**Case study 2: Overweight Child with Insulin Resistance**

AN is a 14-year-old boy who comes to see his physician for a health maintenance visit. His parents report that he has gained a lot of weight over the past two summers while attending an overnight teen travel camp that involved sitting on a bus for many hours and eating all meals at food courts, hotels, or fast food restaurants. They are asking for help because AN has become less interested in sports and prefers to play video games rather than play outside with his friends as he used to.

**Past Medical History**

AN was a full-term infant (birth weight 3950g). His mother notes he was always thin as a child and is now shorter than most of the boys his age. Growing up he always had a good appetite but rarely ate vegetables. AN’s mother notes his weight gain had been relatively stable until he reached the age of 12, when his rate of weight gain increased over the subsequent 2 years.

**Family History**

AN’s family history is positive for type 2 diabetes, obesity, and heart disease. His mother had ges- tational diabetes during her pregnancy with AN. She is 35 years old and has a BMI of 35kg/m2 (obesity class II) and was recently told she has an elevated blood glucose level indicative of prediabetes. His father (age 36) has a BMI of 28kg/m2 (overweight). His maternal grandmother (age 65) is obese (BMI 32 kg/m2) and has hypertension and type 2 diabetes; his maternal grandfa- ther (age 67) had a myocardial infarction (MI) at age 53.

**Social/Development/Puberty**

AN’s early childhood development is described as normal. He walked at age 15 months, was toilet trained at 31⁄2 years. He is described as an average student. He admits that he feels uncomfortable with his stomach and does not want to take his shirt off in the summer when he goes swimming. He has friends but now prefers to spend most of his free time playing video games. AN denies smoking, alcohol, drugs.

**Social History**

AN’s mother works from 9 a.m. to 5 p.m. daily as a school administrator. AN’s father works 8 a.m. to 6 p.m. as an optician. His parents divorced 4 years ago and he splits his time between his mother’s and father’s homes. AN is either alone in the afternoon or watched by his grandmother before either parent comes home from work. He is an only child.

**Diet/Physical Activity History**

AN’s parents state that he has always had a “healthy appetite.” When asked what he eats during the day (24-hour recall), mother states that at her house he usually eats scrambled eggs, bacon, toast, and orange juice for breakfast, and at father’s house he eats a donut or a bagel with cream cheese, and drinks orange juice. Both parents pack a sandwich for lunch at school (peanut butter and jelly with cookies, juice or chocolate milk, or turkey with mayonnaise on white bread). AN usually augments what his parents provide at the school cafeteria with either a slice of pizza or some chips or pretzels. When he comes home from school he will usually have a snack of more chips or a grilled cheese sandwich and orange juice. He will eat fruit when his parents provide it. Mom or dad each eat out with AN once a week where he orders two slices of pizza or a bacon cheese burger with fries and a soda). At home, they make baked chicken or burgers, potatoes or rice, and broccoli or string beans. While salad is usually served, he does not eat it. He drinks whole milk with dinner. AN’s parents state that he is active with soccer and baseball during the year but they have noticed that his performance seems to be suffering as he can sometimes not keep up with the other boys. AN goes to bed between 9:30 and 10:00 p.m. and generally sleeps at least 9 hours. AN’s parents report that he does snore and occasionally naps during the day.

**Review of Systems**

*Skin:* No history of rashes

*Neurologic:* No headaches, tremors, seizures

*Endocrine:* No polyphagia, polydipsia, or polyuria

*Pulmonary:* Regular snoring noted. Some decreased in exercise tolerance noted with weight gain

*Joints:* No swelling; complains that his legs hurt if has to walk for a long distance

**Physical Examination**

**Vital Signs**

*Temperature:* 99 °F (37 °C)

*Heart rate:* 95 BPM

*Respiratory rate:* 26 BPM

*Blood pressure:* 130/80 mm Hg (∼90–95th percentile for age, sex, and height)

*Current weight:* 75 kg (165 lb) (95th percentile for age)

*Current height:* 160 cm (63′′) (25th percentile for age)

*BMI:* 29.3 kg/m2 (>95th percentile for age)

*Weight history: 9 y/o:* 28 kg (50th percentile for age)

*11 y/o:* 35 kg (50th percentile for age) *13 y/o:* 60 kg (90th percentile for age)

**Exam**

*General:* Overweight teenage boy in no acute distress, no hirsutism, no edema, no Cushingoid features

*Skin:* Wrinkled, hypertrophied skin with increased pigmentation at base of neck *HEENT:* No abnormalities noted

