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The relationship between multilateral development and specific sport skill acquisition in middle childhood

Dissertation

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I declare that I compiled this dissertation on my own under my supervisor's leadership, using only the listed sources and literature. I did not use this dissertation to obtain another academic degree.

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Signature

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Abstract

In the first stages of long-term athlete development, the so-called multilateral development is recommended. It means that children should engage in a variety of different sports during their formative years. Multilateral development in children's sports training is associated with many benefits, such as injury prevention, psychosocial benefits, or transfer of motor skills. It is assumed that children with a higher level of multilateral development acquire specific sport skills faster and more easily than children with a lower level of multilateral development. However, there is a lack of prospective longitudinal studies that would prove or disprove the importance of multilateral development in children's sports training for specific sport skill acquisition.

This dissertation aims to investigate the relationship between multilateral development and specific sport skill acquisition, specifically in ice hockey and athletics.

This project is based on non-experimental longitudinal research and uses the tools of correlation analysis. We defined multilateral development indicators according to the study by Perič and Ružbarský (2019). For the proband selection, we used a purposive non-probability sampling method. In the first phase of the research, we assessed multilateral development in six- to seven-year-old children. A year later, in the second phase of the research, we evaluated specific sport skill acquisition in the same children.

Using canonical correlation analysis, we confirmed a statistically significant and positive relationship between the set of multilateral development indicators and the set of specific sport skills in both selected sports, specifically in athletics (canon. cor. = 0.901, $p < 0.05$) and ice hockey (canon. cor. = 0.726, $p < 0.05$). Our model, which includes nine multilateral development indicators, explains 45.4 percent of the variance in the level of ice hockey skill acquisition and 63 percent of the variance in the level of athletic skill acquisition. In both sports, the Standing long jump indicator makes the most considerable contribution to explaining the level of specific sport skill acquisition.

We confirm the importance of multilateral development in children's sports training for specific sport skill acquisition. There is a high probability that children with a higher level of multilateral development will have a higher level of specific sport skill acquisition in selected sports, and vice versa.

Keywords: long-term athlete development, multilateral development, specific sport skill acquisition, middle childhood

Abstrakt

V dlouhodobé koncepci sportovního tréninku je v prvních etapách, tedy ve sportovní přípravě dětí, doporučována takzvaná všestranná sportovní příprava. Tato všestranná sportovní příprava je spojována s mnoha benefity, jako je prevence zranění, snížení rizika syndromu vyhoření či předčasné stagnace sportovní výkonnosti a v důsledku toho předčasné ukončení sportovní kariéry. Jedním z pozitiv všestranné sportovní přípravy je také takzvaný transfer motorických dovedností. Předpokládá se, že děti s vyšší úrovní všestrannosti si budou osvojovat specifické sportovní dovednosti snadněji než děti s nižší úrovní všestrannosti. Nejsou nicméně dostupné longitudinální studie, které by tento pozitivní vztah mezi všestrannou sportovní přípravou a osvojením specifických sportovních dovedností u dětí potvrzovaly.

Cílem této práce je zjistit, jaký je vztah mezi všestranností a osvojením specifických sportovních dovedností u dětí v mladším školním věku, a to v atletice a v ledním hokeji.

V práci se jedná o neexperimentální longitudinální výzkum založený na korelační analýze. Indikátory všestrannosti jsme vybrali na základě studie autorů Periče a Ružbarského (2019). Pro výběr probandů jsme použili záměrný výběr na základě dostupnosti. V první fázi výzkumu jsme zjišťovali úroveň všestrannosti u šesti- až sedmiletých dětí. O rok později, ve druhé fázi výzkumu, jsme u těchto dětí hodnotili úroveň osvojení atletických nebo hokejových dovedností.

Pomocí kanonické korelační analýzy jsme potvrdili statisticky významný a pozitivní vztah mezi skupinou indikátorů pro hodnocení úrovně všestrannosti a skupinou sportovních dovedností v obou vybraných sportech, konkrétně v atletice (canon. cor. = 0.901; $p < 0.5$) a v ledním hokeji (canon. cor. = 0.726; $p < 0.05$). V atletice vysvětlují vybrané indikátory všestrannosti celkem 63 % rozptylu v úrovni osvojení atletických dovedností a v ledním hokeji vysvětlují indikátory všestrannosti 45.4 % rozptylu v úrovni osvojení hokejových dovedností. V obou sportech indikátor Skok z místa nejlépe vysvětluje úroveň osvojení specifických sportovních dovedností.

Potvrzujeme, že všestranná sportovní příprava v mladším školním věku, tedy provádění široké škály pohybových činností, hraje důležitou roli v procesu osvojování sportovních dovedností. U dětí s vyšší úrovní všestrannosti je vyšší pravděpodobnost, že si v pozdějším věku budou osvojovat specifické sportovní dovednosti snadněji než děti s nižší úrovní všestrannosti.

Klíčová slova: dlouhodobá koncepce sportovního tréninku, všestranná sportovní příprava, osvojování sportovních dovedností, mladší školní věk

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Acronyms

CFA	Confirmatory Factor Analysis
EFA	Exploratory Factor Analysis
GMA	General Motor Ability
LJ	Long Jump

1 INTRODUCTION

Nowadays, sport and physical education is a significant source of physical activity for children and youth (Baker, 2003). Children practically do not engage in spontaneous physical activities. They exercise mainly in physical education or sports clubs.

For example, in the United States, nearly 72 percent of school-aged youth are active participants in at least one organized sports team or club. It corresponds to almost 29 million young people engaging in organized sports. Similar growth in sports participation is apparent throughout the world in children of all ages (e.g. Brenner, 2007; Eiðsdóttir, Kristjánsson et al., 2008; Mostafavifar, Best et al., 2013).

Additionally, for most children, physical education is the only guaranteed opportunity to enhance their physical literacy and experience various sports with appropriate instruction and assessment (Myer, Jayanthi et al., 2016).

It follows that most of the physical activity of children and youth is organized by teachers or coaches. Therefore, the theory of coaching children in sport is becoming more and more important.

All sports are beneficial if performed under proper direction and supervision. Each sport has aspects that can contribute to an enjoyable experience and positive physical and mental development (Caslow, 2015). However, teachers or coaches must decide whether to advocate early sport specialization or developmentally appropriate training in children's sports training.

Early sport specialization versus developmentally appropriate training has been debated since the 1970s. It is a long-standing discussion about the relative merits of early versus late specialization in a sport (Williams, Ford, 2008). Most studies highlight the negative aspects of early sport specialization. Therefore, it might seem that the negative consequences of early sport specialization are well known.

However, there are still children who started to specialize in one sport too early. There are sports programs, coaches, and parents who encourage or sometimes even force children to choose one sport at an early age and to begin intensive training at the chosen activity with the ultimate goal of achieving an elite level (Horn, 2015).

Additionally, some coaches or parents still believe that the best way to develop elite athletes is to participate in only one sport from an early age and perform it year-round (Myer, Jayanthi et al., 2016).

Historical trends indicate that team sports athletes appear more likely to diversify their sports, but even this trend has started to change. Certain positions in team sports, such as baseball pitchers, can be trained as if they were specialized individual sports (Myer, Jayanthi et al., 2015). Therefore, early sport specialization from early to middle childhood has become increasingly common (Jayanthi, Pinkham et al., 2013). Additionally, early specialization in youth sports is growing because some believe that children who specialize early develop advanced skills more quickly (Caslow, 2015).

Despite the large number of available studies dealing with the topic of long-term athlete development, researchers claim that we still do not know much about early sport specialization and more research on this topic is needed (e.g. Baker, Cobley, Fraser-Thomas, 2009; Horn, 2015).

Researchers present developmentally appropriate training as an alternative approach to early sport specialization. Developmentally appropriate training can also be found under these synonymous terms: late sport specialization, early diversification or early sport sampling.

One of the basic principles of developmentally appropriate training is the so-called multilateral development. Multilateral development in children's sports training is associated with many benefits, such as respecting the children's biological age, preventing injuries, or helping the transfer of motor skills.

In this dissertation, we focus on the last-mentioned potential benefit of multilateral development. We investigate the relationship between multilateral development and specific sport skill acquisition in middle childhood.

2 LITERATURE REVIEW

2. 1 Children and sports training

Children have participated in spontaneous sports and games since time immemorial. However, the organization of sports competitions for children and adolescents by adults is about 70 years old, and since the 1950s, we have come across the term "children’s sports training" (Štilec, 1989).

The nature of coaching varies between children and adults. Children’s sports training has a preparatory character. During this childhood period, we build the foundations for peak athletic performance later (Perič, 2008).

It is important to not treat children like "miniature adults" owing to clear differences in physical growth and stature (Faigenbaum, Kraemer et al., 2009).

It is essential to respect children’s biological development and sensitive periods in the development of motor abilities. Biological development refers to progressive changes in size, shape, and function during an organism’s life (Waddington, 2019). Sensitive periods are the periods in human life when the organs and systems that determine a given ability undergo intensive development (Drabik, 1996).

Also, childhood is characterized by playing. Therefore, it is crucial not only to compete in children’s sports training but mainly to play (Válková, 1992).

In terms of conditioning, children’s sports training has the following goals (Drabik, 1996):

- to develop a person’s function versatilely,
- to raise the level of motor abilities,
- to prevent the negative results of one-sided, specialized training loads.

2. 2 Long-term athlete development

The concept of long-term athlete development describes the way to achieve the highest possible individual performance in a selected sport. This concept discusses the goals, continuity and appropriateness of the training process. It is not indifferent when and what kind of exercises are done. Many exercises or sports activities lose sense if not used at the right time and place (Dovalil, Choutka et al., 2002).

Several talent development models or frameworks have been proposed during the last years. These models specify the various paths that children can take as they move from initial entry into the sport participation process and through subsequent stages that will allow all to optimize attainment of their ends, whether that means reaching the elite, competitive, recreational, or active lifestyle levels (Horn, 2015).

From a developmental point of view, generally, these models suggest that exposing all children to a high-quality, instructional-based, and fun-oriented sports environment at the younger or more entry levels of play will allow those who are more talented to emerge over time and to channel or track into an elite trajectory eventually (Horn, 2015).

Correspondingly, those children who are not as talented or who do not choose to move to the elite level can still participate in sport, even competitive sport, at the level they prefer (e.g. recreational, amateur competitive, leisure, fitness, social) (Horn, 2015).

Modern athlete development models respect athletes' chronological age, biological development, and psychological development (Vičar, 2018). These models' main goal is to optimize the athlete's sports training in the long-term or optimally develop its talent. These include, for example, the Developmental Model of Sports Participation (DMSP) (Côté, Lidor, Hackfort, 2009), the Long Term Athlete Development Model (LTAD) (Balyi, 2002; Balyi, Hamilton, 2004), the Youth Physical Development Model (YPD) (Lloyd, Oliver, 2012), the Differentiated Model of Giftedness and Talent (Gagné, 2003; Gagné, 2004) or the more recently published Foundations, Talent, Elite, and Mastery (FTEM) (Gulbin, Croser et al., 2013) structure. We discuss these models in Chapter 2. 2. 2. 2 concerning multilateral development.

2. 2. 1 Early sport specialization

Generally, there are two pathways toward elite sports performance. It is an early sport specialization and developmentally appropriate training. The main differences between these two approaches are in children's sports training. Specifically, it is about the ratio of sport specialization and multilateral development, and also it is about the overall view on sports training, approach to sports training, and its goals (Dovalil, Perič, 2010; Dovalil, Choutka et al., 2002). According to Côté, Lidor, Hackfort (2009), the choice of a specific pathway is associated with activities, processes, and outcomes unique to the early years of sport involvement.

There is no generally accepted definition of early sport specialization. Authors create their definitions, which have a similar basis. They claim that early sport specialization is characterized by year-round training in a single sport to exclude other sport or nonsport activities (e.g. Ericsson, Krampe, Tesch-Romer, 1993; Wiersma, 2000; Myer, Jayanthi, et al., 2016). Table 1 below lists some of the common themes seen across these definitions (Ferguson, Stern, 2014). However, there is a discussion about what volume of training constitutes "intense" and whether year-round participation or exclusion of all other sports is essential for classifying an athlete as specialized (Jayanthi, Pinkham et al., 2013).

Table 1: Typical aspects of early sport specialization (Ferguson, Stern, 2014)

High volume, intensity, duration of training at a young age
Minimal rest or time off
High structured training with an emphasis on physical development
May involve the exclusion of other sports
May be initiated by parents, coaches or trainer
The goal of obtaining provincial status

Also, Baker, Cobley and Fraser-Thomas (2009) characterize four specific parameters of early sport specialization:

- early start age in sport,
- early involvement in one sport (as opposed to participating in several sports),
- early involvement in focused, high-intensity training,
- early involvement in competitive sport.

Interestingly, Jayanthi, LaBella et al. (2015) define three parameters that can help determine the level of sport specialization. These parameters include training in one sport for more than eight months, focusing on one sport and ending participation in other sports. According to these authors, highly specialized young athletes meet all three of the above conditions. Those who meet two of these conditions may be classified as moderately specialized athletes. Those who meet one of these conditions may be classified as low specialized athletes.

From a historical perspective, early sport specialization was first reported in Eastern Europe, with athletes involved in individual sports such as gymnastics, swimming, diving, or figure skating (Mostafavifar, Best, Myer, 2013). International Olympic sports such as these likely contributed to increased sports specialization, with selection processes that eventually reached into the primary school years to distinguish future champions and initiate specialized training for an enhanced opportunity of success. These Olympic development programs' relative success combined with the lure of professional contracts likely influence young athletes to isolate their focus to a single sport at younger ages across the globe (Myer, Jayanthi et al., 2016).

2. 2. 1. 1 Theory of deliberate practice and 10.000-hour rule

Early sport specialization has been further supported by the theory of deliberate practice and the 10.000-hour rule.

Several factors influence the level of achievement. However, there is little doubt that extensive experience in a sport is necessary to reach elite performance (Williams, Ford, 2008).

The theory of deliberate practice developed by Ericsson and colleagues (1993; Ericsson, Charness, 1994) advanced the general concept of expertise development through focused training over time with one major stipulation. They suggested that it was not merely any form of exercise that differentiated individual performance, but the engagement in a specific form of training they termed "deliberate practice".

Deliberate practice is defined as a highly-structured activity that requires physical and cognitive effort with no immediate rewards. The activity intends to improve performance rather than enjoy the activity (Ericsson, Krampe, Tesch-Römer, 1993). This concept states that the "level of performance an individual attains is directly related to the amount of deliberate practice" (Myer, Jayanthi et al., 2016).

This type of training involves practice activities that are effortful, low in inherent enjoyment, and purposefully designed to address current areas of weakness (Baker, Cobley, Fraser-Thomas, 2009).

The deliberate practice theory postulates that experts are always made, not born (Ericsson, Prietula, Cokely, 2007). It means that if athletes want to be high-level performers, they need to deliberately engage in practice during the specialization years, spending time wisely and always focus on tasks that challenge current performance (Gonçalves, Rama, Figueiredo, 2012).

This theory of deliberate practice leads to the famous "10.000-hour rule". Specifically, beginning a task at a very young age (before age 5-7) and acquiring high volumes of deliberate practice (5.000-10.000 hours) resulted in the likelihood of an individual becoming an expert (Ferguson, Stern, 2014). It means more than 3 hours of training or competing every day for ten years (Perič, Pecha, 2014).

This 10.000-hour rule examined Ericsson, Krampe, Tesch-Römer (1993). They used questionnaire and diary methods to document expert musicians' practice history profiles in the Berlin Music Academy. The best violinists reported spending more than 24 hours per week in individual practice compared to a mere 9 hours per week for music teachers. After ten years of engagement, the best violinists had accumulated 7410 hours, whereas the good violinists and music teachers had accrued 5301 and 3420 hours, respectively (Williams, Ford, 2008).

Moreover, Ericsson, his colleagues and other researchers have indicated that 10.000-hour rule has applicability to the acquisition of expertise in all areas of human endeavour, for example in mathematics, swimming, distance running, tennis and also in other sports (Baker, Côté, Abernethy, 2003b).

2. 2. 1. 2 The power law of practice

Research that examined the accumulated effects of prolonged practice and the rate of learning has indicated that performance increases monotonically according to a power function. The power law of practice states that learning occurs rapidly after the onset of practice but that this rate of learning decreases over time as the practice continues (Baker, 2003).

In other words, the more time individuals devote to practice, the greater their level of achievement, but the more difficult it becomes to make further improvements (Perič, Pecha, 2014).

2. 2. 1. 3 Pros and cons of early sport specialization

On the one hand, some authors support the early sport specialization mainly because of the theory of deliberate practice and the 10.000-hour rule. In other words, those who advocate early specialization believe that investment in deliberate practice in one activity from young age distinguishes future experts from non-experts (Côté, Lidor, Hackfort, 2009). For example, Helsen and colleagues (Helsen, Hodges, Van Winckel, Starkes, 2000; Helsen, Starkes, Hodges, 1998) found support for the relationship between the amount of sport-specific practice and the attainment of expertise across a variety of team sports.

On the other hand, scientific evidence claim that early intensive training (i.e. deliberate practice) can have negative developmental consequences. The most discussed risks include overuse injuries, dropout, burnout and further compromised psychological and psychosocial development. Myer, Jayanthi et al. (2016) noted that exceeding 16 hours per week of total sports participation, regardless of the number of sports, carries the greatest risk for the emergence of these negative consequences. According to Hecimovich (2004), the potential negative effects of early sport specialization are three: physiological/physical, psychological, and sociological.

Below we list the most frequently mentioned positive and negative consequences of early sport specialization.

2. 2. 1. 3. 1 Facilitated skill acquisition and better coaching and skill instruction

Those who defend early sport specialization believe that the early start of special and intense training distinguishes future professionals from amateurs (Côté, Lidor, Hackfort, 2009). Thus, early sport specialization benefits seem to be mostly in motor skill acquisition (Hecimovich, 2004).

According to Ericsson, Krampe, Tesch-Römer (1993), early specialization is essential for future success because the earlier one starts adhering to a strict training regime, the quicker one will attain their desired skill level. More specifically, someone starting a deliberate practice routine at a later age would be unable to "catch up" to a performer who started earlier, all other things being equal.

Some studies suggest that early sport specialization may be necessary for athletes to acquire the hours of deliberate practice needed for elite sport participation. Starkes, Deakin et al. (1996) and Gould (2010) claim that early sport specialization provides an advantage to athletes mainly through deliberate practice experience. Ericsson, Krampe, Tesch-Römer

(1993) also argue that it is not merely the accumulation of deliberate practice hours that lead to superior performance levels, but that the accumulation of such hours must coincide with crucial periods of biological and cognitive development (i.e., childhood).

The extra hours of deliberate practice can enhance skill acquisition and contribute to the estimated 10.000 hours needed to become highly competent in the specialized sport (Gould, 2010). It confirms Ward and colleagues (2004), who assert that early sport specialization with sole involvement in deliberate practice during preadolescence was the most effective path toward developing elite performance in soccer.

Aditionally, Gould (2010) noted that one of the benefits of early specialization often included better coaching and skill instruction because the most experienced coaches usually worked with players who specialized.

Wiersma (2000) claims that perhaps the most significant and most apparent benefit of specialization is the acquisition, development, and proficiency of motor skills related to success in a given sport.

For example, an athlete who practices a skill or set of skills with increased frequency and duration, considering he or she does so in a scientifically appropriate manner, may become more proficient at the skills that practices periodically (Wiersma, 2000).

Additionally, many athletes and coaches believe that it is foolish not to specialize because of a relatively short career and a perceived finite amount of time with which an individual can reach peak physical performance (Wiersma, 2000).

Moreover, research among sport directors indicated that a majority of coaches who promoted specialization had a positive effect on player skills in that sport (81.8%) and on the overall performance of their teams (57.4%) (Hill, Simons, 1989).

2. 2. 1. 3. 2 Overuse injuries

Overuse injuries can cause early retirement from sports and are typically the starting point for burnout in sports (Malina, 2010; Myer, Jayanthi et al., 2016). Many studies confirm an increased risk of injury and severe overuse injury among young athletes who specialize early in one sport.

According to Jayanthi, LaBella et al. (2015), the risk of injury, overuse injury, and severe overuse injury increases as the degree of specialization increases. Injury threatens especially athletes, who spend numerically more hours per week participating in sports versus their age in years and those who spend more than twice as many hours per week participating in organized sports as in free play. Also, Myer, Jayanthi et al. (2015) claim that an increased degree of specialization is positively correlated with increased serious overuse injury risk.

Similarly, Hall, Foss et al. (2015) conducted a separate retrospective study of 546 high school athletes. They found a relationship between patellofemoral pain syndrome development and single-sport training in athletes in basketball, soccer, and volleyball.

Goldstein, Berger et al. (1991), in their epidemiologic investigation, found that young gymnasts who practice for over sixteen hours a week have been shown to have higher incidences of back injuries.

Especially during crucial periods of biological development (i.e., childhood), excessive training forms could have serious costs. During maturation, bones grow fast and can lead to tightness and inflexibility around joints because muscles and tendons have not increased in length at the same rate as bones. It creates imbalances that increase a youth’s susceptibility to osteochondrosis, a group of diseases involving degeneration of the ossification where tendons attach to bones (Dalton, 1992; Kulund, 1982). This group of disorders includes Osgood-Schlatter disease, Sinding-Larson-Johansson syndrome, and Sever’s disease, all conditions related to overuse injuries in the leg, whose common aetiology is repetitive microtrauma such as that resulting from stressful training (Baker, Cobley, Fraser-Thomas, 2009).

Without sport diversification, children may not fully develop neuromuscular patterns to protect against injury (Sluder, Fuller et al., 2017). The lack of diversified activity may not allow young athletes to develop the appropriate neuromuscular skills effective in injury prevention and do not qualify for the necessary rest from repetitive use of the same segments in the body (Myer, Jayanthi et al., 2015). Jayanthi, LaBella et al. (2015) show the relationship between the level of specialization and the risk of injury (Table 2). Interestingly, according to Goodway and Robinson (2015), no data exist regarding early sport specialization’s health benefits.

Table 2: Degree of sports specialization and risk of all-cause injuries (Jayanthi, LaBella et al., 2015)

Degree of Specialization	Risk of injury	Risk of Serious Overuse Injury	Risk of Acute Injury
Low specialization (0 or 1 of the following): Year-round training (>8 months per year) Chooses a single main sport Quit all sports to focus on 1 sport	Low	Low	Moderate
Moderately specialized (2 of the following): Year-round training (>8 months per year) Chooses a single main sport Quit all sports to focus on 1 sport	Moderate	Moderate	Low
Highly specialized (3/3 of the following): Year-round training (>8 months per year) Chooses a single main sport Quit all sports to focus on 1 sport	High	High	Low

2. 2. 1. 3. 3 Dropout

Another negative consequence of early sport specialization may be the premature ending of a sports career.

For example, Fraser-Thomas, Côté, Deakin (2008) examined the sport's development of twenty-five dropouts and twenty-five engaged adolescent swimmers. They found that dropouts involved in fewer extra-curricular activities, less unstructured swimming play, and received less one-on-one coaching throughout development. Also, dropouts reached several developmental milestones (i.e. started training camps, started dryland training) earlier than engaged athletes. Interestingly, according to this study, dropouts were more likely to have had parents who were high-level athletes in their youth (Fraser-Thomas, Côté, Deakin, 2008).

Also, Butcher, Lindner, and Johns (2002), in their 10-year retrospective investigation, found that "lack of enjoyment" during early stages of long-term athlete development was the most crucial reason for transfer to a different sport or withdrawal from sport.

Interestingly, Molinero, Salguero et al. (2006) investigated reasons for dropout in a sample of young Spanish athletes and their relationship to gender, participation in individual or team sports, and level of competition reached at the time of dropping out. This study showed that having other things to do, dislike of the coach, perception of failure, or lack of team atmosphere was the most critical reason for dropout.

According to Gould (2010), these factors can cause a dropout: negative evaluation of individual performance, critical feedback from coaches and overtraining. Other factors may include injuries, over-supervision and protection of coaches, parents, and the athlete's perception of himself as unable to meet his or her expectations.

