NUTRITIONAL MANAGEMENT OF PEDIATRIC DYSLIPIDEMIA

Lauren A. Williams, MCN, RDN, LD, Pediatric Cardiology, McLane Children's, Baylor Scott&White, Temple, Texas
Don P. Wilson, MD, FNLA, Diplomate, American Board of Clinical Lipidology, Endowed Chair, Cardiovascular Health and Risk Prevention, Pediatric Endocrinology and Diabetes, Cook Children's Medical Center, Fort Worth, Texas. don.wilson@cookchildrens.org

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ABSTRACT

Lifestyle therapies are important in helping to reduce risk of premature cardiovascular disease. A family-centered, behavioral approach to lifestyle modification is generally the most successful approach for children and adolescents. A registered dietitian nutritionist plays a pivotal role in implementing therapeutic lifestyle changes, uniquely trained to fully assess the child's nutrition status as well as outlining practical strategies to obtain the desired behavioral changes. For all children and adolescents one year of age and older, the Cardiovascular Health Integrated Lifestyle Diet (CHILD-1 diet) is the first step in helping achieve the goal of a healthy lifestyle. Key to this initial dietary recommendation is restricting saturated fat intake to <10% of daily calorie intake and reducing cholesterol consumption to <300 mg/day. Those unable to achieve the desired goals while following a CHILD-1 diet should be advanced to the CHILD-2 diet after a three-month trial. The CHILD-2 diet includes further restriction of saturated fat and cholesterol. In addition to the CHILD-2 diet, supplementation with plant sterol and stanol esters, water-soluble psyllium fiber, or omega-3 fatty acids may help a child achieve the desired lipid goals. Nutrition recommendations vary according to age, and parents/caregivers should be counseled accordingly. Each individual age range provides unique challenges, making ongoing nutrition counseling an important part of maintaining modifications in those following a lipid-lowering diet. Regular follow-up visits with appropriate monitoring of the child's understanding of, and satisfaction with, the diet, test results, readiness to change, and growth parameters is important for continued success. The use of motivational interviewing during visits is frequently helpful in enhancing knowledge, maintaining interest, identifying barriers, and setting short- and long-term goals.

ROLE OF MEDICAL NUTRITION THERAPY IN PEDIATRIC DYSLIPIDEMIA

The National Lipid Association (NLA), American Heart Association (AHA), and American College of Cardiology (ACC) all regard lifestyle therapies as an important component in helping reduce risk of premature cardiovascular disease, alone or in conjunction with pharmacotherapies (1-4). Research of cardiovascular disease risk reduction has shown improper diets, especially those with excess energy intake, to be major contributors to hypercholesterolemia and obesity in children and adolescents (5). Counseling of those at risk of premature atherosclerotic cardiovascular disease (ASCVD) focuses on (1) altering diet composition; (2) increasing physical activity; (3) calorie reduction for weight loss in those who are overweight and obese; (4) global reduction of risk factors associated with metabolic syndrome; and (5) cessation/avoidance of

tobacco use (1). A behavioral approach to lifestyle modification provided by a registered dietitian nutritionist has been identified as the most consistently effective approach to evoke dietary change (5). In the pediatric population, both the child and family should be engaged in counseling efforts.

NUTRITION ASSESSMENT

Prior to providing recommendations for lipid-lowering diets, it is important to gather a comprehensive assessment of the child's current nutritional status and the entire family's readiness to change. Identification of a family's current healthcare beliefs and practices, nutritional status, and eating patterns can be a valuable resource in estimating future success in implementing and sustaining therapeutic lifestyle changes. Growth charts, if available, should be reviewed to determine nutrition risks such as malnutrition or obesity. Anthropometric measures of note include the child's age- and sex- appropriate height, weight, body mass index (BMI), and BMI Z-score. Although generally not formally assessed, the body weight and body mass index of the parent/caregiver as well as other family members should also be taken into account. Food insecurity or financial barriers to diet modification should also be addressed, including use of the food assistance programs such as the Supplemental Nutrition Assistance Program (SNAP), Supplemental Nutrition Program for Women, Infants, and Children (WIC), National School Lunch Program (NSLP), and food pantries. This allows modification of dietary recommendations to better align with child and family needs.

