

Review Article

Strategies for Primary Prevention of Cardiovascular Disease (CVD) in Adolescents:

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Cardiovascular diseases (CVD) is one of the leading causes of death globally. While the majority of adolescents are free of CVD, far fewer are free of CVD risk factors, especially lifestyle factors such as physical inactivity and dietary habits. There is a need to improve modifiable risk factors during adolescence to prevent progression to CVD in later life. Therefore, the prevention of CVD in adolescents is of the utmost importance for researchers, health professionals, and policymakers to prevent premature death from CVD in future generations. The metrics of ideal cardiovascular health like maintaining a normal body weight, adhering to a healthy diet, staying physically active, abstaining from smoking, and having blood pressure, total cholesterol, and fasting blood glucose levels in the normal range are less prevalent in the adolescent population in many countries (1). Improving the cardiovascular health of adolescents is a crucial public health priority that will pay dividends well into the future as young people transition into adulthood.

Strategies for Primary Prevention of CVD in Adolescents:

Approaches to the prevention of cardiovascular disease (CVD) are often initiated too late. Population-level and individual-level approaches that support the establishment of positive health behaviours early in life are the foundation of preserving ideal cardiovascular health and promoting positive cardiovascular outcomes. With the increasing population of adolescents and the growing demand for prevention services, traditional in-person services are insufficient alone to meet the demand. Innovative and contemporary population-based solutions are needed for the adoption of healthy lifestyle risk factors to prevent CVD in adolescents. Currently, adolescents have low uptake of health interventions across many areas, due to a lack of initial engagement (2).

Conventional Strategies:**Nutrition and Dietary Interventions:**

Healthful dietary patterns develop in childhood and the cardiovascular health benefits accrued from such patterns track into adulthood. Some of the dietary interventions that can be recommended to adolescents are

Primary care providers should counsel their adolescent patients and their families to adhere to prudent dietary patterns:

1. Low total and saturated fat and cholesterol, provide youth with more fruits, vegetables, and fiber, and fat-free or low-fat dairy; encourage the consumption of less dietary salt and sodium and limited or no intake of sugar-sweetened beverages.
2. To encourage every child to have breakfast regularly, as those who eat breakfast have been reported to be at lower risk of being overweight or obese and more likely to consume adequate intakes of essential nutrients such as calcium and iron (3).
3. Both school and community-based programs can directly engage teens in health behavior change. Health care providers can actively support efforts to improve and scale such community-based initiatives.

Exercise and Physical Activity:

Interventions designed to increase physical activity and decrease sedentary time have consistently demonstrated reductions in blood pressure, decreased measures of body fat, decreased BMI, improved cardiorespiratory fitness, and improved cardiometabolic risk profiles (4). Physically active children and youth are more likely to engage in other health-promoting behaviors and less likely to engage in health-compromising behaviors than their less active counterparts. Some of the strategies aimed at increasing the physical activity in adolescents are

1. Encouraging both individual/clinical and population-based strategies, including advocacy and support for daily physical education in schools are needed to improve levels of physical activity in adolescents.
2. Healthcare providers (HCP) should assess physical activity and sedentary behaviours at every clinic visit.
3. Current recommendations for healthy children and youth (6 years of age and older) include at least one hour of moderate (3-6 METS) to vigorous (> 6 METS) physical activity daily with vigorous-intensity physical activity and muscle and bone-strengthening activities on at least three days of the week (4).
4. Reduction of sedentary time (leisure screen time) to less than two hours per day (4).
5. Primary HCPs should provide age-appropriate suggestions for increasing physical activity and limiting sedentary behaviours in children and youth.
6. Beginning early in life and extending through adolescence, parental role modelling of physical activity behaviours is important in promoting physical activity behaviours in offspring. Encouragement of parent engagement in physical activities, optimally with their children, is advised.

Obesity:

Childhood obesity has reached epidemic proportions globally. Cardiovascular risk factors such as hypertension, type 2 diabetes, metabolic syndrome, sleep apnea, left ventricular hypertrophy, and abnormal lipid profiles (e.g., high triglycerides, low HDL) are higher in obese than in normal-weight youth (5). Some of the interventions aimed at decreasing the incidence and prevalence of obesity in adolescent are

1. All children, regardless of their weight status, should have their weight and height measured and BMI calculated at every visit with the HCP.
2. Parental obesity, family medical history, BMI trajectory and CVD risk factors (e.g., diabetes) are considered in the management of weight and CVD risk reduction.
3. For healthy weight children and adolescents (BMI 5th percentile to 84% percentile), the goal is to prevent excess weight gain through lifestyle modifications that include eliminating the intake of sugar-sweetened beverages, increasing intake of fruits and vegetables daily, limiting screen time to no more than 2 hours daily, and participating in at least 60 minutes of exercise daily.
4. Metformin can be considered for adolescents with signs of insulin resistance or risk factors for diabetes (6).

