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## Primary nonadherence to statin medications: Survey of patient perspectives

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### ABSTRACT

Statin medications reduce cardiovascular events, but many patients never start taking their prescribed statin (primary nonadherence). Limited knowledge exists about the attitudes and beliefs of those with primary nonadherence. In this study, patients with primary nonadherence to statin medications (n = 173) completed a self-administered cross-sectional survey that assessed their attitudes and beliefs related to primary nonadherence and to potential motivators for statin use. Patients were recruited in 2019 from two academic health systems and nationwide internet advertisements. Only 49 of 173 (28.3%) patients with primary nonadherence reported having cardiovascular disease (CVD). Ninety-nine patients (57.2%) never filled their prescription, and 74 (42.8%) filled but never took any statin. Over half failed to initially inform their prescriber they might not take the statin. Patients strongly or somewhat agreed that they desired alternate treatment plans such as diet and/or exercise (n = 134; 77.4%) or natural remedies/dietary supplements (n = 125; 72.3%). Ninety-eight (56.6%) strongly or somewhat worried about the possibility of statin dependence or addiction. Twenty-seven (15.6%) patients noted that they would not take a statin based solely on CVD risk estimates; 50 (28.9%) selected a CVD risk threshold of >20%; and 23 (13.3%) a threshold of >50% as motivating factors to take statins. Patients with primary nonadherence have attitudes about taking statins based on CVD risk that differ from scientific recommendations, may not tell providers about their hesitation to take statins, and likely prefer alternative initial approaches to cholesterol lowering. Early shared decision-making and assessment of patient attitudes about statins could potentially better align initial approaches for CVD risk reduction.

### 1. Introduction

Primary nonadherence (typically defined in existing literature as never filling a newly prescribed medication) occurs in about 20% of patients in the United States who are newly prescribed a statin medication (Lemstra et al., 2018). It is well-established that poor adherence to statin medications increases the risk of cardiovascular events and death in patients prescribed statins for both primary and secondary cardiovascular disease (CVD) prevention (Rodriguez et al., 2019; Chowdhury et al., 2013). Trials on both primary and secondary prevention support the use of statins for CVD risk reduction, as statins have

been shown to decrease the risk of all-cause mortality (risk ratio (RR) = 0.86), cardiovascular mortality (RR = 0.69), stroke (RR = 0.71), myocardial infarction (RR = 0.64), and composite cardiovascular outcomes (RR = 0.70) (Arnett et al., 2019; Chou et al., 2016; Grundy et al., 2019; Mach et al., 2020). Despite numerous studies utilizing multiple approaches to increase medication adherence, no universally accepted or successful method exists to increase medication adherence (Haynes et al., 2008, 2002; Nieuwlaat et al., 2014). Poor understanding of patient attitudes and concerns may be responsible for this situation.

Only a few studies have examined factors associated with primary nonadherence; most existing studies on nonadherence have either

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focused predominantly on patients with secondary nonadherence or have combined those with primary and secondary nonadherence for analysis (Cheetham et al., 2013; Lee et al., 2018; Ju et al., 2018; Hope et al., 2019). Studies focused on primary nonadherence have mostly used administrative databases to identify patients and examine characteristics associated with their nonadherence. These studies were therefore hampered by their inability to identify patients who may have filled prescriptions, but chose not to start them. In addition, while administrative databases can elucidate relationships between patient characteristics found in electronic health records (e.g., demographics and health conditions) and primary nonadherence, they are unable to yield an understanding of *why* patients chose not to start their medications, or of factors that might motivate statin use (Ekedahl and Månsson, 2004; Fischer et al., 2011, 2010; Joyce, 2010; Solomon and Majumdar, 2010; Raebel et al., 2012). Though a few studies have examined attitudes of patients with primary nonadherence, they lacked exploration of patient views regarding taking statins based on CVD risk, and of the most important reasons patients chose not to start a statin (Lee et al., 2018; Bradley et al., 2019; McHorney and Gadkari, 2010; McHorney and Spain, 2011; Harrison et al., 2013). The objective of this study is to describe the attitudes, beliefs, and knowledge about statins/cholesterol of patients with intentional primary nonadherence (i.e., not due to forgetfulness or negligence).

## 2. Methods

This self-administered cross-sectional survey was administered in 2 large academic health systems and through internet classified advertising between May 1 and August 31, 2019. The University of California, Los Angeles (UCLA) Institutional Review Board approved the study protocol and served as the single IRB for this study through the UC IRB Reliance Registry. Participants received information about privacy protections, and were assured that participation (or non-participation) in the study would not affect their medical care.

