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Brief Article

To TT or not TT: Considerations for Children's Cycling in Triathlon

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Abstract

Triathlon and Time Trial (TT) bicycles are engineered for performance by optimizing aerodynamics for maximum speed and race efficiency. As going fast on a bicycle essentially involves the cyclist overcoming air resistance, the objective is to devise ways to lower the influence of drag. For adults participating in triathlon, cycling at high speed in what is known as an aerodynamic position can be physically demanding where every athlete is constantly looking for the smallest improvements to enhance their performance. In road cycling there has been recent conjecture that training on TT bicycles is dangerous, with some professional cyclists calling for the use of TT bicycles in training to be banned due to the safety considerations. Despite this, a recent trend in junior (children) triathlon events has seen the use of aerodynamic bars and TT bicycles appear in age groups starting from ages 12 and upwards for both sexes. The desire for children to win and compete with the latest bicycle that provides a mechanical advantage has created debate with some jurisdictions banning the use of TT bicycles in junior triathlon events. Scientists involved in long-term athletic development (LTAD), biomechanics and exercise physiology that concern children have discussed that a balanced and long-term approach is needed when introducing children to triathlon and the use of TT bicycles. The purpose of this communication is to enable coaches to recognise the risks and limitations involved when working with junior triathletes and the considerations of using TT bicycles.

Keywords

Bicycles; Children; Cycling; Triathlon

1 Introduction

Organizational initiatives that encourage sport participation and physical activity are important for children's health and development [1], addressing societal issues of dropout [2], and inactivity and obesity [3]. Declining and stagnant sport participation are issues affecting both developed and developing countries worldwide [4]. Integral to health and sport participation is the acquisition of movement skills, concepts and strategies to enable children to participate in a range of physical activities confidently, competently and creatively. Triathlon can promote physical activity and participation as the multisport can assist in the development of functional movement skills and general athletic skills. Providing children with ways to improve their functional and foundational movement skills and confidence can have significant positive consequences for future participation in physical activity [5] and sport.

Birchwood et al. [6] highlighted the importance of early childhood engagement and reinforcement of physical and sport activity as vital determinants of participation. This point is further enhanced by children's main perceived factors for deciding to participate in sport. For instance, perceived factors are not individual motive factors, but rather are multi-component patterns that incorporate fun, enjoyment involving friends, competition, challenge, and fitness, as well as tangible outcomes such, as sport prizes, goodies and medals [7].

In the United States of America, triathlon participation weakened over the last five or six years after a period of growth in the 2000s. While reasons for this decline vary, challenges of participation, intrapersonal (e.g. lack of skill), interpersonal (e.g. lack of partners), and structural (e.g. cost and availability) issues have been identified. Yet initiatives have occurred to address the decline. Reference to a lack of skill in children's gross and fine motor skill development and obtainment of such skill has been a particular area of focus, notably on competent and safe bicycle riding in a triathlon context. The increased trend for improved aerodynamics and improved geometrical design in adult time trial (TT) bicycles has meant that in some circumstances, children aged 9, 10 and 11 have been observed cycling using mounted (clip-on) aerodynamic bars on road bicycles ranging from a standard road bicycle frame to more technical geometry found on TT bicycles. This has led to some jurisdictions, notably in the United States, banning children using TT bicycles in triathlon.

It is a truism that a well-engineered TT bicycle can make the difference between finishing first in a race or twentieth during the cycling discipline in triathlon. Aerodynamics and other technical aspects of bicycles can substantially influence the outcome of a race, but when the cyclist is a child aged 13 and under, the research on the benefits is less clear. At the professional, elite level, where teams are backed by corporate brands, have sponsorship agreements in place, and have financial resources to allocate testing and analysis, this is considered part of the process of climbing the elite hierarchy. Yet at the junior whereby most triathletes are on teams with limited budgets, or are self-funded, the expenses involved can act as a barrier to participation, restricting junior triathletes coming into an already expensive sport.

2 Children's triathlon

Children's (junior) triathlons are commonly classified as non-competitive events that are designed to introduce children to the fundamentals of swimming, cycling and running. The focus for more akin to finish lines than finish times and ensuring that children have fun, that is, the child chooses to

participate in triathlon based on curiosity, willingness and motivation to try. The risk is if a child feels forced to partake in an activity that is viewed as strenuous or overly competitive, the fun aspect will be removed which will elude the major highlight of the sport.

