



Published in final edited form as:

Obesity (Silver Spring). 2025 October ; 33(10): 1921–1929. doi:10.1002/oby.24365.

Assessment of Guideline-Recommended Laboratory Screening for Obesity-Related Chronic Conditions in US Youth 10–18 Years

Samantha Lange Pierce, MPH^a, Emily M. Kraus, MPH PhD^{a,b}, Renee Porter, DNP^a, Mona Sharifi, MD, MPH^c, Lyudmyla Kompaniyets, PhD^a, Alyson B. Goodman, MD, MPH^{a,d}

^aDivision of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA, USA

^bPublic Health Informatics Institute, Task Force for Global Health, Atlanta, GA, USA

^cDepartment of Pediatrics, Yale School of Medicine, New Haven, CT, USA

^dUnited States Public Health Service Commissioned Corps, Rockville, MD USA

Abstract

Objective: The 2023 AAP Clinical Practice Guideline (CPG) recommends testing children ≥ 10 years with obesity for abnormalities in lipids, glucose metabolism, and liver function. We aimed to assess laboratory screening and test results for three obesity-related chronic conditions in a large cohort of US patients 10–18y with obesity.

Methods: We used electronic health record data to estimate (1) prevalence of screening for diabetes, dyslipidemia, and nonalcoholic fatty liver disease (NAFLD), individually and in combination, and (2) prevalence of abnormal test results, by obesity severity and demographics.

Results: Among 333,110 patients, only one-quarter (26%) were screened for diabetes, dyslipidemia, or NAFLD during 2020–2022. Among those screened, complete screening (all 3 conditions) occurred half of the time. Screening rates were significantly higher in those with more severe obesity, yet 64% of children with class 3 obesity remained unscreened. When screening occurred, results revealed a high proportion of abnormal lipid (56%), NAFLD (44% elevated or borderline), and diabetes markers (14% prediabetes or diabetes).

Conclusions: Most youth with obesity were not screened for chronic conditions. Many who were screened had abnormal results. These findings establish baseline estimates and highlight opportunities for improvement in uptake of CPG recommendations to support evidence-based obesity pediatric care.

Keywords

child obesity; screening; clinical practice guidelines

Corresponding Author: Samantha Lange Pierce, 4770 Buford Hwy NE, Atlanta, GA 30341, nya7@cdc.gov.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Introduction

Obesity affects more than 14.7 million US children and adolescents (19.7%),¹ making it one of the most common pediatric chronic conditions. Children with obesity have high amounts of adipose cells that secrete inflammatory cytokines in the body; this chronic inflammation can lead to cardiometabolic health risks, such as impaired glucose tolerance, abnormal cholesterol and other lipid levels, and high blood pressure.² Obesity also increases risk for other serious chronic diseases, including type 2 diabetes, dyslipidemia, and nonalcoholic fatty liver disease (NAFLD, now commonly called metabolic dysfunction-associated steatotic liver disease or MASLD).³

Due to the high burden of obesity and its well-established association with chronic diseases, screening youth with obesity for co-occurring chronic diseases has been recommended for more than a decade.⁴ Most recently, in 2023, the American Academy of Pediatrics (AAP) released a clinical practice guideline (CPG) to further support evidence-based evaluation and treatment of childhood obesity.⁵ Though it was not the first to recommend screening, it did consolidate a wealth of existing evidence and recommendations for pediatric healthcare providers. According to the CPG, clinicians should evaluate all children with obesity aged 10 years and older for abnormal lipids, glucose metabolism, and liver function (Key Action Statement #3). Screening can provide early detection, diagnosis, and intervention. Interventions are based on patient and family readiness as well as severity of obesity and comorbidities, and can include: motivational interviewing to encourage behavior change; family-centered intensive health behavior and lifestyle treatment (IHBLT) programs; or pharmacotherapy. These interventions can prevent or delay serious complications and improve health outcomes.

Despite benefits of screening and early intervention, prior studies using electronic health record (EHR) data generally found very low rates of laboratory screening for obesity-related conditions. For example, studies reported a dyslipidemia screening rate of 9–11% among 9–16-year-olds with obesity,⁶ a diabetes screening rate of 13% among 10–19-year-olds with obesity,⁷ and a NAFLD screening rate of 14% among 9–19-year-olds with obesity⁸ during 2019–2021. Screening rates were higher in children with higher body mass index (BMI),^{6–10} older children,^{6,9–10} and females.^{7–10} Another study of commercial claims data found that approximately 27% of children with diagnosed obesity received laboratory screening for diabetes, dyslipidemia, and NAFLD.¹¹ Although screening prevalence was generally low, the prevalence of elevated lab results was high.^{6–9} For example, among children and adolescents with obesity in 2019–2021, 22% of those screened for diabetes, 44% of those screened for NAFLD, and more than 50% of those screened for dyslipidemia had elevated lab results.^{6–8} Abnormal results were even more common in those with severe obesity.

Prior studies have assessed screening for these conditions individually^{6–10} or in combination but without demographics or measured BMI data.¹¹ However, we are not aware of any that have assessed screening for all three conditions, calculated prevalence of abnormal laboratory results, and used measured BMI to examine differences by obesity severity. Baseline estimates prior to the release of the CPG can help track changes in uptake of CPG recommendations over time. The present study used a large cross-sectional cohort of

US children and adolescents with obesity to estimate (1) the prevalence of screening for NAFLD, dyslipidemia, and diabetes, individually and in combination, and (2) the prevalence of abnormal test results for NAFLD, dyslipidemia, and diabetes, overall and by obesity severity and patient demographics.