2. 2. 1. 3. 4 Burnout

Due to early sport specialization, an athlete may suffer from burnout (Gould, 2010). Burnout is a withdrawal from an activity that was previously enjoyable due to stress or dissatisfaction and resulted from a combination of physical and psychological factors (Myer, Jayanthi et al., 2015).

Burnout is an unfortunate byproduct of early specialization in one sport brought on by physical and emotional exhaustion from the sport's psychological and physiological demands (Kutz, Secrest, 2009). It is not sudden but develops over time (Malina, 2010).

Interestingly, Strachan's, Côté's, Deakin's (2009) study showed that "specializers" scored significantly higher on the exhaustion dimension than "samplers". They concluded that it seems evident that those who are spending more time in sport may feel tired, which can later cause burnout.

Sometimes retirement from sport may be the consequence of burnout, which young athletes may experience with continued intense and specialized participation (Gould, Tuffey et al., 1996; Hootman, Dick, Agel, 2007).

2. 2. 1. 3. 5 Compromised psychosocial development

Early sport specialization could stifle sociological and psychological development by reducing the number of growth opportunities in these areas. Through sport, we can also develop social skills such as cooperation or socially acceptable behaviour. However, spending too much time training in childhood may not provide enough time for social growth and lead to "social isolation". As an athlete increases involvement in a single sport, social interaction opportunities outside that sport may become less likely (Wiersma, 2000).

Early focus on a single sport and the associated time commitment may foster isolation and lack of peer socialization, especially during the adolescent years, and limit their experiences throughout their lifetime. Early specialization may also alter relationships with peers, parents, and family (Malina, 2010) and interfere with normal identity development (Gould, 2010).

Additionally, overpressure to win from early childhood can also decrease sport enjoyment, sense of failure, low self-confidence and low self-esteem (Baker, Cobley, Fraser-Thomas, 2009).

Interestingly, sometimes the lives of young elite athletes are highly regulated. It may foster overdependence on others and, in many cases, loss of control of what is happening in life. The potential consequence may be arrested behavioural development such as socially maladaptive behaviours during youth and extending into adulthood (Malina, 2010).

2. 2. 1. 3. 6 Eating disorders

Early specialized athletes may suffer from eating disorders. The prevalence of eating disorders is higher in athletes than in the general population (Beals, Manore, 1994). Especially athletes in sports that have an aesthetic requirement and usually follow an early specialization model (e.g. dancing, gymnastics, figure skating) seem particularly susceptible to disordered eating (Baker, Cobley, Fraser-Thomas, 2009). Athletes in these sports are often "deselected" from teams if they fail to meet their ideal weight or body composition (Smolak, Murnen, Ruble, 2000).

2. 2. 1. 3. 7 Lost development of lifetime sport skills

Efforts to specialize early in one sport can reduce children's opportunities to participate in a diverse year-round sports season and lead to lost lifetime sports skills development. Also, early sport specialization may reduce motor skill development and ongoing participation in games and sports as a lifetime choice. These lost opportunities for fun and focused physical activity during childhood and youth can lead to deficits in current and long-term physical activity and health (Mostafavifar, Best et al., 2013).

More specifically, early sport specialization may lead to reduced motor skill development. Reduced motor skill proficiency may occur as young athletes focus on their motor skills but ignore the motor skills developed through a diversified participation portfolio (Hall, Barber et al., 2015; Mostafavifar, Best et al., 2013).

Without exposure to various skill-building games and activities early in life, children are less likely to maximize their physical development and capitalize on their athletic abilities later (Güllich, Emrich, 2014; Moesch, Elbe et al., 2011).

2. 2. 2 Developmentally appropriate training

In contrast to early sport specialization, the developmentally appropriate training is based on ontogenetic development. This approach adapts the goals and methods of sports training for this development (Perič, Pecha, 2014; Dovalil, Choutka et al., 2002).

Notably, a high volume of the so-called multilateral development is characteristic of developmentally appropriate training (see Chapter 2. 2. 2. 1 below that focuses on multilateral development).

These are characteristics of developmentally appropriate training, according to Perič and Pecha (2014):

- performance is age/developmentally appropriate,
- elite performance is a perspective goal,
- childhood and youth is a preparatory phase,
- there is an appropriate proportion of multilateral development,
- takes into account the level of individual development and age mentality,
- increases demands slowly and gradually,
- limits pressure to performance,
- joy, enjoyment, playfulness, relaxedness, the richness of experience, proper appreciation.

According to Higgs, Way et al. (2019), the characteristics of developmentally appropriate training are as follows:

- increases duration, volume and intensity progressively,
- takes advantage of sensitive periods,
- is based on the stage of physical development of the participant,
- supports the individual needs of participants,
- incorporates equipment and playing spaces that are appropriate for the stage of the participant,
- uses movement preparation as part of warm-up, and
- develops all round athleticism and general fitness before sport-specific fitness.

Importantly, authors also use different terms for naming an opposite or alternative approach to early sport specialization. For example:

- early sport sampling (e. g. Goodway, Robinson, 2015),
- early diversification (e. g. Baker, 2003; Baker, Cobley, Fraser-Thomas, 2009; Côté, Lidor, Hackfort, 2009),
- late sport specialization (e. g. Sluder, Fuller et al., 2017).

According to Côté, Lidor, Hackfort (2009), early diversification refers to engaging in various sports during the youth sports years with the ultimate goal of learning skills and having fun.

Similarly, in early sport sampling, authors emphasize that children learn a broad base of fundamental motor skills before they start to specialize in one sport (e. g. Goodway, Robinson, 2015). These skills include locomotor (running, jumping, etc.) and object control skills (throwing, catching, striking, etc., see Haywood, Getchell, 2009).

Early sport sampling favours a focus on involvement in several different sports before specializing in later development stages (Wiersma, 2000). Therefore, early sampling years are considered essential building blocks for self-regulated investment in the elite sport during adolescence and adulthood (Côté, Lidor, Hackfort, 2009).

In this early sport sampling approach or early diversification approach are young athletes called „samplers“ (e. g. Sluder, Fuller et al., 2017; Goodway, Robinson, 2015).

2. 2. 2. 1 Multilateral development

Notably, a high volume of the so-called multilateral development is characteristic of developmentally appropriate training. Multilateral development is one of the essential training principles of children's sports training (Perič, 2008).

Multilateral development is the ability to do a wide range of physical activities (Perič, 2008). Simultaneously, the physical activity level is influenced by physical abilities, movement skills, and psychological conditions (see Figure 1 below).

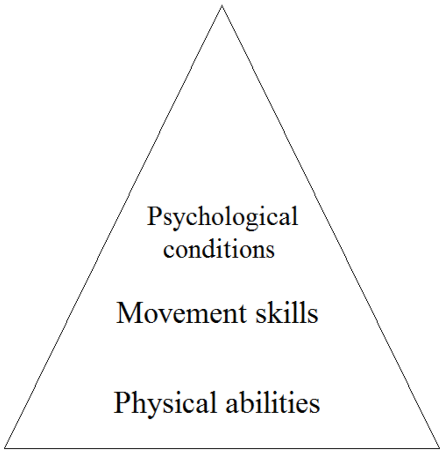


Figure 1: Structure of physical activity (Perič, 2008)

Also, Perič (2008) distinguishes three different levels of multilateral development:

- general level of multilateral development,
- specialized level of multilateral development,
- special level of multilateral development.

The general multilateral development level includes all physical activities (e.g. athletics, swimming, skiing, etc.). The specialized multilateral development level includes physical activities with similar movement patterns (e.g. track cycling, road cycling, cyclocross, etc.). A special multilateral development level includes physical activities within one sport (e.g. ice hockey player can play as a forward and also as a defenceman).

According to this multilateral development classification by Perič (2008), we deal with the general multilateral development level in this dissertation.

„The purpose of multilateral development is to improve overall adaptation. Children and youth who develop a variety of skills and motor abilities are more likely to adapt to demanding training loads without experiencing stresses associated with early specialization." (Bompa, Carrera, 2015, p. 6)

The position of multilateral development in long-term athlete development is illustrated in Figure 2 below. *„Although the ages will vary from sport to sport and from individual to individual, the model demonstrates the importance of progressive development. The base of the pyramid, which may consider the foundation of any training program, consists of multilateral development. When the development reaches an acceptable level, athletes specialize in one sport and enter the second phase of development. The result will be a high level of performance.“* (Bompa, Carrera, 2015, p. 5-6)

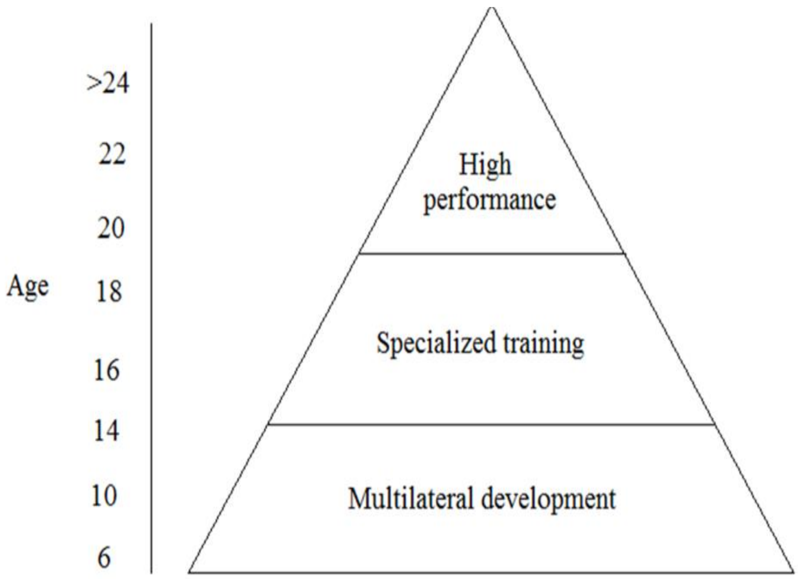


Figure 2: The suggested long-term approach to specificity of training includes a base of multilateral development (Bompa, Carrera, 2015)

According to Perič and Pecha (2014), the multilateral development approach to sports training uses a broad spectrum of adaptation stimuli (largely non-specific stimuli).

It has to be noted that different authors use different terms for this concept of "multilateral development" in the early stages of long-term athlete development. For example:

- versatility (e.g. Drabik, 1996),
- all-round development (e.g. Drabik, 1996),
- multisite development (e.g. Perič, Pecha, 2014),
- overall development (e.g. Balyi, 2002),
- multiskill development (e.g. Bompa, Carrera, 2015).

Furthermore, terms such as multisport athlete or multisport participation are also used (e.g. Roetert, Woods, Jayanthi, 2018).

2. 2. 2. 2 Multilateral development in the long-term athlete development

First publications about long-term athlete development were published in Russia (e.g.Vajcechovskij, 1971; Valik, 1975; Matvejev, Novikov, 1976). Nowadays, sports organizations worldwide adopt various theoretical concepts about long-term athlete development (Mckeown, Ball, 2013). The most popular is Balyi's LTAD model (Balyi, 2001; Balyi, Hamilton, 2004), Côte's Developmental Model of Sports Participation (DMSP) (Côté, Lidor, Hackfort, 2009), and Lloyd's Youth Physical Development Model (YPS) (Lloyd, Oliver, 2012).

In the Czech literature, Choutková, Fejtek (1989) or Štilec (1989) dealt with long-term athlete development. The latest and well-known publications on this topic are by these authors: Dovalil, Choutka et al. (2002), Dovalil, Perič (2010), Perič (2008).

All these models mentioned above emphasize the importance of playing multiple sports or doing various physical activities during the early stages of long-term athlete development.

For example, in the LTAD model, the first stage of athlete development recommended an emphasis on the overall development of the athlete's physical capacities and fundamental movement skills and is encouraged participation in as many sports as possible (Balyi, 2002; Balyi, Hamilton, 2004). According to Balyi (2001), fundamental movement skills should be practised and mastered before sport-specific skills are introduced. There is a high probability that this emphasis on motor development will produce athletes with better trainability for long-term sport-specific development. Suppose the fundamental motor skill training is not developed between the ages of nine to twelve. In that case, skills cannot be recaptured later.

Similarly, the Côte's Developmental Model of Sports Participation (DMSP) (Côté, Lidor, Hackfort, 2009) says that early diversification in childhood is linked to a longer sports career and has positive implications for long-term sports involvement. As we mentioned in the previous text, early diversification refers to engaging in various sports during the formative youth sports years.

Also, Lloyd's Youth Physical Development Model (YPS) (Lloyd, Oliver, 2012) suggests that the most suitable period for acquiring fundamental movement skills is early and middle childhood in boys and girls. According to Lloyd, Oliver (2012), fundamental movement skills are building blocks for sport-specific movement patterns and should be typically the focus of physical development programs for children from early childhood to develop gross motor skills.

Sports respect these theoretical concepts and try to apply them in practice. For example, in Canada were published sport frameworks for various sports (Sport Frameworks, 2020). These documents have been created as guides for coaches, administrators, and parents of Canada's sports community. In all these theoretical concepts, multilateral development is recommended in the early stages of athletic development, especially in "late specialization sports", where peak performance is usually achieved after full maturation. (read more about late and early specialization sports in Chapter 2. 2. 4).

2. 2. 2. 3 Deliberate play

For the period of multilateral development in children's sports training is characteristic sampling various sports and engaging in the so-called deliberate play (Côté, Fraser-Thomas, 2007).

Côté, Baker, Abernethy (2007) describe deliberate play as engaging in an activity primarily for intrinsic enjoyment, although the activity may still contribute to skill learning.

According to Baker and Côté (2006), deliberate play is defined as sports activities that are intrinsically motivating and provide gratification and enjoyment. Similarly, sampling in the early years of sport participation may lead to more happiness and a lower frequency of dropout, indirectly contributing to attaining a high level of performance in adult years.

Deliberate play is informal and allows children to engage in sports with minimal equipment, in any space, with a different number of players, and also with players of different ages and sizes. These conditions are easy to create and do not require adult supervision, coaches, officials, specialized equipment or time limits (Côté, Lidor, Hackfort, 2009).

2. 2. 2. 4 The issue of transfer in motor skill learning

Transfer of learning happens when learning in one context enhances (positive transfer) or undermines (negative transfer) a related performance in another context. The transfer includes immediate transfer (to closely related contexts and performances) and far transfer (to different contexts and performances). The prospects and conditions of transfer are crucial educational issues (Perkins, Salomon, 1992).

There remains much scope for empirical research focusing on transfer, not least because there are potentially significant implications for those interested in promoting skill transfer across sports (Slot, 2007).

„Do specific skills transfer across sports? If so, what skills transfer and from which sport to another? How does one promote this transfer and at what stage of development is it most

important? Can progression to an elite level in a particular sport be circumvented if an athlete has accumulated considerable experience in a related sport (e.g. consider basketball or netball to handball or gymnastics to high diving)?" (Williams, Ford, 2008).

We can investigate these issues retrospectively by examining athletes' deliberate practice histories that successfully transfer from one sport to another or via traditional laboratory-based experimental work (Williams, Ford, 2008).

The issue of skills transfer across sports often evokes discussion. Generally, this assumes that talented individuals from one sport have some common skills to transfer across sports or even to other domains. In other words, it is hypothesized that experiences in different sports provide the young athlete with essential abilities. These abilities prove beneficial in developing sport-specific skills required to reach elite performance in the primary sport at a later stage in the career (Williams, Ford, 2008).

Transfer of skills can be considered the basic principle of the early sport sampling (early diversification) approach (Baker, Cobley, Fraser-Thomas, 2009).

There is an assumption that this diversity of exposure to different sports facilitates skill acquisition (Williams, Ford, 2008).

Athletes gain benefits via some transfer mechanism from engagement in non-domain activities requiring similar skills to those in their expertise domain (Baker, Côté, Abernethy, 2003a).

Also, Hatano and Inagaki (1986) claim that greater diversity across sports at an earlier age may manifest itself in more flexible perceptual-motor and perceptual-cognitive solutions to a broader range of existing and novel problems.

Schmidt and Wrisberg (2000) and Côté, Murphy-Mills, Abernethy (2012) suggest that the effect of such a transfer is most pronounced during the early stages of athlete development, which corresponds to the timeframe of the sampling years in the „Developmental Model of Sport Participation" by Côté, Lidor, Hackfort (2009).

A high amount of deliberate play during sampling years establishes a range of motor and cognitive experiences that children can ultimately bring to their principal sport of interest (Côté, Lidor, Hackfort, 2009).

Some studies confirm the positive effects of skill transfer in sport. For example, Baker, Côté, and Abernethy (2003b) indicated that participation in other relevant activities (e.g. other sports where dynamic decision-making is necessary) during early phases of development augmented the physical and cognitive skills essential in their primary sport. They have shown that world-class team players that demonstrated greater diversity across several domains had also accrued fewer practice hours within the specialist domain before national selection compared to those who exhibited a less diverse participation profile and were not of world-class standing.

Also, Smeeton, Ward and Williams (2004) found that skilled soccer and field hockey players responded equally well in recognizing attacking game-play across respective sports, indicating successful transfer across similar perceptual demands.

Similarly, researchers found that among high-level athletes of basketball, netball, and field hockey, the greater the number of activities that the athletes experienced and practiced in their developing years (ages 0-12 years), the less sports-specific practice was necessary to acquire expertise in their sport (Baker, Côté, Abernethy, 2003a; Baker, Côté, Abernethy, 2003b).

Also, physical conditioning elements can transfer across similar sports. For instance, short-term interventions of combined run-cycle training, which share identical muscle groups (i.e., similar modes), are as effective as running alone in increasing physiological parameters such as aerobic capacity (e. g. Mutton, Loy et al., 1993). In comparison, combined run-swim training has not been as effective (Foster, Hector et al., 1995).

Based on these considerations, it can be hypothesized that involvement in different sports may help reach elite performance in individual sports during the early stage of the career. Therefore, a broad base of fundamental motor skill development learned through sport sampling is necessary and essential before sport specialization. Thus, sport sampling in the formative youth years is superior to early sport specialization (Goodway, Robinson, 2015).

In contrast, some studies do not confirm the positive effects of skill transfer in sport. Authors claim there is little robust evidence about this successful transfer across sport (Baker, Cobley, Fraser-Thomas, 2009; Feltovich, Prietula, Ericsson, 2006).

2. 2. 2. 5 Pros and cons of developmentally appropriate training

The pros and cons of developmentally appropriate training are often discussed. Below we list the most frequently mentioned advantages and disadvantages of this approach to children's sports training.

2. 2. 2. 5. 1 Psychosocial benefits

In a longitudinal study, Busseri, Rose-Krasnor et al. (2006) examined the participants' involvement in various activities and their relationship to several positive and negative developmental outcome measures (i.e., risk behaviours, well-being, academic orientation, and interpersonal functioning). They found that more activities predicted successful development over time. The greater amount of time spent in activity was related to a higher risk behaviour incidence.

Therefore, it may be postulated that those who sample a variety of sports have the potential to gain more positive developmental outcomes and engage in fewer risky behaviours over time (Strachan, Côté, Deakin, 2009).

In a similar vein, Wilkes and Côté (2007) propose that children who sample different activities have a greater chance of developing the following five develop outcomes compared to children who specialize in one activity: 1) life skills, 2) prosocial behaviour, 3) healthy identity, 4) diverse peer groups and 5) social capital. Life skills consist of intrapersonal (e.g. time management) or interpersonal (e.g. communication skills, leadership) skills and can be developed in sports programs. Second, a sampling approach is better suited to promote prosocial behaviour. Sampling is a strategy to help ensure that children are exposed to prosocial norms in multiple sports programs. Third, sampling stimulates healthy identity development. Sampling encourages identity exploration by exposing children to different environments that provide opportunities to decide the level at which they wish to participate. The fourth developmental outcome is that sampling can connect children to diverse peer groups. The fifth developmental outcome is that sampling helps youth acquire social capital by developing relationships with a broader range of adults.

Also, Côté, Horton et al. (2009) claim that sampling is a strategy to ensure that children are exposed to prosocial norms in multiple sports programs.

Interestingly, studies suggest that athletes engaged in multiple sports can find their identity earlier in their lives. Multiple types of people and groups surround them because of the different kinds of sports. In other words, athletes who do not specialize early tend to get more opportunities to interact with various athletes because each sport requires conversation and understanding of their teammates. Late specializers or “samplers” have increased the capability to connect with diverse peer groups (Strachan, Côté, Deakin, 2009).

Furthermore, playful involvement in various sports is beneficial for the development of intrinsic motivation, which is required during the later stages of athlete development, when training becomes more structured and challenging (Côté, 1999; Côté, Hay, 2002).

2. 2. 2. 5. 2 Injury prevention

The developmentally appropriate training is associated with a lower frequency of sports injuries than early sport specialization.

Suppose children do not have the opportunity to "sample" different sports during childhood. In that case, they are less likely to acquire the foundational physical, psychosocial, and cognitive skills necessary for long-term success in sport. (Côté, Lidor, Hackfort, 2009).

Sampling various sports during childhood may promote prolonged engagement in sport by limiting physical injuries (Fraser-Thomas, Côté, Deakin, 2005).

Those who specialize early, the primary focus is on developing skills through a high amount of deliberate practice that can lead to injury due to the overloading of a young organism (Côté, Horton et al. 2009).

Therefore, the sampling approach and deliberate play rather than deliberate practice has been proposed as a strategy to limit overuse and other sport-related injuries (Micheli, Glassman, Klein, 2000).

Also, from Côté and colleagues’ view of early sampling (Côté, Baker, Abernethy, 2003, 2007), one might suggest that children will be less prone to injury if they engage in a variety of sports and have a more deliberate play and less time and intensity of deliberate practice.

Likewise, Myer, Jayanthi et al. (2015) recommend that youth should be given opportunities for free, unstructured play to improve motor skill development. Also, parents and educators should encourage child self-regulation to help limit the risk of overuse injuries and provide opportunities for free, unstructured play to improve motor skill development during the growing years, reducing injury risk during adolescence.

Jayanthi, LaBella et al. (2015) confirmed this statement confirm and indicated that unstructured free play might have a protective effect from serious overuse injury.

2. 2. 2. 5. 3 Transfer of motor skills

Transfer of motor skills is considered one of the benefits of multilateral development in children's sports training. We already discussed the issue of transfer in Chapter 2. 2. 2. 4.

It is assumed that thanks to sampling various sports during childhood, children will acquire a wide range of motor skills and also tactical skills that can transfer to other sports (Brylinsky, 2010).

Transfer of motor skills is considered the underpinning principle of sampling various sports during childhood (Baker, Cobley, Fraser-Thomas, 2009). It is most pronounced during the early stages of involvement (Abernethy, Baker, Côté, 2005).

2. 2. 2. 5. 4 Longterm physical activity involvement and active lifestyle

„Limited range of motor skills performed during early sport specialization could limit overall motor skill development. This, in turn, may affect long-term physical activity involvement (and therefore, long-term health) by decreasing the likelihood of participation in alternative physical activities." (Wiersma, 2000)

Robertson-Wilson, Baker, Derbyshire and Côté´s (2003) study of physically active and inactive adult females indicated that sampling numerous sports and physical activities in childhood was associated with being physically active during adulthood. Therefore, another benefit of sampling is that it may foster a lifelong engagement in physical activity.

Also, Côté, Lidor, Hackfort (2009) claim that one benefit of sampling is that it may foster a lifelong engagement in physical activity. To date, no study has linked sampling and sport dropout. According to these authors, early sport sampling is associated with prolonged engagement in sport and physical activity because it tends to provide more enjoyable early athletic experiences.

2. 2. 2. 5. 5 Time and financial requirements

There are also negative aspects of the developmentally appropriate training, such as time and financial requirements.

From a financial and time point of view, developmentally appropriate training could be more demanding than early sport specialization. Athletes who play multiple sports have to manage their time, and depending on the number of sports they play; this can be not easy (Sluder, Fuller et al., 2017). Thus, ensuring a child's participation in all training and competitions often requires a scheduled timetable (Bodey, Judge, Hoover, 2013).

Bodey, Judge, Hoover (2013) noted that parents also accrue additional obligations beyond the athlete's responsibilities, including time constraints and the financial burden associated with maintaining multiple sports participation.

