# Cholesterol Screening and Treatment Practices and Preferences: A Survey of United States Pediatricians

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**Objectives** To determine pediatricians' practices, attitudes, and barriers regarding screening for and treatment of pediatric dyslipidemias in 9- to 11-year-olds and 17- to 21-year-olds.

**Study design** American Academy of Pediatrics (AAP) 2013-2014 Periodic Survey of a national, randomly selected sample of 1627 practicing AAP physicians. Pediatricians' responses were described and modeled.

**Results** Of 614 (38%) respondents who met eligibility criteria, less than half (46%) were moderately/very knowledgeable about the 2008 AAP cholesterol statement; fewer were well-informed about 2011 National Heart, Lung, and Blood Institute Guidelines or 2007 US Preventive Service Task Force review (both 26%). Despite published recommendations, universal screening was not routine: 68% reported they never/rarely/sometimes screened healthy 9- to 11-year-olds. In contrast, more providers usually/most/all of the time screened based on family cardiovascular history (61%) and obesity (82%). Screening 17- to 21-year-olds was more common in all categories ($P < .001$). Only 58% agreed with universal screening, and 23% felt screening was low priority.

Pediatricians uniformly provided lifestyle counseling but access to healthy food (81%), exercise (83%), and adherence to lifestyle recommendations (96%) were reported barriers. One-half of pediatricians (55%) reported a lack of local subspecialists. Although 62% and 89% believed statins were appropriate for children and adolescents with high low-density lipoprotein cholesterol (200 mg/dL) unresponsive to lifestyle, a minority initiated statins (8%, 21%).

**Conclusions** US pediatricians report lipid screening and treatment practices that are largely at odds with existing recommendations, likely because of lack of knowledge and conflicts among national guidelines, and concern about treatment efficacy and harms. Education regarding pediatric lipid disorders could promote guideline implementation. *(J Pediatr 2017;185:99-105).*

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Screening for and treatment of cholesterol disorders in childhood and adolescence has been recommended for several decades by the American Academy of Pediatrics (AAP) most recently in 2008,[1] by the 2011 Expert Panel of the National Heart, Lung, and Blood Institute (NHLBI),[2] by the National Lipid Association[3]; it was subsequently incorporated into the AAP Bright Futures schedule for well-child supervision in early 2014.[4] Both the AAP and the 2011 Expert Panel recommend pediatric lipid screening for lipid disorders if there is a family history of early atherosclerotic disease or high cholesterol to detect familial hypercholesterolemia, which occurs in 1 in ~250 individuals,[5,6] or if the child or adolescent has a high-risk condition such as hypertension, diabetes, or obesity (**Table I**; available at www.jpeds.com).[2] The 2011 Expert Panel also recommends universal lipid screening of all 9- to 11-year-olds and 17- to 21-year-olds because family history is not a reliable indicator of risk; 30%-60% of children with elevated low-density lipoprotein cholesterol (LDL-C) have no family history of early heart disease or stroke.[2,7] Both the AAP and NHLBI Expert Panel recommend treating children with statins starting at age 8-10 years, if LDL-C remains significantly elevated despite lifestyle counseling.[2]

The release of the 2011 NHLBI guidelines re-ignited significant controversy in the medical and popular press about whether and how to screen for pediatric lipid disorders.[8-11] The 2011 NHLBI Task Force recommended expanding to universal pediatric lipid screening, whereas the 2007 US Preventive Services Taskforce

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|---|---|
| AAP | American Academy of Pediatrics |
| LDL-C | Low-density lipoprotein cholesterol |
| NHLBI | National Heart, Lung, and Blood Institute |
| USPSTF | US Preventive Services Taskforce |

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(USPSTF) concluded from review of essentially the same literature base that there was insufficient evidence to recommend for or against pediatric lipid screening,[7] a conclusion they reiterate in their most recent recommendations.[12] In light of this controversy, questions have been raised about the degree to which lipid screening and treatment recommendations have been embraced and implemented by practicing clinicians. Surveys of pediatric lipid screening practices in the 1990s suggested low uptake by pediatricians.[13,14] A more contemporary survey reported in 2014 that although 74% of Minnesota pediatric providers viewed lipid screening as important, only one-half screened patients selectively, and one-third did not regularly screen; more than one-half of respondents were opposed to the use of statins in children.[15] Analysis of nationally representative surveys of ambulatory well-child visits from 1995 through 2010 indicates cholesterol testing is performed at very low rates (3.4% of visits) with minimal increases over time.[16] These studies may not reflect full dissemination of the 2011 guidelines, and may not be nationally representative. Therefore, we conducted a survey with practicing AAP physician members about screening for and treatment of lipid disorders in children and adolescents.