Methods

Data Source & Cleaning

IQVIA's Ambulatory Electronic Medical Record (AEMR-US) database contains structured clinical data for >90 million patients, including 15 million children. Data come from a single EHR vendor that collects data from >100,000 healthcare providers affiliated with >800 medium-to-large US ambulatory practices and physician networks. Though not nationally representative, the dataset is geographically diverse with over-representation in the south. Data, including clinical diagnoses, medication orders, and laboratory test results, were extracted using IQVIA's Health Data Engine, a web-based software as a service platform (OMOP Version 5, February 2023 data release).¹²

Height and weight measurements for patients aged 2–19 years during 2009–2022 were extracted and cleaned using growthcleanr, an algorithm for detecting errors in longitudinal anthropometric EHR data.^{13–14} We further excluded extreme values of BMI (kg/m²) and BMI z-score based on CDC's cutpoints.¹⁵ This resulted in excluding <3% of patients. BMIs were categorized based on sex- and age-specific percentiles: underweight (<5th percentile), healthy weight (≥5th to <85th percentile), overweight (≥85th to <95th percentile), class 1 obesity (≥95th percentile to <120% of the 95th percentile), class 2 obesity (≥120% to <140% of the 95th percentile), and class 3 obesity (≥140% of the 95th percentile).¹⁶ To explore baseline data for the CPG in a screening-eligible population, we cropped the dataset to BMIs for patients aged 10–18 years in 2020–2022.

Eligibility Criteria

A total of 1,494,743 patients aged 10–18 years had ≥1 valid BMI in 2020–2022; this represents 75% of patients aged 10–18 years in IQVIA's AEMR-US. The study sample included those with ≥1 BMI ≥95th percentile (n = 350,681 or 23%) during the time period. If patients had multiple BMIs ≥95th percentile, the highest was used to define obesity class. Patients were excluded if they had evidence of NAFLD (n = 2,611), dyslipidemia (n = 8,609), or diabetes (n = 3,338) in the EHR during the 2 years preceding the study (2018–2019) or if they were pregnant (n = 5,044) during the study (2020–2022); exclusion conditions were not mutually exclusive. The final study sample was 333,110.

Specifically, exclusion criteria comprised the following: diagnostic code for NAFLD or NAFLD-like conditions, order for anti-retroviral or hepatotoxic medications, diagnostic code for non-NAFLD conditions that impact liver function (e.g., hepatitis),¹⁷ diagnostic code for diabetes, order for diabetes medications, code for insulin pumps or continuous glucose monitors, diagnostic code for dyslipidemia, or order for dyslipidemia medications (i.e., statins) (Tables S1–S3). Of note, if patients had orders for only metformin, a common diabetes medication, they were not excluded because metformin is also prescribed as an

anti-obesity medication. Pregnancy exclusion criteria comprised >900 diagnostic codes, derived from a previously-established algorithm, applied to female patients.¹⁸

Screening Tests

For cleaning, we extracted non-missing, non-zero results for 13 laboratory tests from 2011–2022. For NAFLD, alanine transaminase (ALT) tests were included. For dyslipidemia, tests included total cholesterol, triglycerides, low-density lipoprotein, high-density lipoprotein (HDL), very low-density lipoprotein, and non-high-density lipoprotein. For diabetes, CPG-recommended tests included glycated hemoglobin (A1c), fasting blood glucose, and oral glucose tolerance test (OGTT); we also included random blood glucose, blood glucose test without specified fasting status (unspecified glucose), and non-2-hour glucose tolerance test (other GTT) due to common use in practice.

Screening test results were categorized as healthy, borderline, or abnormal based on condition-specific thresholds as defined by current clinical practice guidelines.^{19–21} Extreme results were defined as the upper 1% of abnormal values (or lowest 1% for HDL), calculated separately for each screening test, and excluded as potentially erroneous values. Thresholds are specified in Table 1. Only tests from 2020–2022 were used for the present analysis.

Statistical Analysis

Descriptive statistics were summarized across obesity category by patient age group, sex, race-ethnicity, and well-child care status. Age was estimated based on the patient's index BMI date during 2020–2022 and midpoint of their birth year (i.e., July 2), and categorized as 10–14 or 15–18 years. Race and ethnicity were reported as a single variable in AEMR (White, Black, Asian, Hispanic, Other, or Unknown). Well-child care status was defined as a diagnostic or procedure code for a well-child or preventive primary care visit during 2020–2022 (Table S4).

Screening prevalence was calculated as the number of patients who had ≥ 1 test result divided by the number of patients with obesity. Partial screening was defined as ≥ 1 test result for 1 or 2 conditions. Complete screening was defined as ≥ 1 test result for all 3 conditions. Prevalence of abnormal results was calculated as the number of patients who had ≥ 1 abnormal test result divided by the number of patients who had ≥ 1 test result for each condition. To establish a single status per condition per patient, if a patient had abnormal and borderline test results for the same condition (e.g., dyslipidemia), they were categorized as abnormal. Chi-square tests were used to examine differences by obesity severity, age group, sex, and well-child care status. Analyses were conducted using SAS version 9.4.

Results

Among 1.5 million patients aged 10–18 years during 2020–2022, approximately 3% had a BMI classified as underweight, 56% healthy weight, 17% overweight, and 23% obesity (14% class 1, 6% class 2, and 3% class 3) (Table 2). Among 333,110 patients with obesity in the final study sample, 54% were male, 59% had class 1 obesity, and 57% were White (Table 3). Approximately one-quarter (27%) had evidence of a well-child visit during 2020–2022.

Overall, 74% of patients ($n = 247,492$) had no evidence of screening for NAFLD, dyslipidemia, or diabetes during 2020–2022 (Table 4). Thirteen percent were partially screened (1–2 conditions), and 13% had complete screening (all 3 conditions). Prevalence of complete screening was higher among those with more severe obesity (9% class 1, 15% class 2, and 22% class 3). Prevalence of complete screening was substantially higher in those with evidence of well-child visits than those without (21% vs 9%). Screening occurred more often in older patients aged 15–18 years than those aged 10–14 years (complete: 14% vs 11%) and females than males (partial: 15% vs 11%, complete: 14% vs 12%). All differences were statistically significant, $p < .0001$.

