

The Physical and Physiological Differences between Adults and Children

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A large proportion of the ITFNZ membership is below the age of 15 years. The statistics for the organisation regularly show that more than 50% of the members are juniors. Many clubs have specific kid's classes allowing children below a certain age to train while at other clubs children train with adults at every session. With such a large proportion of members in the junior age bracket it is important that instructors have an idea of the differences and the limitations or advantages that they create, both physical and mental, between adults and children.

This essay is designed to deal with the physical side of children training and how their bodies react differently from adults to activity and in some cases I will explain why they have to react differently. It will be split up into sections but it is important to remember that all different sections overlap and each characteristic of exercise characteristics which will affect many other parts of the body. The topics that will be covered are aerobic and anaerobic exercise as well as covering topics which apply during both these types of exercise, cardiovascular, ventilation, thermoregulation, nervous system as well as some parts of bone development.

Aerobic Exercise

Children use a greater amount of aerobic energy relative to adults, this means they do not have the same ability to perform anaerobic activities such as intense sparring or pad rounds. This is due to the difference between fuel sources between children and adults (Delamarche, 1992). Normally at rest and during light exercise the primary source of energy is by converting fat to use as energy, this occurs in both kids and adults, as the exercise gets more intense, above about 50 %, blood and muscle glycogen are used to provide energy. Due to the fact that kids do not have the same level of glycogen stores as adults and they do not have the same ability to convert this into energy during exercise, children use a greater proportion of fatty acids to provide their energy not just normally but when they perform exercise as well (Saltin, 1974). This is one reason why kids are able to exercise for long amount of time.

The second factor that design kids for less intense forms of exercise is due to the size difference between adults and children; this size difference means that all the internal organs are comparatively smaller as well. During exercise the blood controls the amount of oxygen that is transported around the body, this is controlled by two means, either the heart rate can change or the amount of blood pumped around with each heart beat can change. Children have the same ability to increase the amount of blood pumped around with each heart beat relative to their size however their blood does not have the same ability to carry oxygen as adults, therefore even if the amount of blood pumped out of the heart on each beat increases the amount of oxygen carried doesn't increase much. This creates a reliance on increasing their heart rate as the exercise gets more intense. This is another reason why children are far better suited to performing longer and less intense forms of exercise than adults.

Anaerobic Exercise

As the intensity of exercise increases the body can no longer use oxygen fast enough to provide the amount of energy required for exercise so it reverts to another pathway to provide this energy. This is because the body cannot produce enough of the chemical that turns stored energy into the form that the muscles can use. The down side is that this using this method to provide the energy required results in lactic acid being produced.

It has been shown that kids have a lower amount of lactic acid during exercise as adults (Freedson, 1997). This may be due to either decreased production (meaning there is a lower capacity for anaerobic exercise than adults) or increased removal of the acid (meaning there would be a higher capacity for anaerobic exercise than adults). However it has also been shown that children do not have the same amount of chemicals which lead to the creation of lactic acid and lower amount of chemicals which remove lactic acid from the blood stream (Freedson, 1997), therefore it is fair to assume that there is a lower level of production. This is one reason why kids can participate in large amounts of exercise and not feel as sore the day after as adults.

Obviously this means when performing exercise such as pad rounds kids will not be able to produce or maintain the same level of effort as adults, and likely will need to be limited. This does not mean that no activities such as sparring should be done with kids but instructors should be aware that even when training up for a black belt grading juniors will not always be able to participate as intensely as senior members in some parts of training.

Cardiovascular

During exercise the blood controls the amount of oxygen that is transported around the body, as said earlier this can be altered by altering the heart rate or the amount of blood pumped on each beat.

Even at rest you will find kids have a higher heart rate than adults but will be relying less on the amount of blood in each heart beat, this is due to the smaller size of the heart. The heart beat will only increase when exercise is involved but the amount of blood pumped with each beat will only slightly increase. When training at the same intensity an adult's heart rate would have increased by less than a child's but the same result is being achieved by a different method. This is another limitation which means that adults can exercise more at higher anaerobic levels and for longer periods of time than children, they can continue to increase the amount of oxygen they are carrying around the body through two means, kids however rely more on one method, increasing their heart rate, as exercise intensity increases.