## Methods

The AAP 2013-2014 Periodic Survey was developed in collaboration with members of the AAP Committee on Nutrition and the Department of Research, and researchers at Tufts Medical Center Institute for Clinical Research and Health Policy Studies and Boston Children's Hospital based on knowledge of content and survey methodology, and previous experience with AAP Periodic Surveys using general questions to assess knowledge, attitudes and barriers (eg, knowledge of guidelines, and attitudes toward and barriers to screening and treatment). The survey was approved by the AAP Institutional Review Board as exempt from human subjects review and pilot-tested for clarity with a random sample of 200 AAP members. Patient scenarios were used to better understand treatment practices. Pediatricians were asked what kinds of treatment(s) they would recommend for 2 hypothetical patients who, despite 6 months of lifestyle counseling, had persistent elevations in LDL-C of 140 mg/dL (3.6 mmol/L), a level one might see with lifestyle-related lipid abnormalities, and 200 mg/dL (5.2 mmol/L), a severe elevation more typical of a genetic lipid disorder such as familial hyperlipidemia. We posed each question for 2 different aged patients, a 9- to 11-year-old and a 17- to 21-year-old, to see if responses differed based on patient age; we focused on these ages as they are when the 2011 NHLBI guidelines recommend universal screening. Provider and practice characteristics were also assessed.

Following institutional review board approval by the AAP, surveys containing a token of appreciation ($2 bills) and a cover letter from the Executive Director of the AAP were mailed to a randomly selected sample of 53 859 nonretired US AAP members between December 2013 and June 2014. Those who did not respond were re-approached with up to 6 follow-up mail contacts and 2 e-mail contacts directing them toward an online version of the survey.

### Statistical Analyses

Survey responses were analyzed for all respondents who completed the survey and reported providing direct patient care. To assess nonresponse bias, the age and sex of respondents were compared with those of nonrespondents using the AAP administrative database. Additional analyses were conducted for the subset of respondents who provided health supervision (ie, primary care) and for the subset providing health supervision to both 9- to 11-year-olds and 17- to 21-year-olds to facilitate comparisons by patient age. Descriptive statistics of physician and practice characteristics, knowledge, screening and treatment practices, attitudes, and barriers were summarized as means and SEs, or frequencies and percentages. Physician and practice characteristics were compared by whether or not the respondent provided health supervision using 2-sample $t$ tests or $\chi^2$ tests. Responses were collapsed into "never/rarely/sometimes" and "usually/most/all of the time" and compared across child age using the McNemar test (to account for clustering of pediatrician responses).

Logistic regression was used to assess predictors of responses to screening and treatment practices. Using the previously collapsed responses ("usually/most/all of the time" vs "sometimes/rarely/never"), the following binary outcomes were defined: (1) screening healthy children and (2) referring to lipid specialist or starting statins for patients with a persistently elevated LDL-C of 200 mg/dL (5.2 mmol/L). Multivariable models were built for each outcome that included all relevant physician and practice characteristics. Separate adjusted models were then built for child age and each relevant knowledge, attitude, and barrier variable. These models all adjusted for physician and practice characteristics. We included respondent as a cluster in the logistic regression models because physicians provided responses to each outcome for children aged 7-11 years and 17-21 years.

Alpha was set to 0.01 to account for multiple testing and 99% CIs were reported for the ORs. All analyses were conducted using SAS v 9.4 (SAS Institute, Cary, North Carolina). To account for differences in age and AAP membership status (ie, resident or not) by response status, all analyses were weighted by the inverse of the response rate. These weights were taken into account using the SURVEY procedures or by using the weighting option in other procedures.

## Results

### Survey Respondents

Of the 1627 nonretired AAP members who were sent the 2014 Periodic Survey, 705 (43%) returned surveys (75, 11% of these were returned electronically), of which 621 (38%) were complete. When survey respondents were compared with nonrespondents, no difference was found in the percent female (63% vs 60%, $P = .335$) or region of the country. Respondents were slightly older than nonrespondents (mean = 47 years vs mean = 44 years, $P < .001$), and more nonrespondents were

**Table II. Physician and practice characteristics of respondents providing direct patient care**

| | Overall n = 615 | No health supervision n = 172 | Health supervision n = 443 | *P* value |
|---|---|---|---|---|
| Physician characteristics | | | | |
| Age, mean (SE) | 44.6 (0.5) | 47.0 (0.9) | 43.6 (0.6) | .003 |
| Period in practice, y, mean (SE) | 12.4 (0.5) | 13.4 (0.9) | 11.9 (0.6) | .16 |
| Male, n (%) | 221 (36.2%) | 71 (41.5%) | 150 (34.1%) | .09 |
| Hispanic, n (%) | 32 (5.3%) | 10 (5.9%) | 22 (5.1%) | .70 |
| Race, n (%) | | | | .42 |
| White | 435 (70.8%) | 120 (69.9%) | 315 (71.1%) | |
| Black | 23 (3.8%) | 4 (2.0%)§ | 20 (4.5%) | |
| Asian | 94 (15.3%) | 28 (16.2%) | 66 (14.9%) | |
| Missing/other/multiple/American Indian | 62 (10.1%) | 20 (11.9%) | 42 (9.4%) | |
| Resident, n (%) | 128 (20.8%) | 13 (7.7%) | 115 (25.9%) | <.001 |
| Hours in DPC, mean (SE) | 38.9 (0.8) | 33.0 (1.4) | 41.3 (0.9) | <.001 |
| Well-child visits per wk, mean (SE) | 25.6 (1.1) | 1.1 (0.6) | 29.5 (1.2) | <.001 |
| All time in general pediatrics, n (%) | 342 (56.0%) | 20 (11.5%) | 322 (73.3%) | <.001 |
| Practice characteristics | | | | |
| Region, n (%)* | | | | <.001 |
| Urban, inner city | 166 (27.5%) | 62 (37.0%) | 104 (23.8%) | |
| Urban, not inner city | 162 (26.9%) | 61 (36.3%) | 101 (23.2%) | |
| Suburban | 226 (37.3%) | 39 (23.5%) | 186 (42.7%) | |
| Rural | 50 (8.3%) | 5 (3.2%)§ | 45 (10.3%) | |
| % Public insurance patients† | | | | <.001 |
| <50% | 261 (49.9%) | 37 (34.0%) | 224 (54.1%) | |
| ≥50% | 262 (50.1%) | 73 (66.0%) | 190 (45.9%) | |
| Practice setting, n (%)‡ | | | | <.001 |
| Solo/2 MD practice | 58 (10.0%) | 5 (3.3%)§ | 53 (12.5%) | |
| Group practice/HMO | 257 (44.3%) | 34 (21.7%) | 223 (52.8%) | |
| Medical school, hospital, clinic, community health center | 265 (45.7%) | 119 (75.0%) | 146 (34.7%) | |

