Excerpt from "A Mom's Guide to Sports Medicine for Kids", Dr. Randy Goldstein

Growth and Development During Adolescence:

To understand when growth is abnormal- it is best to first understand what is normal.

Most girls start puberty around eight to ten years old. Most boys start around ten to twelve years old. Puberty is classified in five stages called "Tanner Staging". Tanner 1 is from infancy to the beginning of puberty. Tanner 2-4 occurs during adolescence and Tanner 5 is adulthood. So Tanner 2 is important because it is the proof that puberty has begun. Tanner 4 is also important as it is typically the time of most growth as well as the start of menses (the period) in females and increase of muscle mass in males.

Tanner Staging- Development

	Boys	Girls
1	No pubertal development	No development
2	Scrotum enlargens around age 10-13	Breast bud develops around age 8-11 (late if after 14 yrs)
3	Increased growth and sexual development	
4	Increased muscle mass and stature around age 14-17	Period (menses) starts (late if after 16 yrs) and increased stature, "female appearing hips"
5	Final adult sexual maturation and height	

Normal growth in adolescence is two inches per year with one or two growth spurts occurring before adulthood; a growth spurt is an increase of around four inches or more in one year.

A child's final height can be predicted using several techniques. The first is looking at his or her growth curve. Clinicians can make an educated guess of final height by observing the child's current height velocity compared to others their same age.

Added information can assist the clinician in predicted height. Parental adult height along with when they started puberty and had a growth spurt can be used to come up with a mean parental height (MPH).

An x-ray of the hand (a bone age) can be used to determine how the child's development is progressing compared to others their age. This is an interesting and fairly important part of a growth work up. If a twelve year old girl has not started puberty (remains a Tanner 1) and is short on the growth curve and the parents are both average height and they began puberty at 10 (mom) and 12 (dad)- a bone age is a great first step in evaluating the child's growth. While the chronological age of the girl may be 12, the bone age- or development of the body- may be delayed. A book is used to compare the x-ray of the patient's hand and its growth plates to that of other girls the same age. Along with an accurate height and weight, previous measurements, and a good physical exam- the bone age needs to be the first step in any height or puberty and development work up in an adolescent boy or girl.

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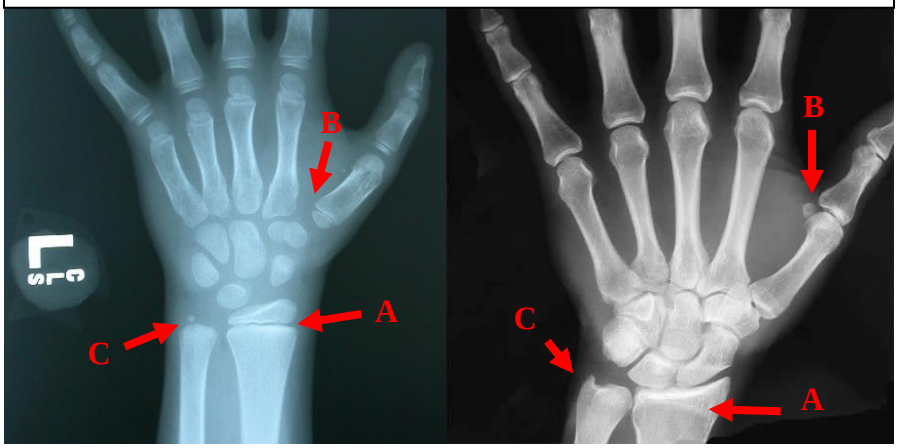
Just for a few examples of the many changes that occur in the hand during growth

BOY around 8 years old:	ADULT:
The open physis of radius (growth plate): A	The closed growth plates: A
The immature thumb (no sesamoid): B	Now the sesamoid is visible: B
The immature shape of the ulna: C	The mature shape of the ulna: C



Bone age film of the left hand, the "cracks" in the bones are growth plates (physis) and each bone is evaluated to determine the age of the child's bones- which may or may not turn out to be the same as the patient's chronologic age

Finally, there are several lab tests that can be accomplished including growth hormone, thyroid levels, chromosomes (to look for Turner syndrome in short stature girls), and growth stimulation tests.