*Neck:* Non-palpable thyroid

*Eyes:* EOMI, PERRL, normal disc margins

*Abdomen:* BS (+), soft, no masses or organomegaly palpable, liver span by percussion 8 cm, stretch marks noted

*Cardiac:* Regular rate and rhythm, S1, S2, no murmurs

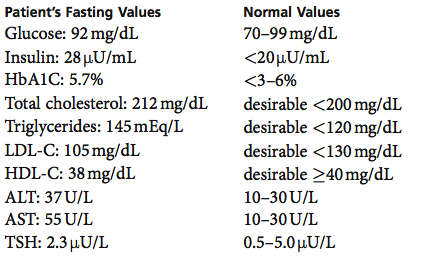
*Chest:* Clear

*Genitalia:* Tanner 2 boy, phallus moderately obscured by fat pad, testes normal

*Neurologic:* Alert, strength 5/5, DTR +2 upper and lower extremities, normal tone

*Orthopedic:* Wide-based gait without a limp, mild bowing of lower aspect of legs bilaterally, full range of motion in both hips

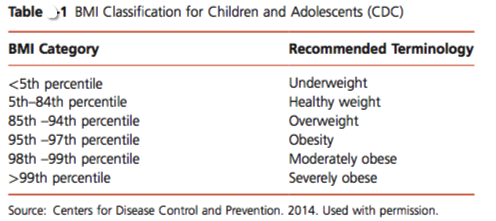
**Laboratory Data**



# Diagnosis

**Describe methods that can be used to assess AN’s weight.**

In the current CDC growth charts, which include BMI growth curves for children and adolescents, overweight is defined as a BMI between the 85th and 95th percentile, and obesity is defined as BMI greater than the 95th percentile. However, BMI is only a screening tool and the patient’s degree of overweight must be confirmed on physical examination. Such screening is necessary to identify those who require intervention. The goal of intervention may be weight loss, or weight stabilization depending on the specific circumstances. Decreasing the rate of weight gain while a child is growing will help decrease ultimate gain in relative weight. AN’s BMI of 29.3 kg/m2 is >95th percentile for BMI for his age and sex. This places him in the obese category



**Describe the risk factors and health consequences associated with being an over- weight child or adolescent.**

Overweight children and adolescents are at risk for similar health problems as adults who are overweight or obese, including type 2 diabetes, hypertension, dyslipidemia, sleep apnea, asthma, gall bladder disease, orthopedic problems, and non-alcoholic fatty liver disease. AN’s dyspnea on exertion is likely due to poor cardiovascular fitness. An appro- priate program for AN’s fitness level should be recommended with the goal to improve his overall cardiovascular fitness level, which will help support overall weight management efforts.

**Sleep Apnea** Upon further questioning about his sleep patterns, AN and his parents indicate that he is a restless sleeper who snores loudly and sometimes has daytime sleepiness. These symptoms may be consistent with sleep apnea. AN should be referred to a pulmonary specialist for further evaluation and possibly a formal sleep study.

**Diabetes** A positive family history of type 2 diabetes is associated with an increased risk of insulin resistance (insulin resistance is thought to be part of the etiology of type 2 diabetes). AN’s grandmother has diabetes, and the mother’s history of gestational diabetes and current elevated glucose level suggest she has insulin resistance and is at risk of developing type 2 diabetes. The increased skin pigmentation that AN demonstrates could be acanthosis nigricans, which is associated with insulin resistance. Since AN is obese, has a strong family history of type 2 diabetes and cardiovascular disease, and has acanthosis nigricans and prehypertension, he meets the criteria to be screened for diabetes. Thus a fasting serum glucose, insulin, and hemoglobin A1C were obtained. AN has a high normal glucose (92 mg/dL) and hemoglobin A1C (5.7 percent), with an elevated insulin level (28mIU/mL), which is consistent with insulin resistance. However, in the evolution of type 2 diabetes, post-prandial glucose increases earlier than fasting glucose, therefore, determining plasma glucose 2 hours after a standard glucose load as part of an oral glucose test or 2 hours after a meal should be considered, along with further evaluation by an enodcrinologist.

**Heart Disease/Hypertension** As AN has multiple risk factors for adult cardiovascular disease (family history of heart disease, obesity, elevated blood pressure), a fasting lipid panel was ordered. These results, when compared to the age appropriate percentiles, indicate that AN has elevated triglyceride levels, and a reduced HDL-C level. Hypertriglyceridemia and low HDL-C are the most common lipid abnormalities associated with insulin resistance. AN’s blood pressure is elevated. Further evaluation to confirm these levels should be undertaken. Weight management and dietary change would be the first recommended intervention, and ANs blood pressure should be moni- tored at least every 6 months.