*DPC*, direct patient care; *HMO*, health maintenance organization; *MD*, medical doctor.
Respondents were included in the health supervision group if they provided health supervision to either 9- to 11-year-olds or 17- to 21-year-olds. Results have been weighted based on nonresponse (this may cause column and row numbers not to add as expected).
*n = 12 are missing data on region of practice.
†n = 89 are missing data on patient insurance type.
‡n = 30 respondents are missing data on practice setting.
§n < 10 indicating weighting may be unstable.

residents (26% vs 12%, $P < .001$). Seven respondents were excluded because they did not provide direct patient care, leaving 614 surveys (615 respondents based on weighting) for analysis (**Figure 1**; available at www.jpeds.com).

Characteristics of the included pediatricians are described in **Table II**, presented as weighted data based on response rate. The average age was 44.6 (SE 0.5) years; pediatric residents represented 21% of respondents. Approximately one-third of respondents were male, and 71% were white. More than one-half (56%) spent all of their time in general pediatrics; the average number of well-child visits provided per week was 26 (SE 1). Respondents generally practiced in urban and suburban settings and worked in group practices or practices associated with academic medical centers, hospitals, or clinics. One-half of the respondents worked in practices where >50% of their patients received public health insurance (eg, Medicaid, State Children's Health Insurance Program [SCHIP] or other). Most (72%) respondents reported providing health supervision, and the bulk of the analyses focus on these primary care physicians. Those providing health supervision were younger, were more likely to be female or a resident, spent more time in general pediatrics, practiced in suburban settings, had fewer patients with public insurance, and were more likely to practice in a group practice or health maintenance organization (all $P < .001$).

## Knowledge

Of pediatricians providing health supervision, about one-half (46%) reported being moderately or very knowledgeable about the 2008 AAP guidelines. Familiarity with the 2011 NHLBI expert panel guidelines, which include recommendations for universal screening of healthy children, was lower (26%). Familiarity with the 2007 USPSTF evidence review on pediatric lipid screening and treatment was also low (26%).

## Screening Practices, Attitudes, and Barriers

**Screening Practices.** The screening practices of pediatricians who provided health supervision are shown in **Table III**, reported by various indications for 2 age groups, 9- to 11-year-olds and 17- to 21-year-olds. Regarding their younger patients, respondents reported screening usually/most/all of the time based on selective criteria, such as family history of early atherosclerosis (61%) or high cholesterol (69%), or based on a personal risk factor, such as obesity (82%) or other high-risk conditions (86%). However, less than one-third (30%) reported screening all healthy children ages 9-11 years as recommended by the NHLBI guidelines. Similar practices were reported with regard to screening 17- to 21-year-olds, although providers screened their older patients more often in all categories ($P < .001$ when comparing all screening practices across child age). Universal screening of healthy teens was

**Table III. Lipid screening and treatment practices reported by pediatricians providing health supervision to 9- to 11-year-olds and 17- to 21-year-olds, shown by screening indication as n (%)**