### 2.1. Participant identification, eligibility and data collection

Potential eligible patients were identified through data extractions from UCLA and University of California, San Francisco (UCSF) health system electronic health records (EHRs) (linked to SureScripts dispensed prescription data (The Surescripts Network, 2020)). Health system EHR data included patient contact information (including email addresses), demographics, preferred language, and data derived from patient care activities, such as electronic prescriptions, while SureScripts data yielded information about pharmacy dispensing of medications. Data extractions generated lists of patients aged 18 and older who: 1) were prescribed a statin medicine between September 2017 and August 2018 (index prescription); 2) had no statin prescriptions in the two years before the index prescription; and 3) did not fill the index prescription (or another prescription for a statin or statin-combination medication) within 60 days after the initial prescribing date. Previous studies have defined primary nonadherence as failure to fill a medication from 14 days up to 9 months after the prescribing date, but since most studies used 60 days or less in their definitions (Cheetham et al., 2013; Raebel et al., 2012; Harrison et al., 2013; Shin et al., 2012; Shrank et al., 2010; Karter et al., 2009; Liberman et al., 2010; Derose et al., 2013; Tamblyn et al., 2014), we conservatively chose 60 days as our cutoff. Since EHR data are imperfect, we used eligibility screening questions to determine patient eligibility. Patients who filled another statin medication within this time frame were not included, as their insurance plan may have mandated use of a statin that differed from the index prescription. Patients with available email addresses were emailed survey links through an online survey platform (Qualtrics). Those without email addresses were mailed a paper copy of the survey.

Patients also were recruited through an internet-based classified advertisements website (Craigslist). We placed advertisements in eight

major metropolitan areas from June 7–11, 2019: Los Angeles and San Francisco, CA; Chicago, IL; Baltimore, MD; Detroit, MI; Jackson, MS; New York NY; and El Paso, TX. These areas were chosen because they have large racial/ethnic minority populations. Advertisements targeted people who never filled or took a newly prescribed statin. We did not have access to medical records of those who responded to the Craigslist advertisements.

All participants answered eligibility screening questions ensuring that they: 1) had been prescribed a statin; 2) were not currently taking a statin; 3) had never taken a statin; and 4) had no significant problems in the last 12 months with memory or thinking that interfered with their ability to do regular activities (Holsinger et al., 2012). Though participants may have filled their statin prescription, we included only those who indicated that they never started taking a prescribed statin (regardless of whether or not they had filled their prescription). Screening questions were self-administered and appeared immediately before survey questions. Research staff attempted to contact patients with missing data to complete surveys. Participants received a \$25 gift card for completing the survey.

### 2.2. Survey instrument

The survey instrument was forward translated from English to Spanish and back translated. Cognitive testing of questions and response options was conducted in both English and Spanish for clarity, comprehension and validity (Peterson et al., 2017; Collins, 2003). Questions regarding patient attitudes, beliefs, and knowledge about statins were informed by previously conducted focus groups with those with primary statin nonadherence and by existing literature (Bradley et al., 2019; Harrison et al., 2013; Horne et al., 1999; Nanna et al., 2018; Navar et al., 2018; Tarn et al., 2021).

Participants selected “the most important reason [they] decided not to fill or take” their statin prescription from a list of options. They also were asked how much they agreed with statements concerning why they “chose not to take a statin” and reasons they “would start taking a statin medicine.” Response options were based on five-point Likert scales ranging from “strongly disagree” to “strongly agree.” Participants also selected the level of risk of a heart attack or stroke within the next 10 years that would motivate them to take a statin. Other survey items queried patient worry about a statin causing various side effects (“not at all,” “somewhat” or “extremely”). Participants also provided information about their race/ethnicity, age, gender, education, medical history, other prescription medications, and interactions with their prescribing provider. Responses for all but the question on educational achievement were mandatory.

### 2.3. Analyses

The analysis excluded participants who responded more than once and those who completed the screening questions and survey in less than 5 min, as survey pilot-testing with students, staff, and patients indicated that survey completion required a minimum of 5 min.

We defined primary nonadherence as never taking a statin, regardless of whether a patient had filled a prescription. We evaluated participant characteristics and response frequencies for attitudes and beliefs. For questions regarding knowledge about statins and cholesterol, we collated the percentage of participants indicating that they “strongly” or “somewhat” agreed with each statement.

We calculated overall descriptive statistics, described patient characteristics based on method of recruitment (EHR versus Craigslist), and also analyzed responses based on patient reported history of CVD. We also explored whether the most important reason patients chose not to start a statin differed based on whether they were prescribed a statin at their first visit with the prescriber.

### 3. Results

**EHR recruitment.** Survey invitations were successfully sent to 1570 UCLA and UCSF patients. The overall survey response rate was  $342 / 1570 = 21.8\%$ . Of the respondents, 73 were eligible and 65 (19%) completed the survey and were included in the study. The survey completion rate among known eligible participants was  $89\%$  ( $65/(73)$ ).

**Internet (Craigslist) recruitment.** Of 201 people who responded to our internet advertisements, 140 were eligible and 112 completed the survey. Four participants submitted multiple surveys and were deemed ineligible, resulting in 108 responses (53.7% of total respondents). Data on the number of people viewing advertisements are unavailable to advertisers.