**Non-Alcoholic Fatty Liver Disease (NAFLD)** Overweight children may present with increased liver enzymes [alanine amino transferase (ALT) and aspartate amino transferase (AST)], which may be indicative of hepatic fat infiltration. Abnormal liver function tests have been described in 6 to 10 percent of obese adolescents. This condition, know as non-alcoholic fatty liver disease (NAFLD), has been described to progress to cirrhosis and liver failure in adults and in rare cases in children. Obesity-associated NAFLD is commonly associated with insulin resistance. Other than weight loss, there is currently no accepted therapy for NAFLD. Persistent elevations in liver enzymes should be evaluated further.

**What additional information should be asked regarding AN’s increasing weight over the past 4 years?**

AN’s 24-hour recall reveals that a lot of calories, sugar, and fat could be coming from meals eaten away from home, such as pizza, burgers, fries, and soda. It would be especially helpful to determine the portion sizes of meals and drinks when he eats out, as well as when AN was eating “on his own” at camp and at home in the afternoon. Since AN is drinking juice at home with meals and snacks, it is also important to probe for the size of these drinks. Though juice contains more nutri- ents than soda, juice and other sugar containing beverages can provide a lot of calories. AN is doubling up on his lunches when in school and although after school snacks for growing adoles- cents may be appropriate, the caloric density of the foods consumed must be considered. When assessing dietary intake, it is important to note that dietary information provided for obese indi- viduals tends to be under-reported. Studies suggest that obese adolescents under-report their caloric intake by as much as 40 to 60 percent, and that obese individuals under-report to a greater degree than non-obese individuals.

Further questioning reveals AN eats at least two slices of pizza and a large soda or an adult bacon cheese burger with large fries and a large soda when eating out and at least 12 ounces of orange juice at each meal or snack at home. During school, after AN eats his packed lunch, AN will also purchase a bag of chips or an ice cream dessert. After school he spends most days with his grand- mother, who serves him a bag of chips and a grilled cheese sandwich with chocolate milk at 3:30 p.m. for a snack, after which time he does his homework and plays video games until dinner. After dinner, AN also enjoys either ice cream and a few chocolate chip cookies or an 8 ounce (240 mL) glass of whole milk with peanut butter crackers before bed.

**Sedentary Activity** Detailed questioning about AN’s television, video, and computer game usage reveals that on weekdays, on average, he watches 3 hours of screen time per day. On weekends AN watches television, plays video or computer games, or “surfs the web” for up to 6 hours per day. AN’s parents stated that he is active with soccer in the fall and baseball in the spring. He usually has one game each week and plays goalie or a defensive position where there is very little running involved. As both teams have many players, AN never plays more than half a game or about 25 minutes. Following the game AN’s family often go to a fast food restaurant. AN is sedentary during the winter months.

**How can AN and his family’s readiness to change be assessed and how should this treatment process be explained?**Prior to recommending any dietary or lifestyle suggestions, it is very important to assess both AN’s and his family’s interest in making changes, which will need to be consistent at both his mother’s and father’s houses. It is best to directly address the motivation and willingness to change with AN and his parents. Some families may express significant interest in changing, yet will be unable to identify concrete changes they are willing to undertake. It is also important to assess other potential environmental obstacles (e.g., uncooperative family members like AN’s grandmother).

Motivational interviewing strategies use a ladder or Likert scale to determine how important the issue is to address and how competent each family member is in being able to institute needed changes. This conviction and confidence model has been used with success in many behavior change studies. AN’s parents stated in the initial work-up that he has gained a lot of weight since last year so they seem to realize that there may be a problem with his weight. However, the fact that they blame his activities at teen travel camp and do not recognize the contribution of his sedentary lifestyle and increased caloric intake as a problem suggests some denial, or lack of will- ingness to change. Because AN says he does not like they way his stomach looks and admits that he feels embarrassed to take his shirt off at the pool, suggests that he has some interest in changing. However, the fact that he is becoming more and more withdrawn may suggest depression or other psychosocial issues that may be necessary to address before weight management interventions can be successful.

When explaining the process of weight management and the implications of excessive weight gain, it is useful to review the child’s growth curve with the family. The specific medical issues affecting the child should also be discussed. In AN’s case, his insulin resistance, acanthosis nigri- cans, snoring indicating possible apnea, elevated blood pressure, and dyslipidemia are all partially related to his obesity. The family history of insulin resistance, diabetes, and premature heart disease should also be noted as additional reasons for increased vigilance. Explaining to parents and other family members that improved diet and increased physical activity with weight stabilization or weight loss can decrease AN’s risk of developing diabetes and cardiovascular disease, may help motivate them to support him and potentially to join him in making changes.