| | 9- to 11-y-olds | | 17- to 21-y-olds | |
|---|---|---|---|---|
| **Screening for lipid disorders in childhood** | | | | |
| **Respondents, n (%)** | **Never/rarely/sometimes screen** | **Usually/most/all of the time screen** | **Never/rarely/sometimes screen** | **Usually/most/all of the time screen** |
| Family history of heart attack or stroke* | 156 (39.4%) | 240 (60.6%) | 102 (25.7%) | 295 (74.3%) |
| Family history of high cholesterol* | 125 (31.4%) | 273 (68.6%) | 78 (19.6%) | 319 (80.4%) |
| Obesity* | 74 (18.5%) | 324 (81.5%) | 37 (9.4%) | 357 (90.6%) |
| High-risk conditions *,† | 55 (13.7%) | 343 (86.3%) | 32 (8.1%) | 364 (91.9%) |
| Healthy* | 277 (67.9%) | 120 (30.3%) | 228 (57.6%) | 167 (42.4%) |
| **Treatment of LDL 200 mg/dL (5.2 mmol/L) that persists despite 6 months of lifestyle counseling** | | | | |
| **Respondents, n (%)** | **Never/rarely/sometimes treat** | **Usually/most/all of the time treat** | **Never/rarely/sometimes treat** | **Usually/most/all of the time treat** |
| Provide dietary and exercise counseling | 11 (2.7%) | 384 (97.3%) | 9 (2.4%) | 385 (97.6%) |
| Refer to dietician | 95 (24.4%) | 293 (75.6%) | 90 (22.8%) | 302 (77.2%) |
| Start statin* | 350 (92.1%) | 30 (7.9%) | 305 (79.0%) | 81 (21.0%) |
| Refer to lipid specialist* | 179 (45.8%) | 212 (54.2%) | 159 (40.3%) | 235 (59.7%) |
| Start statin OR refer to lipid specialist* | 171 (43.5%) | 222 (56.5%) | 125 (31.5%) | 271 (68.5%) |

Restricted to those providing health supervision to both 9- to 11-year-olds and 17- and 21-year-olds. Weighted N = 398.
*$P < .05$ comparing ages.
†High-risk conditions include obesity, family history of heart attack or stroke, or family history of high cholesterol.

not performed by the majority of pediatricians: 58% of respondents reported they do not routinely screen healthy teens.

**Attitudes.** Pediatrician attitudes were not uniformly supportive of guideline-driven screening behaviors (data not shown). Although a minority (30%) of respondents agreed or strongly agreed that family history was sufficient to identify familial dyslipidemias, only 55% agreed or strongly agreed that "all children should have cholesterol screening prior to puberty and in late adolescence." Nearly one-quarter (23%) of pediatricians agreed or strongly agreed that cholesterol screening in children and adolescents was a low priority for them, and 47% of pediatricians agreed or strongly agreed that "screening all children for high cholesterol will lead to unnecessary and costly follow-up."

**Barriers.** Barriers to screening reported by pediatricians are shown in **Figure 2**, A. Although few felt the ability to obtain an accurate family history or interpret a pediatric lipid profile were major barriers (13% and 7% respectively), patients not returning for a fasting lipid test was a major barrier to screening for nearly one-half (47%) and a minor barrier to an additional 44% of respondents.

**Factors Associated with Screening.** Male physicians (OR = 0.55, $P = .006$) and those practicing in rural settings (compared with urban, inner city; OR = 0.31, $P = .006$) were less likely to screen healthy children and adolescents usually/most/all of the time (**Table IV**; available at www.jpeds.com). Years in practice, race and Hispanic ethnicity, practice setting, spending all time in general pediatrics, and being a resident was not associated with screening healthy children and adolescents ($P = .11$). Providers were more likely to screen their older patients than younger patients (OR = 1.75, $P < .001$; **Table V** available at www.jpeds.com). More knowledge about the NHLBI guidelines was associated with screening (OR = 2.43, $P < .001$). Agreeing that knowing cholesterol makes screening worthwhile (OR = 3.17, $P < .001$) and that all children should have cholesterol screened (OR = 5.36, $P < .001$) were associated with more screening. On the other hand, agreeing that family history is sufficient to identify familial dyslipidemias (OR = 0.48, $P = .002$), that cholesterol screening is a low priority (OR = 0.31, $P < .001$), and that cholesterol screening would lead to unnecessary and costly follow- up (OR = 0.28, $P < .001$) were associated with less screening. No barriers were associated with reported screening.

## Treatment Practices, Attitudes, and Barriers

**Treatment Practices.** Nearly all pediatricians reported they would provide diet and exercise counseling to a patient with persistently very high LDL-C (200 mg/dL, 5.2 mmol/L) in both age groups (97% and 98%, $P = .63$ for difference by age); three-quarters reported they would refer to dieticians ($P = .33$ for difference by age), as shown in **Table III**. Substantially fewer prescribed statins, particularly to younger ages: although 21% reported they would prescribe statins to a 17- to 21-year-olds with severely elevated LDL-C of 200 mg/dL (5.2 mmol/L) despite lifestyle counseling, only 8% endorsed statin use in a 9- to 11-year-old with that same profile ($P < .001$ for difference by age). More respondents referred 17- to 21-year-olds with severely elevated LDL-C to lipid specialists (60%) than 9- to 11-year-olds (54%, $P = .006$). Combining the outcomes of prescribing statins or referring to a lipid specialist, 32% of respondents reported they would not routinely prescribe statins or refer 17- to 21-year-olds with persistent significant LDL-C elevations to a subspecialist; 44% would not prescribe statins or refer 9- to 11-year-olds similarly affected