A diet recall or discussion regarding typical daily dietary intake is generally the most useful information to determine areas of dietary improvement (6). Special attention should be paid to the child's main sources of meals, frequency of eating meals outside of the home, between-meal snacks, and baseline level of physical activity. Identifying use of nutritional supplements, herbal remedies, and dietary restrictions is also important, as these may affect baseline and follow-up lipid levels.

NUTRITION INTERVENTIONS

Dietary Guidelines

CHILD-1 (STEP 1 DIET)

The CHILD-1 diet (Table 1) is the first step in diet modification for all children 1 year of age and older, including those with a family history of early cardiovascular disease, obesity, dyslipidemia, diabetes mellitus, primary hypertension, or exposure to smoking at home. Parameters of this diet include restricting total fat intake to 25-30% of daily calories, saturated fat intake to less than 10% of daily calories, and limiting daily cholesterol intake to 300mg or less (5). Polyunsaturated fatty acids should constitute up to 10% of daily caloric intake, while targeting a monounsaturated fatty acid intake of 10-15% of daily caloric intake (5). Trans fats should be avoided as they have been shown to increase LDL-C as well as decrease HDL-C. Common sources of saturated and unsaturated fats are outlined in Table 2. Reduction of sugar-sweetened beverage intake should be encouraged, as this has been associated with decreased obesity measures (5). In addition, a daily dietary fiber intake of at least the child's age + 5g for young children and up to 14g per 1000 calories for older children should be encouraged (7). The American Academy of Pediatrics (AAP) recommends at least 1 hour of moderate-to-vigorous physical activity daily for children 5 years and older (8). This diet has shown to decrease total cholesterol and LDL-C, while lowering the incidence of obesity and insulin resistance. The CHILD-1 diet has been shown to be safe and effective, and may decrease LDL-C by an average of 12% from baseline values. Any resulting decrease in body weight for those who are overweight or obese may also increase levels of HDL-C and decrease triglyceride concentrations (9).

TABLE 1. EVIDENCE-BASED DIET FOR CHILDREN AND ADOLESCENTS: CHILD-1

Birth to 6 months
All babies should be exclusively breastfed until 6 months of age. Donor breast milk or iron-fortified infant formula may be utilized if maternal breastmilk is unavailable or contraindicated.
No supplemental food is recommended.

6 to 12 months
Breastfeeding should be continued until at least 12 months of age while gradually adding solids; transition to iron-fortified infant formula until 12 months if if maternal breastmilk is unavailable or contraindicated.
Fat intake should not be restricted unless medically indicated.
No sweetened beverages should be offered; Limit other beverages to 100% fruit juice (≤4oz/day); Encourage water.

12 to 24 months
Transition to unflavored, reduced-fat cow's milk. Fat content (2% to fat free) should be based on child's growth, intake of other nutrient-dense foods, total fat intake, and family history of obesity or
cardiovascular disease
Avoid sugar-sweetened beverages; Limit 100% fruit juice to ≤4oz/day; Encourage water
Offer table foods with:
Total fat 30% of daily kcal intake
Saturated fat 8-10% daily kcal intake
Avoid trans fats
Mono- and polyunsaturated fat up to 20% daily kcal intake
Cholesterol <300mg/day
Limit sodium intake

2 to 10 years
Primary beverage should be unflavored, fat-free milk
Limit/avoid sugar-sweetened beverages; Limit 100% fruit juice to ≤4oz/day; Encourage water
Dietary fat:
Total fat 25-30% of daily kcal intake
Saturated fat 8-10% daily kcal intake
Avoid trans fats
Mono- and polyunsaturated fat up to 20% daily kcal intake
Cholesterol <300mg/day
Encourage high dietary fiber intake
Encourage at least 1 hour of moderate-to-vigorous physical activity daily for children >5 years