The general rule of a maximum heart rate being 220 minus the person's age does not apply to younger people below about 15 years of age where it is not uncommon to see children increase their heart rate up above 220 depending on how hard they are being pushed and how hard they can push themselves. Please be aware that there is no danger for a healthy and fit person to push their heart rate up to its maximum level, it is difficult to achieve but is not harmful.

Ventilation

When the oxygen does get to the muscles in children they are also less efficient at using the oxygen for work, roughly to get the same amount of energy as an adult they require 10 % more

oxygen. The body only has one way of increasing the amount of oxygen it gets and that is to breathe faster and deeper.

Generally the amount of breaths a person takes per minute decreases as they get older.

Obviously as a person grows their lung size increases, but at rest the only use roughly about the same amount of oxygen whether they are a child or an adult, since the adult has a greater lung capacity they get a greater amount of oxygen every time they take a breath in. The child must make up the deficit somehow and they do this by increasing the amount of breaths they take per minute (Coyle, 1984). When taking into account their body size however the depth of breathing decreases as people grow (Shepherd, 1967). Therefore they are using less air for each kilo of body weight; this is evidence of a more efficient use of the air they are breathing in.

This does however create an added risk for children, a combination of a higher heart rate (which also causes more carbon dioxide to be sent back to lungs to be breathed out) combined with the higher ventilation means that the amount of carbon dioxide in the blood can decrease. This is bad because the breathing rate is controlled by the amount of carbon dioxide that is in the blood. This is the reason why children are more likely to hyperventilate than adults. The solution to hyperventilation is to get the individual to breathe air which has a higher proportion of carbon dioxide in it until their breathing returns to normal; this is mainly done by having the person breathe into and out of a paper bag.

Thermoregulation

When performing exercise the temperature of the body increases, in children roughly 20 % of the energy is converted into work, the remaining energy (approximately four times the amount of work produced) is produced into heat and is dissipated throughout the body. In adults a higher proportion of energy is converted into the work done and less into heat. The body has produced ways to deal with the excess heat to give the heat to the surrounding environment and therefore reduce the body temperature; the main way in adults is through sweating. However children obviously do not sweat as much as adults so they have deal with overheating in a different way.

Children obviously have a smaller bodyweight than adults, they also have a smaller skin surface area but relative to adults they have a larger surface area relative to body mass than adults (Bar-Or, 1989). This larger surface area relative to mass, means that a greater proportion of heat can be released into the environment through the skin. This works differently from adults who, through sweating, release fluid on to the skin which then evaporates as its temperature increases and this increases the speed at which the heat is transferred from their bodies. To help give off more of the heat kids divert more blood, which is carrying heat and therefore warm, to the skin. This blood is directed from the body tissue that is not currently working (Nielson, 1990). This does create a problem in Taekwon-Do where often there is very little of the body not working.

In times of high temperatures, such as in a warm hall during the summer months such as January, February or March in New Zealand, the children's increased surface area relative to mass can cause some problems. Not only does it allow for an increased ability to give heat to the surrounding environment it also allows, in times where it is hot, an increased ability to receive

heat from the environment as well. In these circumstances the fact that they do not sweat as much as adults means they do not have anywhere near the same ability to lower the body temperature as adults since their main mechanism is ineffective.

In the colder months, normally July or August in New Zealand, this same factor can cause them to lose heat too fast. Where adults will simply stop sweating to prevent a drop in body temperature kids cannot slow down the speed at which they lose heat due to the fact they cannot instantly change their body surface area.

Generally this surface area to mass ratio means children are far less tolerant to temperature extremes than adults, but during normal more mild temperatures children have an advantage due to less sweating causing less dehydration.

Normally the temperatures do not cause great problems in Taekwon-Do in New Zealand due to the fact most training occurs between 6pm and 8pm at night and not during the heat of the day in summer and due to the fact that Taekwon-Do is quite physical and involves a lot of activity meaning as long as they continue to exercise without large breaks kids will not have problems with the cold in winter.