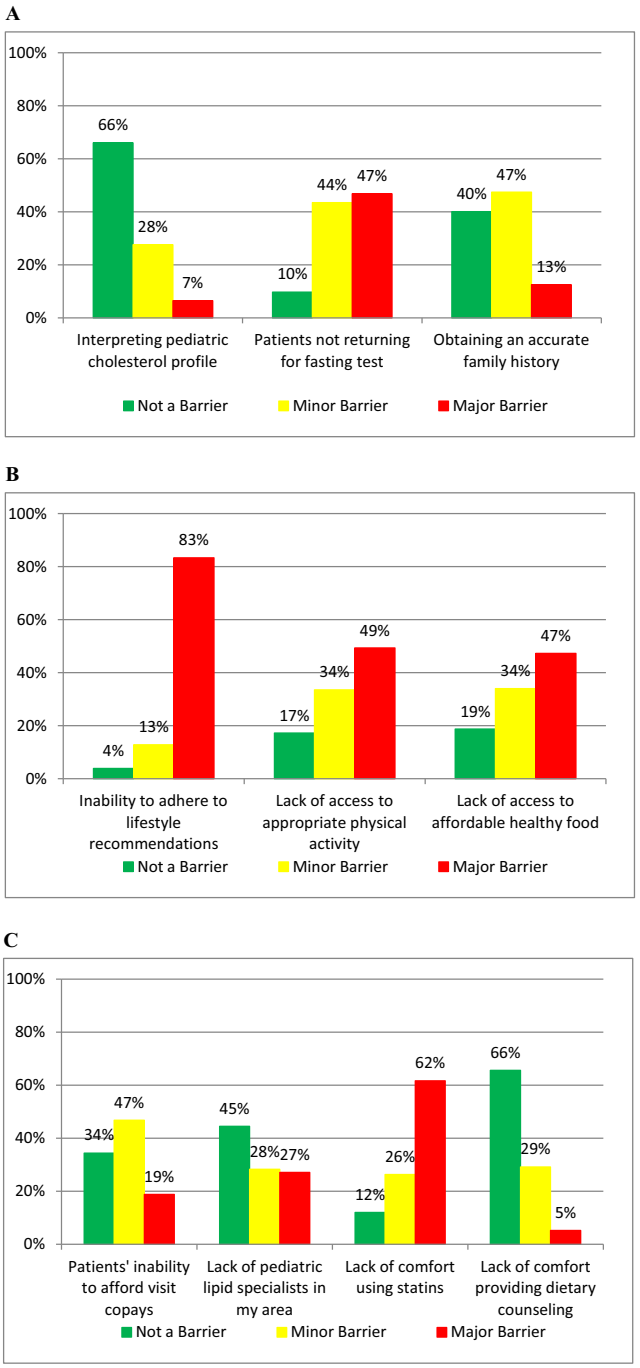


**Figure 2.** Barriers to pediatric lipid screening and treatment as identified by pediatricians. **A,** Lipid screening barriers. **B,** Patient and family barriers to implementing a healthier lifestyle. **C,** Provider and systems barriers to treating pediatric lipid disorders.

with high LDL. Respondents were more likely to refer or treat older children (68%) than younger children (56%, $P < .001$).

**Treatment Attitudes.** There was a clear consensus that diet and exercise changes in childhood can decrease cardiovascular risk (99% agreed or strongly agreed, data not shown). However, only 62% agreed or strongly agreed with statin use in 9- to 11-year-olds if LDL was ≥190 mg/dL (4.9 mmol/L) despite lifestyle counseling. Pediatricians were divided as to whether primary care providers could manage most lipid disorders without referral, with 56% agreeing or strongly agreeing and 44% disagreeing or strongly disagreeing that a pediatric lipid disorder could be managed in primary care.

**Barriers.** Major barriers to lipid treatment identified by responding pediatricians included lack of access to affordable healthy foods (47%) and appropriate physical activity (49%); few (5%) reported lack of comfort providing dietary counseling as a major barrier (**Figure 2**, B). The most commonly reported major barrier to lipid treatment was inability of patients and families to adhere to lifestyle recommendations, reported by 83% of respondents. Some reported systems issues as major barriers including patients' ability to afford copays (19%) and lack of lipid specialists in the surrounding area (27%) (**Figure 2**, C). Lack of comfort prescribing statins was a major barrier for most (62%) and a minor barrier for some (26%) respondents.

**Factors Associated with Treatment Responses.** More years in practice (OR = 0.97, $P = .005$) and Hispanic ethnicity (0.12, $P = .008$) were associated with less prescribing statins or referring to a lipid specialist among children and adolescents with elevated LDL-C (**Table IV**). Sex, race, being a resident, spending all time in general pediatrics, region, having a majority of patients with public insurance, and practice setting was not associated with statin treatment or referral. Providers were more likely to prescribe or refer their older patients than younger patients (OR = 1.74, $P < .001$; **Table V**). Knowledge about the NHLBI guidelines was not associated with prescribing or treating ($P = .86$). Providers agreeing that cholesterol disorders can be managed in primary care (OR = 0.51, $P = .007$) were less likely to prescribe or treat, as were those reporting lack of comfort using statins (OR = 0.41, $P < .001$) and lack of insurance coverage for dietary counseling (OR = 0.46, $P = .001$).