11 to 21 years
Primary beverages should be fat-free unflavored milk and water
Limit/avoid sugar-sweetened beverages; Limit 100% fruit juice to ≤4oz/day

Dietary fat:
Total fat 25-30% of daily kcal intake
Saturated fat 8-10% daily kcal intake
Avoid trans fats
Mono- and polyunsaturated fat up to 20% daily kcal intake
Cholesterol <300mg/day
Encourage high dietary fiber intake
Encourage at least 1 hour of moderate-to-vigorous physical activity daily
Encourage healthy eating habits such as daily breakfast, limiting fast-foods, and eating meals as a family.

TABLE 2. COMMON DIETARY FAT SOURCES

Saturated Fat	Trans Fat	Monounsaturated Fat	Polyunsaturated Fat
Red meats Poultry skin Full fat dairy products Butter Deep fried food Margarine Shortening Lard Pastries Processed foods	Fried or processed foods Shortening Pastries Donuts Baking mixes	Vegetable oils (olive, canola, sunflower, sesame, peanut) Avocados Natural peanut butter Many nuts/seeds	Vegetable oils (corn, safflower, soybean) Fatty fish (salmon, trout, mackerel) Some nuts/seeds

*Note: Above lists are intended to provide examples and are not all-inclusive.

CHILD-2 (STEP 2 DIET)

If elevated levels of LDL-C and non-HDL-C persist after adequate compliance to the CHILD-1 diet for 3 months, transition to the CHILD-2 diet should be recommended (Table 3). Parameters of the CHILD-2 diet include further restriction of saturated fat intake to less than 7% of daily calories and a decrease in daily cholesterol intake to 200mg or less. This diet may be further modified, if necessary, to more specifically address elevated LDL-C, non-HDL-C, and elevated triglycerides (TG).

TABLE 3. EVIDENCE-BASED NUTRITION RECOMMENDATIONS FOR PEDIATRIC DYSLIPIDEMIA

Nutrition Recommendations for LDL-Lowering
Indication: Children and adolescents with familial hypercholesterolemia or persistent hypercholesterolemia.

Refer to a registered dietitian nutritionist for family-centered medical nutrition therapy.
Dietary fat:
Total fat 25-30% of daily kcal intake
Saturated fat ≤7% daily kcal intake
Avoid trans fats
Monounsaturated fat ~10% daily kcal intake
Cholesterol <200mg/day
Familial hypercholesterolemia patients may benefit from plant sterol and stanol esters up to 2g/day as a replacement for usual dietary fat sources.
Water-soluble fiber psyllium can be added to the CHILD-2 diet at a dose of 6g/day for children 2-12 years of age, and 12g/day for children ≥12 years of age.
Encourage at least 1 hour of moderate-to-vigorous physical activity daily while limiting sedentary screen time to <2 hours/day.

Nutrition Recommendations for TG-Lowering
Indication: Children and adolescents with hypertriglyceridemia or persistent hypertriglyceridemia.

Refer to a registered dietitian nutritionist for family-centered medical nutrition therapy.
Dietary fat:
Total fat 25-30% of daily kcal intake
Saturated fat ≤7% daily kcal intake
Avoid trans fats
Monounsaturated fat ~10% daily kcal intake
Cholesterol <200mg/day
Reduce sugar intake.
Replace simple carbohydrates with complex carbohydrates.
Avoid sugar-sweetened beverages.
Increase dietary fish to increase omega-3 fatty acid intake.
Omega-3 fatty acid supplementation can be added at 1-4g/day for TG >200-499mg/dL.

The CHILD-2 LDL lowering diet places additional emphasis on dietary fiber intake and use of plant sterol/stanol esters, as appropriate. Dietary fiber, specifically soluble fiber intake, may help further reduce LDL-C. Supplemental water-soluble psyllium fiber may be added, though efficacy of supplementation varies in published trials. In children and adolescents with familial hypercholesterolemia, plant sterol and stanol esters may be safely incorporated at 2g/day to enhance LDL-C lowering

effects (5). (See the nutrition supplementation section of this chapter for more information on supplemental therapies).