"Balancing the cost to purchase the gear required for each sport, ensuring the student makes it to games and practices, and managing the family's financial obligations contributes to the overall increase in time and financial demands when young athletes play multiple sports." (Bodey, Judge, Hoover, 2013)

2. 2. 3 Evidence for and against early sport specialization

Some coaches and parents believe that the earlier children participate in a single sport; they will be more likely to succeed in that sport (Sluder, Fuller et al., 2017). However, the theory of deliberate practice, according to Ericsson, Krampe, Tesch-Römer (1993) is valid for other activities, especially for music. Therefore, researchers in the sports domain have been keen to examine the validity of deliberate practice theory and the 10.000-hour rule.

The answer to the question of whether the high quantity and quality of deliberate practice at a young age is sufficient to achieve a peak performance level is of crucial importance for sports training and talent selection (Ward, Hodges et al., 2004).

Scientific evidence from different sports supports a positive relationship between practice hours and expertise level (e.g. Helsen, Starkes et al., 1998; Hodges, Kerr et al., 2004; Baker, Côté, Deakin, 2005). However, the 10.000-hour rule and the theory of deliberate practice some studies in sport confirmed, but others refused.

Starkes and colleagues (1996) were the first to undertake work on deliberate practice in sport. Athletes who participated in individual sports reported spending on average more than ten years in practice before reaching an international level (Ward, Hodges et al., 2004).

Afterwards, Helsen, Hodges et al. (1998, 2000) extended this initial work to team sport athletes by examining the practice histories of international, national, and provincial level soccer players from Belgium. Furthermore, in a second team-sport domain, they examined players' practice habits at similar levels of skill in field hockey. In both cases has been confirmed a positive relationship between several sport-specific practices and the achievement of skill levels.

Among other studies that provided support for many contentions of Ericsson and his colleagues, including the strong relationship between accumulated hours of practice and level of performance include, for example, figure skating, karate, wrestling, middle distance running and field hockey (Baker, Côté, Abernethy, 2003b).

On the other hand, some researches claim that 10.000 hours of deliberate practice may not be required to achieve elite performance. For example, Hodges, Kerr et al. (2004) found that elite triathletes and swimmers trained for more than ten years, but they did not accumulate 10.000 hours of deliberate practice. Also, Baker, Côté, Abernethy (2003b) found that elite basketball, football and hockey players did not accumulate 10.000 hours of deliberate practice, although they have been training in their sports for over 11 years. Similarly, Goodway and Robinson (2015) concluded that if the goal is elite athletic performance, the intense and deliberate practice that results from early specialization is not necessarily a reliable trajectory into elite sport.

Interestingly, some studies confirm that for athletes is deliberate practice fun (Baker, Young, 2014; Deakin, Cobley, 2003). This finding is in contradiction with the definition of deliberate practice by Ericsson, Krampe, Tesch-Römer (1993). Therefore, the theory of deliberate practice and 10.000 hour rule may not be exactly the same for the development of expertise in sport.

Additionally, several studies of elite athletes have found that elite performance is usually preceded by sampling various sports. Therefore, these studies do not support early sport specialization.

For most sports, there is no evidence that intense training and specialization before puberty are necessary to achieve elite status (Jayanthi, Pinkham et al. 2013). For example, Baker, Côté and Abernethy (2003b) through a process of semi-structured interviews, retrospectively examined the participation histories of elite players who held an international or world-class ranking in a variety of different team sports. These authors also found that expert and world-class athletes engaged in considerably more „deliberate play“ during the sampling years (i. e., 7 to 12 years) than non-experts.

Vaeyens, Güllich et al. (2009) revealed that a higher proportion of the world-class athletes trained and competed in other sports beyond their current individual primary sport. They invested significantly more training time in other sports.

Bridge and Toms (2013) found that significantly more high-performance athletes in the United Kingdom had competed in multiple sports during their early teens rather than having specialized in only one sport.

Ginsburg, Smith et al. (2014) found that only 25% of professional baseball players had specialized before the age of 12, and those who specialized later were more likely to receive college scholarships.

Stevenson (1990) examined elite field hockey, rugby, and water polo players and suggested that those who have a diversified early involvement are not disadvantaged.

Barynina and Vaitsekhovskii's (1992) study of elite swimmers indicated that athletes who specialized early spent less time on the national team and ended their sports careers earlier than athletes who specialized later.

Carlson (1988) found that elite tennis players specialized later than their near-elite peers. Still, around the age of 15, their training significantly increased in intensity compared to their near-elite peers.

Moesch, Elbe et al. (2011) illustrated that elite athletes accumulate the same amount of deliberate practice by age 15 as non-elite athletes. However, non-elite athletes practiced almost twice as much by age 9.

A study at one university on National Collegiate Athletic Association (NCAA) Division I athletes found that 70% did not specialize in their sport until at least age 12 years, and 88% participated in more than one sport (National Collegiate Athletic Association, 2010).

Furthermore, evidence suggests a beneficial effect of early sport sampling on sports performance and other variables. Children who sample multiple sports in the early years are more likely to develop competence in object control and locomotor skills that make up many different sports. Therefore, these children will have many different sports available to them across the lifespan (Goodway, Robinson, 2015).

Limited skill acquisition during early sport specialization may limit the acquisition of fundamental motor skills and negatively affect sports activities later in adulthood (Wiersma, 2000; Branta, 2010). For example, young children who specialize early in gymnastics will not necessarily develop competence in object control skills (e.g. catching, throwing) and thus they will be less likely to find enjoyment in lifetime sports such as basketball, softball, and tennis (Goodway, Robinson, 2015).

If children develop fundamental motor skill competence through sport sampling, they will apply these fundamental motor skills to many physical activities later in life (Clark, Metcalfe, 2002).

Additionally, early sampling may stimulate generic physiological and cognitive adaptations during the early phases of growth and maturation, laying the groundwork for specialized physical and cognitive capacities necessary for later expertise. Moreover, athletes who sample and diversify in their young years may be at less risk for injuries than their peers that specialized early (Baker, Côté, 2006).

Jayanthi, Pinkham et al. (2013) presented an interesting overview of studies that examined athletes in various sports concerning their performance development and sports career. They found that research in athletes has not consistently demonstrated that intense early training is essential for attaining an elite level in all sports (Table 3 in Appendix 6).

2. 2. 4 Early specialization sports versus late specialization sports

Early sport specialization might be necessary for sports that require peak performance to occur earlier in the developmental window (i.e., before puberty). Specifically, in sports where peak performance occurs at early ages (i.e., before biological maturation), such as in women's gymnastics (Law, Côté, Ericsson, 2008) and women's figure skating (Deakin, Cobley, 2003), in these sports is early specialization necessary to accumulate the hours of deliberate practice needed to reach the elite level (Côté, Baker, Abernethy, 2007).

Especially in gymnastics or figure skating, there are specific acrobatic skills that athletes must master before biological maturation, because later they would not have to be mastered (Judge, Gilreath, 2009). Also, Goodway and Robinson (2015) claim that for a female gymnast, the onset of puberty is one developmental factor to be considered, as it would adversely affect performance. Therefore, we can name these sports as early specialization sports.

„However, for most sports, such intense training in a single sport to exclude others should be delayed until late adolescence to optimize success while minimizing injury, psychological stress, and burnout". (Jayanthi, Pinkham et al., 2013) In these sports is peak performance usually achieved after full maturation (for example, in basketball, ice hockey, athletics or baseball). Therefore, we can name these sports as „late specialization sports".

Myer, Jayanthi et al. (2016) present recommendations for the stage of specialization and sport (see Table 4).

Table 4: Recommendations for the stage of specialization and sport (adapted from Jayanthi, Pinkham et al.,2013)

Type of Sport	**Recommended Stage of Specialization**
Gymnastics, diving, figure skating	Early adolescence
Team sports, tennis, golf	Middle adolescence
Endurance sports, track, distance events	Late adolescence

2. 3 General motor ability

In observations of everyday motor behaviour, common experience suggests that specific individuals can perform well on many motor tasks. It might seem unlikely that practice is the main reason. Therefore, these individuals may have the ability or potential to perform well on many motor tasks (Lorås, Sigmundsson, 2012).

This concept, called general motor ability (GMA), maintains that an individual can perform a broad spectrum of activities (Clarke and Clarke, 1987). It is assumed that a person with a high GMA is successful in performing any movement skill (Burton, Rodgerson, 2001).

There are different definitions of GMA. However, they are similar. For example, Sage (1984) claim that GMA is a common factor that enables individuals to perform well or quickly acquire a high proficiency level on any motor task. Similarly, Schmidt and Lee (1999) refer to GMA as a single trait of a person who underlies all movement skills.

According to Schmidt and Lee (1999), two essential components of GMA are ability and skill. Historically, relationships between movement skills, motor abilities and general motor ability (GMA) were studied from the 1920s to the 1970s. In 2001, Burton and Rodgerson (2001) revisited these constructs' conceptualisation and suggested a new perspective based on a four-level taxonomy. According to these authors, these levels are in the following hierarchical structure:

- at the first level are movement skills which are the tools in life, discernible from another that is used to work and play (e.g. running, jumping, throwing),
- on the second level are movement skill sets that are the movement skills clustered together into subtests in an assessment instrument,
- at the third level are movement skills foundations that are all aspects of a person (physical, mental, and emotional that facilitate or limit her/her performance on movement skills),
- at the fourth level is the general motor ability (GMA).

There are several specific tests of motor ability that were developed and become accepted. Although these tests do not define general motor ability *per se*, their interpretation assumes that this underlying ability exists (Burton, Rodgerson, 2001).

For example, the Movement Assessment Battery for Children–Movement ABC (Henderson, 1992) used to determine Developmental Coordination Disorder (DCD) in school-aged children. Or the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978), a proficiency test for gross motor skills and fine motor skills given to participants aged

4 to 21 years. Alternatively, the McCarron Assessment of Neuromuscular Development–MAND (McCarron, 1982) is also a standardized evaluation of fine and gross motor skills for children and adults.

Nevertheless, controversy has surrounded the acceptance of the general motor ability concept. *„Some agree with GMA's notion underlying movement tasks and performances, while others believe in specific motor ability (SMA)".* (Ibrahim, 2009)

For example, Sherrill, in 1998, argued that the belief in GMA is now outdated. On the other hand, recently, authors supported GMA's existence (e.g. Ibrahim, Hear, Blanksby, 2011).

However, generally, the authors agree that the evidence supporting GMA's existence is minimal. Further investigations of this construct should be continued (Ibrahim, 2009).

2. 4 Characteristics of middle childhood

Middle childhood is sometimes called a „bridge" between early childhood and adolescence (Yücelyiğit, 2020).

„It is the period of a lifetime, which sets the stage for some crucial milestones such as developing self-identity; mastering critical thinking, reasoning and decision making; learning health literacy; gaining the habit of healthy nutrition and regular exercise, improving communication skills at school or developing peer relations." (Yücelyiğit, 2020)

The gradual change in physical growth and a significant change in psychological development is characteristic of middle childhood (5–11 years of age). Children at this age reach new levels of cognitive, emotional and social functioning (Harold, Hay, 2005).

According to DelGiudice (2018), this life stage is not static. The transition from early to middle childhood is characteristic of a change in cognition, motivation, and social behaviour. (see Table 5).

Table 5: Development in middle childhood (adapted from DelGiudice, 2018)

Body growth	The eruption of permanent molars
	Mid-growth spurt, followed by decelerating skeletal growth
	Increased muscle mass
	Increased adiposity and BMI (adiposity rebound)
	Initial development of axillary hair and body odour
	Increased sex differences in adiposity (F > M), bone strength, and muscularity (M > F)
	The emergence of sex differences in vocal characteristics

Brain growth	Approaching the peak of overall brain volume
	Peak of gray matter volume
	Continuing increase in white matter volume/integrity
Motor and perceptual skills	Increased gross motor skills (e.g., walking)
	Increased fine motor skills
	Local-global shift in visual processing preferences
Cognitive skills	Increased reasoning and problem-solving skills (e.g., concrete operations)
	Increased self-regulation and executive functions (inhibition, attention, planning, etc.)
	Increased mentalizing skills (multiple perspectives, conflicting goals)
	Increased navigational skills (working memory, ability to understand maps)
Motivation and social behavior	Acquisition of cultural norms (e.g., prosociality)
	Complex moral reasoning (conflicting points of view)
	Increased pragmatic abilities (gossiping, storytelling, verbal competition, etc.)
	Consolidation of status/dominance hierarchies
	Changes in aggression levels (individual trajectories)
	Development of disgust
	Changes in food preferences (e.g., spicy foods)
	Onset of sexual/romantic attraction
	Increased frequency of sexual play
	Increased sense of gender identity
	Peak of sex segregation
	Peak of sex differences in social play (including play fighting vs. play parenting)
	Increased sex differences in physical aggression (M > F)
	Emergence of sex differences in attachment styles
Psychopathology	Early peak of psychopathology onset (externalizing, anxiety, phobias, ADHD)
	Peak onset of fetishistic attractions
	Emergence of sex differences in conduct disorders (M > F)
Social context	Active involvement in caretaking, foraging, domestic tasks, helping
	Expectations of responsible behavior
	Attribution of individuality and personhood (“getting noticed”)
Behavior genetics	Increased heritability of general intelligence and language skills
	New genetic influences on general intelligence, language, aggression, and prosociality

BMI body mass index, *M* male, *F* female, *ADHD* attention deficit hyperactivity disorder

2. 4. 1 Physical development

Physical development is in progress. Children's bones broaden and lengthen. (Yücelyiğit, 2020). Muscle fibres replace the proportion of cellular fluid in the tissue, and bones continue to strengthen (Harold, Hay, 2005).

The body height regularly increases by 6-8 cm per year. Also, the development of internal organs, blood circulation, lungs and vital capacity is continuously increasing. The spine's curvature becomes stable**,** bone ossification continues rapidly, but the joints are still very soft and elastic (Perič, 2004).

At the beginning of this period, boys are taller while girls grow by leaps and become taller by the end (Yücelyiğit, 2020). At about 12 years of age, bone ossification in girls is two years ahead compared with boys. Also, children's physical strength develops. Interestingly, the average 10-year-old can throw a ball twice as far as the average 6-year-old (Harold, Hay, 2005).

Approximately at the age of six, the nervous system is mature enough for complex coordination movements. The nervous system's plasticity and nervous processes' mobility create favourable conditions for coordination and speed development (Perič, 2004).

2. 4. 2 Motor development

In terms of motor development, middle childhood is characterized by spontaneous physical activity. New motor skills are easily and quickly acquired. Children improve both their fine and gross motor skills. However, in the case of low repetition, new skills are quickly forgotten. Children's experience from natural motor skills is used in learning new motor skills. A characteristic feature of children's motor behaviour is that it lacks movement efficiency (Perič, 2004).

The period from 10 to 12 years is considered the ideal age for motor development. It is called the "golden age of motor skill development/learning". Individual skills mastery can begin and accelerate. However, provided the athlete has acquired a solid foundation of fundamental sport skills (referred to often as the ABCs, i.e., agility, balance and coordination) (Mancini, 2015).

Children can do new movements for the first time after their first demonstration. At the end of this period, children can do challenging coordination exercises (Perič, 2004).

During this period, we should focus mainly on coordination, speed and flexibility development (Dovalil, Choutka et al. 2002).

2. 4. 3 Cognitive development

Jean Piaget characterized middle childhood as a particularly crucial developmental stage in cognitive development. Children begin to use concrete operations, i.e. a set of 'rules' or 'strategies' to examine and interact with the world. Children also improve significantly in their ability to store and retrieve information, the so-called mnemonic ability. For example, they learn that rehearsing information is a helpful aid to memory. Likewise, children better understand other people's speech complexities, including passive voice, comparatives, metaphorical speech, and their vocabulary increase (Harold, Hay, 2005).

2. 4. 4 Psychological and social development

In middle childhood, personal characteristics are not stable. Children are impulsive and quickly move from joy to sadness and vice versa. The will is not fully developed. Children can not follow a long-term goal and concentrate on a brief time, about 4 - 5 minutes. Additionally, all activities are strongly emotionally experienced (Perič, 2004).

Social development begins when the child realizes that he or she has its own identity. At that moment, the child begins to acquire skills which she/he needs for life in human society. Children have to learn to communicate, share things and follow generally accepted interpersonal contact rules (Newman, 2004). They develop social skills, such as sharing, helping, creating relationships, and controlling one's temper (Gresham, Elliott, 1990).

During this period, children integrate into the collective at school. Formal authorities, such as teachers and coaches, are beginning to translate into relationships. Children meet with peers in the school or training team, create interpersonal relationships, build their social status and form first friendships (Perič, 2004). Children receive feedback concerning peer-relation, adaptation to school rules, all of which are new to their lives (Yücelyiğit, 2020).

Interestingly, at the end of this period, there is a decrease in adults' natural authority. Children begin to assess reality negatively and look for their idols who can create natural authority for them (Perič, 2004).

3 RESEARCH PROBLEM

Some research supports the concept of multilateral development in the early stages of athlete development. Several studies have found that elite performance is usually preceded by sampling various sports (see Chapter 2. 2. 3 for an overview). Also, it has been demonstrated that some athletes who had diversified sport backgrounds and engaged in deliberate play during childhood still reached an elite level in sport (Baker, Côté, Abernethy, 2003; Baker, Côté, Deakin, 2005; Soberlak, Côté, 2003). Moreover, in long-term athlete development models, multilateral development (i.e. sampling various sports and physical activities) in childhood is recommended (see Chapter 2. 2. 2. 2 for an overview).

However, some experts argue that these models were developed based on the use of a combination of methods (e.g. literature reviews, collection of retrospective or case study data, information obtained from practitioners in the sports talent development field, comparison of children as measured across several levels, observational/anecdotal data) (Horn, 2015). Furthermore, many studies have been conducted with a retrospective design based on the seminal work of Bloom (1985), which could face methodological problems, because athletes cannot recall their past experiences or the recall of their past experiences could be distorted (Moesch, Elbe et al., 2013). Additionally, other authors (e. g. Bailey, Collins et al. 2010; Ford, Croix et al. 2011; Oliver, Lloyd, 2012) also criticize that the long-term athlete development model by Balyi (2002) is mainly theoretical and lacks supporting longitudinal empirical evidence.

At present, prospective longitudinal studies proving or disproving the importance of multilateral development for specific sport skill acquisition are not commonly available. Goodway and Robinson (2015) claim that we have much to learn about developmental pathways into the elite sport, and therefore prospective, rather than retrospective, studies are needed. Correspondingly, Myer, Jayanthi et al. (2016) argue that there have been few, if any, long-term prospective surveillance studies comparing the potential benefits and risks of young athletes who are specialized versus those who are diversified.

Also, Horn (2015) asserts that it would be of particular value to conduct longitudinal studies following a large sample of children as they progress through the tracks illustrated in the various talent development frameworks. According to Horn (2015), it would be particularly beneficial to conduct a longitudinally based investigation of a sample of children to obtain richer detail regarding the how and why of children's and adolescents' movement through the stages.

4 METHODOLOGY

4. 1 Aim of the study

This dissertation aims to investigate the relationship between multilateral development and specific sport skill acquisition, specifically in ice hockey and athletics.

4. 2 Objectives

We assigned the following objectives:

1. make an overview of long-term athlete development,
2. define the concept of multilateral development in long-term athlete development,
3. select and define multilateral development indicators,
4. select sports and specific sport skills within these sports that children acquire in middle childhood,
5. determine the evaluation of specific sport skill acquisition in selected sports,
6. organize and execute testing sessions,
7. analyze the collected data,
8. write up and summarize the results.

4. 3 Research questions

Our main research question was:

1. What is the relationship between multilateral development and specific sport skill acquisition in middle childhood? In other words, does a higher level of multilateral development leads to a higher level of specific sport skill acquisition at a later age?

From this main research question above arose these other sub-questions:

2. How much of the variance in ice hockey/athletic skill acquisition is explained by multilateral development indicators? In other words, how well do multilateral development indicators predict the level of ice hockey/athletic skill acquisition at a later age?
3. Which multilateral development indicators are the best predictors of better ice hockey/athletic skill acquisition?
4. Can statistical approaches such as confirmatory factor analyses provide evidence to support the general motor ability concept?

4. 4 Hypothesis

H1: There is a strong positive and statistically significant relationship between multilateral development and specific sport skill acquisition in both selected sports.
In other words, there is a strong positive relationship between selected nine non-specific motor tests (multilateral development indicators) and three specific motor tests (specific sport skills) within selected sports.

H2: Multilateral development indicators explain more than 60 percent of the variance in the level of athletic/ice hockey skill acquisition.

H3: The best predictors of better athletic/ice hockey skill acquisition are multilateral development indicators that evaluate coordination predispositions.

H4: Our „model“ for multilateral development evaluation provides evidence to support the general motor ability concept.

4. 5 Proband and sport selection

Regarding the selection of sports, we chose one collective and one individual sport, whereas both are characterized as "late specialization sports". It is ice hockey and athletics.

For the proband selection, we used a purposive non-probability sampling method. We selected 6-7-year-old children from two athletic clubs and two ice hockey clubs in Prague (Czech Republic). Thanks to my internship abroad, we also included children from an ice hockey club in Herentals (Belgium) in our sample.

Sports clubs were selected based on their availability and concerning their sports facilities. The main requirement was a gym or playground with a minimum length of 25 meters.

The condition of choosing a child from a sports club was his/her age and health status. The child had to be 6-7 years old and had no health problems that would limit him/her in sports performance.

The research did not include children whose parents disagreed with the investigation and children who did not come to the test due to illness or other personal reasons.

4. 6 Procedures

Firstly, we asked coaches to cooperate in the research. Secondly, coaches familiarized parents with the possibility of their children's participation in the study. After that, there was a meeting with the parents of the children. Parents were acquainted with their children's involvement in the research, realizing testing sessions, schedule, and personal data protection. Before participating, parents of children read and signed an institutional review board-approved informed consent document (Appendix 2).

In the first phase (see Figure 3 below), we assessed children's multilateral development. We conducted the testing sessions only indoors. All participants wore suitable sports clothing (gym tracksuit, tee-shirt, gym shoes, or rubber-soled shoes).

We organize each testing session as follows. After the anthropometric measurements and warm-up, we separated the group of children into two groups. One group started the first test (Flag tag game); the second group had a rest. Then we changed the groups.

Subsequently, we performed the following tests (Routine with a stick, Flexed-arm hang, Rolling three balls, Sit and reach, Agility Illinois test, Standing long jump, and Sit-ups) as a "circuit training". It means that we separated the group of children into smaller groups (the number of groups depended on the number of children), and each group went to one station (test). After each child from the group completed the test, the whole group moved to the next station (test). In the end, all participants together performed the last test, which was the Shuttle run. Find a description of multilateral development indicators and their evaluation in Appendix 3.

In the second phase (one year later), we evaluated selected ice hockey skills or athletic skills in the same children. Find a description of selected specific sport skills and their evaluation in Appendix 4 and Appendix 5.

We used non-standardized questionnaires completed by the children's parents or close relatives for a more detailed description of children's sports background. These survey results are in Chapter 5. 1, which deals with the research sample's characteristics and Appendix 10.

4. 7 Research design

This dissertation is based on non-experimental longitudinal research and uses the tools of correlation analysis. We searched for the relationship between multilateral development and specific sport skill acquisition in children in middle childhood.

In the first phase, we evaluated multilateral development in children who were 6-7 years old. One year later, we assessed the level of specific sport skill acquisition in the children, specifically in ice hockey and athletics (see phases of the research in Figure 3 and the testing sessions schedule in Table 6 below).