## Discussion

In this nationally representative survey of practicing pediatricians, knowledge about existing recommendations on lipid screening and treatment in children and adolescents was moderate, despite multiple statements, evidence reviews, and guidelines from the AAP, the NHLBI, USPSTF, and the National Lipid Association. Selective lipid screening based on family history of early cardiovascular disease or high cholesterol was reported as a reasonably common practice, although less common than lipid screening in the setting of obesity, even though the AAP and others have recommended family history-based screening since 1992. Universal screening was not routine, with only 30%-42% of pediatricians reporting that they screened healthy children and adolescents usually/most/all of the time. Although many pediatricians do not routinely follow patients to age 21 years, this is unlikely to be a factor in this study given the high percentage of respondents who reported

providing health supervision to 17- to 21-year-olds. Nearly all pediatricians offered lifestyle modification counseling for lipid disorders. Statin therapy was not commonly recommended, even for children with severe lipid disorders that persisted despite lifestyle counseling; 44% would not routinely prescribe statins or refer such a patient to a subspecialist, which may also reflect a reported lack of available specialists or a lack of knowledge about the cardiovascular risk associated with severe lipid disorders.

The existing literature on practices around pediatric lipid screening is sparse. Phone surveys of providers caring for children conducted in 1988 and 1998 reported low rates of lipid screening by pediatricians (12%) under past guidance.[13,14] Dixon et al[15] surveyed Minnesota pediatric providers and found one-third of respondents did no lipid screening, most were uncomfortable managing lipid disorders, and one-half were opposed to using lipid lowering medications in children. We also found limited uptake of these guidelines. Although respondents believed that childhood risk factors contributed to adult cardiovascular disease and family history was insufficient to identify childhood cholesterol disorders, the majority did not regularly screen for lipid disorders in their healthy patients, particularly at younger ages.

Our findings are limited in that they reflect reported practices, not actual testing or treatments delivered, and actions may vary in the course of clinical care. However, available information on rates of testing in clinical practice supports our findings. In an analysis of the National Ambulatory Medical Care Surveys from 1995 through 2010, which report outpatient practices at the time of health maintenance visits, cholesterol testing was ordered at only 3% of pediatric health maintenance visits, and testing rates increased minimally over time.[16] Reviews of records from 1 or more practices suggest more frequent screening (17%-27%), but still at relatively low rates and primarily in children with higher risk conditions such as obesity or family history of cardiovascular disease.[17,18] A large review of the records of children enrolled in managed care organizations (n = 301 080) between 2007 and 2010 found only 10% of pediatric patients had lipid testing.[19] Other data actually suggest a decline in lipid testing among children in recent years.[20] These studies were conducted before or at the time of the release of the most recent 2011 NHLBI guidelines. Our respondents reported slightly higher screening rates, perhaps reflecting increased awareness of the NHLBI guidelines since their release.

The findings of this survey may not be generalizable to family practitioners, nurse practitioners, or pediatricians that are not AAP members. However, response rates were consistent with other recent national surveys of physicians,[21,22] and the methodology was robust, including the use of response rate weights to account for non-response bias.[23] Furthermore, data from the American Board of Pediatrics estimates 61% of US board-certified pediatricians ages 27 to 70 years are AAP members, suggesting AAP members do represent the majority of board-certified pediatricians. It is possible that pediatricians who are AAP members may be more academically oriented and, therefore, might be more familiar with guidelines, and more inclined to screen and treat; if this is the case, rates of screening and treatment in US pediatric care over all may be even lower than we report. We included resident responses in our analysis because they make up an important membership group within the AAP. Resident practice patterns may be more in line with the AAP endorsed NHLBI guidelines; however, we found no differences in screening or treatment practices based on resident status. Alternatively, the USPSTF "I" review could sway residents to screen and treat less. Resident status was included as a candidate predictor variable, but no univariate differences were found for screening or treating between residents and nonresidents. It is possible that the topic of the survey might have motivated or deterred pediatricians from responding based on whether they are in favor of or against the guidelines. These factors could lead to results that are not necessarily representative of all pediatricians, which should be considered when interpreting these findings.

Our results raise concerns about guideline dissemination and implementation. Lack of implementation can be explained in part by lack of knowledge about published guidelines, as reported by our respondents. Incomplete guideline implementation can also be due to a lack of support for the recommendations because of perceived or real research gaps regarding the relationship between childhood lipid levels and adult cardiovascular outcomes. Lipid screening in childhood has always been debated, and the recommendation for universal screening was particularly controversial because of the substantial expansion of scope.[8] The USPSTF has not recommended for or against lipid screening or treatment in childhood, citing a lack of evidence (grading it as an Inconclusive or "I" recommendation); this may lead some clinicians to postpone prioritizing universal screening until further evidence is available. Conflicting recommendations between the USPSTF, NHLBI, and AAP guidelines may also inhibit uptake. Health systems issues may get in the way of implementation, as identified by the respondents, including a lack of local specialists, patients not returning for fasting testing, and families not adhering to lifestyle change advice. Concern about treatment options, such as a perceived or real lack of response to lifestyle modification or possible adverse effects of statin treatment, may also limit the implementation of lipid screening and treatment guidelines. Finally, the reasonably high rate (32%-44%) of pediatricians who reported that they would not routinely treat with statins or refer a patient to a subspecialist in situations of severely elevated LDL-C not responsive to dietary counseling, such as is seen in familial hypercholesterolemia,[3] suggests a knowledge gap about lipid disorders among pediatricians.

