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Overcoming the real and imagined barriers to cholesterol screening in pediatrics

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The recent United States Preventive Services Task Force (USPSTF) recommendation statement declaring incomplete evidence for or against universal lipid screening in young people has highlighted both discordances with previously published multi-national and multi-society guidelines and evidence gaps related to lipid screening early in life.[1] Conflicting recommendations add unnecessary challenges that delay incorporation of screening, identification, and treatment of young people with lipid disorders, particularly familial hypercholesterolemia (FH).[2–5] FH is a genetic condition that causes exposure to elevated levels of low-density lipoprotein cholesterol (LDL-C) from birth, resulting in premature atherosclerotic cardiovascular disease (ASCVD) and its sequelae.[6] Identifying patients with FH and initiating appropriate therapies improves health outcomes and reduces mortality;[7] however, less than 10% of patients living with FH worldwide are aware of their diagnosis, despite trusted means of disease identification.[6] Many countries have successfully implemented lipid screening programs at varying levels of scope, providing hope for improving ASCVD prevention in children despite continued dispute over best practices.[4,5,8–10]

Implementation science research empowers researchers to recognize evidence care gaps, create targeted strategies to overcome implementation barriers, and translate evidence-based guidelines into high-quality patient care. This field addresses healthcare system-, clinician-,

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Tyler J. Schubert: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Samuel S. Gidding:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Laney K. Jones:** Supervision, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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and patient-level barriers to clinician performance of evidence-based guidelines, utilizing the co-development of targeted strategies agreed upon by these stakeholder groups.[11,12] Efforts to improve the care of patients with FH using implementation science principles are already underway.[13–15]

In this commentary, we will identify both real and imagined barriers to lipid screening in youth. Real barriers are those which have a measurable impact limiting uptake of cholesterol screening in practice. Imagined barriers are those that have been identified as context-dependent and possibly having limited uptake of cholesterol screening in practice by some groups, but not all. We will then provide evidence of how we can use implementation science to develop feasible, opportunistic, and effective solutions by using input from relevant stakeholders to address these real and imagined barriers.

History of pediatric lipid screening recommendations

There have been two streams of thought in United States guidelines related to cholesterol screening. In the first, the USPSTF has consistently given cholesterol screening in childhood an incomplete grade, leaving the choice of whether to screen up to the clinician.[1,16,17] The second is the sequence of recommendations from the American Academy of Pediatrics (AAP), which has provided support to guidelines sponsored first by the National Heart, Lung, and Blood Institute (NHLBI) of the National Institutes of Health (NIH), and subsequently by the multi-society guidelines published in 2018.[18,19] These recommendations have advocated for at first selective screening, and subsequently, universal screening in childhood. The AAP has endorsed the NHLBI sponsored statement supporting universal lipid screening in healthy children aged 9–11, while the American Academy of Family Physicians (AAFP) aligns with the USPSTF statements. Consequently, pediatricians are more supportive of universal lipid screening in children compared to family physicians. For example, pediatricians in a Wisconsin study screened over 60% of eligible patients for cholesterol while their family physician colleagues screened approximately 35% during the year of study.[20] Table 1 demonstrates the evolution of United States pediatric lipid screening guidelines.

Beginning in 2007, the USPSTF has authored three evidence-review recommendation statements regarding cholesterol screening in children and adolescents, with each declaring “insufficient evidence” for or against cholesterol screening in individuals up to 20 years old (Table 1).[1,16,17] The USPSTF evidentiary threshold for recommendation statements in pediatrics remains too narrow to fully understand the burden of FH as opposed to other pediatric dyslipidemias, and the group uses this evidentiary threshold to justify its position.[21] Each iteration of the USPSTF recommendation statements has failed to expand its scope of evidence-review beyond randomized controlled trials. Specifically, the USPSTF calls for reandomized controlled trials assessing the efficacy of pediatric lipid screening in preventing cardiovascular events in adulthood. While randomized controlled trials may provide the gold standard for evidence, the inclusion of a placebo group and a short study duration prevent a high-quality RCT in this scenario from existing.[1,16,17] Not only does the methodology of randomized controlled trials preclude the feasibility of such a study, the desired randomized controlled trial evidence sought by the USPSTF could be

considered unethical in children,[22] given the proven benefits of lipid-lowering therapies in mitigating cardiovascular disease risk.[7,23] Overall, by limiting its evidentiary scope to randomized controlled trials, the USPSTF only endorses an A or B grade for eight preventive recommendations in children.[24]

The statements released by the AAP Committee on Nutrition (1989) and the NIH National Cholesterol Education Program (1992) are important as they were the first two published documents providing clinical guidance for pediatric cholesterol screening, and their historical precedent may prevent the uptake of more updated evidence-based recommendations. Guidelines sponsored by other groups, including the National Lipid Association's 2011 FH guideline, are generally concordant with those endorsed by the AAP. While nuances among best age to screen, number of tests in childhood, and other parameters distinguish these statements from each other, their sentiment remains common: selectively screen children early in life with a family history of hypercholesterolemia and ASCVD, and universally screen for cholesterol in all children later in childhood. In addition to the selective screening precedent set by the earliest United States guidelines, the ambiguity of the 2018 multi-society guidelines in regard to universal screening may only perpetuate the debate and leave clinicians more confused.

Some groups have prioritized the impacts of FH by unequivocally calling for universal cholesterol screening in children. FH pediatric screening is now considered a best practice for the prevention of non-communicable diseases in Europe according to the European Commission Public Health Best Practice Portal,[31] and it is now recommended that every European country should develop and implement an FH screening program.[32] European groups have employed diverse data sources, including Mendelian randomization, epidemiological, observational, registry, and cohort studies, to inform their positions on universal screening. Both existing and currently developing European screening programs will contribute important information on how best to screen early in the life course.[9,31,33,34,35] The International Atherosclerosis Society (IAS) has put forth guidance for best practices of FH screening, diagnosis, and management, all informed by implementation science methodologies.[36]

Real barriers to pediatric lipid screening

Both systemand clinician-level barriers exist that prevent adequate lipid screening rates in children. Systems-level barriers are forces existing at the national-, organizational-, or group-level that influence clinician behavior. Clinicianlevel barriers are those faced by individuals providing care to patients. Some examples include insufficient time with patients and lack of FH awareness. Table 2 demonstrates the systemand clinician-level barriers that exist in pediatric lipid screening.