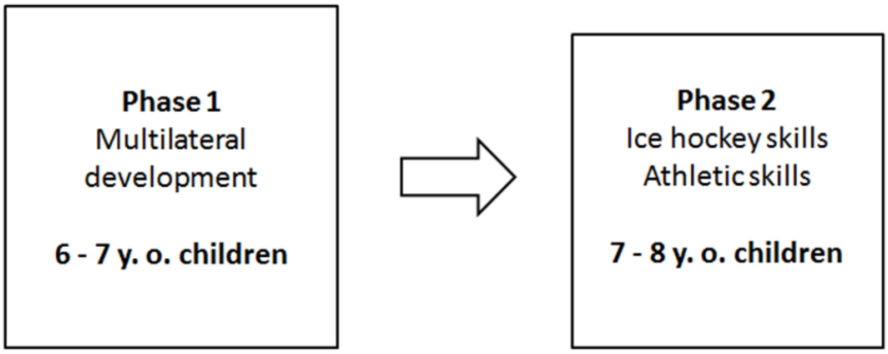


Figure 3: Phases of the research

Table 6: Schedule of testing sessions

Year	Group A	Group B
2018	Evaluation of multilateral development (6-7 years old children)	
2019	Evaluation of specific sport skill acquisition (7-8 years old children)	Evaluation of multilateral development (6-7 years old children)
2020		Evaluation of specific sport skill acquisition (7-8 years old children)

4. 8 Multilateral development evaluation

4. 8. 1 Selection of multilateral development indicators – the first phase

We selected the so-called multilateral development indicators according to the study by Perič, Ružbarský (2019). These authors set up an expert committee that consisted of university teachers (n=5) (at least associate professors and experts in the field of sports training and talent identification). Under the head of the expert group's supervision, the authors did individual and group interviews with these experts to propose multilateral development indicators.

Group interviews with experts were used to define primary domains of multilateral development based on the general theory of sports performance structure. This theory describes five fundamental factors underlying the structure of individual sport performance (Dovalil, 2012) (see Figure 4):

1) conditioning factors
2) technical factors
3) tactical factors
4) somatic factors
5) personality factors (psychological factors)

However, the expert commission concluded that only four of these five factors could be evaluated in training or physical education conditions: conditioning factors, technical factors, tactical factors and somatic factors.

Experts excluded psychological factors (personality factors) due to difficult indications of personality traits in six and seven-year-old children due to a low degree of stability of these personality traits caused by ontogenetic development (Perič, Ružbarský, 2019).

When evaluating the options for the evaluation of multilateral development, which are based on the factors mentioned above, the expert commission decided to choose the following domains:

a) chronological age
b) somatic predispositions (body height and body weight)
c) conditioning factors (motor abilities)
d) predispositions for manipulation of objects (for the domain of non-specific predispositions for technique)
e) predispositions for decision-making processes (for the domain of non-specific predispositions for tactics)

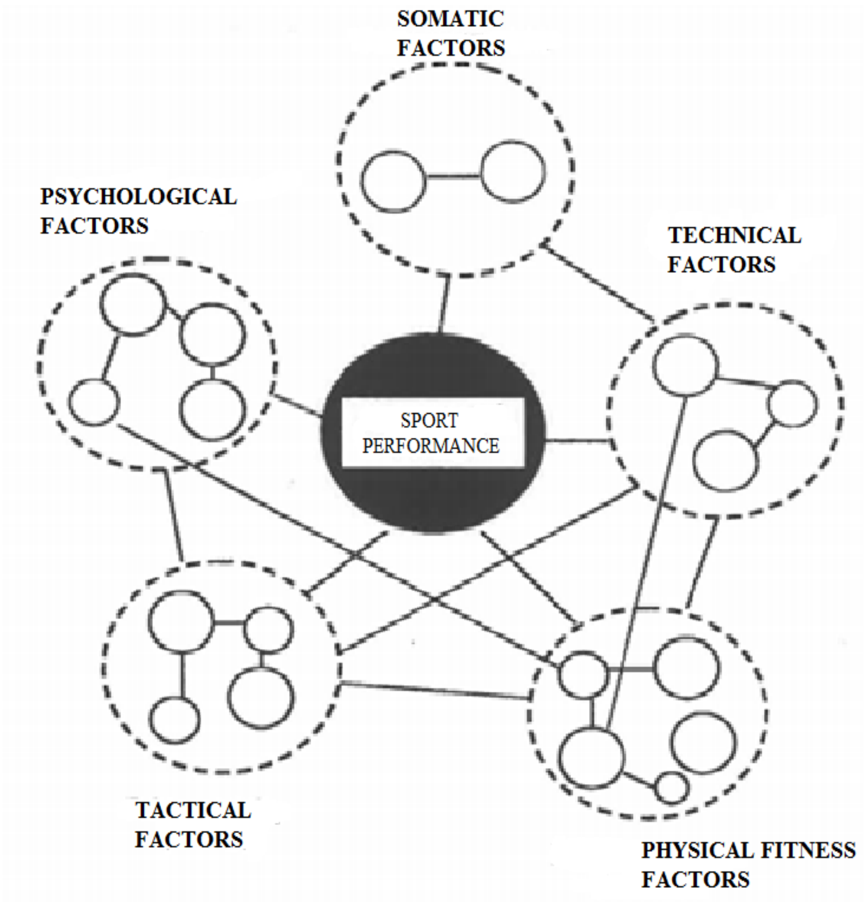


Figure 4: Structure of sport performance (Dovalil, 2012)

4. 8. 2 Selection of multilateral development indicators – the second phase

In the second phase, the expert commission determined indicators for evaluating individual domains mentioned in the previous Chapter 4. 8. 1. The main requirement was to select indicators with high validity and reliability to the assessed criterion. The second requirement was that it should be possible to realize these indicators (tests) in training conditions or physical education.

However, the most relevant requirement was that the indicators could not be affected by children's previous movement experience. It means that selected indicators can not be specific for ice hockey or athletics. In other words, selected indicators (motor tests) should not be commonly used in ice hockey or athletics. This requirement ensured that children would have minimal motor experience with these indicators (motor tests).

In terms of somatic factors, it was included evaluation of body height and body weight.

Regarding conditioning factors, the expert commission decided to evaluate the level of individual motor abilities (coordination, speed, strength, endurance and flexibility) and the "blending" some of these motor abilities (coordination-speed, speed-strength and strength-endurance). Therefore, it was designed this basic structure:

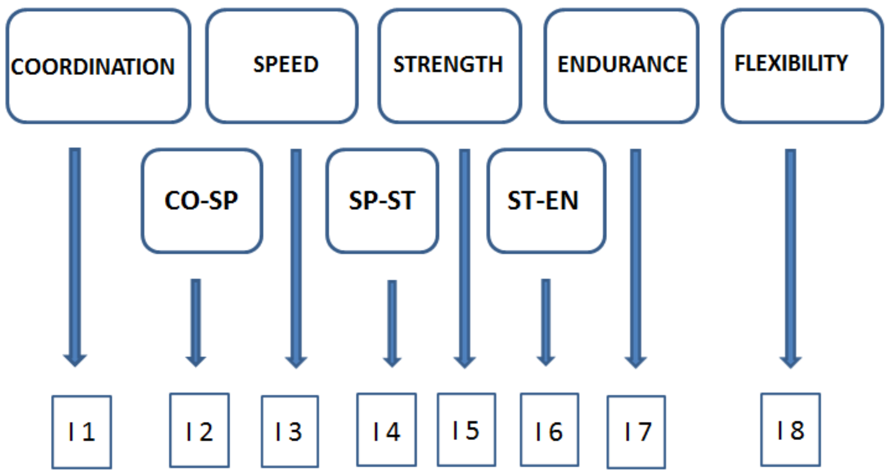


Figure 5: Indicators for the evaluation of motor abilities (adapted from Perič, Ružbarský, 2019)

Depending on the validity, reliability, and simplicity of administration, the following indicators (motor tests) for evaluating motor abilities were selected (see Table 7 below). Find a description of these selected motor tests in Appendix 3. For some of these selected tests were established standards for children in middle childhood (see Kovář, 1985).

However, there is no specific indicator for assessing speed. The pilot study revealed that a high percentage of schools do not have a gym larger than 50 m and transition from the gymnasium to the playground caused organization-related severe problems. Therefore, the expert commission excluded a 50-meter sprint from the test battery. Hence, the expert commission proposed an option of predicting levels of speed abilities by administering the Standing long jump and the Shuttle run, respectively (see Table 42) (Perič, Ružbarský, 2019).

As written in Table 7, we exchanged the 4*10 m shuttle run for the Agility Illinois test. We made this change due to the higher validity of the Agility Illinois test.

Table 7: Selected motor tests for the evaluation of motor abilities

Motor ability	**Indicator (test)**	**Reliability (r_{stab})**
Coordination	Routine with gym stick	0,95*
Speed-coordination	Agility Illinios test	0,94-0,99***
Speed- strength (explosive strength)	Standing long jump	0,93*
Strength	Flexed arm hang	0,80*
Strength-endurance	Sit-ups in 30 seconds	0,80*
Endurance	Endurance shuttle run	0,93**
Flexibility	Sit and reach	0,97*

Reliability coefficient cited by:

** Měkota, Blahuš, 1983*
*** Liu, Plowman, Looney, 1992*
**** Raya, Gailey et al., 2013*

Table 42: Predictive validity values for the 50-meter sprint (n=407) $p_{0,001}$=0,13 (adapted from Perič, Ružbarský, 2019)

Predictive validity coefficient	Prediction 50 m - Total	Prediction 50 m boys (n=220)	Prediction 50 m girls (n=187)
50-meter sprint	0,680	0,754	0,601

In non-specific indicators for tactical predispositions, experts formulated a requirement that the motor test should be simple, easy to understand, and easy to administer. The group interviews yielded a proposal for children playing games that children know, making the games simple to organize. As determined by the expert commission, several games were proposed, and three games with the highest degree of logical validity were chosen. The game chosen was the Flag tag game, during which children had to steal colour flags from each other (Perič, Ružbarský, 2019) (see Table 8 below).

In the area of non-specific indicators for technical predispositions (manipulation of objects) expert committee chose three tests that, from the perspective of validity, assess predispositions for manipulation of objects and are not dependent on previous movement experience. As the domain of decision-making indicators, the commission chose the test that required children to roll three balls over a specific course (test named Rolling three balls) (Perič, Ružbarský, 2019) (see Table 8 below).

Table 8: Selected motor tests for evaluation of technical and tactical predispositions

Non-specific technical predispositions	**Test (indicator)**	**Reliability**
Predispositions for manipulation of objects	Rolling three balls	0,84*
Non-specific tactical predispositions	**Test (indicator)**	**Reliability**
Predispositions for decision-making processes	Flag tag game	being determined ****

Reliability coefficient cited by:

* *Měkota, Blahuš, 1983*

**** *Perič, 2018a (unpublished)*

4. 9 Selection and evaluation of specific sport skills

In athletics, children under 11 years are classified into these age categories:

- athletic kindergarten (5-7 y.o. children),
- mini athletic preparation (8-9 y.o. children),
- athletic preparation (10-11 y.o. children).

The content of practices during these periods are mainly games and fun exercises for speed and coordination development. Children learn fundamental movement skills and acquire the basic technique of athletic disciplines, primarily running, jumping, and throwing. Therefore, we chose these athletic skills for evaluation: Long jump, Overarm throw, and 50 m sprint.

We are aware that a 50 meters sprint is strongly influenced by physical abilities, especially by speed development. In children, however, the running speed is significantly affected by the running technique. Additionally, in Kids' athletics, great emphasis is usually placed on improving children's running technique. Therefore, we assume that children with a better running technique are faster than children who do not master the running technique so well. Consequently, we consider a 50 meters sprint as a skill in this work.

We evaluated athletic skills quantitatively according to the rules of athletics. However, some rules have been adjusted according to the children's age (e.g. the long jump was measured from the point of take-off). Find the description and evaluation of selected athletic skills in Appendix 5.

When we were selecting ice hockey skills, we were also based on the age of children and the united training systém, according to Belmonte, Emahiser et al. (2010). We chose ice hockey skills that children should acquire in middle childhood. It is passing, shooting, and stickhandling. We evaluated selected ice Hockey skills also quantitatively according to Perič (2018b). Find the description and evaluation of selected ice hockey skills in Appendix 4.

4. 10 Statistical analysis

4. 10. 1 Descriptive statistics

We used descriptive statistics to describe the basic features of the data. Descriptive statistics provide simple summaries about the sample and the measures. With descriptive statistics, we are merely describing what is or what the data shows. Descriptive statistics help us to simplify large amounts of data sensibly and provide a powerful summary that may enable comparisons across people or other units (Trochim, 2020).

4. 10. 2 Checking for outliers and extreme points

We inspected our data in terms of outliers and extreme points. Outliers are cases with values well above or well below the majority of other cases (they extend more than 1.5 box-lengths from the edge of the boxplot). Extreme points are those that extend more than 3 box-lengths from the edge of the boxplot (Pallant, 2002).

We decided to transform the outliers according to Winsorizing method. Generally, in all indicators, outliers were less than 5 percent of the total data. According to Duan (1997), winsorizing less than 5% of data points will not likely affect the hypothesis testing outcome. Winsorizing method was described first by John Tukey (1962) who described Charles P. Winsor as the inventor of this procedure to deal with an outlier. Winsorizing method means that we do not delete outlier but we change its value replacing its original value by the nearest value (highest of lowest) of an observation not seriously suspect.

As for the extreme values, we considered them to be measurement errors. Therefore, we decided to trim these values. It means we removed these values from the data set.

4. 10. 3 Assessing the normality assumption

Verification of the data distribution is required for most statistical methods. We can use normal probability plot or normality tests to determine if the data come from a normal distribution or not. If the data is not normally distributed, non-parametric methods can be used (Hendl, 2012).

Therefore, we assessed the normality of multilateral development indicators distribution using the Kolmogorov-Smirnov test (see Appendix 7).

We assessed the normality of data distribution separately for athletes and ice hockey players and separately for girls and boys. Null hypothesis claim that the data is normally distributed.

Alternative hypothesis claim that the data is not normally distributed. A non-significant result (Sig. value of more than 0,05) indicates normality.

In both sports, almost all indicators do not have a normal distribution (except the indicator Standing long jump that has a normal distribution in both selected sports and the indicator Illinois Agility test that has normal distribution only in ice hockey sample).

Similarly, when we divided our sample into boys and girls, we found that almost all indicators do not have a normal distribution (except indicator Illinois Agility test and indicator Standing long jump that has normal distribution in both groups).

4. 10. 4 Transforming variables to have a normal distribution

We decided to transform the data to have a normal distribution to use parametric methods for data processing (Pearson correlation and Independent samples t-test). For transforming continuous variables to normal, we used a two-step approach for transforming continuous variables to normal, according to Gary Templeton (2011).

The first step involves transforming the variable into a percentile rank, which results in uniformly distributed probabilities. The second step applies the inverse-normal transformation to the first step's results to a form of a variable consisting of normally distributed Z-scores.

Read the article by Gary Templeton (2011) for a detailed illustration of implementing this approach in SPSS, Excel or SAS and explaining implications and recommendations for research.

4. 10. 5 Determination of the specific sport skill acquisition level

The nature of our results does not permit direct comparison. Therefore, to express the level of specific sport skill acquisition of the child, we converted the results of sports skill tests to standardized values, namely z-scores according to this formula:

$$Z_{ij} = \frac{Xij - \bar{x}}{sj}$$

We added up these z-scores for each proband (child). This procedure ensured that we could express the child's level of specific sport skill acquisition in one number.

In other words, the resulting score is "the level of ice hockey skill acquisition" or "the level of athletic skill acquisition" of an individual (child).

4. 10. 6 Inferential statistics

Pearson correlation analysis and Partial correlation analysis were used to find correlations between individual indicators of multilateral development in athletes and ice hockey players in particular and also together.

Independent samples t-test was used to assess whether young ice hockey players and athletes differ in multilateral development indicators. Also, this test was used to determine whether boys and girls differ in multilateral development indicators.

Exploratory factor analysis (EFA) was applied to determine the underlying factor structure in a set of variables that evaluate multilateral development in the sport.

To answer research question number two and three (see Chapter 4. 3), a standard multiple regression was performed between multilateral development indicators as independent variables and the level of ice hockey skill acquisition as a dependent variable.

To answer the fourth research question, whether our multilateral development assessment model provides evidence to support the general motor ability concept, we used the one-factor confirmatory factor analysis (CFA).

To answer the first research question, precisely, to determine the relationship between multilateral development and specific sports skill acquisition, we performed a canonical correlation analysis between a set of multilateral development indicators and a set of ice hockey (or athletic) skills.

4. 10. 7 Statistical Analysis Software

For statistical data processing, we used the program IBM SPSS (Statistical Package for the Social Sciences) Statistics 25, the program RStudio, and for processing CFA, we used the program Mplus.

5 RESULTS

We divided this part into three sections. In the first section (Chapter 5. 1), we characterize our research sample.

In the second section (Chapter 5. 2), we analyze the results of multilateral development testing sessions. Therefore, this section includes all children who participated only in the first phase of the research. It is a total of 95 children from ice hockey clubs and 77 children from athletic clubs.

In the third section (Chapter 5. 3), we deal with the relationship between multilateral development and specific sport skill acquisition. Therefore, this section includes children who participated in the first and second phases of the research, i.e. multilateral development testing sessions and specific sport skill acquisition assessment. It is a total of 54 children from ice hockey clubs and 31 children from athletic clubs.

5. 1 Characteristics of the research sample

In the first phase of the research, we measured the multilateral development of a total of 172 children, specifically children from two athletic clubs in Prague (n=77), two ice hockey clubs in Prague (n=83) and one ice hockey club in Herentals (Belgium) (n=12). In both sports dominated boys.

Table 9: Characteristics of the research sample and the number of drop-outs

Sport	**1st phase of the research** Evaluation of multilateral development			**2nd phase of the research (one year later)** Specific sport skill acquisition assessment			**Drop-out**	
	n	**Mean age** (in decimal years)	**Training age**	**n**	**Mean age** (in decimal years)	**Training age**	**n**	**%**
Athletics	77 (boys=49; girls=28)	6,9	0,9	31 (boys=23; girls=8)	7,6	2,1	46	59,7
Ice hockey	95 (boys=91; girls=4)	6,6	2,1	54 (boys=54; girls=0)	7,3	3,2	41	51,3

On average, at the time of multilateral development measurement, children from athletic clubs were 6,9 years old, and children from ice hockey clubs were 6,6 years old.

The average training age[1] of children from selected athletic clubs was 0,9 year. The average training age of children from selected ice hockey clubs was 2,1 years.

We evaluated the specific sport skill acquisition in ice hockey or athletics in these same children one year later. Unfortunately, the number of dropouts was relatively high. In both sports, more than 50% of children participated only in the first phase of the research (evaluation of multilateral development) and did not participate in the second phase of the study a year later. This dropout was caused by the children who ended their participation in athletic or ice hockey practices during the year and also by the children who did not come to practice for other reasons (e.g. illness, injury, holidays).

Table 10: Body height and body weight of children who participated only in the first phase of the reasearch (multilateral development testing sessions)

Sport (number of children)	Average body height (cm)	Average body weight (kg)
Athletics (n=77)	126,4 ± 7,6	24,9 ± 3,8
Ice hockey (n=95)	122,7 ± 6,6	23,9 ± 3,9

On average, children from athletic clubs were 3,7 cm taller and 1 kg heavier than children from ice hockey clubs. It was probably due to their chronological age because young athletes were approximately four months older than young ice hockey players (as recorded in Table 9).

Table 11: Changes in children's body weight and body height after one year

	Average body height (cm)		Average body weight (kg)	
Sport (number of children)	**1st year**	**2nd year**	**1st year**	**2nd year**
Athletics (n=31)	127,4 ± 6,4	132,3 ± 6,2	25,5 ± 3,7	28,5 ± 4,0
Ice hockey (n=54)	123,2 ± 6,0	127,3 ± 6,3	23,7 ± 3,3	25,9 ± 4,1

Table 11 above shows changes in body weight and body height after one year. In other words, in this table are changes in body weight and body height of children who participated in both research phases. It means evaluation of multilateral development and assessment of specific sport skill acquisition a year later.

The average weight gain was 3 kg in athletes and 2,2 kg in ice hockey players per year. The average height gain was 4,9 cm in athletes and 4,1 cm in ice hockey players per year. According to WHO growth reference (see de Onis, M., Onyango et al., 2007) for school-aged

[1] Training age is a measure of how long an athlete has been training is a specific sport (Higgs, Way et al., 2019).

children and adolescence, these changes in body height and body weight are in line with standards

Table 12: Number and duration of training sessions per week in athletics and ice hockey

Sport		6-7 years old children	7-8 years old children
Athletics	Number of practices per week (duration of one practice in minutes)	1-2 (60 min)	1-2 (60 min)
	The average number of athletic competitions per year	2	2
Ice hockey	Number of practices per week (duration of one practice in minutes)	3-4 (75 min)	3-4 (75 min)
	The average number of matches per year	10	10

We asked coaches about the frequency and duration of training units per week in selected sports (find specific questions for coaches in Appendix 9).

Children in selected athletic clubs have 1-2 training sessions per week in the first and second primary school classes. In selected ice hockey clubs, children in these age category have 3-4 training sessions per week.

There is also a difference in the number of competitions per year. On average, in athletics, a child in this age category participates in athletic competitions twice a year. In ice hockey, a child in this age category plays about ten matches per year.

It follows that the time requirements of selected sports vary significantly from an early age of children. In ice hockey, the time requirements are much bigger than in athletics.

5. 1. 1 Sports background of children

We used a non-standardized questionnaire to find out the sports background of children. 45% of children from our ice hockey sample started to participate in ice hockey training when they were 4-5 years old. In contrast, 80% of children from our athletic sample began to participate in athletic training later, precisely when they were 6-7 years old.

In the ice hockey sample, 90% of children participate in a sport other than ice hockey. 69% of these children participate in one or two more sports. The most frequent is football and floorball, as well as tennis and athletics.

In the athletic sample, 89% of children participate in a sport other than athletics. 60% of these children participate in one or two more sports, and even 38% of these children participate in three of four more sports. Most of these children are engaged in swimming, football and gymnastics.

These findings correspond with the number and duration of training sessions per week. Logically, children from athletics have more free time to engage in other sports than ice hockey players. Find graphically processed results in Appendix 10 (Graphs 1-6).

5. 2 Multilateral development

In this chapter, we analyzed the results from multilateral development testing sessions. Therefore, this part includes children who participated only in the first phase of the research, i.e. multilateral development testing sessions. It is a total of 77 children from athletic clubs and 95 children from ice hockey clubs.

5. 2. 1 Relationship between multilateral development indicators

5. 2. 1. 1 Pearson correlation analysis

The relationships between multilateral development indicators were investigated using Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. To evaluate the strength of the relationship, we used Cohen guidelines (1988).

In general, in both sports, most correlations between multilateral development indicators are small (up to 0,3). We rarely see medium correlations (in tables are marked in bold), and there are no large correlations between selected indicators (more than 0,6).

This analysis confirms the independence of the selected indicators. It means that each selected indicator evaluates different movement predispositions. This finding is in line with our intention to choose indicators that assess a wide range of movement abilities and skills.

Table 13: Pearson product-moment correlation matrix between multilateral development indicators in athletics

	Routine with a stick	**Flexed arm hang**	**Rolling three balls**	**Sit Reach**	**Agility Illinois test**	**Standing LG**	**Sit-ups**	**Shuttle run**	**Flag tag game**
Routine with a stick	1								
Flexed arm hang	0,038	1							
Rolling three balls	**-0,413****	-0,017	1						
Sit-Reach	0,239*	-0,027	0,053	1					
Agility Illinois test	-0,221	-0,259*	-0,083	0,025	1				
Standing LJ	**0,363****	**0,443****	0,208	0,079	**0,324****	1			
Sit-ups	0,240*	**0,319****	0,267*	-0,065	0,125	**0,363****	1		
Shuttle run	0,184	0,027	0,168	0,130	0,276*	0,172	**0,446****	1	
Flag tag game	0,073	0,116	**0,317****	0,142	0,241*	**0,325****	0,190	0,206	1

*** Correlation is significant at the 0,01 level (2-tailed)* *α = 0,217 (p<0,05)*

** Correlation is significant at the 0,05 level (2-tailed)*

In athletics (see Table 13 above), the strongest correlation is between indicator Sit-ups and indicator Shuttle run. These indicators have a common endurance component.

The second strongest relationship is between indicator Standing long jump and indicator Flexed arm hang. These indicators have a common strength component.

The third strongest relationship is between indicator Routine with a stick and indicator Rolling three balls. These indicators have a common coordination component. In both indicators (tests), the child manipulates with objects (with a stick or balls). Therefore, we can also say both these indicators evaluate predispositions for object manipulation.

Interestingly, the indicator Sit and reach that evaluate lower limbs' flexibility does not correlate with any other indicator.