Blood Pressure:

Elevated blood pressure or hypertension has been established as a very potent risk factor for CVD in adults. Elevated blood pressure levels are known to track over time. Thus, an adolescent with elevated blood pressure is much more likely to become an adult with high blood pressure. Some of the interventions to avoid the problem of elevated blood pressure are

1. Blood pressure should be a routine part of health maintenance visits and should be checked at least annually for adolescents up to 18 years, and at every visit thereafter. This should allow better lifetime control of blood pressure and lower risk for the development of CVD.
2. When hypertension is identified, the recommended clinical approach is lifestyle intervention to improve BMI when obesity is present, to lower dietary sodium and to increase the level of physical activity.
3. Diets like DASH type diet can be successful in reducing blood pressure even without a reduction in BMI in adolescents (7).
4. If the blood pressure elevation persists despite lifestyle change, or if target organ damage is present, then pharmacologic intervention may be indicated.
5. The use of either the levonorgestrel-releasing intrauterine device or the etonogestrel implant is recommended as they do not lead to increases in blood pressure and do not rely on the teen remembering to take them (8).

Lipids/Lipoproteins:

Several lines of evidence support the need for reduction of adverse levels of lipids and lipoproteins beginning early in life (9). This evidence comes from the natural history observed for individuals with genetic dyslipidemias, such as homozygous familial hypercholesterolemia in whom LDL-C levels are quite high, and there is a substantially increased risk of evolving atherosclerotic cardiovascular disease (9). Puberty also has an important impact on levels of lipids and lipoproteins. Some of the strategies to keep the lipid levels under control are

1. Tracking of lipids and lipoproteins, particularly total cholesterol and LDL cholesterol are recommended because of the potential for identifying adolescents at risk for CVD in adulthood.
2. Cholesterol screening should be advised for all adolescents with risk factors for CVD (family history of early CVD or personal history of diabetes, hypertension, obesity, or tobacco smoking).
3. Dietary recommendations as outlined above needs to be followed to achieve optimal lipid levels in addition to the recommended physical activity.
4. Inter-individual differences in LDL-C levels in response to reduced intakes low fat diet is not uncommon. Thus, after an adequate trial of therapeutic-dietary lifestyle change, some children and adolescents will be candidates for pharmacologic intervention.
5. The levonorgestrel intrauterine device and the etonogestrel implant are excellent choices for sexually active adolescent females on statin therapy given they do not cause significant worsening of lipid levels (8).

Smoking/Tobacco Exposure:

Tobacco use continues to be the single leading preventable cause of death. Since most of the established adult smokers begin smoking in adolescence and given the unequivocal evidence linking tobacco use, particularly cigarette use, and adverse health and developmental outcomes, prevention of smoking initiation and cessation interventions are essential components of cardiovascular health promotion and risk reduction for adolescents. Some of the strategies recommended to avoid the deleterious effects of tobacco exposure in adolescents are

1. Some of the strategies suggested for HCPs for discussing smoking with adolescents are
 - Encourage young children to actively *avoid environmental smoke* whenever possible.
 - Emphasize the importance of *not experimenting with smoking*.
 - Point out the *harmful health consequences of smoking* and its addictive potential.
 - Deliver *non-smoking messages* in clinical encounters, educational materials in the clinics and advocate for efforts designed to reduce smoking initiation in community-based settings.
2. Restrictions on advertising, promotion, and availability of tobacco products to adolescents should be combined with the implementation of evidence-based, community-wide, comprehensive tobacco control policies.
3. Parents and guardians are advised to maintain a smoke-free home environment.
4. During the school-age years, assessment of smoking status with clear, firm, and consistent messages about the importance of remaining smoke-free should be advised.
5. For adolescent smokers, ongoing support and counselling either personally or through community-based smoking cessation programs will most likely yield positive outcomes.

Both individual /clinical and public health strategies must continue unabated to reduce tobacco use. Additional research on the efficacy and effectiveness of combining behavioural change strategies and pharmacotherapy for long term abstinence in adolescent smokers is warranted.