Tests for Growth and Development

Physical exam: Growth Curve of height and weight and Tanner staging

MPH- (mean parental height) history of parents growth and their adult height

Bone age- x-ray of hand looking at growth plates

Lab tests- Celiac test, sed rate, thyroid, chromosomes in females, growth hormone, Chemistry for kidneys and liver, glucose

Stimulation tests- for growth hormone activity, this takes four hours and typically done in a hospital setting as there is medicine given to stimulate a response and multiple labs drawn to measure activity

MRI head- to rule out pituitary abnormality, not necessary in every case

While many families are satisfied with whatever height their child is- others are interested in having their children achieve some minimal height before their growth plates close. Other families are interested in their children achieving an increased size for sport. Medical as well as ethical considerations must be made before treatment is deemed safe as well as helpful.

Delay of growth (that which is less than 3% on the growth curve, or less than two inches of growth per year), a girl who has not started breast development by 14 or menses by 16 years old, or a child that does not appear he or she will make it to their MPH (mean parental height) should be considered for a work up.

Treatments include testosterone in delayed boys, thyroid hormone in thyroid deficient boys or girls, and growth hormone in the select few who are truly growth hormone deficient (fail their stimulation test). Testosterone and thyroid hormone are inexpensive, safe, and helpful to those who qualify. Growth hormone is extremely expensive ($30,000 or more per year for 5-7 years or more), has potential side effects, and is only helpful if truly growth hormone deficient.

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Children that are progressing too quickly either in height or sexual development should also have a work up. Although they may be "tall" compared to their similar aged friends, they are likely to stop maturing too quickly as well as end up stopping their growth before they should. This will result in the bone age being advanced and growth plates closing before they should. While a precocious growing child may be seen by parents as a strong, mature child- if not slowed- it can result in a shorter than desired adult. There are medications to slow advanced maturation and allow for normal growth.

Parents and patients should not be "scared" of a growth evaluation. Not all short kids need a growth work up. Looking at the family history and growth curves are important. If your doctor is interested in a growth workup though, realize that there are treatments available- so have an open mind! Don't say, "Mother nature meant it this way." You wouldn't say that if your child had diabetes, high blood pressure, or pneumonia!

Growth hormone deficiency affects the heart, immune system, and overall life expectancy- not just the height. Turner syndrome effects girl's height but also their reproductive organs, their heart, and their overall development. Therefore growth and development should not just be "brushed off" as looking for a short or tall person- it should be a part of the overall care of a young athlete.

Treatment Possibilities for Growth Delay

Observation- recheck bone age and exam in 6-12 months
Testosterone for boys who are delayed but have enough GH
Growth Hormone- for those that are truly GH deficient

Look at diet, chronic disease (such as asthma, thyroid disease, celiac disease and other gastrointestinal problems such as ulcerative colitis or Crohns), medications (repeated oral steroids), and environment (neglect, extreme stress)

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Nutrition in the Young Athlete

Let's cover some basics first. Athletes are NOT normal people. They need MORE calories than a person the same age who goes to school and then home to play video games. Video games use up time; not calories!

Calories are made up of carbohydrates, protein, and fat. Everybody needs fat; even athletes. The percentage of each is a debate. People that like the "Zone" or "Atkins" believe you should have more protein while other diets suggest more carbs. There is probably no one correct answer and every expert has a reason why theirs is best.

Protein is used for building blocks for new growth including bones and muscles as well as making enzymes, immune system use, and other long term health needs.

Fat is used as a secondary energy when carbohydrates are running low. It is also an important resource for the brain, connective tissues, and for storing fat soluble vitamins.

Carbohydrates are used for fast energy and are probably most important during the actual activity. Carbs are stored as glycogen to be used during the first 90 minutes of exercise. After that, fat is needed for further energy if carbs are not replenished.

Candy bars and soft drinks are difficult sugars to break down and although often give a quick burst of energy, also have a major let down and lack of important nutrients needed.

For conversation sake, many sports nutritionists would recommend 50-65% carbohydrates, 15-25% protein, and 25-35% fats. If your expert says something different, that is ok… keep reading anyway!

Before practice, an athlete should prepare for workout. **Carbohydrates are the food stuffs that are broken down the quickest.** An apple, fruit juice, or bagel would be examples of easily digested, quickly usable carbs. Peanut butter offers both some carbs and some protein- a great combination to put on a bagel!

Depending on the exercise decides the need for a snack midway through. Aerobic exercise is constant- such as long distance running, swimming, or the forward on a soccer team. Anaerobic exercise is not constant- such as gymnastics, or the center tackle on the football team. Aerobic exercise uses up energy more quickly. That is why marathon runners are offered orange slices and juice every few miles and anaerobic exercise like football linemen might play an entire game only needing water or a sports drink.