Table 14: Pearson product-moment correlation matrix between multilateral development indicators in ice hockey

	Routine with a stick	**Flexed arm hang**	**Rolling three balls**	**Sit-Reach**	**Agility Illinois test**	**Standing LJ**	**Sit-ups**	**Shuttle run**	**Flag tag game**
Routine with a stick	1								
Flexed arm hang	0,118	1							
Rolling three balls	-0,079	-0,234*	1						
Sit-Reach	0,167	-0,061	-0,034	1					
Agility Illinois test	-0,095	-0,169	0,104	0,071	1				
Standing LJ	0,292**	**0,441****	**0,414****	0,027	0,172	1			
Sit-ups	0,069	0,192	**0,309****	0,128	0,261*	**0,417****	1		
Shuttle run	0,059	0,170	**0,390****	-0,094	**0,369****	**0,323****	**0,442****	1	
Flag tag game	**0,314****	0,129	0,197	0,088	0,144	0,222*	0,158	0,255*	1

*** Correlation is significant at the 0,01 level (2-tailed)* α = 0,205 (p<0,05*)*
** Correlation is significant at the 0,05 level (2-tailed)*

Similarly, in ice hockey (see Table 14 above) is the strongest relationship between indicator Sit-ups and indicator Shuttle run. Also, the second most important relationship is between indicator Standing long jump and indicator Flexed arm hang.

Interestingly, in ice hockey, indicator Rolling three balls moderately correlate with the other three indicators: Standing long jump, Sit-ups, and Shuttle run.

Also, in ice hockey, the indicator Sit and reach does not correlate with any other indicator.

Table 15: Pearson product-moment correlation matrix between multilateral development indicators (ice hockey players and athletes together)

	Routine with a stick	**Flexed arm hang**	**Rolling three balls**	**Sit and Reach**	**Agility Illinois test**	**Standing LJ**	**Sit-ups**	**Shuttle run**	**Flag tag game**
Routine with a stick	1								
Flexed arm hang	0,131	1							
Rolling three balls	-0,255**	-0,168*	1						
Sit-Reach	0,187*	-0,045	-0,001	1					
Agility Illinois test	-0,139	-0,203**	0,036	0,053	1				
Standing LJ	**0,303****	**0,431****	**0,315****	0,050	0,229**	1			
Sit-ups	0,204**	0,277**	**0,332****	0,046	0,211**	**0,370****	1		
Shuttle run	0,196*	0,141	**0,329****	0,019	**0,313****	0,228**	**0,479****	1	
Flag tag game	0,188*	0,112	0,227**	0,111	0,178*	0,270**	0,148	0,204**	1

*** Correlation is significant at the 0,01 level (2-tailed)* *α = 0,205 (p<0,05)*

** Correlation is significant at the 0,05 level (2-tailed)*

We put the results of athletes and hockey players together (see Table 15 above), and the correlations between multilateral development indicators remained essentially the same.

However, in this case, indicator Flag tag game does not correlate with another indicator as well as Sit and Reach indicator. This finding suggests that these two indicators evaluate completely different predispositions than other selected indicators. In this sense, these two indicators are, therefore, the most unique.

5. 2. 1. 2 Partial correlation analysis

Partial correlation can indicate an association between variables while statistically controlling for a third variable's influence. This is usually a variable that we suspect might be influencing other variables of interest (Pallant, 2020).

Therefore, we used partial correlation analysis to explore the relationship between selected multilateral development indicators while controlling for children's body height and body weight.

Generally, when we compare Pearson and partial correlation coefficients to see whether controlling for the additional variable impacted the relationship between multilateral development indicators, we find that there are only small changes in the strength of correlations between selected indicators. This finding suggests that the observed relationship between multilateral development indicators is not due merely to the influence of children's body height and body weight.

Table 16: Partial correlation between multilateral development indicators in athletics (controlling for body height and body weight)

	Routine with a stick	Flexed arm hang	Rolling three balls	Sit and Reach	Agility Illinois test	Standing LJ	Sit-ups	Shuttle run	Flag tag game
Routine with a stick	1								
Flexed arm hang	-0,001	1							
Rolling three balls	-0,305	-0,031	1						
Sit-Reach	0,307	-0,021	0,163	1					
Agility Illinois test	-0,224	-0,282	-0,027	0,034	1				
Standing LJ	0,220	0,415	0,038	0,174	0,394	1			
Sit-ups	0,164	0,287	0,161	-0,013	0,133	0,180	1		
Shuttle run	0,074	0,013	0,035	0,127	0,257	0,065	0,414	1	
Flag tag game	0,038	0,096	0,288	0,194	0,220	0,272	0,143	0,195	1

In athletics (see Table 16 above), the most significant change is in the correlation between indicator Standing long jump and indicator Rolling three balls and between indicator Sit-ups and indicator Standing long jump. In both cases, there is a decrease in the correlations between these indicators. In other words, these relationships are most positively affected by the body height and body weight of children.

Table 17: Partial correlation between multilateral development indicators in ice hockey (controlling for body height and body weight)

	Routine with stick	**Flexed arm hang**	**Rolling three balls**	**Sit and Reach**	**Agility Illinois test**	**Standi ng LJ**	**Sit-ups**	**Shuttle run**	**Flag tag game**
Routine with a stick	1								
Flexed arm hang	0,064	1							
Rolling three balls	-0,025	-0,161	1						
Sit-Reach	0,225	-0,010	0,061	1					
Agility Illinois test	-0,035	-0,095	0,181	0,024	1				
Standing LJ	0,232	0,407	0,337	0,163	0,066	1			
Sit-ups	-0,042	0,139	0,255	0,188	0,228	0,356	1		
Shuttle run	-0,025	0,050	0,339	-0,043	0,261	0,243	0,415	1	
Flag tag game	0,258	0,077	0,085	0,169	0,140	0,089	0,037	0,242	1

In ice hockey (see Table 17 above), there is the most significant change in the relationship between the indicators Rolling three balls and Flag tag game. Specifically, there is a decrease in the correlation between these indicators. Therefore, we claim that the relationship between Rolling three balls and Flag tag game is the most positively affected by children’s body height and weight.

Table 18: Partial correlation matrix between multilateral development indicators (ice hockey players and athletes together)

	Routine with stick	**Flexed arm hang**	**Rolling three balls**	**Sit and Reach**	**Agility Illinois test**	**Standing LJ**	**Sit-ups**	**Shuttle run**	**Flag tag game**
Routine with a stick	1								
Flexed arm hang	0,087	1							
Rolling three balls	-0,145	-0,172	1						
Sit-Reach	0,295	-0,033	0,157	1					
Agility Illinois test	-0,149	-0,223	0,086	0,035	1				
Standing LJ	0,148	0,421	0,159	0,200	0,274	1			
Sit-ups	0,094	0,248	0,238	0,137	0,224	0,237	1		
Shuttle run	0,149	0,129	0,285	0,070	0,312	0,169	0,456	1	
Flag tag game	0,159	0,121	0,147	0,177	0,160	0,253	0,113	0,179	1

Interestingly, when we put results of athletes and hockey players together, the relationship between indicator Routine with a stick and indicator Sit and Reach has strengthened suggesting that this relationship is negatively affected by children's body height and weight.

Further, there is a decrease in the correlations between indicator Standing long jump and indicator Routine with a stick, between indicator Routine with a stick and indicator Sit-ups and between indicator Rolling three balls and indicator Standing long jump. These relationship were positively affected by body height and weight of children.

5. 2. 2 The difference in multilateral development indicators between athletes and ice hockey players

We used independent samples t-test to assess whether young ice hockey players and athletes significantly differ in multilateral development indicators. For the calculation of effect size, we used Eta squared.

Table 19: Independent samples t-test (athletes versus ice hockey players)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Routine with a stick	**Equal variances assumed**	**3,523**	**0,062**	**5,300**	**166**	**0,000**	**9,346**	**1,763**	**5,864**	**12,827**
Flexed arm hang	**Equal variances assumed**	**0,481**	**0,489**	**-2,894**	**170**	**0,004**	**-2,090**	**0,722**	**-3,516**	**-0,664**
Rolling three balls	**Equal variances not assumed**	**6,834**	**0,010**	**3,490**	**167**	**0,001**	**4,470**	**1,281**	**1,941**	**6,998**
Sit-Reach	Equal variances assumed	3,327	0,070	0,588	170	0,557	0,442	0,752	-1,042	1,926
Agility Illinois test	Equal variances assumed	1,859	0,174	0,983	170	0,327	0,453	0,460	-0,456	1,361
Standing LJ	Equal variances assumed	2,362	0,126	0,400	169	0,690	1,125	2,814	-4,431	6,680
Sit-ups	**Equal variances assumed**	**0,104**	**0,748**	**-3,114**	**170**	**0,002**	**-2,224**	**0,714**	**-3,634**	**-0,814**
Shuttle run	**Equal variances assumed**	**1,544**	**0,216**	**-3,682**	**169**	**0,000**	**-52,044**	**14,134**	**-79,945**	**-24,143**
Flag tag game	Equal variances assumed	0,198	0,657	0,712	169	0,477	0,407	0,571	-0,720	1,534

Our sample of athletes and ice hockey players significantly differ in these indicators: Routine with a stick, Flexed arm hang, Rolling three balls, Sit-ups, and Shuttle run (in Table 19 above marked in bold). Interestingly, athletes have better average results in all these mentioned indicators (see Table 20 below). It can be caused by the higher average age of children from the athletic sample, as mentioned in Chapter 5. 1.

In other indicators, young athletes and ice hockey players do not significantly differ.

Table 20: Group Statistic (athletes versus ice hockey players)

Indicator	Sport	N	Mean	Std. Deviation	Std. Error Mean
Routine with a stick (s)	Hockey players	93	47,44	10,46	1,08
	Athletes	75	38,10	12,39	1,43
Flexed arm hang (s)	Hockey players	95	5,77	4,52	0,46
	Athletes	77	7,86	4,94	0,56
Rolling three balls (s)	Hockey players	95	29,79	9,65	0,99
	Athletes	75	25,32	7,04	0,81
Sit-reach (cm)	Hockey players	95	52,50	4,44	0,46
	Athletes	77	52,06	5,42	0,62
Agility Illinois test (s)	Hockey players	95	21,76	3,24	0,33
	Athletes	77	21,31	2,68	0,31
Standing long jump (cm)	Hockey players	95	125,72	17,51	1,80
	Athletes	76	124,59	19,21	2,20
Sit-ups (n)	Hockey players	95	13,02	4,76	0,49
	Athletes	77	15,25	4,53	0,52
Shuttle run (s)	Hockey players	95	187,44	88,66	9,10
	Athletes	76	239,48	95,67	10,97
Flag tag game (n)	Hockey players	95	6,33	3,63	0,37
	Athletes	76	5,93	3,81	0,44

Table 21: Effect size (athletes versus ice hockey players)

	Routine with a stick	Flexed arm hang	Rolling three balls	Sit and Reach	Agility Illinois test	Standing LG	Sit-ups	Shuttle run	Flag tag game
Eta squared	0,15	0,05	0,07	0,002	0,006	0,001	0,05	0,07	0,003

However, the effect size is small in most of the indicators, rarely medium. The large effect size is only in the indicator Routine with a stick (Eta squared = 0,15). Expressed as a percentage (multiply eta square value by 100), about 15 percent of the variance in Routine with a stick is explained by sport.

5. 2. 3 The difference in multilateral development indicators between boys and girls

An independent-samples t-test was also conducted to compare the results of multilateral development indicators between boys and girls. For the calculation of effect size, we used Eta squared.

Table 22: Independent samples t-test (boys versus girls)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Routine with gym stick	Equal variances assumed	0,552	0,459	1,959	166	0,052	4,675	2,386	-0,036	9,387
Flexed arm hang	Equal variances assumed	0,671	0,414	0,512	170	0,609	0,484	0,945	-1,381	2,349
Rolling three balls	Equal variances not assumed	3,166	0,077	-0,473	168	0,637	-0,835	1,763	-4,315	2,646
Sit-Reach	**Equal variances assumed**	**0,034**	**0,854**	**-2,634**	**170**	**0,009**	**-2,483**	**0,943**	**-4,344**	**-0,622**
Agility Illinois test	Equal variances assumed	0,015	0,901	-1,260	170	0,209	-0,740	0,587	-1,899	0,419
Standing LJ	**Equal variances assumed**	**0,077**	**0,782**	**3,483**	**169**	**0,001**	**12,069**	**3,465**	**5,229**	**18,909**
Sit-ups	Equal variances assumed	0,054	0,817	-0,525	170	0,600	-0,492	0,938	-2,343	1,359
Shuttle run	Equal variances assumed	0,017	0,897	-0,904	169	0,367	-16,879	18,670	-53,736	19,978
Flag tag game	**Equal variances assumed**	**0,031**	**0,860**	**2,781**	**169**	**0,006**	**1,981**	**0,712**	**0,575**	**3,387**

Generally, girls achieved better average results than boys in these indicators: Routine with a stick, Sit and Reach, Shuttle run and Sit-ups (see Table 23 below). In other indicators, boys had better average results. Nevertheless, only the difference in the indicator Standing long jump, indicator Flag tag game, and indicator Sit and Reach is statistically significant (see Table 22 above).

Even at such a young age, it seems that boys have better preconditions for dynamic strength and game performances. On the other hand, it turns out that girls have a better predisposition to flexibility.

Table 23: Group statistic (boys versus girls)

Indicator	**Sport**	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Routine with a stick (s)	Boys	136	44,16	11,81	1,01
	Girls	32	39,48	13,51	2,39
Flexed arm hang (s)	Boys	140	6,80	4,72	0,40
	Girls	32	6,32	5,26	0,93
Rolling three balls (s)	Boys	139	27,67	9,30	0,79
	Girls	31	28,50	6,60	1,18
Sit-reach (cm)	Boys	140	51,84	4,77	0,40
	Girls	32	54,32	4,99	0,88
Agility Illinois test (s)	Boys	140	21,42	3,04	0,26
	Girls	32	22,16	2,78	0,49
Standing long jump (cm)	Boys	139	127,48	17,76	1,51
	Girls	32	115,41	17,25	3,05
Sit-ups (n)	Boys	140	13,93	4,82	0,41
	Girls	32	14,42	4,64	0,82
Shuttle run (s)	Boys	139	207,41	95,97	8,14
	Girls	32	224,29	91,83	16,23
Flag tag game (n)	Boys	139	6,52	3,63	0,31
	Girls	32	4,54	3,64	0,64

Table 24: Effect size (boys versus girls)

	Routine with a stick	**Flexed arm hang**	**Rolling three balls**	**Sit and Reach**	**Agility Illinois test**	**Standing LG**	**Sit-ups**	**Shuttle run**	**Flag tag game**
Eta squared	0,02	0,000	0,001	0,04	0,009	0,07	0,002	0,005	0,04

The magnitude of the differences in the means of indicators in which boys and girls significantly differ were medium. Only 7 percent of the indicator Standing long jump and 4 percent of the variance in the indicator Sit and Reach and in the indicator Flag tag game is explained by gender.

5. 2. 4 Factor structure in the set of multilateral development indicators

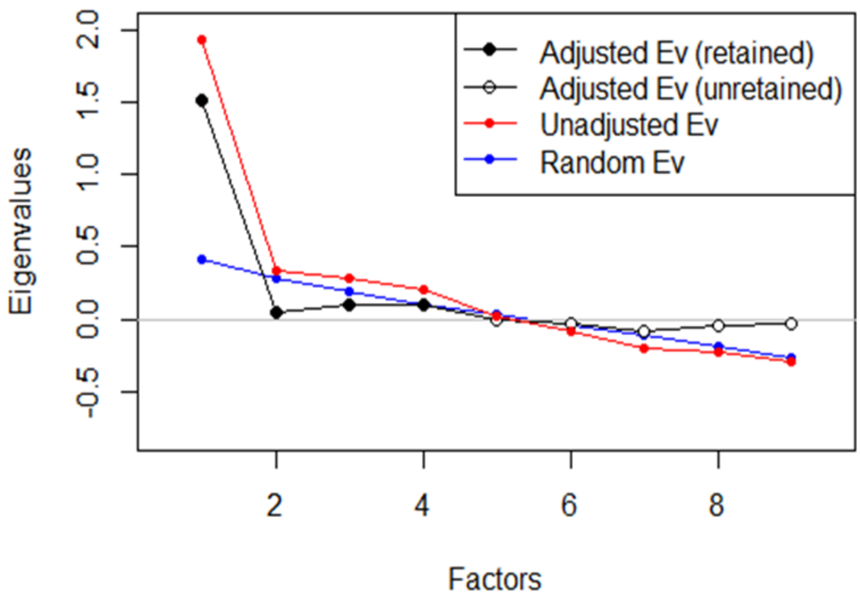
We applied exploratory factor analysis (EFA) to determine the underlying factor structure that exists in a set of multilateral development indicators.

Table 25: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,725
Bartlett's Test of Sphericity	Approx. Chi-Square	225,221
	df	36
	Sig.	0,000

Before performing exploratory factor analysis, we assessed the suitability of data for factor analysis. We inspected the correlation matrix for coefficients of 0,3 and above, calculated the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Barlett's Test of Sphericity. According to these criteria, factor analysis is appropriate for our data analysis. The KMO value is 0,725, and Bartlett's test is significant (p=0,000).

Graph 7: Horn's parallel analysis



To determine the number of factors to retain, we used Horn's parallel analysis (Horn, 1965). This analysis suggested retaining four factors for further investigation (see Graph 7 above). Therefore, we decided to extract four factors.

Table 26: Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,742	30,471	30,471	2,214	24,605	24,605	1,278	14,203	14,203
2	1,175	13,054	43,525	0,535	5,949	30,554	1,155	12,832	27,036
3	1,019	11,322	54,847	0,527	5,851	36,405	0,635	7,058	34,093
4	0,964	10,706	65,553	0,355	3,949	40,354	0,563	6,261	40,354
5	0,860	9,550	75,104						
6	0,750	8,331	83,435						
7	0,543	6,035	89,470						
8	0,510	5,663	95,133						
9	0,438	4,867	100,000						
Extraction Method: Principal Axis Factoring.									

According to Table 26 above, the first four factors explain 65,55 percent of the variance (see Cumulative % column). To aid in interpreting these four factors, we used the orthogonal rotation method, specifically Varimax rotation, because our extracted factors are not correlated.

Table 27: Rotated Factor Matrix[a]

	Factor			
	1	**2**	**3**	**4**
Routine with a stick	0,220	0,242	0,057	**0,452**
Flexed arm hang	0,139	**0,537**	0,144	-0,051
Rolling three balls	**0,537**	0,289	-0,269	0,162
Sit and Reach	-0,008	-0,058	-0,023	**0,431**
Illinois Agility test	0,128	0,196	**0,628**	0,043
Standing long jump	0,193	**0,739**	0,096	0,218
Situps	**0,512**	**0,316**	0,139	0,081
Shuttle run	**0,750**	0,047	**0,320**	0,100
Flag tag game	0,209	0,186	0,112	0,282
Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 7 iterations.				

Table 27 is a matrix of correlations between extracted factors and multilateral development indicators. We looked for significant loading on one factor.

There are many opinions about what is significant loading and what is not significant loading. According to Fidell and Tabachnick (2007), we should interpret only variables with 0,32 and above loadings. The greater the loading, the more the variable is a pure measure of the factor. Comrey and Lee (1992) suggest that loadings in excess of 0,71 (50% overlapping variance) are considered excellent, 0,63 (40% overlapping variance) very good, 0,55 (30% overlapping variance) good, 0,45 (20% overlapping variance) fair, and 0,32 (10% overlapping variance) poor. The cutoff's choice for the size of loading to be interpreted is a matter of researcher preference (Fidell, Tabachnick, 2007). Also, we look for so-called complex variables. Complex variables have a loading of 0,3 or greater on two or more factors.

Rotated factor matrix (Table 27) shows that indicators Shuttle run, Sit-ups and Rolling three balls have a strong loading on Factor 1. Although indicators Shuttle run and Sit-ups have common endurance predispositions, it is more difficult to name this factor because it is not entirely clear how the indicator Rolling three balls is related to them.

For Factor 2, there is a strong factor loading for indicators Flexed arm hang, Sit-ups and Standing long jump. They appear to be together as a power/strength factor.

Factor 3 has indicator Illinois Agility test and indicator Shuttle run. Although these indicators evaluate different motor abilities, both are focused on running. Therefore, we believe that this factor represents running skills. In other words, children who have better running technique are more likely to achieve a good result in both indicators (tests).

For Factor 4, there is loading for indicator Routine with a stick and indicator Sit and reach. Both indicators placed demands on the flexibility of the lower limbs. Those who have better results in indicator Sit and reach have better results in indicator Routine with a stick. This factor represents flexibility and also coordination predispositions.

Both indicators, Sit-ups and Shuttle run, represent complex variables. Indicator Sit-ups has a factor loading on Factor 1 (0,512) and Factor 2 (0,316). Indicator Shuttle run has a factor loading on factor Factor 1 (0,750) and Factor 3 (0,320).

Interestingly, the indicator Flag tag game does not load on any factor. This indicator is, therefore, the most unique. It evaluates completely different assumptions than other indicators.

5. 2. 5 Exploring general motor ability construct

We used one-factor confirmatory factor analysis (CFA) to answer research question number four (see Chapter 4. 3). One factor CFA assumes that the covariance (or correlation) among items is a single common factor. We wanted to know if our „model“ for multilateral development evaluation provide evidence to support this assumption, i.e. general motor ability concept.

Table 28: Chi-Square Test of Model Fit

Value	59,755
Degrees of Freedom	27
P-Value	0,0003

The null hypothesis is that there is no difference between the patterns observed in these data and the model specified. According to Table 28 above, we have to reject the null hypothesis that this is a good fit. From the chi-square value above, our model is not acceptable.

Table 29: RMSEA (Root Mean Square Error Of Approximation)

Estimate	0,084
90 Percent C.I.	0,055 - 0,113
Probability RMSEA <= .05	0,028

Another measure of goodness of fit is the root mean square error of approximation (RMSEA). An acceptable model should have an RMSEA less than 0,05. You can see above that the estimate for RMSEA is 0,084, the 90 percent confidence interval is 0,055 - 0,113 and the probability that the population RMSEA is less than 0,05 is 2,8%. Again, consistent with our chi-square, the model does not appear to fit.

Our model for multilateral development evaluation does not support the theory of general motor ability. This finding is consistent with Ibrahim’s (2009) claim that most of the researchers agree that the evidence which supports the existence of GMA is minimal.

5. 3 Multilateral development and specific sport skill acquisition

In this part of the results, we deal with the relationship between multilateral development and specific sport skill acquisition. Therefore, this section includes children who participated in the first and second phases of the research, i.e. multilateral development testing sessions and specific sport skill acquisition assessment. That means a total of 54 children from ice hockey clubs and 31 children from athletic clubs.

5. 3. 1 Determining the level of specific sport skill acquisition

Firstly, we inspected data in terms of outliers, extreme points and normality. Table 30 and Table 31 present descriptive statistics of ice hockey and athletic tests. Find the description and evaluation of selected sports skills in Appendix 4 and Appendix 5.

Table 30: Descriptive statistics (ice hockey skills)

	N	Min	Max	Mean	Std. Deviation
Shooting (s)	54	29,0	92,0	57,9	14,3
Passing (s)	54	42,1	100,0	67,0	16,7
Stickhandling (s)	54	6,6	19,0	10,0	2,9

Table 31: Descriptive statistics (athletic skills)

	N	Min	Max	Mean	Std. Deviation
Long jump (m)	31	1,90	3,70	2,78	0,49
Overarm throw (m)	31	7,3	30,1	18,5	6,4
50 m sprint (s)	31	8,1 s	12,8	9,4	1,0

We can see that there is a relatively broad range and also standard deviations between measured values within individual test items (skills). For example, in the Long jump, in athletics, is the difference between the worst and the best result almost two meters and in the Overarm throw is the range of nearly twenty-three meters. Similarly, in ice hockey, there are large differences in Minimum and Maximum values in each test. It follows that there are large individual differences in the acquisition of selected sports skills between children in both chosen sports.