Nervous System

Everything in the body is controlled by the nervous system. It transfers the signals from the brain to the part of the body that is required to perform work. It is clear that kids run around and play a lot more than adults, a stimulus which can only be initiated by the nervous system, but this like most other innate behaviour must have one or more reasons.

Firstly it is suspected that the nervous system uses exercise to help balance energy intake. This means that the body will try to maintain a stable weight. As people get older this natural drive decreases and the amount of spontaneous exercise decreases with age (Rowland, 1990).

The second reason is that children are still developing their nervous systems, when a child first learns to walk the brain is figuring out how to control the body this explains why the first steps are so ungainly and lack fluidity. The amount of running around that children naturally do is meant to strengthen the nervous system by performing as much exercise as possible. As they get older the same level of development is not required and therefore activity to improve it is not required to such a great extent. It has also been shown that a child with attention deficit hyperactivity disorder (ADHD) have a lower amount of central nervous activity than other children at the same age, when given nervous system stimulants the amount of activity they perform decreases to normal proving that the amount of activity they perform is a stimulus seeking behaviour. This implies that if kids with ADHD perform exercise specifically suited to learning to control their bodies better the condition should improve.

Bone development

Due to the fact that children are growing their bones are very different from adults. Everyone has cells which both build and break apart bone but in children the number of cells that are building bone is much larger, it is only after the final growth spurt finishes that these cells balance out so that bone size stays roughly constant. The fact that the bone is still being built or is only very new means that it still hasn't had the same chance to develop to its full strength and has weak points that adults don't. It also means that their bones can bend and flex more than adults.

The differences in flexibility and strength mean that when they break they can break differently to an adult. Instead of breaking like an adult a child's bones can break only on one side of the bone, they can also break on a diagonal and can break so that the ends of the bone do not match up.

Bones are made up of two parts. In the centre there is an area of compact bone, on the ends there is another sort which is not as solid and has more gaps. This is the same regardless of adults or children. The growth that occurs in children happens between these two sorts of bone. This growth plate is made of cartilage (which contains no salts or minerals) and is softer than bone. As children age the part nearer the compact bone calcifies and solidifies while more cartilage is added to the end nearer the joint. When this stops occurring growth stops. There is no specific age at which growth stops it depends on the individual and can stop in the early teenage years or continue into the twenty's. It does mean that if damage is caused it can occur in the normal part of the bone or it can occur on the growth plate, something that is not a problem for adults.

Injuries to bones, and more specifically the growth plates, are caused by an external force (such as a fall to getting hit) or can be caused by overuse.

Most injuries occur from falling and happen in the wrist and elbows due to the child putting their arm out to break their fall. In Taekwon-Do the odds of falling are just the same but an area where we take a lot of care is power breaking. Power breaking can have the same effect as a fall; the only difference is the force is generated by their muscles rather than through gravity. For the hand techniques the body is not used to absorbing force therefore those techniques can damage the bones and growth plates. Due to the fact children are constantly running jumping and landing on their legs are excellent at absorbing the force they can generate from a kick. However when they land the force only goes in a straight line up the leg, meaning that for straight line kicks such as a side or back kick they are simply not strong enough to cause damage. For kicking techniques such as turning or reverse turning kick, where due to the fact the technique is rotating in a circle the force actually goes on a diagonal across the leg, something that kids do not typically deal with. In general this means that kids can perform kicking techniques that are performed in straight lines without causing problems. Kicks that use the body to rotate for power can still be used but rarely and hand techniques are too risky to have kids perform for power breaking they shouldn't be used.

This essay has only talked about the basics of exercise physiology in children; many of the points raised in this essay are specifically designed for situations that regularly occur in a Taekwon-Do

class. Because of this not all parts of exercise have been discussed and they have not gone into great amounts of detail.

The topics raised are not designed to try to discouraged younger people or children from participating in Taekwon-Do. They can and do regularly participate in all parts of Taekwon-Do along with adults but it must be remembered that they often achieve the same result but used different methods. Only in some circumstances such as power breaking (particularly with their hands) or some very intense pad rounds, can they not perform the same exercises as adults. In most parts they can participate just as adults and often it will be more mental factors, something that this essay does not deal with, that influence their level of success in Taekwon-Do.

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