US pediatricians report lipid screening and treatment practices that are in large part at odds with existing recommendations from the NHLBI Task Force and the AAP. Gaps in guideline implementation are likely multifactorial and are related to lack of knowledge about published guidelines, conflicting guidance from existing guidelines, concern about lack of efficacy and potential harms of available treatment options, and inadequate knowledge about the risk of some childhood lipid disorders. If we are to increase the implementation of the

AAP and NHLBI pediatric lipid screening and treatment recommendations, better education is needed about recommended screening and treatment approaches, about the health consequences of severe lipid disorders, and about the benefits and potential harms to treatment. ■

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**Table I. Summary of recommendations in published guidelines**

| | USPSTF 2007/2016 | AAP 2008 | NHLBI 2011/ Bright Futures |
|---|---|---|---|
| Screening criteria* | | | |
| Family history of heart attack or stroke | I | R | R |
| Family history of high cholesterol | I | R | R |
| Obese (BMI ≥ 95th percentile) | I | R | R |
| High-risk conditions (eg, hypertension, diabetes) | I | R | R |
| Healthy 9- to 11-y-olds and 17- to 21-y-olds | I | NR | R |
| Statin treatment criteria* | | | |
| LDL ≥190 mg/dL despite 6 mo lifestyle therapy | I | R | R |
| LDL ≥160 mg/dL and additional risk factors despite 6 mo lifestyle therapy | I | R | R |

*BMI*, body mass index; *I*, Indeterminate (eg, no recommendation can be made based on the available evidence); *NR*, not recommended; *R*, recommended.
*See the AAP statement *Screening and cardiovascular health in childhood*, the NHLBI 2011 report from the *Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents*, and the USPSTF evidence review *Lipid Disorders in Children and Adolescents: Screening* for full recommendations on lipid screening and treatment in childhood and adolescents. It should be noted that the 2016 USPSTF evidence review of lipid screening and treatment was unchanged from the 2007 "I" recommendation.

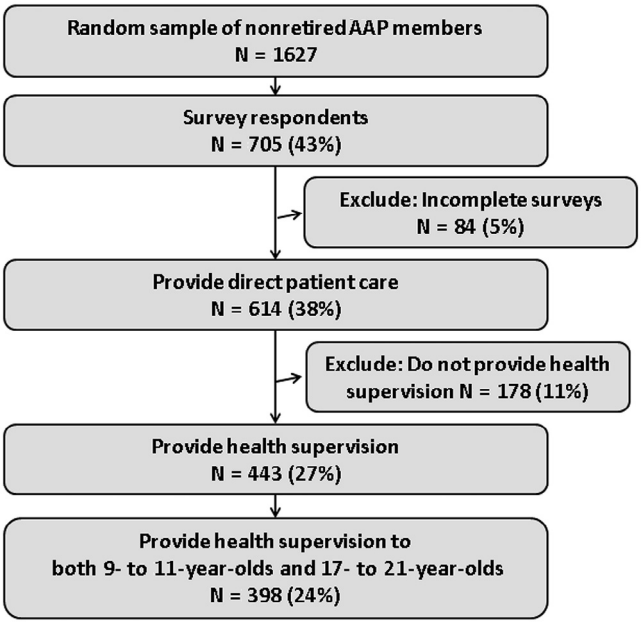


**Figure 1.** Flowchart describing survey respondents.

**Table IV. Multivariable logistic regression model using physician and practice characteristics to predict screening healthy patients and starting statins or referring to lipid specialist for children with elevated LDL-C**

| | Screen healthy | | Treat elevated LDL-C | |
|---|---|---|---|---|
| | OR (99% CI) | *P* value | OR (99% CI) | *P* value |
| Physician characteristics | | | | |
| Period in practice, y | 0.99 (0.96, 1.02) | .46 | 0.97 (0.94, 1.00) | .005 |
| Male | 0.55 (0.31, 0.96) | .006 | 0.80 (0.44, 1.46) | .34 |
| Hispanic | 1.30 (0.26, 6.61) | .67 | 0.12 (0.02, 0.93) | .008 |
| Race | | .67* | | .02* |
| White (ref) | | | | |
| Black | 1.40 (0.42, 4.63) | .47 | 0.43 (0.06, 2.86) | .25 |
| Asian | 1.11 (0.52, 2.36) | .72 | 0.86 (0.45, 1.64) | .54 |
| Missing/other/multiple/American Indian | 1.78 (0.42, 7.52) | .30 | 5.08 (1.00, 25.79) | .01 |
| Resident | 0.54 (0.20, 1.48) | .11 | 0.56 (0.20, 1.55) | .14 |
| All time in general pediatrics | 1.42 (0.68, 2.94) | .22 | 1.53 (0.73, 3.20) | .14 |
| Practice characteristics | | | | |
| Region | | .01* | | .21* |
| Urban, inner city (ref) | | | | |
| Urban, not inner city | 0.48 (0.19, 1.21) | .04 | 0.52 (0.21, 1.29) | .06 |
| Suburban | 0.74 (0.32, 1.73) | .36 | 0.75 (0.29, 1.93) | .43 |
| Rural | 0.31 (0.11, 0.93) | .006 | 0.56 (0.18, 1.73) | .18 |
| ≥50% Public insurance patients | 0.55 (0.27, 1.01) | .03 | 0.59 (0.28, 1.25) | .07 |
| Practice setting | | .81* | | .5* |
| Solo/2 MD practice (ref) | | | | |
| Group practice/HMO | 0.95 (0.44, 2.07) | .86 | 0.73 (0.32, 1.69) | .34 |
| Medical school, hospital, clinic, community health center | 0.80 (0.30, 2.10) | .54 | 0.63 (0.22, 1.80) | .26 |