Secondly, as mentioned in the Methodology, we converted these raw scores in each test to Z scores. After that, we added up these Z scores. The resulting score is „the level of ice hockey skill acquisition“ or „the level of athletic skill acquisition“ of an individual.

5. 3. 2 Variance in the level of ice hockey skill acquisition explained by multilateral development indicators

To answer research questions 2 and 3, we performed a standard multiple regression between the set of multilateral development indicators as independent variables and the level of ice hockey skill acquisition as a dependent variable. We used SPSS REGRESSION, and SPSS EXPLORE for the evaluation of assumptions.

As mentioned in the Methodology, we converted the raw scores in each skill test to Z scores that we added up. The resulting score is „the level of ice hockey skill acquisition" that we considered to be a dependent variable. As independent variables, we considered selected multilateral development indicators.

Table 32: ANOVA[a] (Ice hockey)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	96,950	9	10,772	5,714	,000[b]
	Residual	79,173	42	1,885		
	Total	176,123	51			
a. Dependent Variable: the level of ice hockey skill acquisition						
b. Predictors: (Constant), Routine with a stick, Flexed arm hang, Sit and Reach, Illinois Agility test, Standing long jump, Sit-ups, Shuttle run, Flag tag game						

Our model reaches statistical significance (Sig = 0,000, this means p<0,0005).

Table 33: Model Summary[b] (Ice hockey)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,742[a]	0,550	0,454	1,37298
a. Predictors: (Constant), Routine with gym stick, Rolling three balls, Long jump from a spot, Stamina in pull-up, Illinois Agility test, Sit-ups, Sit and Reach, Shuttle run, Flag tag game				
b. Dependent Variable: the level of ice hockey skill acquisition				

The adjusted R square value of 0,454 indicates that multilateral development indicators predict almost half of the variability in the level of ice hockey skill acquisition. In other words, our model, which includes nine multilateral development indicators (Routine with a stick, Flexed arm hang, Rolling three balls, Sit and Reach, Illinois Agility test, Standing long jump, Sit-ups, Shuttle run and Flag tag game) explains 45,4 percent of the variance in the level of ice hockey skill acquisition.

Table 34: Coefficients[a] (Ice hockey)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	0,419	4,976		0,084	0,933			
	Routine with stick	-0,026	0,022	-0,142	-1,187	0,242	-0,370	-0,180	-0,123
	Flexed arm hang	0,045	0,060	0,097	0,747	0,459	0,470	0,115	0,077
	Rolling 3 balls	-0,050	0,025	**-0,254**	-1,970	**0,055**	-0,505	-0,291	-0,204
	Sit and Reach	-0,036	0,059	-0,074	-0,609	0,546	-0,149	-0,094	-0,063
	Illinois Agility test	-0,058	0,091	-0,077	-0,639	0,526	-0,289	-0,098	-0,066
	Standing long jump	0,034	0,016	**0,294**	2,082	**0,043**	0,589	0,306	0,215
	Situps	0,002	0,059	0,004	0,033	0,974	0,413	0,005	0,003
	Shuttle run	0,001	0,004	0,024	0,156	0,877	0,470	0,024	0,016
	Flag tag game	0,117	0,060	**0,242**	1,945	**0,058**	0,434	0,287	0,201

a. Dependent Variable: the level of ice hockey skill acquisition

Suppose we want to know which multilateral development indicators contributed to predicting the dependent variable (the level of ice hockey skill acquisition). In that case, we have to look in the output box labelled Coefficients in Table 34 above.

Of these nine multilateral development indicators, Standing long jump (Beta value = 0,294), Rolling three balls (Beta value = -0,254) and Flag tag game (Beta value = 0,242) make the most considerable unique contribution to explaining the dependent variable (the level of ice hockey skill acquisition). The Beta value for the other indicators is slightly lower, indicating that they made less contribution. However, only the indicator Standing long jump makes a statistically significant contribution to the equation.

Part correlation coefficient tells us how much of the total variance in the dependent variable is uniquely explained by that variable and how much R squared would drop if we did not include this variable in our model. For example, the indicator Standing long jump has a part correlation coefficient of 0,215. If we square this, we get 0,046. It means that this indicator uniquely explains 4,6 percent of the variance in the level of ice hockey skill acquisition. For the Flag tag game, the value is 0,201, which squared gives us 0,040, indicating a unique contribution of 4 percent to explaining variance in the level of ice hockey skill acquisition.

We can summarize that the standard multiple regression results presented above allow us to answer two methodology questions. Our model, which includes nine multilateral development indicators, explains 45,4 percent of the variance in the level of ice hockey skill acquisition. Indicator Standing long jump, indicator Flag tag game, and indicator Rolling three balls make the most considerable unique contribution. In other words, these indicators are the best predictors of better ice hockey skill acquisition.

5. 3. 3 Variance in the level of athletic skill acquisition explained by multilateral development indicators

Also, in athletics, we performed a standard multiple regression between multilateral development indicators as independent variables and the level of athletic skill acquisition as a dependent variable.

Table 35: ANOVA[a] (Athletics)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	149,648	9	16,628	6,303	,000[b]
	Residual	50,120	19	2,638		
	Total	199,768	28			
a. Dependent Variable: the level of athletic skill acquisition						
b. Predictors: (Constant), Routine with gym stick, Flexed arm hang, Sit and Reach, Illinois Agility test, Standing long jump, Sit-ups, Shuttle run, Flag tag game						

Like in ice hockey, our model reaches statistical significance (Sig = 0,000, this means p<0,0005).

Table 36: Model Summary[b] (Athletics)

Model	R	R square	Adjusted R square	Std. Error of the Estimate
1	0,866[a]	0,749	0,630	1,62416
a. Predictors: (Constant), Routine with gym stick, Flexed arm hang, Sit and Reach, Illinois Agility test, Standing long jump, Sit-ups, Shuttle run, Flag tag game				
b. Dependent Variable: the level of athletic skill acquisition				

The adjusted R square value of 0,630 indicates that more than half of the variability in the level of athletic skill acquisition is predicted by multilateral development indicators. In other words, our model explains 63 percent of the variance in athletic skill acquisition.

Table 37: Coefficients (Athletics)

Model		Unstandardized Coefficients		Standardized Coefficients			Correlations		
		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part
1	(Constant)	-0,191	6,025		-0,032	0,975			
	Routine with a stick	-0,123	0,050	**-0,387**	-2,468	**0,023**	-0,531	-0,493	-0,284
	Flexed arm hang	0,094	0,077	0,194	1,222	0,237	0,571	0,270	0,140
	Rolling three balls	-0,155	0,072	**-0,294**	-2,156	**0,044**	-0,357	-0,443	-0,248
	Sit and Reach	0,051	0,073	0,097	0,706	0,489	0,480	0,160	0,081
	Illinois Agility test	-0,178	0,208	-0,121	-0,855	0,403	-0,450	-0,193	-0,098
	Standing long jump	0,056	0,023	**0,424**	2,415	**0,026**	0,698	0,485	0,278
	Situps	-0,006	0,107	-0,010	-0,056	0,956	0,349	-0,013	-0,006
	Shuttle run	0,007	0,004	0,261	1,464	0,159	-0,055	0,318	0,168
	Flag tag game	-0,110	0,095	-0,174	-1,149	0,265	0,295	-0,255	-0,132

a. Dependent Variable: the level of athletic skill acquisition

Of these nine multilateral development indicators, indicator Standing long jump (Beta value = 0,424), indicator Routine with a stick (Beta value = -0,387) and indicator Rolling three balls (Beta value = -0,294) make the largest unique and statistically significant contribution.

Also, indicator Shuttle run (Beta value = 0,261) makes large contribution. However, this result is not statistically significant. Beta values for the other indicators are lower and are not significant.

According to Part Correlations, the indicator Standing long jump and indicator Routine with a stick explain about 8 percent of the variance in the level of athletic skill acquisition. The indicator Rolling three balls explains about 6 percent of the variance in the level of athletic skill acquisition.

In summary, our model, which includes nine multilateral development indicators, explains 63 percent of the variance in the level of athletic skill acquisition. Of these nine indicators, indicator Standing long jump, indicator Routine with a stick and indicator Rolling three balls are the best predictors of better athletic skill acquisition.

5. 3. 4 The relationship between multilateral development indicators and specific sport skills

We performed a canonical correlation analysis between multilateral development indicators and selected ice hockey (or athletic) skills to determine the relationship between these two sets of variables.

Canonical correlation analysis aims to find pairs of linear combinations of each set of highly correlated variables. These linear combinations are called canonical variates.

The set of multilateral development variables included Routine with a stick, Flexed arm hang, Rolling three balls, Sit and reach, Illinois Agility test, Standing long jump, Sit-ups, Shuttle run and Flag tag game. The set of ice hockey skills variables included Passing, Shooting and Stickhandling. The set of athletic skills had Long jump, Overarm throw and 50 m sprint. Find descriptive statistics for the multilateral development indicators and specific sport skills in Appendix 11.

We utilized an alpha level of 0.05. According to Tabachnick, Fidel (2001), we used the cutoff correlations of 0.30 to interpret the canonical variates. Assumptions for normality, linearity, and homoscedasticity were evaluated through scatterplot distributions; assumptions were met, and no multivariate outliers were detected. However, one child from the athletic sample was eliminated due to extreme points in five multilateral development indicators.

In both sports, we found a statistically significant relationship between the set of multilateral development indicators and the set of specific sport skills.

Generally, results of canonical correlation indicate that our hypothesis is correct. The multilateral development indicators and specific sport skills in ice hockey and athletics are positively correlated.

Table 38: Canonical correlations (Ice hockey)

Root No.	Canon Cor.	Sq. Cor	Eigenvalue	Wilks Statistic	F	Num D.F	Denom D.F.	Sig. of F
1	**0,726**	**0,527**	**1,113**	**0,302**	**2,311**	**27**	**123,304**	**0,001**
2	0,479	0,230	0,298	0,639	1,349	16	86	0,187
3	0,413	0,170	0,206	0,830	1,292	7	44	0,277
H0 for Wilks test is that the correlations in the current and following rows are zero								

In ice hockey, the first canonical root is significant, $\lambda = 0.302$, $F(27, 123) = 2.311$, $p = 0.001$, accounting for 53 % ($r_c = 0.726$) of the overlapping variance. The second canonical root is not significant, $\lambda = 0.639$, $F(16, 86) = 1.349$, $p = 0.187$, $r_c = 0.479$. Also, the third canonical root is not significant, λ = 0.830, F (7, 44) = 1.292, p = 0.277, r_c = 0.413. Therefore, we interpret only the first canonical variant.

The canonical correlation of the first pair of the canonical variant in ice hockey is 0.726. The square of this canonical correlation represents the proportion of the variance in one group's variate explained by the other group's variate. In this case, the squared correlation is 0.527. It means that the variables that we included in the analysis explain about 53% of the relationship between the multilateral development indicators and ice hockey skills.

Table 39: Canonical correlations (Athletics)

Root No.	Canon Cor.	Sq. Cor	Eigenvalue	Wilks Statistic	F	Num D.F	Denom D.F.	Sig. of F
1	**0,901**	**0,812**	**4,311**	**0,113**	**2,190**	**27,000**	**53,212**	**0,007**
2	0,503	0,253	0,338	0,599	0,694	16,000	38,000	0,781
3	0,446	0,199	0,248	0,801	0,708	7,000	20,000	0,665
H0 for Wilks test is that the correlations in the current and following rows are zero								

Similarly, in athletics only the first canonical root is significant, λ = 0.113, F (27,53) = 2.190, p = 0.007, accounting for 82% (r_c = 0.901) of the overlaping variance. Therefore, we interpret only the first canonical variant also in athletics.

The set of multilateral development indicators and the set of athletic skills are positively correlated (Canon Cor. = 0.901). The squared correlation is even higher (Sq. Cor = 0.812) than in ice hockey. Variables that we included in the analysis explained 82% of the relationship between the multilateral development indicators and athletic skills.

Table 40: Correlations and Standardized Canonical Variate Coefficients on the Multilateral development indicators and Ice hockey skills for the First Canonical Variate

Multilateral development indicators	***COR***	***COE***
Routine with a stick	0,124	0,095
Flexed arm hang	0,569	0,069
Rolling three balls	0,687	0,273
Sit and reach	-0,065	0,016
Agility Illinois test	0,379	0,122
Standing long jump	0,821	0,548
Sit-ups	0,600	0,098
Shuttle run	0,673	0,042
Flag tag game	0,565	0,358
Ice hockey skills		
Passing	0,766	0,550
Shooting	0,376	0,205
Stickhandling	0,815	0,615

The first part of Table 40 above presents the correlations between each variable in a group and the first group's canonical variate.

In ice hockey, we can see in the "dependent" variables that the strongest relationship with the first canonical variate has these indicators: Standing long jump, Rolling three balls, Shuttle run, Sit-ups, and Flexed arm hang. Interestingly, there is no relationship between the indicator Sit and Reach and the first canonical variate.

The second part of Table 40 above presents correlations between ice hockey skills (covariates) and canonical variates. Each ice hockey skill test correlates positively with the first canonical variate. However, the test Stickhandling and the test Passing relate most of all three skills. The skill Shooting correlates only moderately with the first canonical variate, which is probably caused by its low reliability. The test Shooting was the most difficult for children to understand. Although coaches demonstrated the test to children several times, children often confused the direction of movement.

The third column in Table 40, named COE, presents standardized canonical coefficients. If all of the variables in the analysis are rescaled to have a mean of zero and a standard deviation of 1, the coefficients generating the canonical variates would indicate how a one standard deviation increase in the variable would change the variate.

For example, an increase of one standard deviation in the Standing long jump would lead to a 0.548 standard deviation increase in the multilateral development measurements' first variate. An increase of one standard deviation in Stickhandling would lead to a 0.615 standard deviation increase in the first variate of the ice hockey skill acquisition measurement.

Table 41: Correlations and Standardized Canonical Variate Coefficients on the Multilateral development indicators and Athletic skills for the First Canonical Variate

Multilateral development indicators	***COR***	***COE***
Routine with a stick	0,581	0,446
Flexed arm hang	0,577	0,055
Rolling three balls	0,411	0,316
Sit and reach	0,510	0,086
Agility Illinois test	0,511	0,228
Standing long jump	0,811	0,598
Sit-ups	0,416	-0,009
Shuttle run	-0,048	0,273
Flag tag game	0,282	-0,176
Athletic skills		
Long jump	0,823	0,377
Overarm throw	0,951	0,702
50 m sprint	0,759	0,030

In athletics, the strongest relationship with the first canonical variate have these indicators: Standing long jump, Routine with a stick, Flexed arm hang and Agility Illinois test. Interestingly, in contrast to the ice hockey indicator Sit and reach is in athletics moderately correlated with the first canonical variate. There is almost no relationship between Shuttle run and the first canonical variate.

In terms of athletic skill tests, each skill strongly correlates with the first canonical variate. The Overarm throw and Long jump correlate most strongly. 50 m sprint has the lowest correlation value.

6 DISCUSSION

Although we found significant differences in some multilateral development indicators between athletes and ice hockey players and also between boys and girls, effect sizes in these indicators were small, rarely medium. We can justify this finding as follows. To start with, children included in our sample have just begun with organized sports training. Therefore, their level of multilateral development is not significantly affected by sports training.

Secondly, we assume that the biological age of the selected children is at approximately the same level. It means that our sample's sports performance is not affected by biological maturation because biological acceleration or retardation begins to manifest only with the onset of puberty when a range of hormonal changes occur. It is a process that usually happens between ages 10 and 14 for girls and ages 12 and 16 for boys. Until this time, the children's biological development proceeds at about the same rate in boys and girls (Pearson, Naughton, Torode, 2006). The children in our sample were six to seven years old at the time of multilateral development measurement and seven to eight years old at the time of specific sport skill acquisition assessment.

However, the only large effect size was found in the indicator Routine with a stick between athletes and ice hockey players. On average, girls performed better in this indicator than boys. Therefore, we suggest that this difference was caused by a larger number of girls in the athletic sample.

Exploratory factor analysis revealed a four-factor structure in the multilateral development set of indicators. The first four factors explain 65.55 percent of the variance in the set of multilateral development indicators. Factor 2 represents power and strength predispositions, Factor 3 represents running skills, and Factor 4 represents flexibility predispositions. The indicators Shuttle run, Sit-ups, and Rolling three balls have a strong loading on Factor 1. Although the Shuttle run and Sit-ups indicators have common endurance predispositions, it is more difficult to name this factor because it is not entirely clear how the Rolling three balls indicator is related to them.

Using multiple regression analysis, we have found that almost half of the variability in the level of specific sport skill acquisition in ice hockey is predicted by multilateral development indicators. The most considerable unique contribution to explaining ice hockey skill acquisition has the Standing long jump, which evaluates explosive power of the lower limbs. This finding is consistent with the research which confirms that explosive power of the lower limbs is a limiting factor of skating performance (e.g. Blanár, Brodani et al., 2019).

The second-largest contribution to explaining the level of ice hockey skill acquisition has the Rolling three balls indicator that evaluates predispositions for manipulating objects. Specifically, the test assesses what is known as hand-eye coordination, which plays a necessary part, for example, in deflecting shots and knocking down high passes to control the puck or help a goalie make a glove save.

The third-largest unique contribution to explaining ice hockey skill acquisition has the Flag tag game indicator, which evaluates decision-making processes. Although it may seem that these predispositions in selected ice hockey skill tests were not necessary, the opposite is true. Children who understood the rules of the Flag tag game faster also understood the rules and the technical execution of individual ice hockey skill tests more quickly.

In athletics, more than half of the variability in the level of athletic skill acquisition is predicted by multilateral development indicators. The Standing long jump also makes the most considerable contribution to explaining the athletic skill acquisition level. As in ice hockey, the explosive power of the lower limbs is limiting factor of sports performance in many athletic disciplines, including overarm throw, long jump, and sprint.

The indicator Routine with a stick makes the second-largest contribution to explaining the level of athletic skill acquisition. Surprisingly, in ice hockey, this indicator has almost no contribution to explaining the level of ice hockey skill acquisition.

We claim that the Routine with a stick indicator is a non-specific coordination test, in contrast with the Rolling three balls indicator, which is a rather specific coordination test that focuses on hand-eye coordination. Therefore, we conclude that specific coordination is more critical than non-specific coordination in ice hockey, and the other way round in athletics. However, the Rolling three balls indicator is one of the best predictors of better skill acquisition also in athletics. Interestingly, the Flag tag game indicator does not make a significant contribution to explaining athletic skill acquisition. It is perhaps because athletics is not as demanding in terms of decision-making processes as ice hockey.

Canonical correlation has showed that there is a large positive canonical correlation between the set of multilateral development indicators and the set of specific sport skills in athletics and ice hockey. It indicates that our first hypothesis is correct, meaning that there is a strong positive relationship between multilateral development and specific sport skill acquisition in both selected sports. We confirm a close connection between non-specific motor tests (multilateral development indicators) and specific motor tests (specific sport skills) in middle childhood in athletics and ice hockey.

In practice, there is a high probability that children who have a higher level of multilateral development will also have a higher level of specific sport skill acquisition, and vice versa. In other words, children with a higher level of multilateral development acquire specific sports skills more efficiently than children with a lower level of multilateral development.

Interestingly, the canonical correlation in athletics is higher (canon. cor. = 0.901) than in ice hockey (canon. cor. = 0.726). This finding is consistent with the multiple regression results that have revealed that the percentage of variance explained by multilateral development indicators is also larger in athletics than in ice hockey.

We suggest that the stronger relationship between multilateral development and specific sport skill acquisition in athletics can be caused by greater non-specificity of athletic skills and also by the nature of children's sports training in athletics.

In several respects, children's sports training in athletics is more non-specific than that in ice hockey. For example, most athletic disciplines are based on the natural movements that each child in middle childhood has already mastered at a certain level (e.g. running, jumping, throwing). In contrast, ice hockey skills are based on movements that are not part of everyday life. For example, it is not a matter of course that everyone can skate. Therefore, due to the greater non-specificity of athletic skills, there is a better connection between athletic skills and the set of multilateral development indicators selected to be as nonspecific as possible for any particular sport.

Secondly, when coaching children in athletics, coaches teach athletic disciplines that are more diverse in terms of the required amount and nature of motor skills (e.g. overarm throw versus long jump) compared to ice hockey positions, where skills are more intertwined (e.g. right-wing position versus left-wing position).

Additionally, ice hockey coaches know more precisely than coaches in athletics what kind of movement skills and movement abilities the child will need as a future top ice hockey player. In athletics, there is a broader spectrum of disciplines with different movement requirements. For example, in an eight-year-old child, we do not know whether he or she will engage in sprints, long jump, or javelin throw in the future. While in ice hockey, we know more accurately what skills the child needs to practice because we already know that the child will play ice hockey.

Also, ice hockey practices and matches take place in one particular environment, i.e. at an ice hockey stadium, where the temperature and ice surface are still the same. In contrast, athletics is mainly an outdoor sport. Athletic training and competitions take place mostly outside, where athletes have to adapt to varying weather conditions (for example rain or wind).

Our findings align with the literature that identifies ice hockey and athletics as late specialization sports because peak performance is usually reached after maturation. Therefore, the importance of multilateral development is relevant to these sports.

However, as coaches, we must realize that it is up to the coach to decide whether to advocate early sport specialization or developmentally appropriate training, whether it is late specialization sport or early specialization sport. In other words, these approaches can be applied in both early specialization sports and late specialization sports.

Nevertheless, in practice, these two approaches often intersect. Therefore, a "black-and-white" thinking about this topic is not appropriate. For example, Armand Duplantis, an American-born Swedish pole vaulter and the current world record holder, first began pole vaulting when he was four. However, he also practiced other sports during his childhood. Can we decide whether this athlete specialized early or not? We cannot really answer this question. In this example, we see that the characteristics of early specialization and developmentally appropriate training often overlap.

It is also necessary to discuss the limits of this dissertation and the problems we dealt with during the testing sessions. As we mentioned in the theoretical part, multilateral development in long-term athlete development is not precisely defined. There is no generally accepted definition of multilateral development in sport. Moreover, researchers use different terms for this concept, and also coaches have different opinions on multilateral development in sport.

In terms of the selected indicators of multilateral development, experts may argue that in the set of indicators for multilateral development evaluation, there are no indicators to assess movement skills. This objection begs the following question. What movement skills or sports skills should we choose when there is such an enormous number of them? On the other hand, we cannot claim that the selected multilateral development indicators do not contain any movement skills.

In terms of evaluating specific sport skill acquisition, we used product-oriented measures that focus on the outcomes of the movement performed (e.g. velocity, distance). However, we are aware that process-oriented measures, which assess the quality of movements performed (selected skills), would probably be more accurate, especially in athletics, where each discipline often has one model technique, which athletes try to emulate. In ice hockey, process-oriented measures of selected skills would be more challenging to implement, as there are more options on how to perform given skills technically correctly.

Regarding sampling, our non-probability sample may not represent the population well. Therefore, we cannot generalize the results to the whole population. We did not make a random selection mainly due to the practical limitation of the sports facilities available to the participating sports clubs. To ensure standard test conditions, we performed the testing sessions indoors only. Due to the number and nature of tests, we needed a gym with appropriate dimensions (a minimum length of 24 meters and a width of 12 meters). Unfortunately, not every ice hockey club or athletic club in the Czech Republic has a gym with these dimensions. Hence, we had to select ice hockey clubs and athletic clubs which had a gym with the required dimensions available.

The next aspect to consider is the research design. We measured the “initial” level of multilateral development, and a year later, we assessed specific sport skills. We examined how this “initial” level of multilateral development affected skill acquisition a year later. However, it would be interesting to measure multilateral development and assess specific sport skills every year and for a period longer than two years. In this way, we could see how specific sport skill acquisition changes, depending on multilateral development changes over time. However, this research design would exceed the time required to complete doctoral studies.

Another consideration that must be mentioned is the sports background and upbringing of the participating children. We are aware that the environment the child comes from can significantly affect the results of testing. Therefore, we investigated the sports background of the children using non-standardized questionnaires that we distributed to the parents. Thanks to this measure, we were able to make sure that our sample of children came from similar sports environments, and that their results were comparable with each other. However, there is still room for improvement in this regard. It would be interesting to focus on a similar research in qualitative terms. It means that it would be valuable to find out more detailed information about the sports training, sports background, and upbringing of the participating children and to examine how these factors affect their multilateral development in sport.