The prevalence of screening was 22% for diabetes, 19% for NAFLD, and 18% for dyslipidemia (Table 4). For each condition, screening occurred significantly more often for patients aged 15–18 years than 10–14 years (e.g., 22% vs. 16% for NAFLD) and for females than males (e.g., 26% vs. 19% for diabetes) ($p < .0001$). For each condition, the prevalence of screening was higher for those with more severe obesity; for example, dyslipidemia screening occurred in 15%, 21%, and 28% among those with class 1, 2, and 3 obesity, respectively (Table 4).

Figure 1 shows screening by combinations of conditions. Nearly 42,000 patients (13%) were screened for all 3 conditions. Among the 27,244 patients screened for 2 conditions (8%), the most common combination was diabetes and NAFLD ($n = 19,218$) followed by diabetes and dyslipidemia ($n = 7,413$). Among the 16,455 patients screened for only 1 condition (5%), screening for dyslipidemia was the most common ($n = 10,417$).

Figure 2 displays the prevalence of abnormal test results. Among those screened for dyslipidemia, 56% had at least 1 abnormal test result. The proportion of patients with abnormal results was higher in those with more severe obesity (50% vs 60% vs 64% for class 1, 2, and 3 obesity, respectively). Males had a higher proportion of abnormal results than females (61% vs 51%), and older adolescents had a higher proportion of abnormal results than younger (59% vs 54%) ($p < .0001$).

Among patients screened for NAFLD, 13% had at least 1 abnormal result, and another 31% had at least 1 borderline result. The proportion of patients with abnormal results was higher in those with more severe obesity (10% vs 15% vs 19% in those with class 1, 2, and 3 obesity, respectively) ($p < .0001$). The proportion of patients with abnormal results was much higher in males than females (19% vs 9%) and in those aged 15–18 years than 10–14 years (15% vs 11%) ($p < .0001$).

Among patients screened for diabetes, 3% had at least 1 result in the diabetes range (i.e., abnormal) and 11% had at least 1 result in the prediabetes range (i.e., borderline). The proportion of patients with results in the prediabetes or diabetes range was higher in those with more severe obesity (9% vs 15% vs 23% in those with class 1, 2, and 3 obesity, respectively). The proportion of patients with results in the prediabetes range was higher in patients 10–14 years than those 15–18 years (13% vs 9%, $p < .0001$).

Discussion

Using EHR data for >330,000 patients, this study found no evidence of screening for diabetes, dyslipidemia, or NAFLD for nearly 75% of patients aged 10–18 years with obesity during 2020–2022. Even among patients with a documented well-child visit in this period, two thirds (64%) did not have documentation of screening. Laboratory screening for these conditions has been recommended since at least 2007,^{4,19–21} and was most recently recommended by AAP's 2023 CPG.⁵ The low prevalence of screening directly before the release of the CPG highlights an opportunity for substantial improvement in provider uptake of these recommendations. Improving provider self-efficacy²² and addressing key barriers, including inadequate and inconsistent coverage for obesity services,²³ may facilitate uptake of evidence-based obesity care.

Among the 26% of patients who received screening, approximately half had screening for all 3 conditions; thus, complete screening was more common than screening for any single condition or combination of conditions. This finding is promising as it aligns with comprehensive evaluation recommended for patients aged ≥ 10 years with obesity, outlined in AAP's CPG algorithm.²⁴ This approach can help providers more completely understand the range of factors influencing patients' health and inform decision-making for appropriate treatments.

Among those screened, a high proportion had abnormal test results. For example, more than half of patients screened for dyslipidemia had ≥ 1 abnormal lipid biomarker. Further, 13% of patients screened for NAFLD had high ALT, and an additional 31% had borderline high values. Consistent with previous studies,^{6–8} these findings show how common metabolic abnormalities are among youth with high BMIs, and underscore the importance of screening for early detection. Early detection coupled with providing or referring to evidence-based interventions, such as IHBLT, can help improve health outcomes and reduce risk for future disease.⁵

Both the prevalence of screening and the prevalence of abnormal results were higher among those with more severe obesity. Complete screening occurred in 22% of patients with class 3 obesity, up from 9% and 15% in those with class 1 and 2 obesity, respectively, which aligns with previous studies showing that children with higher BMIs have higher rates of screening.^{6–9} Higher screening rates of these children could be due to a variety of factors, such as patient and family concern, higher provider self-efficacy in obesity-related care for those with very high BMI, or provider awareness of increased health risks associated with higher levels of excess adiposity. In addition, children with more severe obesity may have had obesity-related signs and symptoms (e.g., acanthosis nigricans or elevated blood pressure) that prompted clinicians to conduct lab screening. These diagnoses may help substantiate payer reimbursement for laboratory screening, which is not universally covered with only an obesity diagnosis. Insufficient reimbursement for obesity services has been long identified as a major barrier to evidence-based obesity care.^{23,25}

Importantly, among patients with class 3 obesity who had laboratory testing, nearly two-thirds had abnormal lipids and nearly one-quarter had abnormal ALT or elevated diabetes

markers (borderline or abnormal), which is markedly higher than patients with less severe obesity. This dose response effect mirrors an analysis of nationally representative data from 8,500 US youth with overweight or obesity; Skinner et al. found that the more severe the obesity, the higher the risk for abnormal cardiometabolic markers, including high triglycerides and A1c.²⁶ Given that more than 4.5 million US children are affected by severe obesity, screening for this high-risk group is a critical step to early identification of obesity-related complications and evidence-based intervention to prevent long-term consequences.