Clinical inertia resulting from the conflicting state of pediatric lipid screening guidelines has created an unnecessary divide on the issue, perhaps most notably in practices of selective screening and a patient's fasting status (Table 2). The precedent of selective screening set in 1989 may have caused its persistence in clinical practice (Table 1).[25,37] Selective screening is inherently flawed often due to incomplete or inaccurate family histories, which has an

appreciable consequence of potentially not identifying individuals with dyslipidemia when choosing who to screen.[38,39] The literature suggests that non-fasting status provides similar, albeit non-identical, lipid metrics compared to fasting samples,[40] and that non-fasting samples have clinical utility for screening purposes.[41–43] Despite these advances, family physicians may use a child's non-fasting status as a reason to forgo cholesterol screening more often compared to pediatricians.[20]

Clinicians routinely face day-to-day obstacles that prevent pediatric lipid screening. Insufficient time during well-child visits, due to a rise in non-patient facing tasks and mental-health focused visits, take time away from general preventive measures.[44–47] Changing clinical workflow to comply with guidelines in a clinician's physical office is a barrier to screening.[48] FH awareness and knowledge remains suboptimal among clinicians globally,[49–51] and this can lead to poor rates of FH identification and treatment.[52] Finally, clinician discomfort of treating pediatric dyslipidemia, including patient costs,[37,53] safety concerns of lipid-lowering therapies in children,[54,55] and patient non-adherence to treatment[56] all may prevent screening.

Thankfully, both proven and in-progress solutions for overcoming these systemsand clinician-level barriers exist (Table 2). Addressing clinical inertia requires both system-wide change and targeted educational interventions. A combination of universal, selective, and opportunistic screening strategies can be used to improve FH identification,[36] and other system-wide detection measures can increase FH awareness among clinicians and screening rates.[15,57] Educational interventions, whether completed in-person[15] or delivered virtually,[58] can shrink educational gaps. For example, an educational intervention focusing on the 2011 NHLBI guidelines helped increase lipid screenings by over 30% in healthy 9to 11-year-old children among a group of clinicians at one federally qualified health center.[59] Similar measures could educate clinicians on the safety of statin use in children,[7] increase awareness of FH identification and treatment,[15] and promote the collection of lipids at the primary care visit when other blood tests are recommended (e.g., lead screening). Screening performed by non-primary care clinicians, including pharmacists, workplace physicians, and optometrists, can alleviate time constraints and promote collaborative care.[15,60] Screening children outside of the clinical space increases testing accessibility, as evidenced by both universal screening programs and clinical trials that screen children in their school environment.[33,35,38]

The United Kingdom has a long history of innovation regarding FH, and there has been a long-standing interest in early identification of children with FH.[61–64] However, there has been difficulty in implementing childhood screening. Beginning with the NICE guideline in 2008 and subsequent research, screening of children via cascade testing and effective pilot screening programs, using both genetic testing and lipid screening, have been published.[65–67] Because the National Health Service provides health care in the United Kingdom, the added challenge has been to satisfy criteria for inclusion of FH screening at the population level, including issues of equity and cost.[68,69] Despite showing favorable cost effectiveness, and overcoming other hurdles related to cholesterol or genetic screening, resistance remains, with some combination of use of electronic health records and cascade screening of children of cases identified in adults as a competing strategy.[70,71]

Imagined barriers to pediatric lipid screening

Imagined barriers are those that have been known in some groups to prevent adequate screening, while they are not experienced in others. As with the real barriers, these imagined challenges can occur both at the systems- and clinician-level, albeit under different circumstances. The culture, policies, and processes of systems may facilitate screening in some countries, while discouraging screening in others. This culminates as the observed uneven nature of these imagined barriers depending on their context. A so-called best age to screen children for cholesterol and the misconception that clinicians do not have an interest in ASCVD prevention in children are two appreciable imagined barriers (Table 3).

An ideal age to screen young people is often touted as an imagined barrier. At present, there is no evidence to suggest an optimal age to screen children for lipid disorders.[78,79] Rather, the FH Expert Group has broadly defined “childhood” as the best time to screen, which has provided generous leeway for screening in vast age ranges.[80] Past and current trials that investigated FH screening in children illustrate both the diversity in selected screening ages and the uniformity of clinical results.[4,33–35,65,66,81] Other analyses show a majority of FH cases could be identified by screening anytime between ages 1–9.[39] Furthermore, expanding screening recommendations past childhood and into adolescence provides the opportunity to identify more individuals with FH, and therefore, initiate lipid-lowering measures.[78]

Perceived lack of clinician interest in ASCVD prevention in young people is another imagined barrier. This concept requires careful consideration, as its implications are profound. Clinicians surveyed in the Collaborative Approach to Reach Everyone with Familial Hypercholesterolemia (CARE-FH) trial at Geisinger believed that early ASCVD prevention was an essential part of their role in primary care and felt that screening for FH would support that role.[15] However, this does not reflect other nationwide surveys among pediatricians and other primary care clinicians.[3,54] While clinicians support early ASCVD prevention, existing multi-leveled barriers discussed previously contribute to this apparent disconnect: that clinicians are invested in ASCVD prevention, yet they are reluctant to prescribe medication if a significant risk factor is identified. The presence of conflicting clinical guidelines, concerns regarding safety of lipid-lowering therapies in children,[54,55] and fears of poor patient adherence to lab draws or treatment[56] all contribute to this disconnect.

Solutions to these imagined challenges are like those discussed for overcoming real challenges. Targeted educational interventions that inform clinicians of the lack of consensus for best age to screen children for lipids can help remove the burden of this challenge. Without a best age to screen, clinicians can build trust and understanding with their patients by offering cholesterol screening when it is most convenient for children their families. Adequately tackling the misconception that clinicians have little interest in ASCVD prevention in children will take more effort, as it requires removing the barriers that prevent clinicians from acting upon this interest, including a lack of time in appointments and apprehension regarding patient costs and treatment.

Implementation science and creating new solutions

Implementation science provides unique insights for how systems, clinicians, and patients have overcome some of these challenges while also providing guidance to remove those that remain. The IAS recently published evidence-based recommendations for using implementation science to inform best practices for FH identification and management on the basis that current guidelines provide little insight into effective strategies to improve FH identification and clinical care.[36] This expert working group selected by the IAS as having expertise in FH evaluated the relevant literature and authored implementation recommendations scored according to class of recommendation and their corresponding levels of evidence.[36] These recommendations intend to provide clinicians worldwide with evidence-based best practices on identifying and treating the greatest number of people living with FH.

Through multi-level engagements with clinically relevant stakeholders, including survey data, semi-structured interviews, observations in various clinical environments, and deliberative engagement sessions, the CARE-FH trial has developed an understanding of the current state of FH screening, diagnosis, and treatment within the health system.[15] Barriers identified in the CARE-FH study reflect many of those present in the literature. These included a lack of clinician knowledge and awareness of FH, high cost of genetic testing, inconvenience for patient testing, and insufficient time in visits for clinicians to adequately address FH and screening guidelines. In contrast, facilitators included the clarity of cholesterol screening guidelines and access to new lipid lowering therapies, namely the PCSK9 inhibitors.