In conclusion, it must be said that every research has some limits, and there is always room for improvement in this regard. Moreover, thanks to these limits, there are other future research ideas mentioned in the previous paragraph. We believe this dissertation will inspire other students interested in this topic and would like to research it.

7 CONCLUSION

This work aimed to investigate the relationship between multilateral development and specific sport skill acquisition in middle childhood. For these purposes, we chose two sports characterized as late specialization sports because peak performance is usually achieved after full maturation. It is ice hockey and athletics.

Firstly, in the theoretical background, we defined two basic approaches to long-term athlete development and presented an overview of the most frequently mentioned pros and cons of these two approaches. Secondly, we defined multilateral development in children's sports training and emphasized its potential benefits. Also, we devoted one chapter to the characteristics of middle childhood. Besides, we included a chapter about the theory of general motor ability, which we verified in the results of our research.

Based on a study by Perič and Ružbarský (2019), we selected nine indicators for assessing multilateral development. Then, we selected three ice hockey skills and three athletic skills that children acquire in middle childhood in these sports. We chose these specific sport skills mainly with regard to the age of the children participating in our research.

During the four years of research, we managed to measure the multilateral development of 172 children, specifically children from two athletic clubs and three ice hockey clubs. One year later, we evaluated the level of ice hockey skill acquisition or athletic skill acquisition in these same children.

Unfortunately, the dropout rate in both sports was relatively high. Almost 60 percent of children from the athletic sample did not participate in the second phase of the research. In ice hockey, 51 percent of children did not participate in the second phase of the research.

Pearson correlation analysis confirmed the independence of multilateral development indicators. The strength of the relationship between most selected indicators was small (up to 0.3), and there was no large correlation between indicators. Additionally, partial correlation analysis showed that the observed relationship between multilateral development indicators is not due merely to the influence of body height and body weight. This analysis confirms the expert commission's intention to select such multilateral development indicators that evaluate a wide range of physical activities (i.e. wide range of movement abilities and skills).

In ice hockey, almost a half of the variability in the level of specific sport skill acquisition was predicted by multilateral development indicators. In athletics, even more than a half of the variability in the level of athletic sport skill acquisition score was predicted by multilateral development indicators. In both selected sports, the best predictor of a higher level of specific skill acquisition at a later age was the Standing long jump and also the Rolling three balls indicator. Therefore, we can claim that explosive power of the lower limbs and coordination, specifically hand-eye coordination, are essential motor abilities for skill acquisition in these two sports.

Using canonical correlation analysis, we found a positive relationship between multilateral development and specific sport skill acquisition in ice hockey and athletics. In ice hockey, the variables that we included in the analysis explained about 53 percent of the relationship between multilateral development and ice hockey skill acquisition. In athletics, the canonical correlation was even higher. Variables that we included in the analysis explained about 82 percent of the relationship between multilateral development and athletic skill acquisition.

The results of this research indicate that our initial hypothesis was correct. There is a strong positive relationship between multilateral development and specific sport skill acquisition in both selected sports.

In other words, this dissertation confirms the importance of multilateral development in children's sports training for specific sport skill acquisition later. Specifically, there is a high probability that six- to seven-year-old children with a higher level of multilateral development will acquire specific sports skills easily or faster than children with a lower level of multilateral development.

Also, we partially confirm our second hypothesis. Multilateral development indicators explain more than 60 percent of the variance in the level of athletic skill acquisition. However, in ice hockey is this percentage lower.

Similarly, the third hypothesis is partially correct. In both sports, the second-best predictor of better skill acquisition was an indicator that assessed coordination predispositions. Specifically, in ice hockey, it was the indicator Rolling three balls, and in athletics, it was the indicator Routine with a stick. However, in both sports, the best predictor of better specific sport skill acquisition was the indicator Standing long jump that evaluates lower limbs' explosive power.

Unfortunately, we did not confirm hypothesis number four. Our „model“ for multilateral development evaluation does not provide evidence to support the general motor ability concept.

In conclusion, we should emphasize that developmentally appropriate training (which is characterized by multilateral development in early stages of athlete development) is applicable in sports for which it is typical to achieve elite sports performance after maturation (that is, in late specialization sports). Still, this approach can also be suitable in sports where peak performance is achieved typically before maturation (in early specialization sports).

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List of attachments

Appendix 1: The original of the confirmed form by the Ethical Committee of Charles University FTVS

Žádost o vyjádření Etické komise UK FTVS

k projektu výzkumné, kvalifikační či seminární práce zahrnující lidské účastníky

Název projektu: Vztah mezi úrovní všestrannosti a osvojováním specifických sportovních dovedností u dětí v mladším školním věku

Forma projektu: výzkumná práce - doktorská práce

Období realizace: březen 2018 – květen 2021

Předkladatel: Mgr. Linda Komínková, Katedra pedagogiky, psychologie a didaktiky UK FTVS

Hlavní řešitel: Mgr. Linda Komínková, Katedra pedagogiky, psychologie a didaktiky UK FTVS

Místo výzkumu (pracoviště): Katedra pedagogiky, psychologie a didaktiky UK FTVS

Vedoucí práce (v případě studentské práce): doc. PaedDr. Tomáš Perič, Ph.D

Finanční podpora: o finanční podporu tohoto projektu požádáme Grantovou agenturu UK (GAUK)

Popis projektu: Cílem projektu bude zjistit, jaký je vztah mezi úrovní všestrannosti a osvojováním specifických sportovních dovedností u dětí v atletice a hokeji. Úroveň všestrannosti budeme hodnotit pomocí indikátorů (testů), které budou testovat oblast předpokladů kondičních, taktických a manipulačních. Jedná se o tyto testy: Sestava s tyčí, Výdrž ve shybu, Vytrvalostní člunkový běh, Hluboký předklon, Illinois agility test, Skok daleký z místa, Sedy-lehy, Manipulace a Vlajková honička. Osvojování specifických sportovních dovedností budeme hodnotit pomocí specifických indikátorů (testů), které vybereme na základě metody dotazování a interwiev s experty vybraných sportovních odvětví. Vztah mezi úrovní všestrannosti a osvojováním specifických sportovních dovedností vyhodnotíme pomocí mnohonásobné a kánonické korelace. Děti budeme testovat ve věku 7-8 let, 8-9 let a 9-10 let. Bude se jednat o longitudinální výzkum.
Charakteristika účastníků výzkumu: Výzkumný soubor budou tvořit děti mladšího školního věku. Z každého vybraného sportovního odvětví budeme testovat 50 dětí. Testu se nebudou účastnit děti, které jsou aktuálně nemocné nebo mají jakoukoli jinou zdravotní překážku, která jim brání zúčastnit se testování. V případě jakékoli kontraindikace některého z účastníků k absolvování testu, účastník nebude součástí výzkumu.
Zajištění bezpečnosti: Jedná se o neinvazivní metodu. Zdravotní riziko je minimální. Děti budou provádět standardizované motorické testy. U testování budou přítomni odborní pedagogičtí pracovníci se znalostmi o první pomoci. Provádění testování a bezpečnost dětí bude zajištěna hlavním řešitelem práce, trenéry a pomocníky při testování.
Etické aspekty výzkumu: Výsledky výzkumu obohatí teorii sportovní přípravy dětí ve vybraných sportovních odvětvích. Výzkum zahrnuje vulnerabilní skupinu nezletilých osob, protože se tento projekt zaměřuje přímo na problematiku sportovní přípravy dětí. Pro zajištění relevantních výsledků je tedy nezbytné, aby se výzkumu účastnila vulnerabilní skupina nezletilých osob, a to právě děti mladšího školního věku. Přínosem tohoto výzkumu pro dítě bude zjištění úrovně jeho všestrannosti, později posouzení a odborné zhodnocení úrovně sportovních dovedností v daném sportovním odvětví a po zpracování výsledků vyplynou individuální doporučení pro sportovní přípravu a sportovní kariéru dítěte. Získaná data budou zpracovávána a bezpečně uchována v anonymní podobě a publikována v disertační práci, případně v odborných časopisech, monografiích a prezentována na konferencích, případně budou využita při další výzkumné práci na UK FTVS. Po anonymizaci budou osobní data smazána. V maximální možné míře zajistím, aby získaná data nebyla zneužita.
Informovaný souhlas: přiložen

Povinností **všech účastníků výzkumu na straně řešitele** je chránit život, zdraví, důstojnost, integritu, právo na sebeurčení, soukromí a osobní data zkoumaných subjektů, a podniknout k tomu veškerá preventivní opatření. Odpovědnost za ochranu zkoumaných subjektů leží vždy na účastnících výzkumu na straně řešitele, nikdy na zkoumaných, byť dali svůj souhlas k účasti na výzkumu. Všichni účastníci výzkumu na straně řešitele musí brát v potaz etické, právní a regulační normy a standardy výzkumu na lidských subjektech, které platí v České republice, stejně jako ty, jež platí mezinárodně.
Potvrzuji, že tento popis projektu odpovídá návrhu realizace projektu a že při jakékoli změně projektu, zejména použitých metod, zašlu Etické komisi UK FTVS revidovanou žádost.

V Praze dne: 9.11. 2017

Podpis předkladatele: Komínková Linda

Vyjádření Etické komise UK FTVS

Složení komise: **Předsedkyně:** doc. PhDr. Irena Parry Martínková, Ph.D.
Členové: prof. PhDr. Pavel Slepička, DrSc.
doc. MUDr. Jan Heller, CSc.
PhDr. Pavel Hráský, Ph.D.
Mgr. Eva Prokešová, Ph.D.
MUDr. Simona Majorová

Projekt práce byl schválen Etickou komisí UK FTVS pod jednacím číslem: 198/2017

dne: 14. 11. 2017

Etická komise UK FTVS zhodnotila předložený projekt a **neshledala žádné rozpory** s platnými zásadami, předpisy a mezinárodní směrnicemi pro provádění výzkumu zahrnujícího lidské účastníky.

Řešitel projektu splnil podmínky nutné k získání souhlasu Etické komise.

UNIVERZITA KARLOVA
Fakulta tělesné výchovy a sportu
José Martího 31, 162 52, Praha 6

razítko UK FTVS

podpis předsedkyně EK UK FTVS

Appendix 2: An institutional review board-approved informed consent document

Vážený pane, vážená paní,

v souladu se Všeobecnou deklarací lidských práv, zákonem č. 101/2000 Sb., o ochraně osobních údajů a o změně některých zákonů, ve znění pozdějších předpisů a dalšími obecně závaznými právními předpisy *(jakož jsou zejména Helsinská deklarace, přijatá 18. Světovým zdravotnickým shromážděním v roce 1964 ve znění pozdějších změn (Fortaleza, Brazílie, 2013); Zákon o zdravotních službách a podmínkách jejich poskytování (zejména ustanovení § 28 odst. 1 zákona č. 372/2011 Sb.) a Úmluva o lidských právech a biomedicíně č. 96/2001, jsou-li aplikovatelné),* Vás žádám o souhlas s účast Vaší dcery/Vašeho syna ve výzkumném projektu v rámci disertační práce s názvem Vztah mezi úrovní všestrannosti a zvládáním specifických sportovních dovedností u dětí ve vybraných sportovních odvětvích prováděné na Fakultě tělesné výchovy a sportu Univerzity Karlovy.

1. projekt bude financován Grantovou agenturou Univerzity Karlovy,
2. cílem práce je zjistit, jaký je vztah mezi úrovní všestrannosti a osvojováním specifických sportovních dovedností u dětí ve vybraných sportovních odvětvích,
3. pro posouzení úrovně všestrannosti budeme používat standardizované motorické testy hodnotící kondiční, technické a taktické předpoklady. Jedná se o tyto testy: Sestava s tyčí, Výdrž ve shybu, Vytrvalostní člunkový běh, Hluboký předklon, Illinois Agility test, Skok daleký z místa, Sedy-lehy, Manipulace a Vlajková honička. Úroveň osvojování specifických sportovních dovedností budeme hodnotit na základě hodnocení techniky a také na základě výsledků v jednotlivých specifických sportovních dovednostech,
4. děti budou testovány v rámci tréninkové jednotky,
5. zdravotní rizika výzkumného projektu jsou minimální, jednotlivé testy pro posouzení úrovně všestrannosti jsou neinvazivní a bezbolestné, od dětí vyžadují pouze fyzické úsilí, které může být doprovázeno subjektivně nepříjemnými pocity. Rizika prováděného výzkumu nebudou vyšší než běžně očekávaná rizika u aktivit a testování prováděných v rámci tohoto typu výzkumu,
6. výzkumný projekt obohatí teorii sportovní přípravy dětí ve vybraných sportovních odvětvích,
7. Vaše účast v projektu nebude finančně ohodnocená,
8. získaná data budou zpracovávána a bezpečně uchovaná v anonymní podobě a publikovaná v doktorské, práci, případně v odborných časopisech, monografiích a na konferencích, případně budou využitá při další výzkumné práci na UK FTVS. Po anonymizaci budou osobní data smazána,
9. pokud budete mít zájem o seznámení se s celkovými výsledky a závěry výzkumného projektu a o způsobu jejich zveřejnění, kontaktujte mne na emailové adrese Lindass@seznam.cz,
10. v maximální možné míře zajistím, aby získaná data nebyla zneužita.

Jméno a příjmení předkladatele a hlavního řešitele projektu:……………Podpis:.............................
Jméno a příjmení osoby, která provedla poučení: ……………………… Podpis:.............................

Prohlašuji a svým níže uvedeným vlastnoručním podpisem potvrzuji, že dobrovolně souhlasím s účastí ve výše uvedeném projektu a že jsem měl(a) možnost si řádně a v dostatečném čase zvážit všechny relevantní informace o výzkumu, zeptat se na vše podstatné týkající se účasti ve výzkumu a že jsem dostal(a) jasné a srozumitelné odpovědi na své dotazy. Byl(a) jsem poučen(a) o právu odmítnout účast ve výzkumném projektu nebo svůj souhlas kdykoli odvolat bez represí, a to písemně Etické komisi UK FTVS, která bude následně informovat předkladatele projektu.

Místo, datum ....
Jméno a příjmení účastníka .... Podpis: ....
Jméno a příjmení zákonného zástupce ....
Vztah zákonného zástupce k účastníkovi .... Podpis: ....

Appendix 3: Description and evaluation of selected multilateral development indicators

Iindicator: Routine with a stick (adapted from Měkota, Blahuš, 1983)

Description:

Indicator Routine with a stick evaluates coordination predispositions.

Performance:

Child stands and holds the stick straight down at the back (held at the edges). At the command, the child overstep the stick. The stick gets forward, the child sits and lies on his/her back while both legs thread through above the stick, than gets up and straightens his/her trunk. Now the stick is straight down at the back again (held at the edges).
This described routine is repeated five times as quickly as possible. Reliability $r_{S\text{-}B}$=0,95

Equipment:

- mattress, stopwatches, stick

Indicator: Sit and reach (adapted from Měkota, Blahuš, 1983)

Description:

Test of active joint mobility, flexibility, and muscular elasticity, primarily focusing on the loin segment of the spine and the hip joint. Reliability r_{stab}=0,97 (Měkota, Blahuš, 1983).

Performance:

We begin with a explanation and a demonstration. The tested child is barefoot. The examiner check knee tension by touch. The child bends forward while sitting on the ground, legs are stretched in his/her knees, feet rest on firm support. Child reaches by fingers to a flat scale. At the level of the feet is the value 50 cm. With such a selected zero point, the results of all tested children will be positive. The greater the forward bend, the better the result.

Scoring:

The limit position in the forward bend must not be reached by hitting. only the touch in the position in which the endurance is possible (2 seconds) is valid. The test is repeated twice. The scoring is done in cm, and the better of the two trials is registered.

Equipment:

- mattress, the flat scale on which centimetres are marked

Indicator: Flexed-arm hang (adapted from Měkota, Kovář, 1995)

Description:

Test of the static, endurance-strength ability of upper extermities and shoulder muscles.

Equipment:

A round horizontal bar (2-4 cm diameter), to be reaching with a jump; chair, stopwatch.

Performance:

The subject, possibly with some assistance, takes the starting position – flexed-arm hang in a forward grip, the chin above the bar and the chest close to the bar. He tries to maintain this position as long as possible.

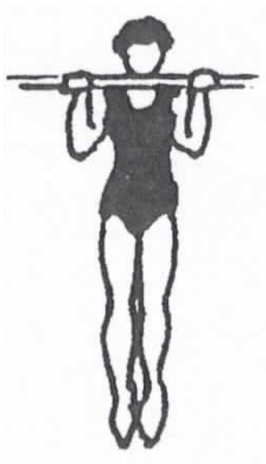


Figure 8: Flexed-arm hang (adapted from Měkota, Kovář, 1995)

Scoring:

- The length of time the subject holds the hanging position is measured. Accuracy of the scoring is within 1 second.

Directives:

- The starting position (flexed-arm hang, forward grip) is taken with sme assistance (use of chair, etc.), the feet must not touch the floor.
- The test ends when the (a) subject's chin drops below the bar level, (b) subject's chin touches the bar, (c) subject's head tilts backwards to keep her chin above the bar.

Indicator: Endurance shuttle run (maximal multistage 20-m shuttle run test) (adapted from Měkota, Kovář, 1995)

Description:

This is a test of prolonged running endurance ability. It is of a comprehensive and general character, and has close physiological links to the maximum aerobic performance and the cardio-respiratory fitness.

Equipment:

A running track and space large enough to mark out a run „from line to line“ over the 20-metre distance. A casette player powerful enough for group testing; a pre-recorded tape of the programme; a stopwatch, and a table for eventual corrections of the track length.

Performance:

The subject repeatedly runs along the 20-metre track „from line to line“ accroding to the sound signal emitted from the tape recorder. The aim is to make the subject move in the 20-metre-long track with progressively increasing speed, for as long as possible, while at each time signal he must reach one of the boarder lines of the 20-metre distance. The test ends when the subject failed, twice in succession, to reach the line in the set time limit; the maximum difference allowed is two steps. The pre-recorded tape contains, beside the signal for reaching the line, continuous information about the duration of the test.

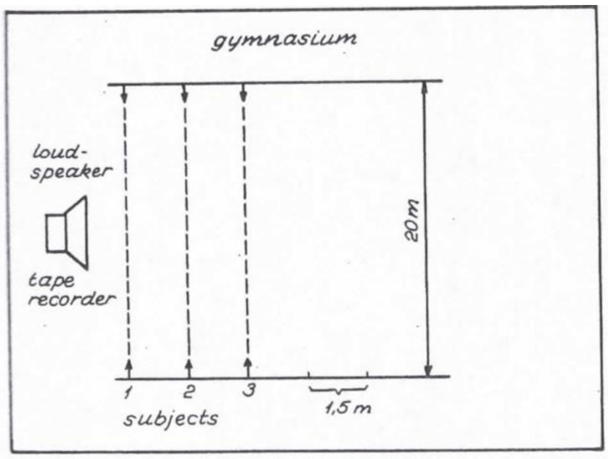


Figure 10: The track of endurance shuttle run (adapted from Měkota, Kovář, 1995)

Scoring:

The subject stops when he was unable, twice in sucession, to reach the line at the moment when the acoustic signal was sounded. The registered score is the last number announced from the tape – the duration of the run in minutes. The accuracy of the recording is within 0,5 minute.

Indicator: Illinois Agility test

Description:

Indicator Illinois Agility test is a commonly used agility test (Getchell, 1979) in sport. It monitors the agility development of an athlete.

Performance:

The field is 10 m long and 5 m wide. 2 cones are used to mark the start and finish and 2 are used as turning points. The other 4 cones are placed along the center at the same distance from each other (3.3 m). On command, the child takes off and runs as fast as possible, without overturning the cones. Reliability r = 0,94 – 0,99 (Raya, Gailey et al., 2013).

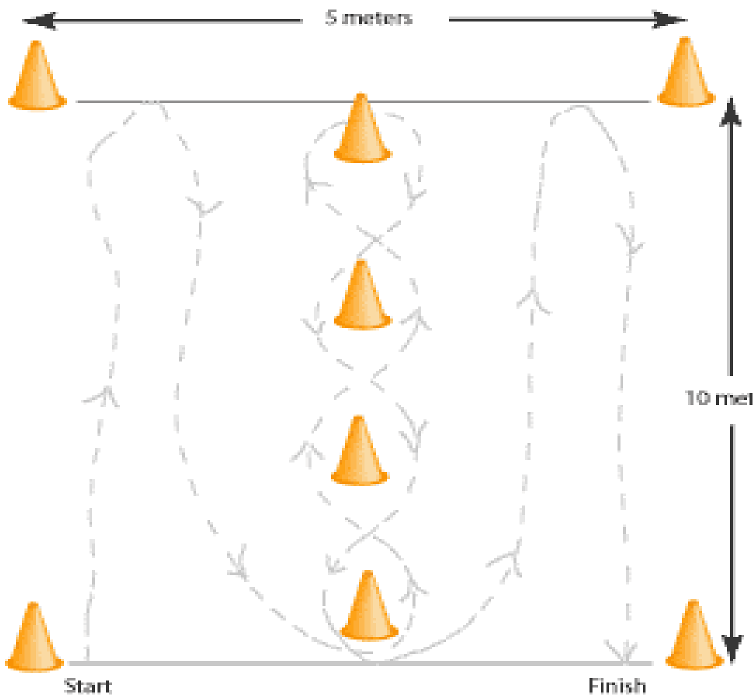


Figure 7: The track of Illinois Agility test (adapted from Acar, Eler, 2019)

Equipment:

- flat and non-slip surface, cones, stopwatch

Indicator: Standing long jump (adapted from Měkota, Kovář, 1995)

Description:

Test of the dynamic, explosive-strength ability of lower extermities. Reliability r = 0,93 (Měkota, Blahuš, 1983).

Equipment:

A flat, hard surface (mat, felt or plastic strip, landing area in the sportsground), a measuring tape.

Performance:

The subject stands with his feet apart (the normal distance), close to the take-off line (feet parallel, approximately at shoulder width). He bends his knees with his arms in front of him and as he swings both arms he pushes off vigorously and jumps as far as possible, with his feet together. Preparatory movements of arms and trunk are allowed, but no jump prior to the take-off is permitted. There are three trials.

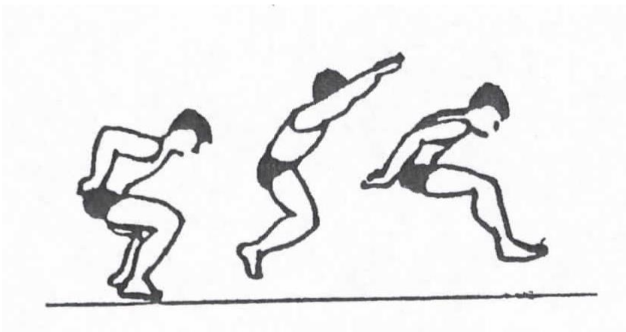


Figure 11: Standing long long jump (adapted from Měkota, Kovář, 1995)

Scoring:

The scoring is done in centimetres (cm), and the best of the three trials is registered. Accuracy of the score is within 1 cm.

Directives:

- The motor performance is explained or executed.
- The takke-off is on level, hard and non-slip surface; no support (e.g. on the hard edge of the landing area) and no spiked running shoes are allowed. The testee lands on sand, on a mat or a felt strip, which should be firmly fixed to the floor so that it cannot shift. Care must be taken so that takė-off and landing mats are on the same level approximately.
- The distance is measured from the takė-off line to the point where the back of the heel nearest to the takė-off lands on the mat (this holds for any other touch by an other part of the body than the foot, too).

Indicator: Sit-ups in 30 seconds (adapted from Měkota, Kovář, 1995)

Description:

Test of the dynamic, endurance-strength ability of abdominal muscles and loin-hip-thigh flexors. Reliability r = 0,8 (Měkota, Blahuš, 1983).

Equipment:

A felt strip, carpet ornonelastic gym mat, a stopwatch.

Performance:

The subject takes the starting position, lying on his back, his arms bent, his hands calsped behind the neck, with fingers folded, the elbows touching the mat. The knees are bent at a 90 degree angle, the feet soles are kept 20-30 apart, fixed on the ground by the test leader's attendant. When the signal is heard, the subject repeats the action as quickly as possible, i.e. repeats the sit-ups (with elbows touching the bent knees) and lie-downs (the subject's back and the back of his hands touching the mat). The aim is to achieve the maximum number of cycles per 60 seconds.