According to the International Triathlon Union [8], junior triathletes can enter the sport aged 8. Starting younger than 8 is discouraged due to the increased risk of injury as well as the variability relating to the child's level of both cognitive and physical maturation. Although the order of proceedings (i.e., swim, cycle, run) in junior triathlon occurs in the same order as the adults, there is a major difference in race distances for the juniors. Depending on the course and location, children may not be required to cycle on bitumen or tarmac or run outside of a designated venue, and in some instances, children perform both the cycle and run courses on grass. Table 1 provides an overview of the maximum distances for the different triathlon junior age groups.

Table 1. Indicative junior race distances based on age-group.

Age Group	Swim	Cycle	Run
6 years	100 m	1.5 km (0.9 miles)	600 m
7 years	50 m	4 km (2.5 miles)	600 m to 1 km (to 0.6 miles)
8-10 years	100 to 200 m	4 km (2.5 miles)	1.2 km (0.7 miles)
11-15 years	300 m	6 km (3.7 miles)	1.8 km (1.1 miles)

3 Levelling the Playing Field

Many North American junior stage races have now banned TT bikes. Four-time Tour de France winner Chris Froome suggests that it would be safer and fairer to ride time trials on road bikes [9]. Froome went on to discuss whether TT bikes should be banned from racing as well as training. On top of the safety aspect, he highlighted the impact that equipment has on results, emphasizing the potential injustice between the big-budget and low-budget teams. Arguably, this makes sense given that the more barriers that are placed in front of children, and by default, the parents, the less likely it is for the child to participate. While Froome is not a triathlete nor has experience in TT during triathlon, others share his concern. As Zeuwts et al. [10] state, non-competitive events like junior triathlons introduce children to the fundamentals of the swim-bike-run disciplines. Therefore, if children are encouraged to use a TT bicycle and are stimulated to compete, the potential sacrifice of fun and enjoyment is made. Importantly, introducing competition to a child from a young age goes against the Long-Term Athlete Development (LTAD) model that describes how to systematically develop sporting excellence and increase active participation in local, regional, and national sport organizations. A feature of the Balyi and Hamilton LTAD model [11] is the use of stages to organize physical training progression. The FUNdamentals stage (age 6–9 males, 6–8 females) occur during early childhood and refers to a period where children should learn FMS in a fun environment. The emphasis during the Learning to Train stage (age 9–12 males, 8–11 females) is to learn fundamental sport-skills during a ''window of adaptation'' for motor coordination. Learning to move competently in fundamental and sport-specific skills serve as the basis for the FUNdamentals and Learning to Train stages.

There is a substantial gap between a first timer and the "elite" draft-legal youth racing that starts at age 13 that fills the pipeline for collegiate racing and the Olympics. Rather than choosing a bicycle based on age, the key is to know the child's capabilities so that a bicycle is selected that enables them to cycle well whilst allowing for improvements such as pedaling efficiency and appropriate gear change and gear ratios. It is also important to

get the correct bike size so that children are comfortable and confident from the beginning.

4 Motor skills development

Learning to ride a bicycle can be considered a keystone in a child's life [12]. Children start to ride their bicycle at the young age of five [10]. Not only is bicycle riding important in the development of motor coordination, strength, and endurance, but it is also a common form of physical activity that supports a child's development of self-esteem [13]. Cycling safely requires that children execute many complex skills and intrinsic factors when cycling during triathlon. Learning a new motor skill is classically modelled as a three-stage process [14]. In the first, the cognitive phase, children do not control the various subskills, resulting in increased need for cognitive control over the movement execution [15]. The associative phase is characterized by refinement of the performance in which the actual movement is compared to the desired movement. Finally, with experience, motor performance becomes effortless in the autonomous phase. It is assumed that with the increase in automaticity more cognitive resources will be available for decision-making and anticipation on potentially dangerous situations [16]. Targeted education, according to level of experience, is therefore paramount for improving cycling skills and knowledge effectively in children. Conversely, cognitive and physical developmental changes may influence how a child might learn and acquire new skills and knowledge, which has ramifications for children moving from a standard, child-specific road bicycle to a TT bicycle. More specifically, cycling can be considered a 'joint-skill' that requires sufficient:

(1) motor skills (e.g., the ability to coordinate steering, balancing, pedaling, braking, etc.).

(2) perceptual-motor skills (e.g., hazard perception, time-to-contact, attention, planning, judgment, decision-making).

(3) knowledge of the traffic rules and correct.

(4) attitudes (e.g., the willingness to obey the traffic rules or risky behaviour) [10].

Given that children's physical and cognitive development continues well into adolescence, balance, strength and endurance but also the ability to maintain and focus attention and cognitive processing speed, improve with age-related maturation of the central nervous system and practice on the other hand [17]. These developmental changes may influence the type of bicycle that a child rides.