After a workout, the body is craving carbohydrates from the depletion during exercise. If you are going to have something not healthy this would be the time. The snack should not be excessive though- not for about thirty to sixty minutes.

The science:

During exercise, blood goes to the area that is hungry for oxygen. You will notice your biceps fill with blood during curls while weight lifting. Where is this increased blood flow from? Well, during exercise, the brain, kidneys, and heart keep their needed blood flow and the muscles in need "steals" the blood from less vital organs such as the stomach and intestines. During this time, the stomach and intestines receive less blood so the muscles and heart (coronary blood vessels) can get more. It takes time after exercise for the blood flow to regulate itself back to normal. Cramps, stomach aches, and even nausea may result from a large meal immediately after exercise since the stomach and intestines are unprepared to work.

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Still, after exercise it is a good idea to get some carbs in quickly such as a sports drink, some fruit, or even a small milkshake.

How about dinner after competition? This is a good time for protein- those building blocks for future growth of muscle, bone, and needs of metabolism. Athletes need carbohydrates right before, during, and right after exercise and then protein for the days after. Meals not directly around exercise are a good time for protein and fat.

So what about fat? It is actually important too- it is used for reserve energy if carbohydrates are used up. The brain is made of mostly water and fat. Fat is also used to break down and store fat soluble vitamins.

A teenager needs about 25 calories per pound per day
(50-55 calories/kg/day). A teenage athlete needs more to build muscle and keep bones from stress fractures. For a 100 pound athlete that would be at least 2000 calories per day.

Basal Rate: Athletes weight in pounds divided by 2.2= kilograms
If female multiply by 0.8 to see hourly basal rate
If male multiply by 1.0 to see hourly basal rate
Multiply this number by 24 to see daily basal rate

This is the fewest calories necessary just to live, sleep, and eat

If you are involved in moderate exercise add another 0.8 times your basal rate and in heavy exercise, double your basal rate.

Here is an example of *the fewest calories* needed for a premier level male soccer player who weighs 100 pounds.

A: 100 pounds divided by 2.2 = 45 kilograms

- 45 kg times 24 hours = 1080 calories needed for daily basal rate
- 1080 times 2 for heavy exercise = 2160 total calories needed to play soccer at a high level

Therefore, this athlete needs 1080 calories for daily living and ANOTHER 1080 calories to play soccer to ensure that growth is normal, and the chance of injury is reduced

Fewest Acceptable Total daily calories = 2160 calories
More calories are not bad, especially if weight gain is a goal

B: The other calculation takes weight (100 pounds) X 25 calories per pound per day= 2500 calories needed per day

The results: A growing athlete weighing 100 pounds therefore, (during puberty) that does not get between 2100-2500 calories a day risks shorter than normal growth potential, a higher risk of stress fracture and muscle injury, a hungry and easily distracted mind, and a less than full potential athlete.

It's like a race car with 87 octane fuel which knocks and sputters… it would run better, smoother, and faster with 100 octane fuel!

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And how about vitamin and mineral supplements?

Supplements are probably unnecessary in most healthy children who are offered a good diet. If you were to mention a couple though- athletes will benefit from a 1000-1300 mg calcium supplement with Vitamin D between 600-1000 IU (international units) per day if they don't get it during their normal diet. *Check with your doctor as dose recommendations do change.

Calcium and Vitamin D are important for bone health. Because vitamin D helps with calcium absorption, it's best to take them together. Too much calcium in any form can result in kidney stones, as well as potential calcium deposits causing vascular and heart problems, so more is not necessarily better. Athletes with kidney stones, hyperparathyroidism, or urine abnormalities should check with their health care provider before starting a calcium or vitamin D supplement. And every athlete avoiding soft drinks high in Phosphorus (dark colored regular and diet drinks which might steal calcium from your body- this is controversial) is best, replacing them with milk, fruit juices, Gatorade with low sugar, and water.