These insights were used to develop an implementation strategies package that addressed the identified barriers within the Geisinger system while leveraging relevant facilitators, which will be rolled out to every primary care clinic in the system in a stepped-wedge design. The first iteration of the implementation strategies package included in-office clinician education regarding FH, patient notification of their need for cholesterol screening, clinician notification of a patient's need for screening during an upcoming appointment, and clinical-decision support tools to augment the workup of patients with suspected FH. This trial design allows for constant feedback from stakeholders and consequent improvement in the implementation strategies package delivered to each site, which may provide an adequate framework for considering new solutions to increase pediatric lipid screening.

Furthermore, understanding the sustainable qualities of currently existing lipid screening programs can help inform the development of new programs and solutions globally (Table 4). Sustainable programs have adequate buy-in from multi-level stakeholders (i.e. government, clinicians, and patients), sufficient human and financial resources to maintain the work, and demonstrate cost effectiveness. For example, the Dutch program lost its government funding after twenty years but analyses of the outcomes of the program and advocacy by Dutch patients and health care providers achieved partial reinstatement of funding. The development and implementation of new solutions to increase pediatric lipid screening can benefit from understanding the successes and shortcomings of many of these programs.

These new solutions include opportunistic screening, newborn screening, point-of-care testing, screening by non-primary care health workers, and population-wide genetic screening (Table 5 and Fig. 1). Opportunistic screening provides a valuable avenue for increasing pediatric lipid screening rates, as capturing an individual's lipid sample at non-routine clinical touchpoints can improve FH identification. Addition of the most prevalent FH-causing variant in *LDLR* to newborn screening programming could provide vast clinical utility, both for identification and treatment of newborns, but also for cascade testing of their relatives. Point-of-care testing for cholesterol is a cost-effective, accessible, and accurate intervention for an initial screen in children that uses a capillary blood sample rather than traditional blood draw. While primary care clinicians bear the responsibility of screening children for lipids, other health care professionals are already well-positioned to assist. Pharmacists, workplace physicians, and optometry or ophthalmology colleagues can be impact players in ASCVD prevention and increase collaborative care efforts. Genetic testing services, both for commercial and scientific purposes, have continued to grow in popularity and provide further opportunity for increasing awareness of FH. However, while these commercial entities may provide valuable insight into one's genetic health, any positive result requires follow-up testing from an accredited laboratory that can better inform changes in management. The United Kingdom's Biobank and Geisinger's MyCode initiative are other population-based screening tools that provide crucial insights and further direction into identifying FH and increasing awareness on a large scale.[57,82]

Conclusion

Despite a wealth of evidence demonstrating the pathogenesis of atherosclerosis and the expanding arsenal of lipid-lowering therapies shown to prevent and combat ASCVD, cholesterol screening rates remain low in children. Clinicians today are faced with numerous challenges, both concrete and imagined, that prevent them from acting upon their interest in disease prevention. Implementation science provides a pathway to create acceptable, feasible, and effective strategies to overcome these challenges and to act upon existing enablers within health systems. New solutions can be developed and pilot-tested with this methodology to observe for changes in screening rates.

The examples of the difficulties experienced with FH screening in the United States and the United Kingdom, two large countries with very different but complex health care systems, and the success experienced in the Netherlands, Norway, and Slovenia, other countries with adequate resources, highlights both the challenges that need to be overcome and pathways to success created by implementation research.

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Abbreviations:

AAP	American Academy of Pediatrics
ACC	American College of Cardiology
AHA	American Heart Association
ASCVD	Atherosclerotic cardiovascular disease
FH	Familial hypercholesterolemia
IAS	International Atherosclerosis Society
LDL-C	Low density lipoprotein cholesterol
NHLBI	National Heart, Lung, and Blood Institute
NIH	National Institutes of Health
USPSTF	United States Preventive Services Task Force

References

1. Barry MJ, Nicholson WK, et al. United States Preventive Services Task Force Screening for lipid disorders in children and adolescents: US Preventive Services Task Force Recommendation Statement. JAMA. 2023;330:253–260. [PubMed: 37462699]
2. Allen-Tice C, Steinberger J, Murdy K, Zierhut H. Pediatric cholesterol screening practices in 9- to 11-year-olds in a large midwestern primary care setting. J Clin Lipidol. 2020;14:224–230. [PubMed: 32111582]
3. Khoury M, Rodday AM, Mackie AS, et al. Pediatric Lipid Screening and Treatment in Canada: Practices, Attitudes, and Barriers. Can J Cardiol. 2020;36:1545–1549. [PubMed: 32502521]
4. Groselj U, Kovac J, Sustar U, et al. Universal screening for familial hypercholesterolemia in children: The Slovenian model and literature review. Atherosclerosis. 2018;277:383–391. [PubMed: 30270075]
5. Matsunaga K, Mizobuchi A, Ying Fu H, et al. Universal Screening for Familial Hypercholesterolemia in Children in Kagawa. Japan. J Atheroscler Thromb. 2022;29:839–849.
6. Gidding SS, Robinson J. It Is Now Time to Focus on Risk Before Age 40. J Am Coll Cardiol. 2019;74:342–345. [PubMed: 31319916]
7. Luirink IK, Wiegman A, Kusters DM, et al. 20-Year Follow-up of Statins in Children with Familial Hypercholesterolemia. N Engl J Med. 2019;381:1547–1556. [PubMed: 31618540]
8. John C, Neal W. Screening children for hyperlipidemia by primary care physicians in West Virginia. W V Med J. 2012;108:30–35. [PubMed: 22792653]
9. Sustar U, Kordonouri O, Mlinaric M, et al. Universal screening for familial hypercholesterolemia in 2 populations. Genet Med. 2022;24:2103–2111. [PubMed: 35913489]
10. Klancar G, Groselj U, Kovac J, et al. Universal Screening for Familial Hypercholesterolemia in Children. J Am Coll Cardiol. 2015;66:1250–1257. [PubMed: 26361156]
11. Sarkies MN, Jones LK, Gidding SS, Watts GF. Improving clinical practice guidelines with implementation science. Nat Rev Cardiol. 2022;19:3–4. [PubMed: 34799708]
12. Bauer MS, Kirchner J. Implementation science: What is it and why should I care? Psychiatry Res. 2020;283:112376. [PubMed: 31036287]
13. Sarkies M, Jones LK, Pang J, Sullivan D, Watts GF. How Can Implementation Science Improve the Care of Familial Hypercholesterolaemia? Curr Atheroscler Rep. 2023;25:133–143. [PubMed: 36806760]