#### 3.1. Participant and prescriber characteristics

Of 173 patients with primary nonadherence, 99 (57.2%) had never filled their statin prescription, while another 74 (42.8%) who filled their prescription never took it. Only 2 participants completed the survey in Spanish. Participants had a mean age of 48.2 (SD = 12.5), 62.8% were white, 12.8% were Hispanic, and 67.6% were college graduates or completed graduate school (Table 1).

Primary care providers prescribed statins for 106 (61.3%) participants with primary nonadherence and cardiologists for 57 (32.9%). Seventy-two patients (41%) were prescribed a statin the first time they saw the provider, and 90 (52%) failed to tell the provider at the time of prescribing that they might not take the statin (Table 1). The primary source of information about statins was a doctor for 63 (36.4%) and the internet for 62 (35.8%). Only 7 (4%) used the pharmacist for most of their information about statins.

**Characteristics of participants recruited via Craigslist versus EHR.** Participants recruited from Craigslist were younger than those recruited from the EHR (mean age of 43.3 years [SD = 10.3] versus 56.3 years [SD = 11.6];  $p < 0.001$ ), but did not differ in terms of gender or race/ethnicity. Of 108 Craigslist participants, 66 (61.1%) were college graduates and 6 (5.6%) completed graduate school, compared to 24 (36.9%) and 21 (32.3%), respectively, of the 65 participants recruited from the EHR ( $p < 0.001$ ). In addition, 45 (41.7%) of Craigslist participants reported a history of CVD, compared to 4 (6.2%) of EHR-recruited participants ( $p < 0.001$ ), and 44 (40.7%) were prescribed a statin by a cardiologist, compared to 13 (20%) of EHR-recruited participants ( $p < 0.01$ ). Craigslist participants were also less likely than EHR-recruited participants to tell their prescribers that they might not take the statin (39.8% versus 61.5%;  $p < 0.01$ ). For Craigslist participants, the primary source of information about statins was a doctor for 49 (45.4%) and the internet for 31 (28.7%), compared to 14 (21.5%) and 31 (47.7%) of participants recruited from the EHR ( $p < 0.001$ ).

#### 3.2. Knowledge about statins and cholesterol

While more than half of participants with primary nonadherence believed that people with high cholesterol are more likely to have a heart attack or stroke, slightly less than half believed that statins are effective in reducing the risk of a heart attack or stroke. Only 62 (35.8%) participants believed that statins are safe medications (Table 1).

#### 3.3. Reasons for not taking statins

The single most important reasons that participants with primary nonadherence chose for not taking a statin were worry about side effects (27.2%), wanting to try diet and/or exercise first (26.6%), and preferring to take natural remedies or dietary supplements over prescription medications (16.8%) (Fig. 1). Participants who reported a history of CVD most frequently cited worries about side effects as their primary reason for not taking a statin (51%), followed by wanting more laboratory results or other studies first (22.5%); while those without a

**Table 1**

Participant/prescriber characteristics and participant knowledge, n = 173 \*

| Characteristic  | Patients with Primary Nonadherence |
|---|------------------------------------|
| Female, n (%)   | 84 (48.6)                          |
| Age, mean years (SD; range) **  | 48.2 (12.5; 20–74)                 |
| <b>Race / Ethnicity, n (%) †</b>  |                                    |
| Asian   | 8 (4.6)                            |
| Black   | 19 (11.1)                          |
| Hispanic  | 22 (12.8)                          |
| Other   | 15 (8.7)                           |
| White   | 108 (62.8)                         |
| <b>Education, n (%) **</b>  |                                    |
| High school or less   | 21 (12.2)                          |
| Some college  | 35 (20.2)                          |
| College graduate  | 90 (52)                            |
| Graduate school   | 27 (15.6)                          |
| <b>Medical history, n (%)</b>   |                                    |
| CVD (heart attack, angina, stroke, and/or peripheral vascular disease)                          | 49 (28.3)                          |
| Diabetes  | 41 (23.7)                          |
| Hypertension  | 74 (42.8)                          |
| Chronic kidney disease  | 6 (3.5)                            |
| Family history of heart attack, n (%)   | 50 (29.7)                          |
| Currently smoke cigarettes, n (%)   | 26 (15)                            |
| # of prescription medications, mean (SD; range)   | 2.4 (2.9; 0–8)                     |
| # doses of chronic medicines missed in last 30 days, mean (SD; range) †                         | 2.5 (3.6; 0–25)                    |
| <b>Prescriber specialty, n (%)</b>  |                                    |
| Cardiologist  | 57 (32.9)                          |
| Primary care provider   | 106 (61.3)                         |
| Other / unsure  | 10 (5.8)                           |
| First visit to prescriber, n (%)  | 72 (41.6)                          |
| When statin was prescribed, did not tell provider they might not take it, n (%)                 | 90 (52)                            |
| Completely trust provider's decisions (strongly or somewhat agree), n (%)                       | 88 (50.9)                          |
| <b>Knowledge about statins (strongly or somewhat agree)</b>                                     |                                    |
| People with high cholesterol are more likely to have a heart attack or stroke, n (%)            | 103 (59.5)                         |
| Statin medicines are effective in reducing the risk of heart disease and stroke, n (%)          | 83 (48)                            |
| Statin medicines are safe medicines, n (%)  | 62 (35.8)                          |
| People don't have to worry about their cholesterol if they have never had a heart attack, n (%) | 42 (24.3)                          |