The prevalence of abnormal labs is impacted by the thresholds used to define them. We used well-established cutpoints for abnormal lipid levels¹⁹ and diabetes markers.²⁰ However, thresholds for ALT elevation and how to interpret them are less clear. Pediatric studies have used a variety of thresholds.^{9,27–29} We aligned with biology-based cutpoints identified by Schwimmer et al. using NHANES data. In our study, most abnormal ALT results were above Schwimmer's threshold for twice the upper limit of normal (≥ 50 U/L for males, ≥ 44 U/L for females) but < 80 U/L (both sexes). Nonalcoholic steatohepatitis (NASH), the most severe form of NAFLD, is more common in children with ALT values ≥ 80 U/L.²⁹ Although not many youth in our study had ALT values this high, NASH is the most rapidly increasing indicator for liver transplantation in the US,³⁰ thus important for screening and awareness. Similarly, for diabetes and dyslipidemia, many of the non-healthy lab values were in the borderline or prediabetes range, highlighting an opportunity for lower-cost treatment such as lifestyle interventions to help patients improve health behaviors, lose excess weight, and prevent disease progression. In our study, the overall proportion of patients aged 10–18 years who had evidence of well-child visits was low (27%). This may be due in part to specialists representing 60% of providers contributing data to IQVIA overall. As expected, the proportion of patients with well-child visits in our study decreased with age (e.g., 33% in 10-year-olds, 27% in 14-year-olds, and 21% in 18-year-olds). Despite recommendations for annual visits,³¹ older children and adolescents are less likely to receive routine preventive care than younger children;^{32–33} further, there was a large decline in preventive care during the COVID-19 pandemic.³² Children and adolescents who receive well-child care may have more opportunities to get recommended screenings for chronic conditions as well as other components of comprehensive care, including mental and behavioral health assessment and physical examination. During our 3-year study, patients with evidence of well-child visits were much more likely to receive complete screening than those without (21% vs. 9%).

Limitations

Despite strengths such as reliance on measured data, large sample size, and insights into real-world obesity care, this study had limitations. First, the study population comprised healthcare-seeking youth with obesity, which may limit generalizability. Generalizability may be further limited by the COVID-19 pandemic, which impacted care-seeking and clinical practices. Second, laboratory results could have been incomplete if facilities that performed the tests did not contribute data to IQVIA, if tests were not inputted into a structured data format to be detected by standardized search tools, or if test results were not populated by the end of the study; these challenges with secondary use of EHRs could underestimate screening prevalence. Third, we were unable to discern fasting status for lipid tests, which may have overestimated lipid elevation. Fourth, we were unable to distinguish

whether administration of lab tests reflected screening, disease monitoring, or other intent. To mitigate this, we excluded patients with pre-existing diabetes, dyslipidemia, or NAFLD so tests would likely be indicative of screening rather than disease management. Finally, race and ethnicity were documented as a single variable in IQVIA AEMR-US and often missing, and social determinants of health were unavailable; this limited our ability to investigate outcomes by these important drivers of health.

Conclusion

Among 333,110 US pediatric patients with obesity, nearly 75% had no evidence of guideline-recommended screening for diabetes, dyslipidemia, or NAFLD during 2020–2022. Screening was higher among those with more severe obesity; yet two-thirds of those with class 3 obesity remained unscreened, highlighting substantial room for improvement in screening the highest risk youth. When screening did occur, results revealed a high prevalence of elevated cholesterol, triglycerides, A1c, and other chronic disease biomarkers, particularly in older adolescents and those with higher BMIs. Increased screening, from the baseline levels presented in this study before the release of AAP's 2023 CPG, could facilitate earlier identification of youth with adverse metabolic profiles and timely delivery of evidence-based interventions to improve health outcomes and prevent or delay long-term complications.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Disclosures:

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. Sharifi was supported by the National Institute on Minority Health and Health Disparities of the National Institutes of Health award R01MD014853. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References

1. Stierman B, Afful J, Carroll MD, et al. National Health and Nutrition Examination Survey 2017–March 2020 prepandemic data files—development of files and prevalence estimates for selected health outcomes. *Natl Health Stat Report*. 2021;(158). <https://stacks.cdc.gov/view/cdc/106273>
2. Guerreiro VA, Carvalho D, Freitas P. Obesity, adipose tissue, and inflammation answered in questions. *J Obes*. 2022;2252516. doi: 10.1155/2022/2252516 [PubMed: 35321537]
3. Skinner AC, Staiano AE, Armstrong SC, et al. Appraisal of clinical care practices for child obesity treatment. Part II: comorbidities. *Pediatrics*. 2023;151(2):e2022060643. doi: 10.1542/peds.2022-060643 [PubMed: 36622098]
4. Barlow SE; Expert Committee. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120(Suppl 4):S164–S192. doi: 10.1542/peds.2007-2329C [PubMed: 18055651]
5. Hampl SE, Hassink SG, Skinner AC, et al. Clinical practice guideline for the evaluation and treatment of children and adolescents with obesity. *Pediatrics*. 2023;151(2):e2022060640. doi: 10.1542/peds.2022-060640. [PubMed: 36622115]