The CHILD-2 TG-lowering diet may be utilized in children and adolescents with moderate hypertriglyceridemia. Dietary recommendations should encourage choosing complex carbohydrates, limiting simple carbohydrates, and restricting dietary fat intake. Sugar sweetened beverages should be discouraged. If overweight or obese, a gradual weight loss should be encouraged (5). Omega-3 supplementation may be beneficial in those with TG >200-499 mg/dL. (See Omega-3 supplementation section below).

In children and adolescents with severe hypertriglyceridemia or familial hypertriglyceridemia, the CHILD-2 TG-lowering diet, as well as restriction as low as 10-15% daily calories from fat, may be helpful in lowering TG and avoiding pancreatitis. It is imperative these children and adolescents be closely followed by a registered dietitian nutritionist to ensure all essential fatty acid and micronutrient needs are met, as well as maintaining a proper balance of calories from carbohydrates, fat, and protein (10,11).

NUTRITION SUPPLEMENTATION

Plant Sterol and Stanol Esters

Children and adolescents who have been unable to achieve lipid-lowering goals with dietary modification alone may utilize plant sterol and stanol esters for further LDL-C lowering. Recommended dose for children 2 years of age and older is 2g/day as a replacement for usual fat sources (5). As long-term studies on effectiveness have not been completed, plant sterol and stanol supplementation should be reserved for children and adolescents who do not achieve the desired LDL-C and non-HDL-C goals with diet modification alone (1). Therapeutic doses of plant sterol and stanol esters can be achieved through fortified foods or nutrition supplements, and appear to have increased efficacy when administered throughout the day rather than in a single dose (12,13).

Omega-3-Fatty Acids

In children and adolescents with fasting triglyceride levels >200-499 mg/dL, a trial of CHILD-2 TG-lowering diet and increased intake of fatty fish or omega-3 fatty acid supplementation may be beneficial (3). When increasing fatty fish in the diet, seafood choices high in EPA and DHA, but low in mercury are recommended (5). While research into the effects of fish oil supplementation is limited in the pediatric population, no safety concerns have been identified as yet. In adults, omega-3 supplementation has been shown to lower triglycerides by 30-40%, though some may cause an increase in LDL-C (14-18). Therapeutic doses of omega-3 fish oils are 1-4 g/day of the active ingredients (EPA+DHA). If fish-oil supplementation is utilized, prescription formulas are recommended rather than over-the-counter fish-oil capsules, which are not FDA regulated (3,18).

Psyllium Fiber

This water-soluble fiber can be added to the CHILD-2 LDL-lowering diet to aide in lowering total and LDL-C cholesterol. While evidence for efficacy of psyllium fiber is insufficient for specific recommendation, many studies show significant reductions in total and LDL cholesterol when psyllium fiber is added to a CHILD-2 LDL-lowering diet. Recommended doses are 6 g/day for children 2-12 years; 12 g/day for children 12 years and older. (5) Soluble fiber has been shown to be well-tolerated and safe for hypercholesterolemic children and adolescents 2 years of age and older (20-22).

AGE-BASED NUTRITION RECOMMENDATIONS

Birth to 12 Months

Fat plays a pivotal role in brain development, and should not be restricted in children <12 months, unless medically necessary. If implementing, it is imperative that a knowledgeable and experienced dietitian

nutritionist be involved in the child's care. The American Academy of Pediatrics (AAP), Surgeon General's Office, and World Health Organization (WHO) recommend that all babies be exclusively breastfed until 6 months of age (6). Breastfeeding should be continued until at least 12 months of age, with gradual addition of supplemental foods to the child's diet. Iron-fortified formula may be utilized until 12 months of age if breastfeeding is reduced or discontinued. No sugar-sweetened beverages should be offered, and 100% fruit juice should be limited to 4 oz or less daily. While extensive diet modification is not recommended at this age, previous studies have shown repeated dietary counseling, beginning as early as 7 months of age, decreases lipid risk factors of premature coronary heart disease (CHD) in children (23).