\* For race/ethnicity: 1 participant declined to state; for # doses of chronic medications missed in last 30 days: n = 111; CL = Craigslist; CVD = cardiovascular disease

\*\* p < 0.001

† p < 0.05

history of CVD most frequently wanted to try diet and/or exercise first (33.9%), followed by wanting to try dietary supplements before starting a statin (21%);  $p < 0.001$ . There were no differences based on whether or not patients were prescribed a statin at their first visit to the prescriber.

When asked about their agreement with statements regarding why they chose not to take a statin (Table 2), the majority of participants strongly or somewhat agreed that they preferred alternative non-pharmacologic treatment plans such as wanting to try diet and/or exercise before taking a statin (n = 134; 77.4%) and preferring natural remedies, herbs or other dietary supplements (n = 125; 72.3%).

Regarding attitudes and beliefs about the risks of statins, 140 (80.9%) strongly or somewhat agreed that they worried about the side effects of statins. Participants also strongly or somewhat agreed that they did not want to take a medication every day (n = 130; 75.1%), and that they had read or heard bad things about statins (n = 117; 67.6%). Over half of the participants (n = 98; 56.6%) strongly or somewhat agreed that they worried about becoming dependent on or addicted to a

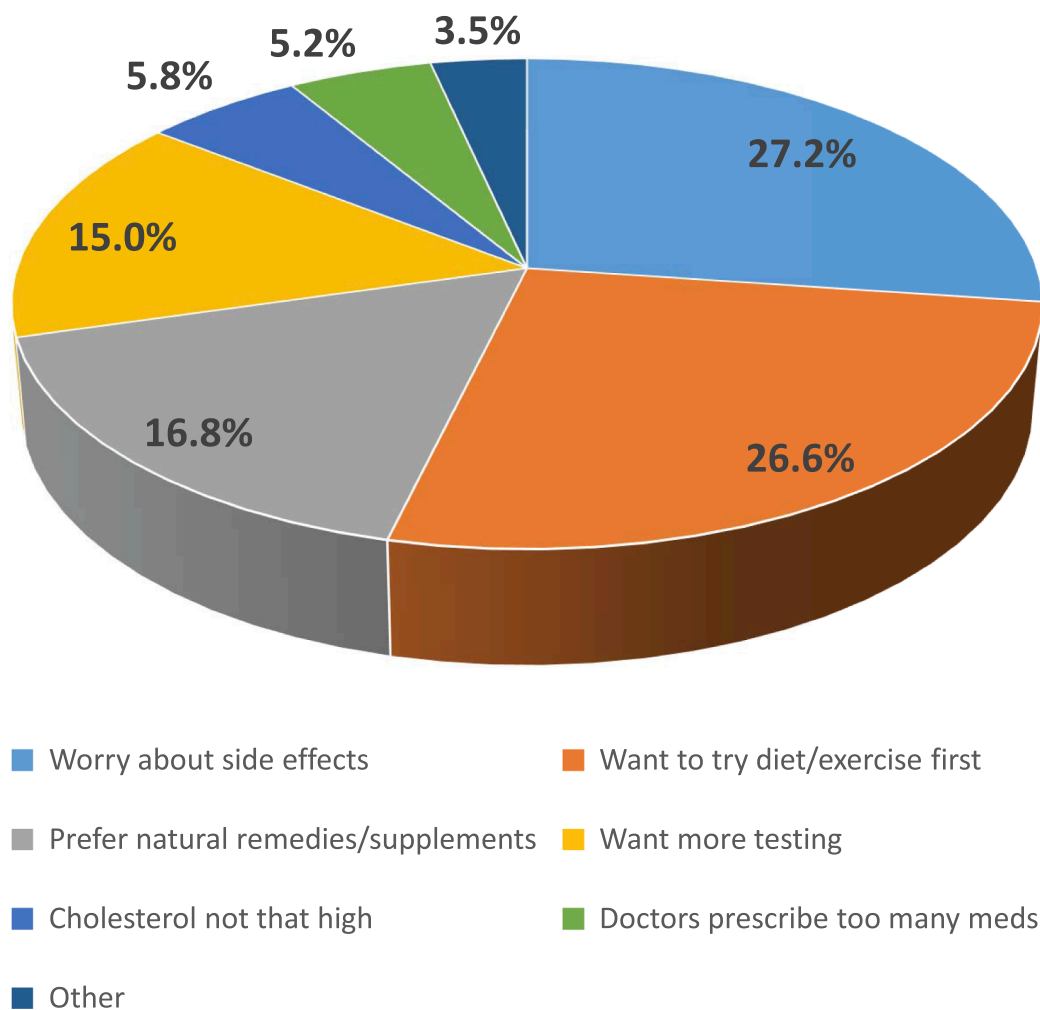


Fig. 1. Single most important reason selected by participants with primary nonadherence to statins for not filling or starting their medication, n = 173.

statin.