*MD*, medical doctor; *HMO*, health maintenance organization.
Restricted to those providing health supervision to both 9- to 11-year-olds and 17- 21-year olds. Weighted N = 398. "Screen healthy" defined as screening healthy children for cholesterol disorder. "Treat elevated LDL-C" defined as referring to lipid specialist or starting statins for patients with a persistently elevated LDL-C of 200 mg/dL usually/most/all of the time vs sometimes/rarely/never.
*Global P value.

**Table V. Adjusted logistic regression models using knowledge, attitudes, and barriers to predicting screening healthy patients and starting statins or referring to lipid specialist for children with elevated LDL-C**

| | Screen healthy | | Treat elevated LDL-C | |
|---|---|---|---|---|
| | OR (99% CI) | *P* value | OR (99% CI) | *P* value |
| Older child age | 1.75 (1.22, 2.51) | <.001 | 1.74 (1.28, 2.37) | <.001 |
| Knowledge* | | | | |
| NHLBI guidelines | 2.43 (1.38, 4.27) | <.001 | 1.05 (0.54, 2.05) | .86 |
| Screening attitudes† | | | | |
| Knowing normal cholesterol makes screening worthwhile | 3.17 (1.82, 5.51) | <.001 | NA | |
| Family history is sufficient to identify familial dyslipidemias | 0.48 (0.26, 0.89) | .002 | NA | |
| Cholesterol screening is a low priority | 0.31 (0.14, 0.71) | <.001 | NA | |
| All children should have a cholesterol screening test done prior to puberty and in late adolescence | 5.36 (2.98, 9.63) | <.001 | NA | |
| Screening all children for high cholesterol will lead to unnecessary and costly follow-up | 0.28 (0.16, 0.49) | <.001 | NA | |
| Treatment attitudes† | | | | |
| Most childhood cholesterol disorders can be adequately managed in primary care | 1.40 (0.81, 2.44) | .11 | 0.51 (0.27, 0.97) | .007 |
| Diet and exercise changes in childhood can decrease cardiovascular risk | 0.81 (0.04, 17.21) | .86 | 2.91 (0.09, 99.49) | .43 |
| Screening barriers‡ | | | | |
| Lack of ability to interpret pediatric cholesterol profile | 0.83 (0.34, 2.06) | .60 | NA | |
| Patients not returning for a fasting test | 0.82 (0.48, 1.43) | .36 | 1.34 (0.75, 2.39) | .20 |
| Inability to obtain accurate family history | 0.35 (0.11, 1.14) | .02 | NA | |
| Treatment barriers‡ | | | | |
| Patients' inability to adhere to lifestyle recommendations | 1.02 (0.57, 1.81) | .94 | 0.96 (0.50, 1.82) | .85 |
| Patients' lack of access to appropriate physical activity | 1.07 (0.60, 1.89) | .77 | 0.94 (0.50, 1.77) | .79 |
| Patients' lack of access to affordable healthy food | 0.92 (0.43, 1.99) | .78 | 1.00 (0.50, 1.98) | .99 |
| Patients' inability to afford visit copays | 0.37 (0.09, 1.48) | .06 | 1.23 (0.37, 4.13) | .66 |
| Lack of pediatric lipid specialists in my area | 1.06 (0.57, 1.97) | .80 | 1.41 (0.76, 2.62) | .15 |
| Lack of comfort using statins | 0.78 (0.40, 1.54) | .35 | 0.41 (0.22, 0.78) | <.001 |
| Lack of comfort providing dietary counseling | 1.14 (0.52, 2.51) | .67 | 0.60 (0.27, 1.31) | .09 |
| Lack of insurance coverage for dietary counseling | 1.02 (0.55, 1.87) | .94 | 0.46 (0.25, 0.84) | .001 |

*NA*, not applicable.

Restricted to those providing health supervision to both 9- to11-year-olds and 17- to 21-year olds. Weighted N = 398. "Screen healthy" defined as screening healthy children for cholesterol disorder. "Treat elevated LDL-C" defined as referring to lipid specialist or starting statins for patients with a persistently elevated LDL-C of 200 mg/dL usually/most/all of the time vs sometimes/rarely/never. Only attitudes and barriers that were a priori deemed relevant to the screening or treatment outcomes were used in the respective models (indicated by NA). Each row represents a different logistic regression model adjusted child age and the physician and practice characteristics in Table IV.

*Knowledge responses collapsed as moderately/very knowledgeable vs not very/somewhat knowledgeable.

†Attitude responses collapsed as agree/strongly agree vs disagree/strongly disagree.

‡Barrier responses collapsed as major vs minor/no barrier.