6. Thompson-Paul AM, Kraus EM, Porter RM, et al. Pediatric lipid screening prevalence using nationwide electronic medical records. *JAMA Netw Open*. 2024;7(7):e2421724. doi: 10.1001/jamanetworkopen.2024.21724 [PubMed: 39042409]
7. Belay B, Kraus EM, Porter R, et al. Examination of prediabetes and diabetes testing among US pediatric patients with overweight or obesity using an electronic health record. *Child Obes*. 2024;20(2):96–106. doi: 10.1089/chi.2022.0209 [PubMed: 36930745]
8. Kraus EM, Pierce SL, Porter R, et al. Using real-world electronic health record data to assess chronic disease screening in children: a case study of non-alcoholic fatty liver disease. *Child Obes*. 2024;20(1):41–47. doi: 10.1089/chi.2022.0208 [PubMed: 36862137]
9. Sahota AK, Shapiro WL, Newton KP, Kim ST, Chung J, Schwimmer JB. Incidence of nonalcoholic fatty liver disease in children: 2009–2018. *Pediatrics*. 2020;146(6):e20200771. doi: 10.1542/peds.2020-0771 [PubMed: 33214329]
10. Morkem R, Theal R, Barber D, Flemming J, Queenan J, Kehar M. Screening patterns of nonalcoholic fatty liver disease in children with obesity in Canadian primary care: a cross-sectional study. *Can J Gastroenterol Hepatol*. 2022;2022:8435581. doi: 10.1155/2022/8435581 [PubMed: 36594051]
11. Sharifi M, Goodman AB, Chua KP. Assessment of underuse and overuse of screening tests for co-occurring conditions among children with obesity. *JAMA Netw Open*. 2022;5(7):e2222101. doi:10.1001/jamanetworkopen.2022.22101 [PubMed: 35834247]
12. IQVIA E360™ SaaS Platform. Accessed February 23, 2024. <https://www.iqvia.com/solutions/real-world-evidence/platforms/e360-saas-platform>
13. Daymont C, Ross ME, Russell Localio A, Fiks AG, Wasserman RC, Grundmeier RW. Automated identification of implausible values in growth data from pediatric electronic health records. *J Am Med Inform Assoc*. 2017;24(6):1080–1087. doi:10.1093/jamia/ocx037 [PubMed: 28453637]
14. growthcleanr. MITRE Corporation; 2021. Accessed February 23, 2024. github.com/mitre/growthcleanr
15. The SAS program for CDC growth charts that includes the extended BMI calculations. Division of Nutrition, Physical Activity, and Obesity, Centers for Disease Control and Prevention. Accessed February 23, 2024. <https://www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm>
16. Child and teen BMI categories. Centers for Disease Control and Prevention. Accessed July 22, 2024. <https://www.cdc.gov/bmi/child-teen-calculator/bmi-categories.html>
17. CCHMC. Non-alcoholic fatty liver disease (NAFLD) & Alcoholic Fatty Liver Disease (ALD). PheKB; 2016. <https://phekb.org/phenotype/non-alcoholic-fatty-liver-disease-nalfd-alcoholic-fatty-liver-disease-ald>
18. Kuklina EV, Whiteman MK, Hillis SD, et al. An enhanced method for identifying obstetric deliveries: Implications for estimating maternal morbidity. *Matern Child Health J*. 2008;12(4):469–477. doi: 10.1007/s10995-007-0256-6 [PubMed: 17690963]
19. Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents, National Heart, Lung, and Blood Institute. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents: summary report. *Pediatrics*. 2011;128 Suppl 5(Suppl 5):S213–S256. doi: 10.1542/peds.2009-2107C [PubMed: 22084329]
20. American Diabetes Association Professional Practice Committee. Classification and diagnosis of diabetes: standards of medical care in diabetes-2022. *Diabetes Care*. 2022;45(Suppl 1):S17–S38. doi: 10.2337/dc22-S002 [PubMed: 34964875]
21. Vos MB, Abrams SH, Barlow SE, et al. NASPGHAN Clinical practice guideline for the diagnosis and treatment of nonalcoholic fatty liver disease in children: recommendations from the Expert Committee on NAFLD (ECON) and the North American Society of Pediatric Gastroenterology, Hepatology, and Nutrition (NASPGHAN). *J Pediatr Gastroenterol Nutr*. 2017;64(2):319–334. doi: 10.1097/MPG.0000000000001482 [PubMed: 28107283]
22. Liebhart JL, Goodman AB, Lindros J, et al. Key predictors of primary care providers' self-efficacy in caring for children with overweight or obesity. *Acad Pediatr*. 2022;22(7):1158–1166. doi: 10.1016/j.acap.2022.02.017 [PubMed: 35247645]

23. Wilfley DE, Staiano AE, Altman M, et al. Improving access and systems of care for evidence-based childhood obesity treatment: Conference key findings and next steps. *Obesity* (Silver Spring). 2016;25(1):16–29. doi: 10.1002/oby.21712 [PubMed: 27925451]
24. American Academy of Pediatrics. Algorithm for the evaluation and treatment of children and adolescents with overweight and obesity. Accessed February 23, 2024. <https://downloads.aap.org/AAP/PDF/Obesity/CPG-Obesity%20Algorithm%2011.17.pdf>
25. Simpson LA, Cooper J. Paying for obesity: A changing landscape. *Pediatrics*. 2009;123 Suppl 5:S301–S307. doi: 10.1542/peds.2008-2780I [PubMed: 19470607]
26. Skinner AC, Perrin EM, Moss LA, Skelton JA. Cardiometabolic risks and severity of obesity in children and young adults. *NEJM*. 2015;373(14):1307–1317. doi: 10.1056/NEJMoa1502821 [PubMed: 26422721]
27. Schwimmer JB. Clinical advances in pediatric nonalcoholic fatty liver disease. *Hepatology*. 2016;63(5):1718–1725. doi: 10.1002/hep.28441 [PubMed: 27100147]
28. Schwimmer JB, Dunn W, Norman GJ, et al. SAFETY Study: Alanine aminotransferase cutoff values are set too high for reliable detection of pediatric chronic liver disease. *Gastroenterology*. 2010;138(4):1357–64.e2. doi: 10.1053/j.gastro.2009.12.052 [PubMed: 20064512]
29. Schwimmer JB, Newton KP, Awai HI, et al. Paediatric gastroenterology evaluation of overweight and obese children referred from primary care for suspected non-alcoholic fatty liver disease. *Aliment Pharmacol Ther*. 2013;38(10):1267–1277. doi: 10.1111/apt.12518 [PubMed: 24117728]
30. Younossi ZM, Stepanova M, Ong J, et al. Nonalcoholic steatohepatitis is the most rapidly increasing indication for liver transplantation in the United States. *Clin Gastroenterol Hepatol*. 2021;19(3):580–589.e5. doi: 10.1016/j.cgh.2020.05.064 [PubMed: 32531342]
31. BrightFutures/American Academy of Pediatrics. Recommendations for preventive pediatric health care. April 2023. https://downloads.aap.org/AAP/PDF/periodicity_schedule.pdf
32. Conmy AB, Peters C, De Lew N, Sommers BD. Children’s health coverage trends: gains in 2020–2022 reverse previous coverage losses. Issue Brief No. HP-2023-07. Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services. March 2023. <https://aspe.hhs.gov/sites/default/files/documents/77d7cc41648a371e0b5128f0dec2470e/aspe-childrens-health-coverage.pdf>
33. Irwin CE Jr, Adams SH, Park MJ, Newacheck PW. Preventive care for adolescents: Few get visits and fewer get services. *Pediatrics*. 2009;123(4):e565–e572. doi: 10.1542/peds.2008-2601 [PubMed: 19336348]

Study Importance

What is already known about this subject?