Over half of participants also strongly or somewhat agreed with perceptions about their personal health that related to not starting a statin: 93 (53.7%) felt healthy and 98 (56.7%) believed they did not need to start a statin right away. Many believed that statins are overprescribed, with 114 (65.9%) strongly or somewhat agreeing that doctors tend to prescribe too many medicines, and 98 (56.7%) strongly or somewhat agreeing that drug companies influence doctors to prescribe statins (Table 2).

### 3.4. Motivators for statin use

Participants strongly or somewhat agreed that they would take a statin if they had a heart attack or stroke (n = 109; 63%) or if it would lower their chances of having a heart attack or stroke in the next 10 years (n = 117; 67.6%). Over half indicated that they would start a statin if their doctor said it was very important (n = 111; 64.1% strongly or somewhat agreed) (Table 2).

When assessing the perceptions about CVD risk on statin use, 27 (15.6%) of those with primary nonadherence indicated that they would not take a statin based solely on their risk of having a CV event during the next 10 years. Another 26 (15%) were unsure about the level of risk that would prompt them to take a statin. Over half chose a CVD risk level in excess of 7.5% that is cited in treatment guidelines. (Arnett et al., 2019; Grundy et al., 2019) (Fig. 2). Participants with and without a

history of CVD differed in their attitudes regarding CVD risk levels; 19.4% of those without CVD indicated they would not take a statin based on their CVD risk, compared to 6.1% of those with CVD. Similarly, while 20.2% with a history of CVD noted that they were unsure about using risk levels to guide their decisions, only 2% of those with CVD indicated uncertainty. Of participants who reported a history of CVD, 42.8% indicated they would start a statin if their CVD risk was greater than 7.5%, and 32.7% chose a risk level greater than 20%, compared to 12.1% and 27.4%, respectively, for participants without CVD.

### 3.5. Concern about potential side effects

A majority of participants with primary nonadherence were extremely or somewhat worried about a statin causing liver damage (82.7%) or memory loss (81.5%). Over 56% were extremely or somewhat worried about each of the side effects listed on the survey (Fig. 3).

## 4. Discussion

This survey study identifies key attitudes, beliefs and behaviors among people with primary nonadherence to statins, which has implications for provider counseling and shared decision-making. Importantly, the current study suggests that the literature likely underestimates rates of primary nonadherence, since 43% of patients in our study filled their statin prescription but never started taking it.