It is common to see the transition area in a children's triathlon event filled with everything from training wheel bicycles, mountain bikes, gravel bikes and road bicycles of all shapes and sizes. Children's bikes are generally measured by the size/diameter of their wheels. This contrasts from adult bikes, which are generally measured by the size of their frame. This is because adult bikes are more specialised and need different wheels for different applications. The most significant factor for cycling is that the child's bicycle is maintained and fits the child well. An excessively large bike can be unsafe and challenging for the child to handle (i.e., steer). Road bikes are also designed to be more versatile, easier to handle in various adverse conditions and easier to stop. Smaller sized children tend to find that using the rear coaster brakes is the easiest way to stop the bicycle.

5 The importance of the Centre of Mass (COM)

The center of mass (COM) is important in cycling given that it is the point of application for external forces and torques, such as gravity. The body's COM is a fictitious point as it is not

observable and does not necessarily have to be at a fixed point on the body. Rather, it depends on the mass distribution within the body. In the case of a rigid body, it is always in the same place as the individual mass parts cannot move. With moving bodies, the COM shifts as soon as parts of the body (e.g., appendages) are moved. The location of the COM varies from person to person and depends on the height and weight of body parts [18]. However, the relative height of the COM differs between children and adults. Because the head develops first and has a relatively high weight compared to the rest of the body, which develops later, the relative COM height is higher in children than in adults. The COM height then decreases as the child develops [19].

Part of balancing a bicycle requires COM control of the rider-bicycle system. Here, the COM is the point at which all the mass (child plus bicycle) can be concentrated. When cycling linearly with no turns, the child must keep the COM over the wheels, or what's called the base of support – an imaginary polygon that connects the two tire contacts with the ground. During cycling the child can use two main balancing strategies: steering and body movement relative to the bike. Steering is critical for maintaining balance as it allows the bicycle to move to bring the base of support back under the COM. Steering input can be provided by the child directly via handlebars (steering torque) or through the self-stability of the bicycle, which arises because the steer and roll of a bicycle are coupled; a bicycle leaned to its side (roll) will cause a change in its steer angle. Body movements relative to the bicycle – like leaning left and right – have a smaller effect than steering but allow a child to make balance corrections by shifting the COM side to side relative to the bicycle and base of support.

Holding the handlebars that curve outward (the drop bars) can help to reduce torso angle. A reduced torso angle is commonly associated with greater aerodynamics and a lowered COM when cornering or descending [20]. Yet the characterization of COM variability relative to torso motion in child cycling remains unclear. To illustrate this concept, one can view three bicycle positions frequently used. The first, classified as the drops position, denotes holding on to the parts of the handlebars that curve outward, with the hands normally positioned directly behind the brake levers. The drops position can be described as cycling with palms placed on the drop bars near or parallel to the ground. The second position is cycling on the 'tops', where braking and aerodynamics are relatively unimportant. In most other situations that position is too slow, yet for children it is commonly considered as the primary position. The third position is known as the aerodynamic (aero position). The aerodynamic bar (aero bar) is either integrated into the bicycle frame or is an extension that is attached to the front stem of a road bike. This position places the triathlete in a lowered position so that the thoracic spine is almost horizontal with the arms extended forward and elbows tucked in [21]. In this regard, the torso is placed in greater flexion in the aero position when compared to the drops position. Crucially, the COM is displaced, or accelerated, differently depending on the cycling hand position that is used [20]. Motion of the COM will also vary depending on the power generated by the child.

Within a traffic-free environment children learn to control their bicycle, so they learn to mount and dismount, to cycle in a straight line, to signal, to look, to cycle over obstacles without falling off, and to use the brakes. Once they have mastered their bicycle and control of the COM, children can then get out on the roads and learn to interact with other travelers, positioning themselves properly on the road. This is harder for a child to complete when

using aerodynamic bars or a TT bicycle without having spent adequate time training and adapting.

6 Practical Applications

Next to age, cycling experience may influence a child's cycling skills. As cognitive and physical developmental changes influence how children might learn and acquire skills and knowledge, it is important to consider the child's age and level of motor and perceptual-motor skills and knowledge prior to integrating aerobars or upgrading to a more advanced bicycle. Education and training are key when introducing children to cycling, particularly cycling within a triathlon context.

7 Conclusions

Children need to master the basics of cycling and safe riding behaviours, road rules and riding in a shared environment. Education for both coaches and children is important to ensure young cyclists have the physical abilities to ride safely and independently prior to the introduction of aerodynamic bars.

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Journal article

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