12-24 Months

The 2020-2025 Dietary Guidelines for Americans recommends a diet consisting of 30-40% calories from fat for children aged 1-3 years (7). Toddlers with family history of heart disease and hypercholesterolemia may transition to milk with reduced fat at 12 months of age to decrease saturated fat intake. This should be done only if the overall diet consistently supplies 30% daily calories from fat. Diets with less than 30% daily calories from fat should only be utilized when medically indicated and closely followed by a registered dietitian nutritionist. Nutrient-rich table foods should be offered, while avoiding concentrated sweets and trans fats (5). Sugar-sweetened beverages should be avoided, while limiting 100% fruit juice consumption to 4 oz or less daily and encouraging water intake (5).

2-10 Years

At this age, focus should be placed on introducing a wide variety of vegetables, fruits, lean proteins, and complex carbohydrates. Dietary recommendations include a total fat intake of 25-30% of daily calorie intake, limiting saturated fats, and avoiding trans fats (5). As milk is a main source of saturated fat at this age, fat-free unflavored milk is recommended. Intake of sugar-sweetened beverages should be limited or avoided, limiting 100% fruit juice to 4 oz or less daily, and encouraging water intake. For children with persistent elevations in LDL-C, the CHILD-2 diet described earlier in this chapter may be utilized (5).

This age presents unique challenges due to selective eating habits and increased consumption of foods prepared at day care facilities and school. The AHA notes that, at this age, regular breakfast consumption begins to decrease, while there is often an increase in foods prepared away from home, increased percent daily calories from snack foods, and an increased consumption of foods that are fried and of low-nutrient value (24). Families should be counseled on choosing nutritionally-dense foods, and encouraging dietary fiber intake (age + 5g daily). Physical activity with limited sedentary time should be encouraged, with a goal of at least 1 hour of moderate-to-vigorous activity daily for children 5 years and older (7).

10-21 Years

Recommendations for this population are similar to children 2-10 years of age. Dietary recommendations remain the same with 25-30% of daily calorie intake from fat, limiting saturated fat to 8-10% of daily calories, and avoiding trans fats. The CHILD-2 diet can be utilized for children and adolescents with persistent elevations in LDL-C and TG (5). Intake of fat-free unflavored milk and water should be encouraged, while limiting or avoiding sugar-sweetened beverages. 100% fruit juice should also be limited to 4 oz or less daily. Foods high in dietary fiber are encouraged with a goal of 14g fiber per 1000 calories (7).

At this age, many children consume meals or snacks at school, after-school programs, restaurants, convenience stores, or vending machines. There is often an increase in choosing foods at home that require minimum preparation. Identifying a child's main sources of nourishment is helpful in the counseling process (24). Family-centered education is

helpful as parental role modeling is important to establish healthy eating at younger ages. As children and adolescents mature, education may be focused on maintaining healthy habits, such as eating breakfast daily, choosing a healthy lunch, and limiting fast food intake (5). Special considerations should also be made regarding the approach to discussions on weight and disordered eating patterns (3).

MONITORING AND EVALUATION

After the initial visit and nutritional counseling, it is recommended that children, adolescents, and their parent/caregiver continue to meet frequently with specially trained cardiovascular disease risk reduction healthcare professionals, including a lipid specialist and registered dietitian nutritionist to monitor the child's progress and efficacy of the lipid-lowering diet. Growth charts and updated laboratory studies should be reviewed with each visit to guide subsequent recommendations for diet modification or supplementation. In children and adolescents who are overweight or obese, moderate, gradual weight reduction has been shown to improve dyslipidemia and decrease insulin resistance. Regular follow-up visits, tracking growth, and evaluating the child's and family's readiness to change can help guide the dietitian nutritionist in providing appropriate and timely counseling. A family-centered approach, transitioning to a patient-centered focus in late adolescence, helps ensure the recommended therapeutic lifestyle changes are followed throughout life stages (3).

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