**Table 2**  
Attitudes and Beliefs related to Reasons for Primary Nonadherence, n = 173.

| "I chose not to take a statin because:"   | Strongly agree, n (%) | Somewhat agree, n (%) | Neither agree nor disagree, n (%) | Somewhat disagree, n (%) | Strongly disagree, n (%) |
|---|-----------------------|-----------------------|-----------------------------------|--------------------------|--------------------------|
| <i>Alternative treatments</i>   |                       |                       |                                   |                          |                          |
| I want to try diet and/or exercise before taking a statin   | 75 (43.3)             | 59 (34.1)             | 30 (17.3)                         | 7 (4.1)                  | 2 (1.2)                  |
| I can lower my cholesterol to normal with diet and/or exercise                                      | 58 (33.5)             | 68 (39.3)             | 35 (20.2)                         | 10 (5.8)                 | 2 (1.2)                  |
| I want more proof that I need a statin (e.g., test results or scans)                                | 49 (28.3)             | 65 (37.6)             | 43 (24.9)                         | 13 (7.5)                 | 3 (1.7)                  |
| I prefer natural remedies, vitamins, herbs or other dietary supplements over prescription medicines | 47 (27.2)             | 78 (45.1)             | 36 (20.8)                         | 11 (6.3)                 | 1 (0.6)                  |
| <i>Risks associated with statin use</i>   |                       |                       |                                   |                          |                          |
| I worry about the side effects of statins   | 95 (54.9)             | 45 (26)               | 11 (6.4)                          | 18 (10.4)                | 4 (2.3)                  |
| I don't like taking medicine every day  | 62 (35.8)             | 68 (39.3)             | 27 (15.6)                         | 10 (5.8)                 | 6 (3.5)                  |
| I have read or heard negative or bad things about statins   | 59 (34.1)             | 58 (33.5)             | 36 (20.8)                         | 18 (10.4)                | 2 (1.2)                  |
| I worry about becoming dependent on or addicted to a statin   | 45 (26)               | 53 (30.6)             | 42 (24.3)                         | 14 (8.1)                 | 19 (11)                  |
| I worry that a statin would interfere or interact with my other medicines                           | 35 (20.2)             | 44 (25.4)             | 52 (30.1)                         | 25 (14.5)                | 17 (9.8)                 |
| Statins do more harm than good  | 28 (16.2)             | 46 (26.6)             | 74 (42.8)                         | 23 (13.3)                | 2 (1.1)                  |
| <i>Perceptions about personal health</i>  |                       |                       |                                   |                          |                          |
| I feel healthy  | 48 (27.7)             | 45 (26)               | 27 (15.6)                         | 38 (22)                  | 15 (8.7)                 |
| I do not need to start a statin right away  | 33 (19.1)             | 65 (37.6)             | 53 (30.6)                         | 20 (11.5)                | 2 (1.2)                  |
| My cholesterol is not that high   | 32 (18.5)             | 53 (30.6)             | 41 (23.7)                         | 33 (19.1)                | 14 (8.1)                 |
| I am too young to take a statin   | 27 (15.6)             | 25 (14.5)             | 51 (29.5)                         | 49 (28.3)                | 21 (12.1)                |
| High cholesterol just runs in my family (is hereditary)   | 16 (9.3)              | 53 (30.6)             | 48 (27.7)                         | 25 (14.5)                | 31 (17.9)                |
| <i>Perceptions about health care system and medication cost</i>                                     |                       |                       |                                   |                          |                          |
| Doctors tend to prescribe too many medicines  | 52 (30.1)             | 62 (35.8)             | 33 (19.1)                         | 25 (14.4)                | 1 (0.6)                  |
| Drug companies influence doctors to prescribe statins   | 47 (27.2)             | 51 (29.5)             | 50 (28.9)                         | 22 (12.7)                | 3 (1.7)                  |
| Statins cost too much   | 20 (11.6)             | 38 (22)               | 82 (47.4)                         | 26 (15)                  | 7 (4)                    |
| <i>"I would start taking a statin medicine if:"</i>   |                       |                       |                                   |                          |                          |
| I had a heart attack or stroke  | 54 (31.2)             | 55 (31.8)             | 39 (22.5)                         | 6 (3.5)                  | 19 (11)                  |
| It would lower my chances of having a heart attack or stroke during the next 10 years               | 41 (23.7)             | 76 (43.9)             | 35 (20.2)                         | 12 (6.9)                 | 9 (5.2)                  |
| My doctor said it was very important  | 40 (23.1)             | 71 (41)               | 40 (23.1)                         | 11 (6.4)                 | 11 (6.4)                 |
| My cholesterol was extremely high   | 36 (20.8)             | 78 (45)               | 25 (14.5)                         | 25 (14.5)                | 9 (5.2)                  |
| I could not get my cholesterol down to normal on my own   | 35 (20.2)             | 74 (42.8)             | 35 (20.2)                         | 18 (10.4)                | 11 (6.4)                 |
| A close family member had a heart attack or stroke  | 29 (16.7)             | 61 (35.3)             | 47 (27.2)                         | 14 (8.1)                 | 22 (12.7)                |

Without information at the patient level regarding medication consumption, primary nonadherence may incorrectly be classified as secondary nonadherence. Therefore, patients with primary nonadherence cannot be identified based purely on administrative database pulls. Direct provider queries about patient intentions to take an initial statin prescription are likely the best way to identify those who are reluctant to start a statin, as well as to assess and address their concerns.

More surprising was that around the time of prescribing, over half of the participants with primary nonadherence did not tell the prescriber that they were not planning to take the statin. It is unknown whether these decisions about statin use occurred during or after the visit, but it is likely that the participants had at least some initial hesitation about the statin medication. Over 40% of participants with primary nonadherence reported that they were seeing the prescriber for the first time, and only slightly over 50% completely trusted the provider's decisions regarding starting use. These findings warrant further investigation to examine whether patients are more likely to start a statin if it is prescribed during a subsequent, rather than a first visit with a prescriber. Our results strongly suggest that physicians prescribing statins during a patient's first visit should assess patient concerns that may contribute to their rejection of statin therapy. It is possible that an initial visit provides inadequate time for full discussions of strategies to lower CVD risk or that patients may be less willing to accept recommendations for initiating a statin medication during an initial visit. As statin use is rarely emergent, it is reasonable to introduce a recommendation for a statin in a first visit yet not prescribe unless the patient is clearly interested.