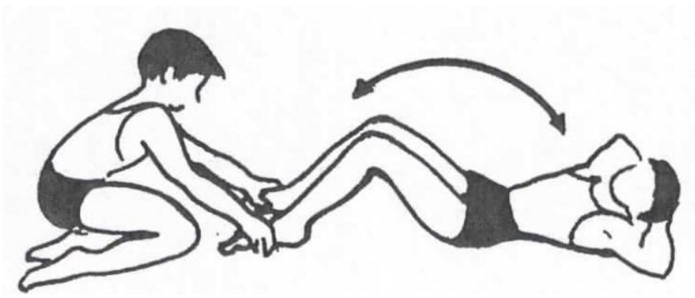


Figure 12: Sit-ups (adapted from Měkota, Kovář, 1995)

Scoring:

The score is the number of complete and correct cycles (performances) per 30 seconds. One cycle is the transition from the lying position into the sitting position and back again. If the subject is unable to perform during the complete one-minute period, the test leader registers the number of cycles performed (interruption of the performance is allowed).

Directives:

The test is done only once. After the explanation and a sample performance, the subject tries out the correct performance himself (he slowly performs two complete cycles).

During the whole performance the subject must keep his knees at the angle of 90 degrees and keep his heels on the mat, his hands clasped behind his neck, fingers folded. In the starting position the head, fingers and elbows are on the mat, in the sitting position the elbows touch the knees (this checked by the test leader).

It is not allowed to také off frm the mat by means of one's elbows, the pectoral part of the spine, or the back.

The movement must be carried out gently and no stops be made for one minute, though an interval (one or more pauses) due to fatique is possible.

By group testing, i.e. testing in couples, several persons can be tested simultaneously. The number of correct performances is counted by a non-performer. It is recommended to tell the subject the time every 15 seconds.

Indicator: Flag tag game (adapted from Perič, Ružbarský, 2019)

Description:

A game by which we evaluate predispositions for decision-making processes.

Performance and rules:

This game plays 5-10 children on the playground with dimensions 10 x 10 m (ie. Half the volleyball court) for 5 minutes. All children play against each other. Each child has one flag in trousers. Child must not play without this flag. Child tries to steal the other children's flag. If the opponent takes the flag from trousers, the child must run to the assistant and do three squats. Then the assistant can give him a new flag and the child can return to play.
Children try to get as many flags as possible, but at the same time they have to defend their flag. Finally, the number of flags obtained is counted. A child who is not active will not receive any flag. Also, a child who has only a defensive strategy of not losing its own flag will not receive any flag. A child who focuses only on the attack loses his flag quickly and must run for a new one.

Equipment:

- textile tapes (flags) about 5-10 cm wide and 50-60 cm long, cones, stopwatch

Indicator: Rolling three balls (adapted from Měkota, Blahuš, 1983)

Description:

The indicator Rolling three balls evaluate the predispositions for manipulation of objects.

Performance:

We put the two parts of the Swedish box according to Figure 6. We mark the finish and start line and put three basketballs on the start line. The tested child starts on command, in the defined slalom track rolls three balls using its lower and upper limbs. The time is measured. The stopwatch stops when these three balls and the test child cross the finish line. The test is repeated twice. The result is a better time from these two attempts.

Equipment

- 3 basketball balls, 2 parts of Swedish box, stopwatch

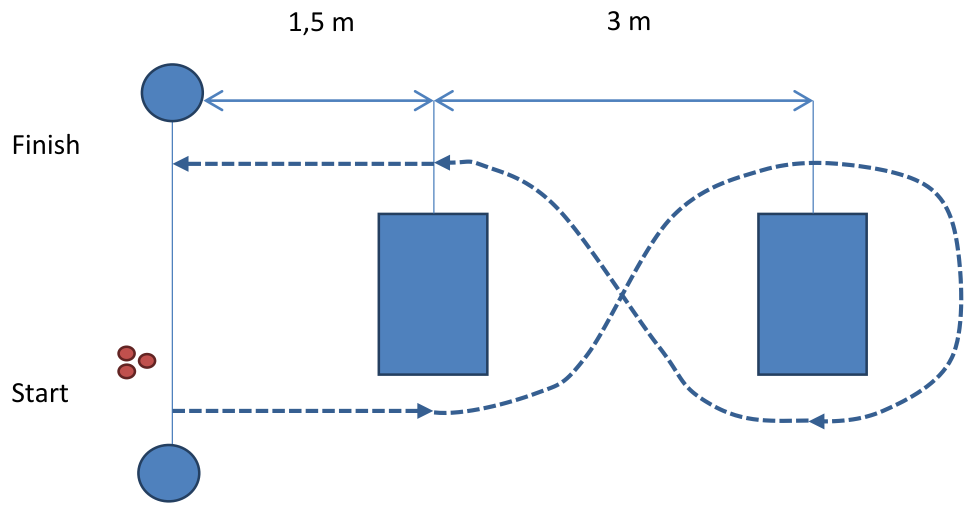


Figure 6: The track of Rolling three balls

Appendix 4: Description and evaluation of selected ice hockey skills

Skill 1: Passing (adapted from Perič, 2018b, unpublished)

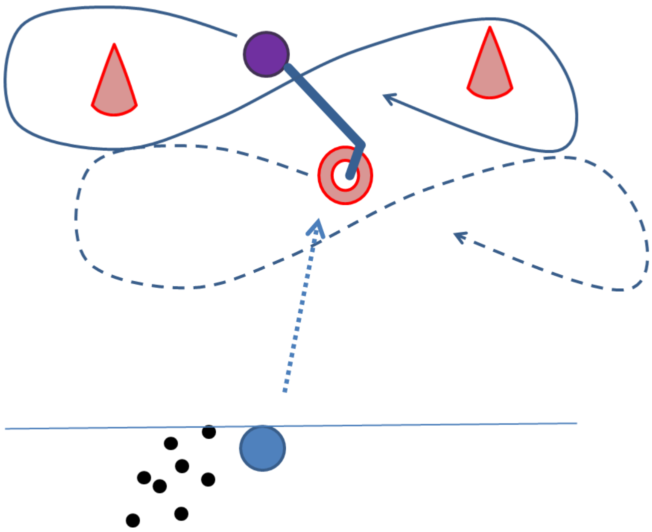


Figure 13: Passing (adapted from Perič, 2018, unpublished)

Test description:

- Two cones are placed 3 metres apart.
- 6 metres from these cones is a line (parallel to the cones). This line is called the „passing line“.
- There are 10 pucks behind the „passing line“.
- The coach is between the cones and has a tire on his stick.
- On the „Start“ command, the coach starts to skate around the cones. He moves on an eight-way track and holds a stick straight in front of him.
- The coach skates at a uniform speed. One “8” lasts approximately 8 seconds.
- The coach skates with a tire on his stick until the player has played all the pucks.
- The player tries to hit the tire as many times as possible and in the shortest possible time.
- The player has 10 pucks available.
- The player has to stand behind the „passing line“ and can move right and left.
- Time stops when the tenth puck hits the tire or cuts the imaginary line between the cones.
- For each puck that does not hit the tire, we added 4 seconds to the result time.

Realization:

- Coach and assistant demonstrate the test to players.
- The trial round follows.
- Everyone has 3 trials that do not count towards the results.
- After the trial, a test follows.
- Each player has two attempts. The better result counts.

Evaluation:

- Time of passing all 10 pucks (4 seconds are added for each non-hitid tire).

Skill 2: Shooting (adapted from Perič, 2018b, unpublished)

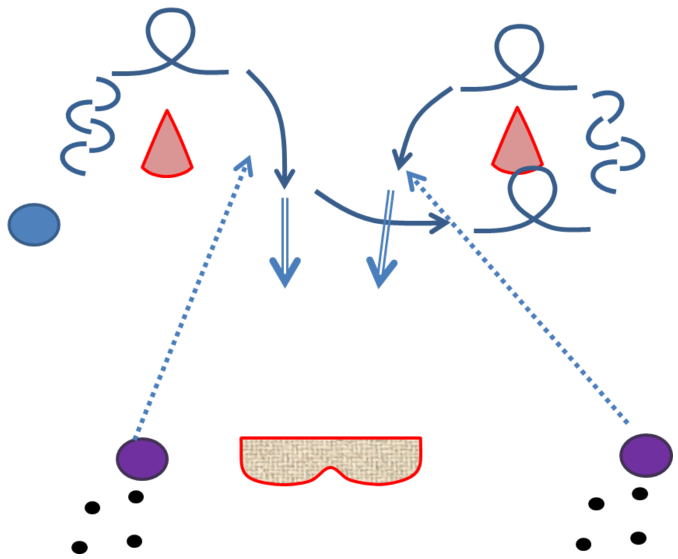


Figure 14: Shooting (adapted from Perič, 2018, unpublished)

Test description:

- Two cones are placed 3 m apart (1.5 m from the axis of the gate).
- A line is drawn between the cones. This line extends at least 1 m over the cone line.
- There are two coaches next to the goal. They stand approximately at the level of cones. Each of these coaches has 5 pucks.
- The player stands on the right side of the right cone (from the goalkeeper's point of view). He/She starts by driving forward around the right cone. He/She skates forward on "eight-way track" around the cones.
- Coaches pass to player alternately.
- All passes are in the player's forehand.
- Coach always passes the puck on who’s side is player rounding the cone.
- The coach passes the puck when the player crosses the imaginary line between the cones.
- The player tries to score as many times as possible and in the shortest possible time.
- When the tenth puck crosses the goal line, the time is stopped.
- For each non-shot goal, 4 seconds are added.

Realization:

- Coach and assistants show the test.
- The trial round follows.
- During the trial round the coaches do not pass to the player.
- After the end of the trial, the test follows.
- The player undergoes 2 repetitions of the test, the better result counts.

Evaluation:

- Time of shooting all 10 pucks (for each non-shot goal 4 seconds are added).

Skill 3: Stickhandling (adapted from Perič, 2018b, unpublished)

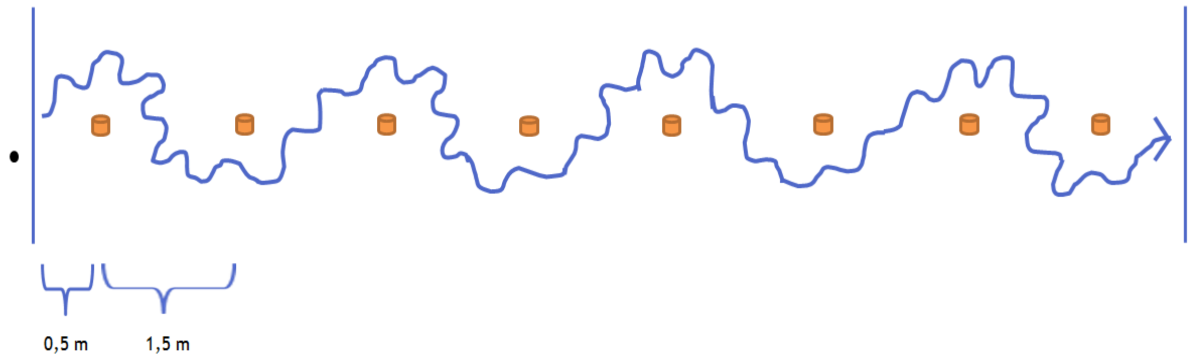


Figure 15: Stickhandling (adapted from Perič, 2018, unpublished)

Test description:

- 8 cones are placed in one line (1,5 m apart).
- The start line is marked before the first cone at a distance of 0.75 cm. Behind the starting line is a puck.
- The finish line is marked after the last cone at a distance of 0,75 from the last cone.
- The player skates slalom with one puck (skates around the cones alternately from the right and left side)
- On command „Start“ the player starts. Time stops when the player crosses the finish line with a puck.
- If the player hits the cone with the puck he/she stops and takes the same puck (for example when the puck leaves the track player goes and gets the same puck back) and continues from the place he stopped.
- If the player touches or moves the cone with a puck or a stick, two seconds are added.

Realization:

- Coach demonstrates the test to players.
- The trial round follows. The trial does not count towards the result.
- After the end of the trial, the test follows.
- The player undergoes 2 repetitions of the test, the better result counts.

Evaluation:

- The time of travel of the entire track.
- The sum of intact cones (add 2 seconds for each touch)

Appendix 5: Description and evaluation of selected athletic skills

Skill 1: Standing overarm throw

Description:

- Each child gets three throws.
- The child has to stand side on the target.
- The child throws as far as possible by one hand.
- A foul occurs if any part of the child's body touches any of the lines marking the throwing area.

Evaluation:

- The best result of three attempts counts.
- We measure with the zero end of the tape in the landing sector and the other end through the throwing line.

Skill 2: Long jump

Description:

- Each child gets three jumps.
- Children must take off with one foot only.
- Children are not allowed to do any form of somersault into the pit.
- Children must land within the sand pit (landing on the runway is a foul).
- Children are not allowed to wear spikes.
- The length of the jump is measured from the place of take-off.

Evaluation:

- The best result of three attmpts counts.
- We measure with the zero end of the tape at in the sand and pull the other end through the take-off place.

Skill 3: 50 m sprint

Description:

- Each child gets one attempt.
- Children sprint in pairs.
- Children start from „standing start" position.
- Children are not allowed to wear spikes.
- The start command is: „On your marks." and „Go.".

Evaluation:

- We measure time with a handheld stopwatches and record the time to the nearest tenth of a second.

Appendix 6: Evidence for and against early sports specialization to achieve elite status

Table 3: Evidence for and against early sports specialization to achieve elite status (adapted from Jayanthi, Pinkham et al., 2013)

			Before Age 12 Years[a]		Before Age 12 Years[a]		
Study	Sport	Athletes	Begin[b]	Specialize[c]	Begin[b]	Diversify/ Specialize	Study conclusions
Hume at al.	Rhytmic gymnastics	106 across all levels	+			+	Amount of gymnastic training during development is related to level of attainment. All gymnasts participated in other sports, with no difference between elites and subelites. Enjoyment of gymnastice was strong predictor of attainment.
Law et al.	Rhytmic gymnastics	6 elite, 6 subelite	+	+			Elites and subelites began intense training at similar ages, but elites were involved in fewer other activities from age 4-16 years and accumulated more hours of training by age 16 years.
Helsen at al.	Men's soccer, men's field hockey	39 intl, 39 natl, 52 provincial			+		Soccer began practicing at age 5 years, field hockey at age 9 years. Hours spent in practice were similar among levels until 12 years
Hodges and Starkes	Wrestling	21 elite, 21 club level			+		Elite wrestlers spent more time training after age 16 years compared with club-level wrestlers. However, since all subjects began intense training at 13.6±0.6 years, comparison to early intense traiinng (before age 12 years) was not possible.
Soberlak, Côté	Men's ice hockey	4 elite			+	+	Elite players intensified their deliberate hockey training in late adolescence and played other sports during developmental years.
Carlson	Men's, women's tennis	10 elite, 10 near-elite			+	+	Elite players began intense training and specialized later (after age 13-15 years) than near-elites (age 11 years).
Lidor, Lavyan	Various men's, women's sports	63 elite, 78-near elite			+	+	Elite more likely than near-elite athletes begin intense training after age 12 years and to have played > 1 sport during developmental years.
Gullich, Emrich	Olympic sports	1558 German athletes (Olympic promotion programs)			+	+	Elite athletes began intense training and competition in their sport later than near-elites (11.4 vs 10.2 years and 13.1 vs 12.0 years). More elites participated in > 1 sport from age 11 years than near-elites (64% vs 50%).

Appendix 7: Assessing normality assumption

Table 43: Tests of normality (athletes and ice hockey players)

	Sport	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Routine with a stick	Ice hockey	0,098	95	0,029	0,969	95	0,026
	Athletics	0,146	77	0,000	0,911	77	0,000
Flexed arm hang	Ice hockey	0,110	95	0,007	0,919	95	0,000
	Athletics	0,125	77	0,005	0,901	77	0,000
Rolling three balls	Ice hockey	0,124	95	0,001	0,949	95	0,001
	Athletics	0,107	77	0,032	0,953	77	0,008
Sit and reach	Ice hockey	0,101	95	0,018	0,968	95	0,021
	Athletics	0,108	77	0,027	0,980	77	0,272
Illinois Agility test	Ice hockey	0,073	95	**,200***	0,969	95	0,024
	Athletics	0,111	77	0,020	0,946	77	0,003
Standing long jump	Ice hockey	0,072	95	**,200***	0,981	95	0,186
	Athletics	0,088	77	**,200***	0,980	77	0,256
Sit-ups	Ice hockey	0,113	95	0,004	0,982	95	0,222
	Athletics	0,107	77	0,030	0,979	77	0,224
Shuttle run	Ice hockey	0,146	95	0,000	0,957	95	0,003
	Athletics	0,123	77	0,006	0,950	77	0,005
Flag tag game	Ice hockey	0,127	95	0,001	0,958	95	0,004
	Athletics	0,136	77	0,001	0,935	77	0,001

*. This is a lower bound of the true significance. a. Lilliefors Significance Correction

Table 44: Tests of normality (boys and girls)

	Sport	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Routine with a stick	Boys	0,083	140	0,021	0,953	140	0,000
	Girls	0,158	32	0,041	0,905	32	0,008
Flexed arm hang	Boys	0,095	140	0,004	0,936	140	0,000
	Girls	0,170	32	0,020	0,880	32	0,002
Rolling three balls	Boys	0,125	140	0,000	0,931	140	0,000
	Girls	0,158	32	0,041	0,900	32	0,006
Sit and reach	Boys	0,118	140	0,000	0,964	140	0,001
	Girls	0,101	32	,200*	0,971	32	0,523
Illinois Agility test	Boys	0,054	140	,200*	0,983	140	0,084
	Girls	0,115	32	,200*	0,956	32	0,214
Standing long jump	Boys	0,057	140	,200*	0,991	140	0,528
	Girls	0,098	32	,200*	0,971	32	0,541
Sit-ups	Boys	0,078	140	0,035	0,987	140	0,220
	Girls	0,091	32	,200*	0,973	32	0,592
Shuttle run	Boys	0,141	140	0,000	0,950	140	0,000
	Girls	0,133	32	0,158	0,968	32	0,457
Flag tag game	Boys	0,117	140	0,000	0,956	140	0,000
	Girls	0,144	32	0,088	0,927	32	0,033
*. This is a lower bound of the true significance.							
a. Lilliefors Significance Correction							

Appendix 8: Questions for parents of children (non-standardized questionnaire)

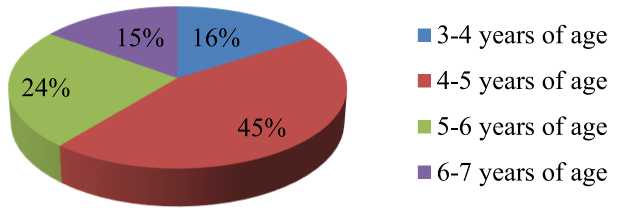
1. From what age does your son/daughter attend ice hockey/athletic training?
2. Does your son/daughter also play other sports? If so, write which one.
3. Is your daughter's/son's family an ancestor who played a top-level sport?

Appendix 9: Questions for coaches (interview)

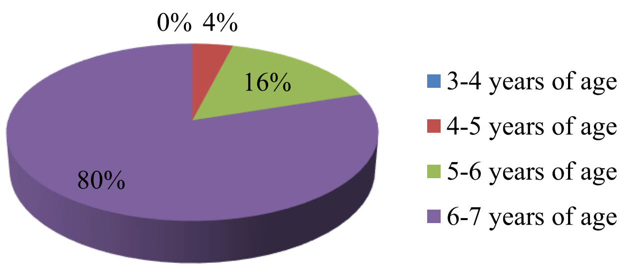
1. How many times a week do 1st grade children train in your club?
2. How many times a week do 2nd grade children train in your club?
3. How long does one training unit last?
4. On average, how many matches/competitions does a child complete in one season?

Appendix 10: Results of non-standardized questionnaire

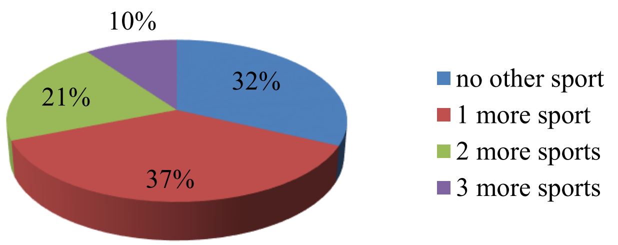
Graph 1: Age of children at the time they started going to ice hockey practice



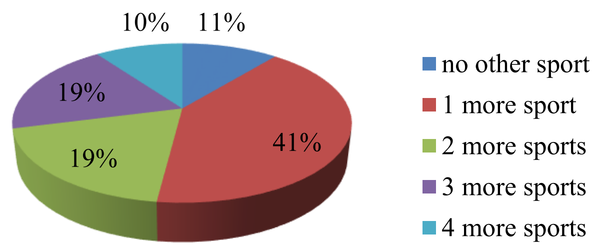
Graph 2: Age of children at the time they started going to athletic practice



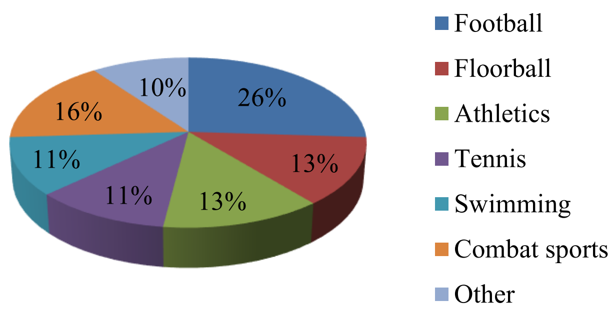
Graph 3: Number of sports that young ice hockey players participate (except ice hockey)



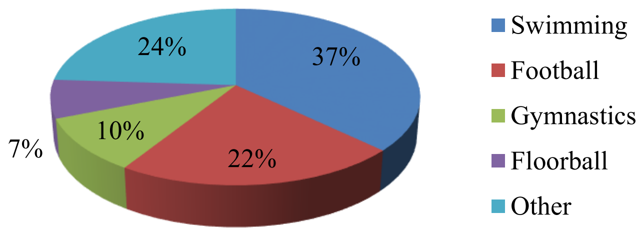
Graph 4: Number of sports that young athletes participate (except athletics)



Graph 5: Sports in which young ice hockey players participate



Graph 6: Sports in which young athletes participate



Appendix 11: Descriptive statistics for the multilateral development indicators and specific sport skills

Table 45: Descriptive statistic for the multilateral development indicators and ice hockey skills

Multilateral development indicators	**N**	**Mean**	**SD**
Routine with a stick (s)	54	50,0	17,9
Flexed arm hang (s)	54	5,4	4,2
Rolling three balls (s)	54	28,3	9,2
Sit and reach (cm)	54	52,0	5,7
Agility Illinois test (s)	54	22,1	2,4
Standing long jump (cm)	54	127,0	15,5
Sit-ups (n)	54	13,0	4,0
Shuttle run (s)	54	199,3	72,7
Flag tag game (n)	54	7,0	4,0
Ice hockey skill tests			
Passing (s)	54	57,9	13,3
Shooting (s)	54	67,8	16,8
Stickhandling (s)	54	10,1	2,8

Table 46: Descriptive statistic for the multilateral development indicators and athletic skills

Multilateral development indicators	**N**	**Mean**	**SD**
Routine with a stick (s)	30	37,8	13,5
Flexed arm hang (s)	30	9,6	5,3
Rolling three balls (s)	30	24,5	5,4
Sit and reach (cm)	30	52,1	5,0
Agility Illinois test (s)	30	19,9	1,9
Standing long jump (cm)	30	130,5	20,6
Sit-ups (n)	30	17,1	4,1
Shuttle run (s)	30	273,4	102,2
Flag tag game (n)	30	7,0	4,0
Athletic skill tests			
Long jump (m)	30	2,84	0,47
Overarm throw (m)	30	19,25	5,98
50 m sprint	30	9,7	1,6