In general, the initial goals of a pediatric weight management program are to decrease the rate of weight gain, aiming to keep weight stable while the child grows to decrease relative weight. In this case, given AN’s continued growth potential, weight stabilization is an important first goal. With significant obesity, weight loss may be appropriate in children, and can be safely implemented with appropriate supervision.

**What are the appropriate medical nutrition therapy and physical activity recommenda- tions for AN and his family?**The most important dietary change that should be recommended for AN is to control portion sizes, reduce snacking, and limit calories from beverages, such as soda and orange juice. Specific recom- mendations could include changing to a bowl of low-sugar cereal (Multigrain Cheerios or Life) with low-fat milk, and fruit or a slice of toast with peanut butter and jelly and a glass of low-fat milk for breakfast. AN’s juice intake is contributing over 800 calories per day and should be reduced to less than 6 ounces (180 mL) per day. Lunch could remain the same, with the substitution of fresh fruit, carrot sticks, and a Greek-style strawberry/banana yogurt to discourage him from buying dessert or other snacks. Both parents could send him to school with a bottle of water, which he can refill during and after school.

AN’s grandmother should be included in these discussions since she is his after-school caregiver. Because she has type 2 diabetes, she may be receptive to the idea of prevention for her grandson. Healthy after-school snack suggestions for AN include fruit, low-fat yogurt, low-fat granola bar, microwave “lite” popcorn, or a frozen fruit bar. Snacks are a normal and important part of a child’sdiet; however, choices should not be high in calories. Given that AN was eating a full meal as an afternoon snack, providing guidance regarding an appropriate serving size for a snack would be important.

Beverage choices are another common problem with overweight children. Efforts should be made to limit the intake of all sugar containing beverages including juices. Many families feel that since juices are “natural,” their intake should not be limited. It is not unusual to see a child ingest 500 to 1000 calories a day in juice, soda, and other sugar-sweetened beverages. Eliminating or significantly limiting juice, soda, and sports drinks, and switching to low-fat milk will likely reduce weight gain. Dinner meals seem to be the healthiest and could remain the same, except for the whole milk. In addition to healthy food choices and meals, children and families should be instructed on proper serving sizes for children for meals and snacks.

AN’s family should provide ample opportunities for him to eat fruits and vegetables and low-fat dairy products. They should limit the availability of salty snacks and prepared foods as these are sources of excess sodium intake, which has been linked to blood-pressure elevation and to increased consumption of sugar-sweetened beverages. His relatively high saturated fat intake may also be contributing to his blood pressure elevation and would be a secondary goal.

Parents and families should assess and plan opportunities for increased physical activity. Find activities that the child enjoys (i.e., do not expect a child to regularly use a treadmill). Parents need to provide an environment where being active several times a week is normal and expected. Parents should be role models and participate in activities with their children. They should not assume children are active during school recess as time for physical education has been consistently decreased and often eliminated from school curricula. Parents should also monitor and set daily limits for sedentary activities, such as watching TV and playing computer and video games. The American Academy of Pediatrics suggests screen time be limited to less than 2 hours per day. According to the Centers for Disease Control and Prevention (CDC), children and adolescents should engage in at least one hour of physical activity every day. AN’s family should have a concrete discussion on goals for decreasing screen time and increasing physical activity with methods for monitoring progress and consequences for non-adherence.

Healthy Lifestyle Recommendations to Maintain or Achieve Healthy Weight

* Limit consumption of sugar-sweetened and fruit juice beverages to 0–1 serving (6 ounces)/day
* Increase fruit and vegetable consumption to ≥5 servings/day (see USDA guidelines- www.choosemyplate.gov)  (needs hanging indent)
* Limit TV and other screen time to <2 hours/day (none before 2 years of age)
* Greater than 1 hour/day physical activity
* Incorporate physical activity (e.g., walking, bike riding) into normal routine
* Remove TVs and other screens from child’s primary sleeping area
* Eat a healthy breakfast daily
* Limit eating out at restaurants and eat home cooked meals as often as possible
* Encourage family meals together at the table
* Offer structured meals and planned snacks in the home
* Involve the whole family in lifestyle changes
* Provide age-appropriate portion sizes
* Avoid the imposition of overly restrictive control on eating

As the child works toward improved weight status, defining roles of the parents and the child is essential. For example, the parents will ensure that healthy after school snacks are available in the home daily after school, while the child is responsible for eating these healthy snacks rather than stopping at a corner store for unhealthy snacks instead. In this case, both the parents and the child have defined responsibilities to fulfill. Involvement of the entire family is vital to achieving and maintaining lifestyle changes.