14. Jones LK, Williams MS, Ladd IG, et al. Collaborative Approach to Reach Everyone with Familial Hypercholesterolemia: CARE-FH Protocol. J Pers Med. 2022;12.
15. Jones LK RK, Schubert TJ, Clegg K, et al. Using Implementation Science to Develop a Familial Hypercholesterolemia Screening Program in Primary Care: The CARE-FH Study. J Clin Lipidol. 2024 S1933–2874(24)00002–3..
16. United States Preventive Services Task Force. Screening for lipid disorders in children: US Preventive Services Task Force recommendation statement. Pediatrics. 2007;120:e215–e219. [PubMed: 17606545]
17. Bibbins-Domingo K, Grossman DC, et al. United States Preventive Services Task Force Screening for Lipid Disorders in Children and Adolescents: US Preventive Services Task Force Recommendation Statement. JAMA. 2016;316:625–633. [PubMed: 27532917]
18. Expert Panel on Integrated Guidelines for Cardiovascular H, Risk Reduction in C, Adolescents, National Heart L, Blood IExpert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents: Summary report. Pediatrics. 2011;128(Suppl 5):S213–S256. [PubMed: 22084329]
19. Grundy SM, Stone NJ, Bailey AL, et al. 2018 AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS/APhA/ASPC/NLA/PCNA Guideline on the Management of Blood Cholesterol: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol. 2019;73:e285–e350. [PubMed: 30423393]
20. Zhang X, DeSantes K, Dodge A, et al. Practices and Attitudes Regarding Pediatric Cholesterol Screening Recommendations Differ Between Pediatricians and Family Medicine Clinicians. Pediatr Cardiol. 2022;43:631–635. [PubMed: 34727231]
21. Gidding SS. Childhood Screening for Familial Hypercholesterolemia: JACC Review Topic of the Week. J Am Coll Cardiol. 2023;82:1558–1563. [PubMed: 37793753]
22. Henschel AD, Rothenberger LG, Boos J. Randomized clinical trials in children–ethical and methodological issues. Curr Pharm Des. 2010;16:2407–2415. [PubMed: 20513232]
23. Vuorio A, Kuoppala J, Kovanen PT, et al. Statins for children with familial hypercholesterolemia. Cochrane Database Syst Rev. 2019;2019.
24. USPSTF search and filter for grade A and B pediatric recommendations. 2023. Accessed 10/25/2023 at https://www.uspreventiveservicestaskforce.org/uspstf/topic_search_results?topic_status=P&grades%5B%5D=A&grades%5B%5D=B&age_group%5B%5D=8&searchterm=.
25. Finberg LBE, Dweck HS, et al. American Academy of Pediatrics Committee on Nutrition: Indications for cholesterol testing in children. Pediatrics. 1989;83:141–142. [PubMed: 2909965]
26. American Academy of PediatricsNational Cholesterol Education Program: Report of the Expert Panel on Blood Cholesterol Levels in Children and Adolescents. Pediatrics. 1992;89:525–584. [PubMed: 1538956]
27. Goldberg AC, Hopkins PN, Toth PP, et al. Familial hypercholesterolemia: Screening, diagnosis and management of pediatric and adult patients: Clinical guidance from the National Lipid Association Expert Panel on Familial Hypercholesterolemia. J Clin Lipidol. 2011;5:133–140. [PubMed: 21600517]
28. Geoffrey RS, Cynthia B, Graham AB 3rd, et al. 2014 recommendations for pediatric preventive health care. Pediatrics. 2014;133:568–570. [PubMed: 24567012]
29. Jacobson TA, Maki KC, Orringer CE, et al. National Lipid Association Recommendations for Patient-Centered Management of Dyslipidemia: Part 2. J Clin Lipidol. 2015;9 S1–122 e1.
30. Jellinger PS, Handelsman Y, Rosenblit PD, et al. American Association of Clinical Endocrinologists and American College of Endocrinology Guidelines for Management of Dyslipidemia and Prevention of Cardiovascular Disease. Endocr Pract. 2017;23:1–87.
31. Groselj U, Wiegman A, Gidding SS. Screening in children for familial hypercholesterolaemia: Start now. Eur Heart J. 2022;43:3209–3212. [PubMed: 35511818]
32. Gidding SS, Wiegman A, Groselj U, et al. Paediatric familial hypercholesterolaemia screening in Europe: Public policy background and recommendations. Eur J Prev Cardiol. 2022;29:2301–2311. [PubMed: 36059237]

33. Kreissl A, Walleczek N, Espina PR, Hallwirth U, Greber-Platzer S. Selective screening for familial hypercholesterolemia in Austrian children - first year results. BMC Pediatr. 2019;19:208. [PubMed: 31238984]
34. Sanin V, Schmieder R, Ates S, et al. Population-based screening in children for early diagnosis and treatment of familial hypercholesterolemia: Design of the VRONI study. Eur J Public Health. 2022;32:422–428. [PubMed: 35165720]
35. Becker M, Adamski A, Fandel F, et al. Screening for familial hypercholesterolaemia in primary school children: Protocol for a cross-sectional, feasibility study in Luxembourg city (EARLIE). BMJ Open. 2022;12:e066067.
36. Watts GF, Gidding SS, Hegele RA, et al. International Atherosclerosis Society guidance for implementing best practice in the care of familial hypercholesterolaemia. Nat Rev Cardiol. 2023.
37. Lin TK, Dispenza TC. Cholesterol Screening in Children: Is a Universal Approach Working? Curr Atheroscler Rep. 2023;25:579–590. [PubMed: 37594601]
38. Ritchie SK, Murphy EC, Ice C, et al. Universal versus targeted blood cholesterol screening among youth: The CARDIAC project. Pediatrics. 2010;126:260–265. [PubMed: 20624798]
39. Wald DS, Bestwick JP, Wald NJ. Child-parent screening for familial hypercholesterolaemia: Screening strategy based on a meta-analysis. BMJ. 2007;335:599. [PubMed: 17855284]
40. Steiner MJ, Skinner AC, Perrin EM. Fasting might not be necessary before lipid screening: A nationally representative cross-sectional study. Pediatrics. 2011;128:463–470. [PubMed: 21807697]
41. Board JBS. Joint British Societies' consensus recommendations for the prevention of cardiovascular disease (JBS3). Heart. 2014;100(Suppl 2):ii1–ii67. [PubMed: 24667225]
42. Lipid Modification: Cardiovascular Risk Assessment and the Modification of Blood Lipids for the Primary and Secondary Prevention of Cardiovascular Disease. London 2014.
43. Chapman MJ, Ginsberg HN, Amarenco P, et al. Triglyceride-rich lipoproteins and high-density lipoprotein cholesterol in patients at high risk of cardiovascular disease: Evidence and guidance for management. Eur Heart J. 2011;32:1345–1361. [PubMed: 21531743]
44. McMillan JA, Land M Jr, Tucker AE, Leslie LK. Preparing Future Pediatricians to Meet the Behavioral and Mental Health Needs of Children. Pediatrics. 2020:145.
45. Cooper S, Valleley RJ, Polaha J, Begeny J, Evans JH. Running out of time: Physician management of behavioral health concerns in rural pediatric primary care. Pediatrics. 2006;118:e132–e138. [PubMed: 16818528]
46. Jones LK, Sturm AC, Seaton TL, et al. Barriers, facilitators, and solutions to familial hypercholesterolemia treatment. PLoS One. 2020;15:e0244193. [PubMed: 33362269]
47. Mahan JD. Burnout in Pediatric Residents and Physicians: A Call to Action. Pediatrics. 2017:139.
48. Soukup J, Zierhut HA, Ison HEof UMNGCPC. Universal Cholesterol Screening among Pediatric Primary Care Providers within California and Minnesota: A Qualitative Assessment of Barriers and Facilitators. J Pediatr. 2021;233 175–82 e2.
49. Pang J, Chan DC, Hu M, et al. Comparative aspects of the care of familial hypercholesterolemia in the "Ten Countries Study". J Clin Lipidol. 2019;13:287–300. [PubMed: 30797720]
50. Pang J, Sullivan DR, Harada-Shiba M, et al. Significant gaps in awareness of familial hypercholesterolemia among physicians in selected Asia-Pacific countries: A pilot study. J Clin Lipidol. 2015;9:42–48. [PubMed: 25670359]
51. Batais MA, Almigbal TH, Bin Abdulhak AA, Altaradi HB, Al-Habib KF. Assessment of physicians' awareness and knowledge of familial hypercholesterolemia in Saudi Arabia: Is there a gap? PLoS One. 2017;12:e0183494. [PubMed: 28817709]
52. Block RC, Bang M, Peterson A, Wong ND, Karalis DG. Awareness, diagnosis and treatment of heterozygous familial hypercholesterolemia (HeFH) - Results of a US national survey. J Clin Lipidol. 2021;15:682–689. [PubMed: 34593357]
53. Gidding SS, Sheldon A, Neben CL, et al. Patient acceptance of genetic testing for familial hypercholesterolemia in the CASCADE FH Registry. J Clin Lipidol. 2020;14 218–23 e2.
54. de Ferranti SD, Rodday AM, Parsons SK, et al. Cholesterol Screening and Treatment Practices and Preferences: A Survey of United States Pediatricians. J Pediatr. 2017;185 99–105 e2. [PubMed: 29144243]