Digital Technology in Primary Prevention:

The global reach and integration of digital technologies in the lives of today's adolescents have the potential to deliver CVD prevention interventions en masse. Electronic health (eHealth) behaviour change interventions are a potential solution for adolescents to improve CVD risk factors, given adolescents are digital frontrunners, early adopters and they often have unique healthcare preferences. It is a promising strategy to improve intervention effectiveness and engagement. This can be achieved by Co-creation and Youth Advocacy programs.

Co-Creation:

A key strategy to increase adolescent's engagement with preventative eHealth services is to engage them in the co-creation process. Through the co-creation process, participants identify their preferences for intervention tailoring, i.e., individually-targeted behaviour change through personalized goal-setting. Some interventions done with “co-creation” for prevention of CVD in adolescents are (10)

1. *Mobile Intervention for Drinking in Young People* - is a co-created mobile phone survey sent to adolescent participants, aged 18–25 years, at hourly intervals on a night out and the next day to monitor drinking events
2. *Cell Phone Intervention for You Trial* - was an RCT comparing two active weight management interventions to a usual care control group among overweight and obese adolescents and young adults aged 18–35.
3. *The Fit for Young Adult Males (Fit4YAMS)* text message-based lifestyle intervention was developed using focus group discussions with rural adolescent and young adult males, aged 18–25 years who are overweight or obese.
4. *Computer-Based Weight Management Program Using Virtual Coaches* - to deliver computer-based weight management interventions for adolescents as self-management of weight can be a complex journey for adolescents, who must balance multiple behavioural changes, including nutrition, exercise, motivation, and socialization.

During the co-creation process, personalized or tailored interventions require additional resources to deliver but might be more effective and cost-effective. Constant adolescent engagement in the entire research process allows the intervention to be altered based on feedback from adolescents at given time points to ensure maximal engagement.

Youth Advocacy:

Advocacy is defined as an action-oriented process by which individuals or groups increase public support for, or recommendation of, a cause or policy at a community, state, national, or international level. Advocacy is most effective when it involves a representative sample of society. Youth advocacy has the potential to be a powerful and effective strategy for the prevention of CVD in adolescents as they often become involved pro-actively due to personal interest.

Youth advocacy has many benefits, including education, skill development, and behaviour and attitude changes. When young people come together to form groups, everyone has inputs that have the potential to influence their own and each other's behaviours and ways of thinking. The accumulation of everyone's inputs gives them the knowledge and enthusiasm to advocate for real change to their community and beyond.

Some of the advocacy strategies for CVD prevention among adolescents are (10):

1. Sharing targeted messages for preventive health via new media channels.
2. Co-creation of health promotion programs through advocacy.
3. Leading health promotion programs to promote healthier behaviours among their peers
4. Engaging with local, national, or international youth advisory groups or social movements to advocate for policies that aim to improve CVD prevention.

Through co-creation and advocacy, researchers and health professionals can potentially optimize the quality of the health promotion services offered to young people and, ultimately, help prevent the early onset of CVD in youth. Adolescents may become involved in co-creation and advocacy through school, university, sports, religious, social, or community groups.

The Challenges

Implementation and execution of preventive health interventions in adolescents pose many challenges. The acceptance and continuation rates of healthy lifestyle changes in adolescents are less and largely depends on their understanding of cardiovascular health and its determinants. Some studies have reported that the levels of physical activity decrease significantly over time, in adolescents (11).

The efficacy or effectiveness of eHealth interventions is reliant on successful engagement, which is complex and provides significant challenges. Youth voices are often unheard in advocacy efforts, despite CVD being one of the greatest public health challenges among adolescents.

Conclusion

Preservation of ideal cardiovascular health and prevention of cardiovascular disease among adolescents must begin early and extend across the full scope of young people's lived experiences from the clinic, into their neighbourhoods, in their schools, and into their homes. CVD prevention must incorporate a deep understanding of the importance of youth developmental trajectories and social determinants of health, along with the application of evidence-based behavioural and pharmacological tools when risk factors emerge and primary prevention is needed. While this is challenging, it can be achieved by instituting and maintaining optimum health behaviours early in life and stressing improvement of the family environment as the most important strategy to achieve these goals. Co-creation, youth advocacy, and eHealth are a few of many approaches to employ in the battle against CVD in addition to the conventional strategies of CVD prevention. Future research should aim to test the effects of co-creation and youth advocacy for eHealth interventions to increase the evidence-based strategies to improve adolescent engagement in CVD prevention interventions and their effectiveness.

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