Laboratory screening for youth with obesity has been recommended since at least 2007. In 2023, the American Academy of Pediatrics (AAP) released a Clinical Practice Guideline (CPG) recommending that providers screen children ≥ 10 years with obesity for abnormalities in lipids, glucose metabolism, and liver function. Studies have shown that screening rates for these conditions individually are sub-optimal.

What are the new findings in this manuscript?

Among 333,110 US youth aged 10–18y with obesity, nearly 75% did *not* receive screening for diabetes, dyslipidemia, or NAFLD in 2020–2022. Among those screened, complete screening (i.e., for all 3 conditions) occurred half of the time. Many youth had abnormal cardiometabolic markers, especially those with more severe obesity and older adolescents.

How might these results change the direction of research or the focus of clinical practice?

Low prevalence of screening and high prevalence of abnormal results underscores an opportunity for substantial improvement in provider uptake of clinical practice guidelines. Given that approximately 15 million US children are affected by obesity, including 4.5 million with severe obesity, laboratory screening is a critical step to early identification of cardiometabolic health risks and facilitation of evidence-based pediatric obesity care.

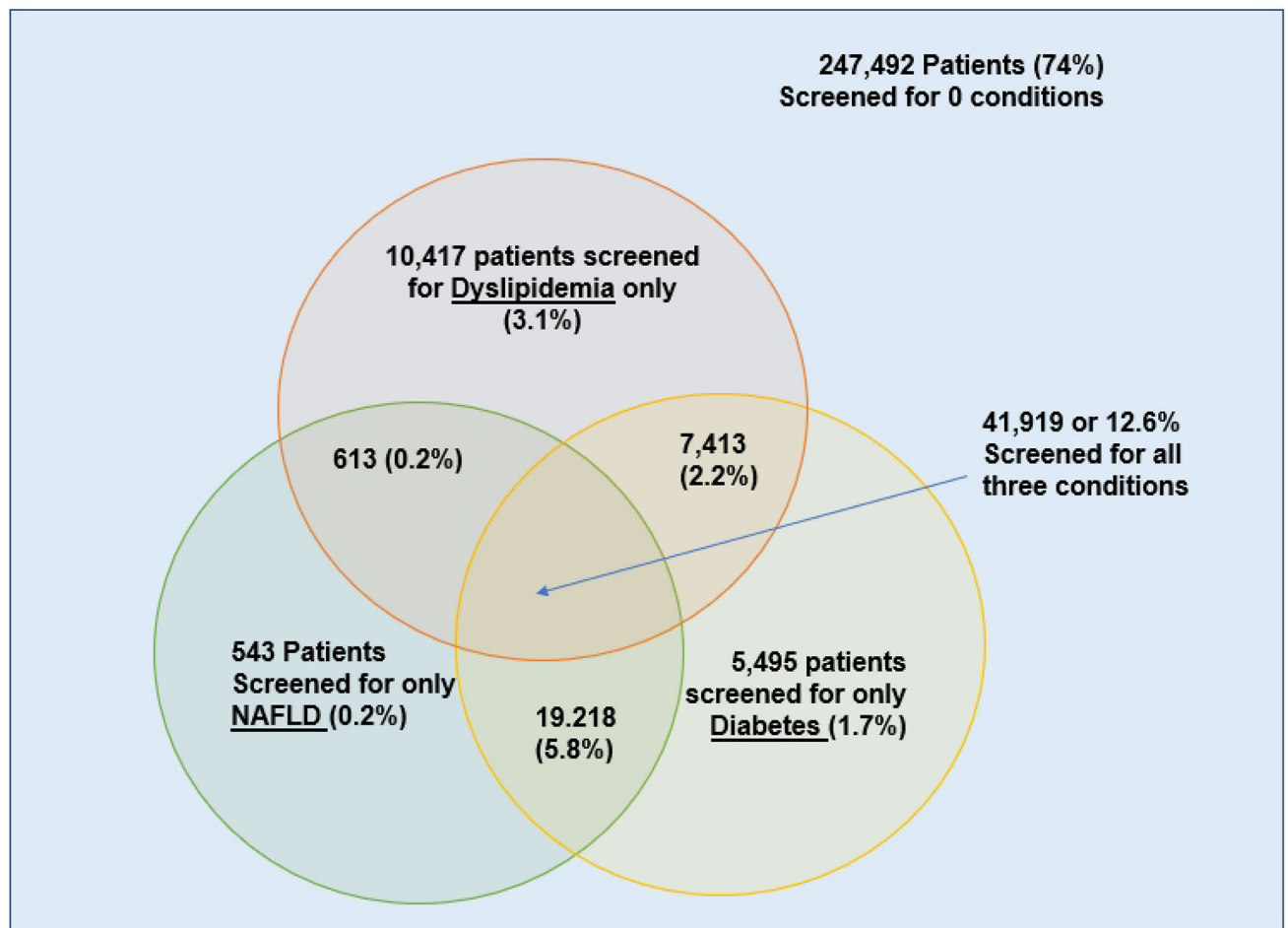


Figure 1.
Patterns of Guideline-Recommended Screening Among Patients Aged 10–18 Years With Obesity, IQVIA Ambulatory Electronic Medical Records 2020–2022