55. Kinnear FJ, Wainwright E, Perry R, et al. Enablers and barriers to treatment adherence in heterozygous familial hypercholesterolaemia: A qualitative evidence synthesis. BMJ Open. 2019;9:e030290.
56. Kedward J, Dakin L. A qualitative study of barriers to the use of statins and the implementation of coronary heart disease prevention in primary care. Br J Gen Pract. 2003;53:684–689. [PubMed: 15103875]
57. Abul-Husn NS, Manickam K, Jones LK, et al. Genetic identification of familial hypercholesterolemia within a single U.S. health care system. Science. 2016;354.
58. Clegg K, Schubert TJ, Block RC, et al. Translating Evidence-based Approaches into optimal Care for individuals at High-risk of ASCVD: Pilot testing of case-based e-learning modules and design of the TEACH-ASCVD study. J Clin Lipidol. 2023;17:592–601. [PubMed: 37550150]
59. Scott L, Dunn L, Oliver J. Increasing lipid screenings in children 9–11 years old at a federally qualified health center - A quality improvement project. J Pediatr Nurs. 2022;67:1–6. [PubMed: 35870386]
60. Krass I, Walker AT, Watts GF. Detection and care of familial hypercholesterolaemia in the community: Is there a role for the pharmacist? Int J Clin Pharm. 2012;34:501–505. [PubMed: 22622591]
61. Ramaswami U, Humphries SE, Priestley-Barnham L, et al. Current management of children and young people with heterozygous familial hypercholesterolaemia - HEART UK statement of care. Atherosclerosis. 2019;290:1–8. [PubMed: 31536851]
62. Marks D, Wonderling D, Thorogood M, Lambert H, Humphries SE, Neil HA. Screening for hypercholesterolaemia versus case finding for familial hypercholesterolaemia: A systematic review and cost-effectiveness analysis. Health Technol Assess. 2000;4:1–123.
63. Hallowell N, Jenkins N, Douglas M, et al. Patients' experiences and views of cascade screening for familial hypercholesterolemia (FH): a qualitative study. J Community Genet. 2011;2:249–257. [PubMed: 22109877]
64. Humphries SE, Ramaswami U, Hopper N. Should Familial Hypercholesterolaemia Be Included in the UK Newborn Whole Genome Sequencing Programme? Curr Atheroscler Rep. 2023;25:1083–1091. [PubMed: 38060059]
65. Wald DS, Bestwick JP, Morris JK, Whyte K, Jenkins L, Wald NJ. Child–Parent Familial Hypercholesterolemia Screening in Primary Care. N Engl J Med. 2016;375:1628–1637. [PubMed: 27783906]
66. Futema M, Cooper JA, Charakida M, et al. Screening for familial hypercholesterolaemia in childhood: Avon Longitudinal Study of Parents and Children (ALSPAC). Atherosclerosis. 2017;260:47–55. [PubMed: 28349888]
67. Familial hypercholesterolaemia: identification and management. National Health Care and Excellence (NICE) Guidance CG71. 2008. Accessed February 11, 2024 at https://www.nice.org.uk/Guidance/CG71.
68. Kerr M, Pears R, Miedzybrodzka Z, et al. Cost effectiveness of cascade testing for familial hypercholesterolaemia, based on data from familial hypercholesterolaemia services in the UK. Eur Heart J. 2017;38:1832–1839. [PubMed: 28387827]
69. McKay AJ, Hogan H, Humphries SE, Marks D, Ray KK, Miners A. Universal screening at age 1–2 years as an adjunct to cascade testing for familial hypercholesterolaemia in the UK: A cost-utility analysis. Atherosclerosis. 2018;275:434–443. [PubMed: 29937236]
70. Page C, Zheng H, Wang H, et al. A comparison of the Netherlands, Norway and UK familial hypercholesterolemia screening programmes with implications for target setting and the UK's NHS long term plan. PLOS Glob Public Health. 2023;3:e0001795. [PubMed: 37097994]
71. Wald DS, Neely D. The UK National Screening Committee's position on child-parent screening for familial hypercholesterolaemia. J Med Screen. 2021;28:217–220. [PubMed: 34292841]
72. Tobik K, Orland KM, Zhang X, Garcia K, Peterson AL. Parental Attitudes and Ideas Regarding Newborn Screening for Familial Hypercholesterolemia. Matern Child Health J. 2023;27:978–983. [PubMed: 36964843]