By quantifying the attitudes and beliefs of patients with primary nonadherence, this study adds to previous knowledge showing that patient characteristics (e.g., younger age, better health, lower rates of hospitalizations and fewer clinic and emergency department visits) are associated with primary nonadherence to statins (Cheetham et al., 2013;

Lee et al., 2018). In the current study, the majority of those with primary nonadherence to statins wanted to pursue alternative treatment plans before starting statins. These included trying dietary measures or exercise, obtaining additional test results or imaging, or pursuing natural remedies or dietary supplements. This study did not collect information on the content of provider-patient discussions regarding alternative treatments, cardiovascular risk, or the risks or benefits of statins. Future studies are needed to evaluate the relationship of these conversations, as well as shared decision-making with patients about treatment goals (Elwyn et al., 2012, 2010) and candid discussions about the expected effects and timeframes for evaluating the results of alternative treatments, on the alignment of healthcare professional and patient approaches to reduce CVD risk.

Most participants with primary nonadherence felt their personal risk for a CV event was low, particularly those without a previous history of CVD. Many indicated that they felt healthy and believed that they did not need to start a statin right away. These findings are consistent with previous studies showing that patients who choose to take chronic medications perceive a greater need for them (McHorney and Gadkari, 2010). The findings also highlight the need to find better ways to convey the concept of personal risk, particularly when patients feel healthy enough to forgo medication. This is especially pertinent given that many patients in this study would not find quantitative measures of their CVD risk to be a compelling reason to start a statin. Worries about the risks of statin use were prevalent, which is unsurprising given the large body of literature demonstrating patient concerns about medication side effects (Lee et al., 2018; Bradley et al., 2019; Wilson et al., 2007). But worries about the potential for becoming dependent on or addicted to statins were unexpected. These concerns could be addressed by providers at the time of prescribing. Patient beliefs that providers prescribe too many medications also may need to be addressed. These beliefs may be

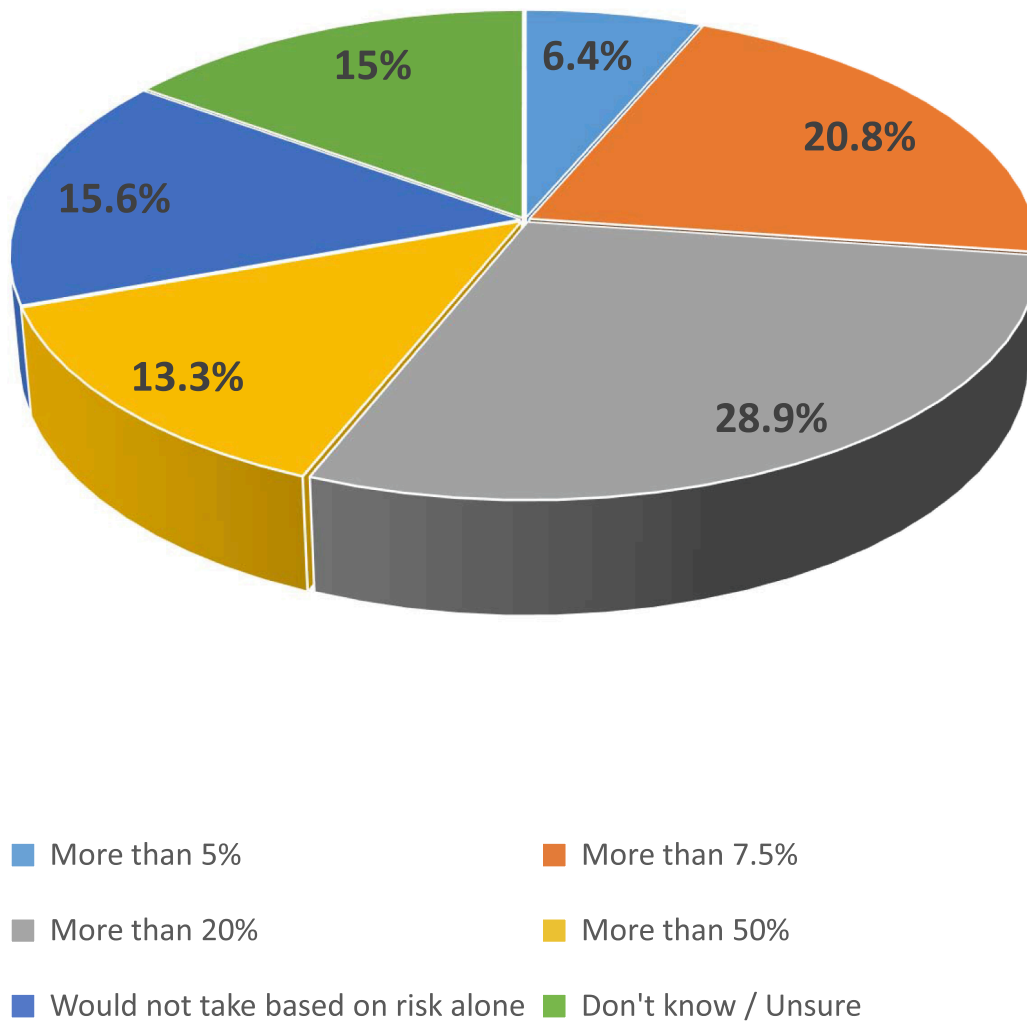


Fig. 2. Risk of having a heart attack or stroke within the next 10 years that would motivate participants with primary nonadherence to take a statin, n = 173.