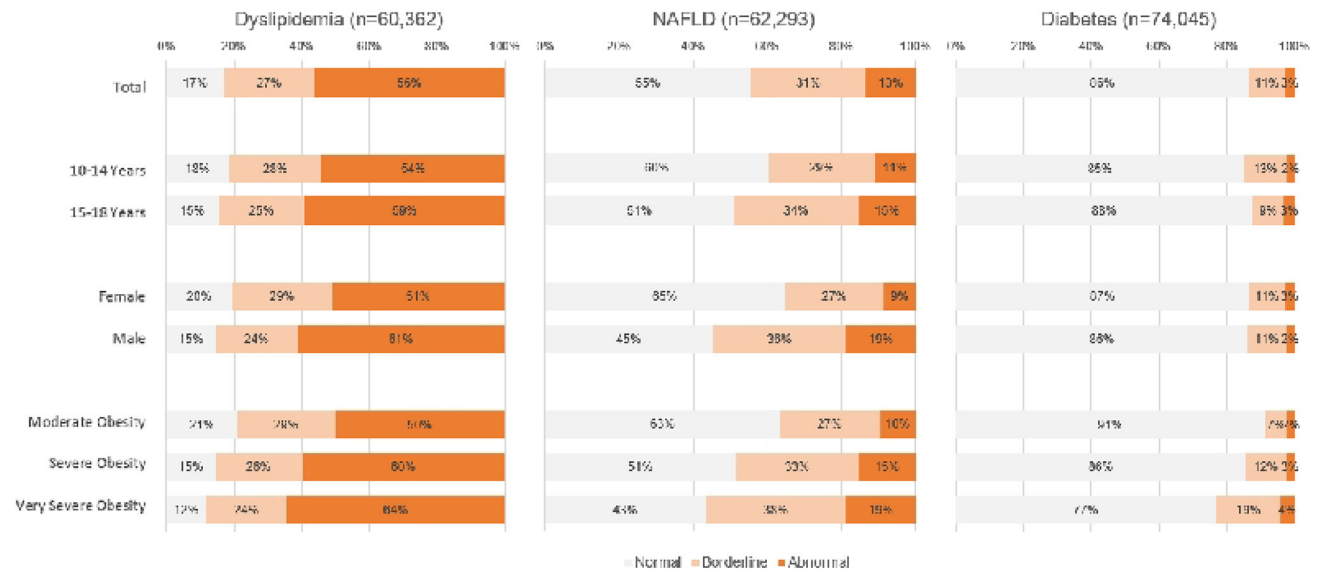


Figure 2. Prevalence of ≥ 1 Abnormal Screening Test Result^a for Dyslipidemia, NAFLD, and Diabetes by Patient Demographics and Obesity Severity, IQVIA Ambulatory Electronic Medical Records 2020–2022

^a Each patient is counted only once for each condition that they were screened for. To establish a single status per condition per patient, if a patient had both an abnormal and a borderline test result for the same condition (e.g., dyslipidemia), they were categorized as abnormal. If they had both a borderline and a normal test result for the same condition, they were categorized as borderline.

Table 1.
Laboratory Test Result Categories^a and Extreme Value Thresholds by Test Type

NAFLD Tests	Acceptable	Borderline	Abnormal	Extreme^b
Alanine Transaminase (ALT, males)	<25 U/L	25–49.9 U/L	≥50 U/L	≥543 U/L
Alanine Transaminase (ALT, females)	<22 U/L	22–43.9 U/L	≥44 U/L	≥704 U/L
Dyslipidemia Tests	Acceptable	Borderline	Abnormal	Extreme^b
Total Cholesterol	<170 mg/dL	170–199 mg/dL	≥200 mg/dL	≥336 mg/dL
Triglycerides	<90 mg/dL	90–129 mg/dL	≥130 mg/dL	≥634 mg/dL
Low Density Lipoprotein	<110 mg/dL	110–129 mg/dL	≥130 mg/dL	≥248 mg/dL
Non-High Density Lipoprotein	<120 mg/dL	120–144 mg/dL	≥145 mg/dL	≥275 mg/dL
High Density Lipoprotein	>45 mg/dL	40–45 mg/dL	<40 mg/dL	≤20 mg/dL
Very Low Density Lipoprotein	≤30 mg/dL	N/A	>30 mg/dL	≥104 mg/dL
Diabetes Tests	Acceptable	Borderline (Prediabetes)	Abnormal (Diabetes)	Extreme^b
Hemoglobin A1c	2%–5.6%	5.7%–6.4%	≥6.5%	≥97.7%
Fasting Blood Glucose	<100 mg/dL	100–125 mg/dL	≥126 mg/dL	≥500 mg/dL
Oral Glucose Tolerance Test	<140 mg/dL	140–199 mg/dL	≥200 mg/dL	≥367 mg/dL
Random Blood Glucose	<140 mg/dL	140–199 mg/dL	≥200 mg/dL	≥634 mg/dL
Non-2-hour Glucose Tolerance Test	<140 mg/dL	140–199 mg/dL	≥200 mg/dL	≥299 mg/dL
Unspecified Glucose Test	<140 mg/dL	140–199 mg/dL	≥200 mg/dL	≥808 mg/dL

Abbreviations: HDL, high-density lipoprotein; NAFLD, nonalcoholic fatty liver disease.

^aLab test result categories were based on cut points from the National Heart, Lung, and Blood Institute (NHLBI) for dyslipidemia, cut points from the American Diabetes Association (ADA) for diabetes, and cut points from the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition (NASPGHAN) for NAFLD.

^bCalculated separately for each screening test as the top 1% of abnormal lab values from 2011–2022 (or bottom 1% for HDL) and excluded from the analysis. Note: laboratory test values that were missing or zero were not included in this analysis.