73. Haney EM, Huffman LH, Bougatsos C, Freeman M, Steiner RD, Nelson HD. Screening and treatment for lipid disorders in children and adolescents: Systematic evidence review for the US Preventive Services Task Force. Pediatrics. 2007;120:e189–e214. [PubMed: 17606543]
74. Authors/Task Force MGuidelines ESCCfP. Societies ESCNC. 2019 ESC/EAS guidelines for the management of dyslipidaemias: Lipid modification to reduce cardiovascular risk. Atherosclerosis. 2019;290:140–205. [PubMed: 31591002]
75. Recommendations for preventive pediatric health care. American Academy of Pediatrics, 2023. Accessed 10/25/2023 at https://www.aap.org/periodicityschedule.
76. Laurence CO, Moss JR, Briggs NE, Beilby JJPo CTTMG. The cost-effectiveness of point of care testing in a general practice setting: Results from a randomised controlled trial. BMC Health Serv Res. 2010;10:165. [PubMed: 20546629]
77. Bastianelli K, Ledin S, Chen J. Comparing the Accuracy of 2 Point-of–Care Lipid Testing Devices. J Pharm Pract. 2017;30:490–497. [PubMed: 27313238]
78. DeSantes K, Dodge A, Eickhoff J, Peterson AL. Improving Universal Pediatric Lipid Screening. J Pediatr. 2017;188:87–90. [PubMed: 28595766]
79. Daniels SR. Lipid Screening in Children. J Am Coll Cardiol. 2015;66:1258–1260. [PubMed: 26361157]
80. Farnier M, Civeira F, Descamps O, group FHew. How to implement clinical guidelines to optimise familial hypercholesterolaemia diagnosis and treatment. Atheroscler Suppl. 2017;26:25–35. [PubMed: 28434482]
81. Kordonouri O, Arens S, Lange K, Christoph J, Marquardt E, Danne TPA. Direct LDL-C estimation in preschoolers: Practicable first step for FH screening. J Clin Lipidol. 2023;17:255–260. [PubMed: 36858936]
82. Bycroft C, Freeman C, Petkova D, et al. The UK Biobank resource with deep phenotyping and genomic data. Nature. 2018;562:203–209. [PubMed: 30305743]
83. Vallejo-Vaz AJ, De Marco M, et al. Collaboration EASFHS Overview of the current status of familial hypercholesterolaemia care in over 60 countries - The EAS Familial Hypercholesterolaemia Studies Collaboration (FHSC). Atherosclerosis. 2018;277:234–255. [PubMed: 30270054]
84. Louter L, Defesche J, Roeters van Lennep J. Cascade screening for familial hypercholesterolemia: Practical consequences. Atheroscler Suppl. 2017;30:77–85. [PubMed: 29096865]
85. Galema-Boers JM, Versmissen J, Roeters van Lennep HW, Dusault-Wijkstra JE, Williams M, Roeters van Lennep JE. Cascade screening of familial hypercholesterolemia must go on. Atherosclerosis. 2015;242:415–417. [PubMed: 26282946]
86. Leren TP, Manshaus T, Skovholt U, et al. Application of molecular genetics for diagnosing familial hypercholesterolemia in Norway: Results from a family-based screening program. Semin Vasc Med. 2004;4:75–85. [PubMed: 15199436]
87. Leren TP, Bogsrud MP. Molecular genetic testing for autosomal dominant hypercholesterolemia in 29,449 Norwegian index patients and 14,230 relatives during the years 1993–2020. Atherosclerosis. 2021;322:61–66. [PubMed: 33740630]
88. Child-Parent Screening Service (CPSS): A pilot screening service for FH. Heart UK, 2024. Accessed February 11, 2024 at https://www.heartuk.org.uk/fh/cpss-information-for-parents.
89. Thajer A, Baumgartner M, Jorda A, Hallwirth U, Lischka J, Greber–Platzer S. A selective screening strategy performed in pre-school children and siblings to detect familial hypercholesterolemia. Children (Basel). 2022;9.
90. Agbaje AO. Adolescents cholesterol passport: A universal pediatric lipid screening tool to combat atherosclerosis-the world's deadliest scourge. Front Pediatr. 2023;11:1228483. [PubMed: 37456560]
91. Futema M, Ramaswami U, Tichy L, et al. Comparison of the mutation spectrum and association with pre and post treatment lipid measures of children with heterozygous familial hypercholesterolaemia (FH) from eight European countries. Atherosclerosis. 2021;319:108–117. [PubMed: 33508743]
92. Haggerty L, Tran D. Cholesterol Point-of-Care Testing for Community Pharmacies: A Review of the Current Literature. J Pharm Pract. 2017;30:451–458. [PubMed: 27121870]

93. List of Personalized Genetic Reports. 23andMe, 2024. Accessed October 25, 2023 at https://www.23andme.com/dna-reportslist/.

94. European Atherosclerosis Society Familial Hypercholesterolaemia Studies C. Familial hypercholesterolaemia in children and adolescents from 48 countries: A cross-sectional study. Lancet. 2024;403:55–66. [PubMed: 38101429]