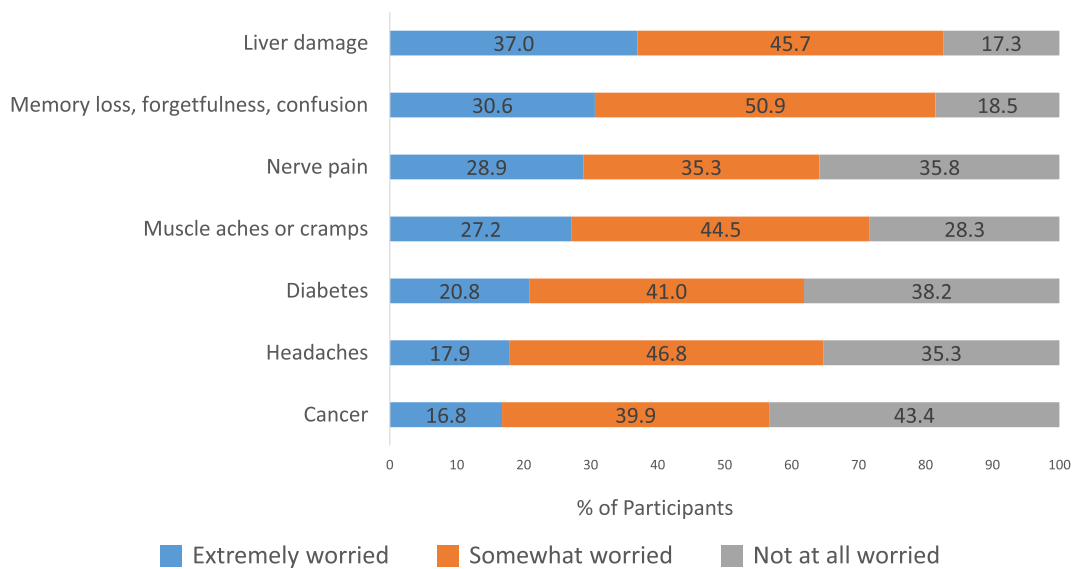


Fig. 3. Percentage of participants with primary nonadherence to statins who are extremely, somewhat, or not at all worried about suffering from side effects due to statin medications, n = 173.

influenced by concerns about the influence of the pharmaceutical industry on provider prescribing (Holbrook et al., 2013; Fadlallah et al., 2016).

Study limitations include having adherence defined only by patient report in a subset of the participants. Response rates from within the academic health systems was low, though the study included a diverse group of people from around the country. The study's generalizability may be limited, as participants were recruited from urban areas, Spanish speakers were under-represented, and over 50% of participants completed college or graduate school. We did not collect information about patient income. We were unable to verify that people who responded to the Craigslist advertisements had been prescribed a statin.

## 5. Conclusions

In summary, we found that participants with primary nonadherence to statins often wanted alternative treatment plans before starting a statin, and more than half failed to tell their prescribers at the time of prescribing that they might not take the statin. In the absence of an urgent indication, a preferable course may be to discuss all potential treatment options at a first visit, provide information for review, offer educational materials about statins (readily available on some EHRs), and schedule a follow-up visit to allow for informed patient decision-making. Addressing patient attitudes, beliefs, and willingness to start a statin before prescribing a statin may be more successful than prescribing a statin and then trying to address nonadherence afterwards. Future studies are needed to better understand differences in the characteristics, attitudes and beliefs, knowledge, and motivation between patients with and without primary nonadherence to statins. By better aligning with patient preferences for CVD risk reduction at the onset using shared decision-making, providers may build better relationships with patients, and may enhance patients' ability to achieve better CV outcomes.

## CRedit authorship contribution statement

**Derjung Mimi Tarn:** Conceptualization, Methodology, Formal analysis, Investigation, Resources, Writing - original draft, Supervision, Funding acquisition. **Mark J. Pletcher:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition. **Rosa Tosqui:** Investigation, Writing - review & editing. **Alicia Fernandez:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition. **Chi-hong Tseng:** Methodology, Writing - review & editing. **Rachel Moriconi:** Investigation, Writing - review & editing. **Doug Bell:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition. **Maureen Barrientos:** Investigation, Writing - review & editing, Project administration. **Jon Turner:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition. **Janice B. Schwartz:** Conceptualization, Methodology, Investigation, Resources, Writing - review & editing, Supervision, Funding acquisition.

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## Declaration of Competing Interest

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