Table 2. Characteristics of Patients Aged 10–18 Years With ≥ 1 BMI^a Measurement During 2020–2022, IQVIA Ambulatory Electronic Medical Records

	N	%	Underweight	Healthy Weight	Overweight	Study Population		
						Class 1 Obesity	Class 2 Obesity	Class 3 Obesity
Total	1,494,743	100	41,291 3%	841,646 56%	261,115 17%	206,484 14%	94,071 6%	50,126 3%
Age Group								
10–14 years	776,040	52	19,323	417,678	142,632	118,021	51,923	26,463
15–18 years	718,703	48	21,968	423,938	118,523	88,463	42,148	23,663
Sex								
Female	756,451	51	15,534	437,240	140,363	97,292	43,010	23,012
Male	738,292	49	25,757	404,376	120,792	109,192	51,061	27,114
Race-Ethnicity								
White	909,818	61	25,533	525,559	157,865	121,644	53,280	25,937
Black	139,029	9	2,674	65,992	25,375	22,561	12,743	9,684
Asian	38,949	3	1,885	26,008	6,005	3,676	1,059	316
Hispanic	3,516	<1	86	1,670	672	653	298	137
Other	70,224	5	1,677	34,134	13,048	11,996	5,874	3,495
Unknown	333,207	22	9,436	188,253	58,190	45,954	20,817	10,557
Well-Child Care^b								
Yes	423,999	28	11,606	243,699	74,247	57,705	24,720	12,022
No	1,070,744	72	29,685	597,917	186,908	148,779	69,351	38,104

^a BMI categories were based on sex- and age-specific percentiles from CDC's growth charts: underweight (<5th percentile), healthy weight (≥ 5 th to <85th percentile), overweight (≥ 85 th to <95th percentile), class 1 obesity (≥ 95 th percentile to <120% of the 95th percentile), class 2 obesity (≥ 120 to <140% of the 95th percentile), and class 3 obesity (≥ 140 % of the 95th percentile).

^b Defined as ≥ 1 diagnostic or procedure code for a primary care visit during 2020–2022, including initial or periodic comprehensive preventive medicine evaluation, well-child visit, or child examination. Appendix 4 contains the full code set.

Table 3.

Characteristics of Study Sample, IQVIA Ambulatory Electronic Medical Records 2020–2022

	N	%
Total	333,110	100%
Age Group		
10–14 years	188,213	57%
15–18 years	144,897	43%
Sex		
Female	153,102	46%
Male	180,008	54%
Obesity Category ^a		
Class 1	197,343	59%
Class 2	88,898	27%
Class 3	46,869	14%
Race-Ethnicity		
White	190,396	57%
Black	42,674	13%
Asian	4,783	1%
Hispanic	1,010	<1%
Other	20,296	6%
Unknown	73,951	22%
Well-Child Care ^b		
Yes	90,752	27%
No	242,358	73%

^aBased on sex- and age-specific BMI percentiles from CDC's growth charts: class 1 obesity (≥ 95 th percentile to $< 120\%$ of the 95th percentile), class 2 obesity ($\geq 120\%$ to $< 140\%$ of the 95th percentile), and class 3 obesity ($\geq 140\%$ of the 95th percentile).

^bDefined as ≥ 1 diagnostic or procedure code for a primary care visit during 2020–2022, including initial or periodic comprehensive preventive medicine evaluation, well-child visit, or child examination.

Table S4 contains the full code set.

Table 4.

Prevalence of Screening for Diabetes, NAFLD, and Dyslipidemia Individually and in Combination by Patient Demographics, Obesity Category, and Well-Child Care Status, IQVIA AEMR 2020–2022

	Screening for Diabetes, NAFLD, and Dyslipidemia			Screening Prevalence by Condition		
	None n = 247,492	Partial n = 43,699	Complete n = 41,919	Diabetes ^a n = 74,045	NAFLD ^b n = 62,293	Dyslipidemia ^c n = 60,362
Total	74%	13%	13%	22%	19%	18%
Age Group						
10–14y	76%	13%	11%	19%	16%	18%
15–18y	72%	14%	14%	26%	22%	19%
Sex						
Female	71%	15%	14%	26%	21%	19%
Male	77%	11%	12%	19%	16%	17%
Obesity Category^d						
Class 1	78%	13%	9%	18%	15%	15%
Class 2	71%	14%	15%	25%	21%	21%
Class 3	64%	14%	22%	34%	28%	28%
Well-Child Care Status^e						
Yes	64%	15%	21%	32%	28%	27%
No	78%	13%	9%	18%	15%	15%

Abbreviations: BMI, body mass index; NAFLD, nonalcoholic fatty liver disease.

Chi-square tests were used to examine differences by age group, sex, obesity category, and well-child care status. All differences were statistically significant with p -values of $<.0001$. Pairwise comparisons tested differences among the three obesity classes; all were statistically significant with p -values of $<.01$.

^aDefined as ≥ 1 test result for hemoglobin A1c, fasting blood glucose, oral glucose tolerance test, random blood glucose, blood glucose test without specified fasting or non-fasting status, or non-2-hour glucose tolerance result.

^bDefined as ≥ 1 test result for alanine transaminase (ALT).

^cDefined as ≥ 1 test result for total cholesterol, triglycerides, low-density lipoprotein, high-density lipoprotein, very low-density lipoprotein, or non-high-density lipoprotein.

^dObesity categories were defined based on CDC's sex- and age-specific BMI percentiles: class 1 obesity (BMI ≥ 95 th percentile to BMI $<120\%$ of the 95th percentile), class 2 obesity (BMI $\geq 120\%$ to $<140\%$ of the 95th percentile), and class 3 obesity (BMI $\geq 140\%$ of the 95th percentile).

^eDefined as ≥ 1 diagnostic or procedure code for a primary care visit during 2020–2022, including initial or periodic comprehensive preventive medicine evaluation, well-child visit, or child examination. Table S4 contains the full code set.