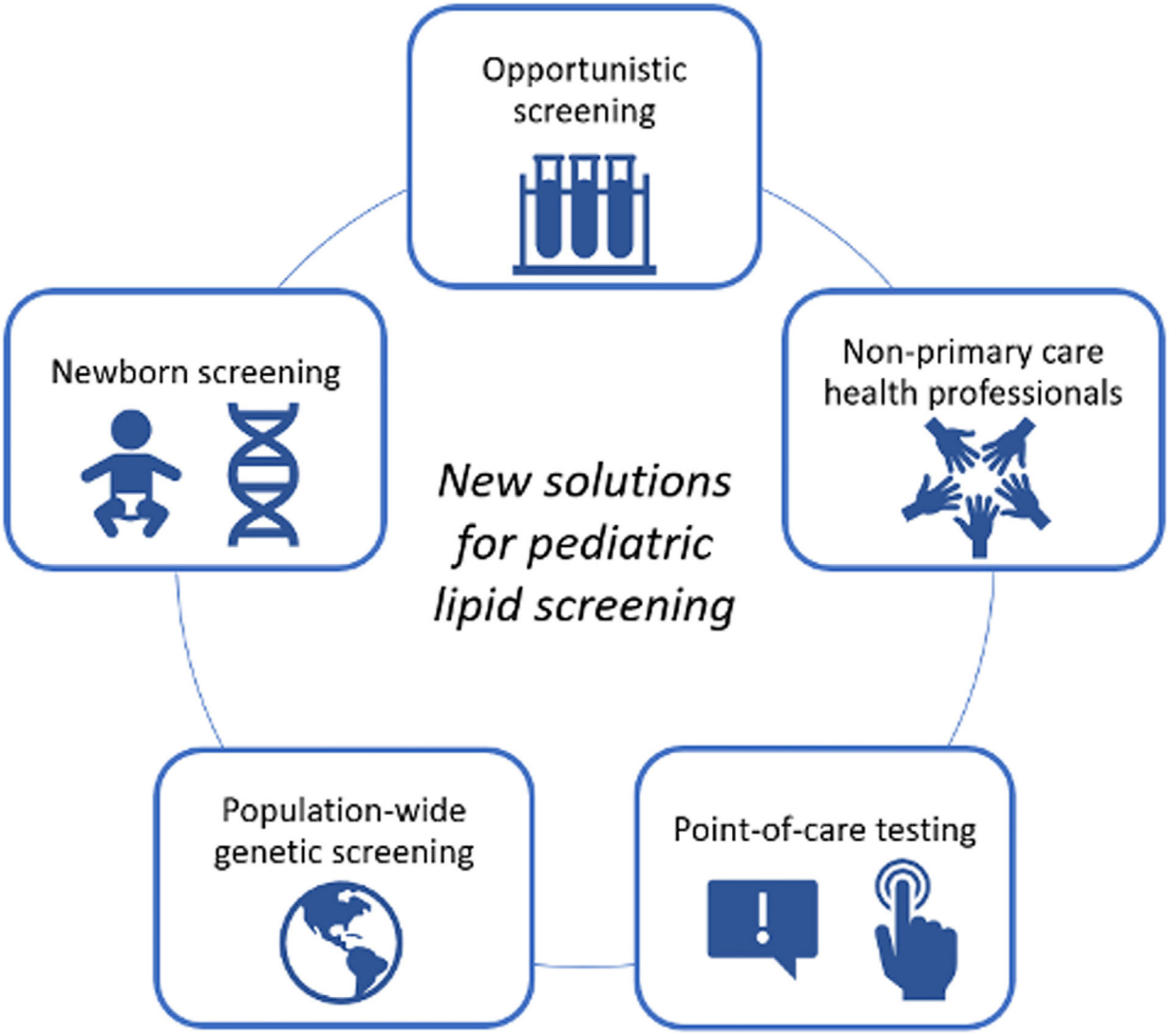

Fig. 1.

New solutions for pediatric lipid screening. The figure illustrates five proposed solutions to overcome the real and imagined barriers to pediatric lipid screening. Opportunistic screening of lipids can occur at any previously scheduled blood draw. Non-primary care health professionals, such as pharmacists, workplace physicians, and optometrists, can all play a role in identifying pediatric dyslipidemia through screening and physical exam. Point-of-care cholesterol testing can reduce blood draw anxiety among children and may provide a more accessible testing method. Population-wide genetic screening programs can include FH among its actionable results. Newborn screening programs can add common FH variants to identify cases early in life.

Table 1

Evolution of United States pediatric lipid screening recommendations.

Guideline	Recommendation for pediatric lipid screening	Recommendation against pediatric lipid screening
1989 AAP Committee on Nutrition	Selective screening of children 2 years and older.[25]	
1992 NIH National Cholesterol Education Panel	Selective screening of children 2 years and older.[26]	
2007 USPSTF	Sparse information regarding the epidemiology and pathophysiology of "familial dyslipidemia."[16]	Insufficient evidence to screen individuals 20 years and younger.[16]
2011 NHLBI / AAP	Universal screening of children aged 9–11 and 17–21.[18] Targeted screening of children aged 2–8 or 12–16.[18]	
2011 NLA	Universal screening of children aged 9–11 with all patients screened by age 20.[27] Selective screening beginning at age 2.[27]	
2014 AAP Bright Futures	Endorses 2011 NHLBI / AAP recommendations.[28]	
2015 NLA	Selective screening of children 2 years and older.[29]	
2016 USPSTF	Universal screening of children aged 9–11 and at 20 years old.[29] First mention of expanded details on the two most common forms of dyslipidemia in children: FH and "multi-factorial dyslipidemia."[1,16,17]	Insufficient evidence to screen individuals 20 years and younger.[17]
2017 AACE / ACE	Selective screening of children at ages under 3, between 9 and 11, and at 18. Patients older than 16 should be screened every 5 years.	Endorses previous NLA, AAP, and NHLBI guidelines but states "universal screening may be reasonable."[30]
2018 AHA / ACC multi-society	Selective screening of children 2 years and older.[19]	Universal screening in children ages 9- to 11- years old and again at 17- to 21- years old *"may be reasonable* given the substantial benefits of identifying severe hypercholesterolemia … including FH, and possible benefits of lifestyle counseling for multi-factorial dyslipidemias."[19]
2023 USPSTF	Includes details of "FH prevalence, polygenic variants, and health outcomes."[1]	Insufficient evidence to screen individuals 20 years and younger.[1]

Abbreviations: American Academy of Pediatrics (AAP); National Institutes of Health (NIH); United States Preventive Services Task Force (USPSTF); National Heart, Lung, and Blood Institute (NHLBI); National Lipid Association (NLA); American Association of Clinical Endocrinologists (AACE); American College of Endocrinology (ACE); American Heart Association (AHA); American College of Cardiology (ACC).

Table 2

Real barriers and corresponding solutions to increase pediatric lipid screening.

Existing challenges		Evidence	Current and proposed solutions
System-level	Selective screening	Nearly 50% of children identified as having dyslipidemia in the CARDIAC study did not have a positive family history for cardiovascular disease.[38] Estimated 30–60% of children with dyslipidemia would not be identified if using selective screening guidance from 2007 USPSTF recommendation statement.[73] U.S. pediatricians reported screening for lipids in 9- to 11- year old children with obesity (82%) or family history of cardiovascular disease (61%) most/some/all of the time, compared to 32% of the time in healthy children.[54]	Universal, selective, and opportunistic screening strategies can all be employed to identify FH cases, with cascade testing implemented thereafter to identify affected relatives.[36] Creation of FH screening programs in primary care.[15] Addition of most common FH variants to newborn screening.[64,72] Adaptation of population-based genetic screening for actionable conditions[57] is cost-effective for parent-child FH screening.[69]
	Fasting status	Cross-sectional study of 12,000 children: Non-fasting children had an average 7 mg/dL higher triglycerides than those who completed an eight hour fast; no clinically significant changes between TC, LDL-C, HDL-C.[40] Family physicians may use a child's non-fasting status as reason to forgo cholesterol screening in comparison to pediatricians.[20]	Removal of fasting status from clinical recommendations and screening guidelines.[19,41–43,74] Targeted education regarding non-clinically significant differences between fasting and non-fasting lipid samples. Collect lipids at initial primary care visit to encourage family compliance.
Clinician-level	Insufficient time	Increasing prevalence of mental health issues for pediatric visits.[44,45] Non-patient facing responsibilities take away from patient care.[46,47]	Opportunistic screening measures: "piggybacking" laboratory samples on other required testing at ages 1–2,[75] screening by non-primary care health professionals.[15,60,76] Point-of-care testing outside the clinician's office.[77]
	Limited FH knowledge	Gaps in FH awareness and knowledge exist across the globe.[49,51]	Focused educational interventions regarding updated screening guidelines can improve lipid screening rates.[59]
		Primary care clinicians and cardiologists may not identify and treat heterozygous FH at an optimal level.[52]	Online modules deliver evidence-based practices to clinicians to increase awareness of clinical problems.[58] Inclusion of pediatric lipid screening as quality metric.[15]
	Physical office	Pediatricians reported that adapting clinical workflow to comply with updated guidelines was a barrier to screening.[48]	Screen children at school as seen in the Austrian national program,[33] the CARDIAC study,[38] and the EARLIE study.[35] Point-of-care testing outside the clinician's office.[77]
	Apprehension of treating pediatric dyslipidemia	Clinician hesitancy to prescribe lipid-lowering medication to children,[54,55] despite endorsement of statin use in children by multi-society guidelines and evidence of their safety in children.[7,19] Discomfort to prescribe lipid-lowering therapies includes patient complexity, lifelong cost of medications, and perceived patient refusal of treatment.[56]	Targeted education for both clinicians and patients regarding the use, cost, and potential side effects of lipid-lowering therapies in children.

