adherent to their statin treatment, there is still room for improvement regarding adherence in general practice. Ideally, the GP should keep adherence issues in mind whenever prescribing. Part of the solution might be post-graduate training initiatives for GPs focusing on known predictors for non-adherence such as patients with poor socio-economy and high degrees of comorbidity and co-medication. In line with the studies from Hung *et al*. (2), it would also be interesting to explore associations between patients' adherence and their GPs' life style related to smoking and exercise habits, body mass index (BMI) and alcohol consumption.

## Conclusions

Our findings suggest that GPs' attitudes to risk, statin therapy or management of non-adherence are not strongly associated with their patients' adherence. Those engaged in improving patient adherence to long-term drug therapies would do well in focusing on other factors.

## Supplementary material

Supplementary material is available at *Family Practice* online.

## Declaration

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Ethical approval: The project was approved by the Danish Data Protection Agency (jour. no. 2013-41-2151) and Statens Serum Institut (ref. no. FSEID-00001063). According to Danish law, the project needed no approval by the regional scientific ethics committee since it did not imply interventions or biomedical samples from the patients. Prior to filling in the questionnaire, all respondents were informed that their answers would be used in a research context.

Conflict of interest: JS has participated in the advisory boards for research projects with Glaxo Smithkline, Astra Zeneca and Boehringer Ingelheim. We declare no conflict of interest or financial recompense as a result of this study. The authors declare that they have no competing interests.

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