Vitamin D has become a "hot topic", not only for improved bone health, but also as a potential benefit to the brain, and may decrease the risk of some cancers, and perhaps decrease chronic pain and some forms of depression. It is a vitamin many health care providers are checking labs in their patients (25-OH Vitamin D), and supplementing when found low, below 30. Prescriptions up to fifty thousand IU of Vitamin D3 once weekly for several months is a treatment used in those patients with lowest levels while doses of 5000IU of Vitamin D3 per day may be considered for those with moderate insufficiency. We get vitamin D from food, such as milk and fish, and also from sunlight. You can't get too much vitamin D from the sun (but you can get a sunburn and skin cancer so 10 minutes or so of sunlight without skin protection is probably enough). People living north of 37 degrees latitude (Tulsa, OK) likely don't get enough vitamin D from sun during the winter season (what may cause Seasonal Affective Disorder (SAD) in some people). Too much vitamin D in foods or supplements can cause diarrhea and too much calcium, may increase the risk of kidney stones and calcium deposits in the vascular and cardiac system. Some health care providers believe D2 is adequate while many believe D3 is superior. *Check with your health care provider if a supplement is necessary and what dose is best for you.

RULE OF THUMB:

There is an increase of osteoporosis in middle age women. Had a woman increased her calcium intake with Vitamin D between childhood and age 23 years- she may have been more protected. The most important time for Calcium and Vitamin D intake is before osteoporosis begins- not after!

Swimming and non-impact sports may increase the risk of osteoporosis. The most AT RISK athlete, theoretically, is a female competitive swimmer.

There is a lot of media attention (and salespeople) interested in selling you other vitamins. Hot topics include iron for runners, fish oil for the heart, probiotics for the intestines, and mangosteen for the immune system. While none are likely dangerous, they are also probably unnecessary (and expensive) if you already have a good diet! Research is constantly being done to prove effectiveness or danger with too little or too much of a vitamin or mineral. It can be difficult for even your health care provider to keep up!

Bottom line- athletes, even more so than non-athletes, need food! And Vitamins DO NOT contain Calories! Eating right is most important, adding supplements might be considered in those that can't achieve optimal nutrition with eating.

The constant media attention on eating right, fad diets, and not eating so much is directed towards the non-athlete. And while the American public indeed has a greater percentage of unhealthy, obese people at risk for diabetes II, hypertension, and high cholesterol--- the great majority of young athletes need healthy calories for continued growth and muscle/bone strength. The media also promotes tiny, fatless models that may mislead young athletes in believing the less you weigh the better. On the contrary, calories help athletes achieve stronger bones and increased muscle- all which must weigh something!

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Eating, A Race Car Analogy:

Nutrition is such an important factor in the success of a high level athlete- and often one that is not discussed- at all! This book is not intended to be a complete guide for any one area- but here is just a little more on eating.

Let's start with an analogy. A race car may have the most horse power (speed),the best driver (mind, attitude, dedication), the strongest body frame (strength), the most expensive tires (equipment, sponsorship), and the best pit crew (coaches, parents, team mates)- and still not make it off the starting line if someone forgot to add the right fuel!

And not just any fuel, like what your parents put in their Sports Utility vehicle (87 or 89 octane)... a race car requires fuel that allows fast speed, long races, and high competition (100+ octane!). This fuel is more expensive and yes, a race car needs LOTS of it- depending on the race- the car may need several pit stops for refueling. Why? Because it burns the fuel so quickly when the driver is constantly going faster and faster and demanding more and more. Athletes are like race cars. They demand energy for practice and competition and then require more energy for re-building and gaining strength. An athlete needs a healthy meal before competition, hydration and possible healthy snacks during competition, and then a healthy meal for rebuilding and strengthening after competition.

Athletes that eat poorly (or not enough) can not perform at their peak, can not rebuild after a long workout, and can not gain endurance and muscle. If an athlete is doing well while eating poorly- they would even be faster, stronger, and healthier if they ate better. Just like a car- it can run on 87 octane- but runs smoother, faster, and more powerfully on 92 or 100 octane.

Race cars use up almost all their fuel during the race (like an athlete during practice) and need to be refueled often. And a car that doesn't get enough energy with gas- or an athlete that doesn't get enough energy with food- will sputter to a stop while the competition passes them by. Race cars that get too little gas (not enough calories) or bad gas (fast food, junk food, soda) ultimately have problems with winning the race and have problems with the car (an athlete will get weak bones, less muscle, trouble concentrating)

Athletes sometimes become overly concerned with eating because they see their non athletic friends gaining unhealthy weight. Kids that are sedentary- playing video games or watching TV are more like SUV than race cars. SUVs travel more slowly (not as much exercise), and therefore use fuel but not as quickly. The left over fuel becomes excess weight in an SUV (person not exercising), while any excess fuel in a race car is helpful to beat its competition in the final laps of the race (an athlete uses excess calories to build stronger bones and more muscle). Although nothing in humans is as simple as this analogy to cars- it is similar and essential for young athletes to understand.

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