Abbreviations: United States Preventive Services Task Force (USPSTF); familial hypercholesterolemia (FH); total cholesterol (TC); low density lipoprotein-cholesterol (LDL-C); high density lipoprotein-cholesterol (HDL-C).

Table 3

Imagined barriers, contrary evidence, and corresponding solutions to increase pediatric lipid screening.

Imagined challenges	Contrary evidence	Proposed solutions
Existence of a best age to screen for lipids	FH Expert Group has endorsed "childhood" as the best time to screen for lipids in children.[80] No evidence suggesting an optimal age to screen children for lipids.[78,79] Multiple trials investigating FH screening in children: Slovenian universal program[4]: 5–6 years old FH Kids Austria (Austria)[33]: 5–7 years old Fr1dolin-Trial (Germany)[81]: 2- to 6-years old VRONI study[34] (Germany): 5- to 14-years old EARLIE study[35] (Belgium): 7- to 12-years old Child-parent FH screening in the UK[65,66]: 13 months old Meta-analysis found 88% of individuals with FH could be identified through routine lipid testing between 1 and 9 years old.[39]	Targeted education regarding lack of best age to screen. Encourage clinicians to screen children when it is most convenient for the individual and their family.
Poor physician interest in ASCVD prevention	Clinicians in CARE-FH trial reported early ASCVD prevention as an essential component of their primary care practice.[15] Two-thirds of surveyed Canadian pediatricians disagreed or strongly disagreed with lipid screening before puberty or late adolescence in otherwise healthy children.[3] Nearly a quarter of surveyed pediatricians in the United States reported cholesterol screening in healthy children as a low priority.[54]	Address the barriers that prevent clinicians from acting upon their interest in ASCVD prevention.

Abbreviations: familial hypercholesterolemia (FH); United Kingdom (UK); low density lipoprotein-cholesterol (LDL-C); atherosclerotic cardiovascular disease (ASCVD).

Table 4

Sustainability of select lipid screening programs.

Screening program	Years	Program status	Details and conclusions
Slovenia: Universal screening	1994 – Present	Sustained	Law has required cholesterol testing in all individuals.[4,83]
Netherlands: FH cascade screening	1994–2014; Present	Sustained	Government funded from 1994 to 2014. Brief hiatus in 2014 after loss of funding. The program was demonstrated as cost-effective, funding was reinstated, and it continues to operate today.[83–85]
Norway: FH cascade screening	1991 – Present	Sustained	Government funded.[86,87]
United Kingdom: Child-parent FH screening	2012 – 2015[65]; Present[88]	Early stages	Aims to screen 10,000 children by October 2024 and will roll-out nationwide thereafter.[65,66,88]
Austria: FH Kids Austria	2017	Pilot	Performing cholesterol screening as part of school entry examination was successful and viewed as “possible” in the future.[33,89]
Germany: Fr1dolin-Trial	2016 – 2021	Pilot	Direct LDL-C measurement in preschoolers during compulsory examination was “practicable and delivers reliable information.”[81]
Germany: VRONI study	2021 – 2024	Pilot	Currently underway.[34]
Belgium: EARLIE study	2021 – 2023	Pilot	Recently completed with conclusions pending.[35]

Abbreviations: familial hypercholesterolemia (FH); low density lipoprotein-cholesterol (LDL-C).

Table 5

Rationale for new solutions to increase pediatric lipid screening.

Solution	Rationale	Potential for implementation science
Opportunistic screening	Promotes addition of lipid screen on top of previously scheduled laboratory work. Serves as an entry point in assessing a child's ASCVD risk. AAP's recommendation to screen for lead and anemia between ages 1–2 provides opportunity to add cholesterol, among other Bright Futures benchmarks.[75]	Identify optimal touchpoints that facilitate opportunistic screening for cholesterol. Collect blood sample for opportunistic screening in compliance with system or practice protocol. Evaluation of patient-centered measures, including "cholesterol passports" that encourage screening at various life milestones, as acceptable, appropriate, or feasible.[90]
Newborn screening	A mutation in *LDLR* was identified as the most common cause of FH in children in eight European countries.[91] Addition of most common FH-causing mutation in *LDLR* could identify new cases and promote cascade screening.	Evaluation of parental opinions of adding FH to Canadian newborn screening was viewed favorably for early diagnosis, initiation of lifestyle modifications, and the ability to screen family members for FH.[72] Parental concern over treatment delay, poor knowledge of FH, and stigma surrounding diagnosis were identified negatives.[72] The United Kingdom announced plans for a newborn whole genome sequencing program to identify treatable inherited disorders, and one analysis found that FH meets inclusion criteria for such a program.[64]
Point-of-care testing	Two commercial point-of-care testing methods are currently used in the U.S.[37] Multiple trials have used capillary sampling for their data collection.[34,65,81] Point-of-care testing can provide clinically similar metrics[77] and greater accessibility[76] compared to traditional blood draws.	Evaluation of both clinician and patient attitudes concerning point-of-care testing Feasibility of using point-of-care testing in non-clinical spaces, including at home or school. Integration of methods from studies using point-of-care testing as a first-step in lipid screening can inform future screening programs.[81]
Role of non-primary care health professionals	Pharmacists can screen, identify, and educate patients with FH.[60,92] Workplace physicians could screen for cholesterol as part of annual wellness physicals or could incentivize screening for lower insurance costs. Optometrists and ophthalmologists can identify FH stigmata and refer patients for lipid testing.	Exploration of attitudes of non-primary care health professionals concerning their role in ASCVD prevention.
Population-wide genetic screening	23andMe genetic testing service presently assesses for 24 known pathogenic variants in *LDLR* and *APOB* genes.[93] Geisinger's MyCode[57] and the United Kingdom's Biobank[82] provide key population-level insights into FH. An estimated 50–75% of children with heterozygous FH would not be identified through use of clinical criteria compared to a genetic diagnosis.[94]	Exploration of patient and clinician attitudes and experiences with genetic testing services to identify FH.

Abbreviations: atherosclerotic cardiovascular disease (ASCVD); American Academy of Pediatrics (AAP); familial hypercholesterolemia (FH); low density lipoprotein receptor (*LDLR*); apolipoprotein B (*APOB).*