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Differences in physical fitness and gross motor coordination in boys aged 6–12 years specializing in one versus sampling more than one sport

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Abstract

The Developmental Model of Sports Participation proposes two pathways towards expertise in sports between 6 and 12 years of age: early specialization and early diversification. This study investigated the effect of sampling various sports and of spending many or few hours in sports on fitness and gross motor coordination. Altogether, 735 boys in three age groups (6–8, 8–10, and 10–12 years) were profiled using a fitness test battery. A computerized physical activity questionnaire was used to obtain data on sports participation. In the eldest group, (M)ANCOVA showed a positive effect of sampling various sports on strength, speed, endurance, and gross motor coordination ($P < 0.05$). A positive effect of many hours per week spent in sports was apparent in every age group. These data suggest an acute positive effect of many hours in sports and a latent positive effect of early sampling on fitness and gross motor coordination. Multiple comparisons revealed that boys aged 10–12 years, who spent many hours in various sports, performed better on standing broad jump ($P < 0.05$) and gross motor coordination ($P < 0.05$) than boys specializing in a single sport. Therefore, our results highlight the importance of spending many hours in sports and sampling various sports in the development of fitness and gross motor coordination.

Keyword: *Development, sports, diversification*

Introduction

Many studies have attempted to model the trajectory of motor abilities from childhood towards adult expert performance. Research has focused on two distinctive pathways in this development process. The first is a performance-centred pathway with the amount of domain-specific practice as the sole contributor of expert performance (Ericsson, Krampe, & Teschromer, 1993; Helsen, Starkes, & Hodges, 1998; Ward, Hodges, Starkes, & Williams, 2007; Ward, Hodges, Williams, & Starkes, 2004). The second is a pathway implementing different stages of athletic development before reaching an expert level (Bompa & Haff, 2009; Côté, 1999; Côté, Baker, & Abernethy, 2003, 2007; Côté & Fraser-Thomas, 2007). The latter is the focus of this study, since it promotes general athletic development through sampling various sports before beginning to specialize in one sport.

In their Developmental Model of Sports Participation (DMSP), Côté and colleagues showed two pathways towards elite performance in sports: early diversification and early specialization (Côté, 1999; Côté et al., 2003, 2007; Côté & Fraser-Thomas, 2007). Ericsson et al. (1993) provide support for the early specialization pathway by showing that 10,000 h of accumulated structured and organized practice called "deliberate practice" are needed to reach an expert level of performance in most sports involving motor skills. Therefore, early specializing athletes enter their primary sport at an early age and participate in a high amount of deliberate practice in their primary sport with almost no deliberate play in any other sports (Ford, Ward, Hodges, & Williams, 2009)

In the early diversification approach, the DMSP introduced three stages of athlete development: the sampling stage (6–12 years), the specializing stage (12–15 years), and the investment stage (+15 years). During the sampling stage, young athletes participate in various sports (Côté, 1999) and engage in many deliberate play activities designed to maximize enjoyment through less structured play and age-adapted rules. Sampling is considered beneficial for athletic development because of the exposure to a number of different physical, cognitive, affective, and psycho-social environments, reinforcing physical,

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personal, and mental skills needed for future successful sport specialization (Côté, Lidor, & Hackfort, 2009). In a study involving elite athletes in field hockey, basketball, and netball, Baker and colleagues (Baker, Côté, & Abernethy, 2003) reported that athletes who required fewer hours of sports-specific practice to attain expertise had participated in many sports activities prior to reaching an expert level. Furthermore, expert triathletes (Baker, Côté, & Deakin, 2005) had participated in more hours in different sports activities prior to starting triathlon than their non-expert counterparts, who generally finish at the back of the pack. Also, 6- to 8-year-old ice-hockey players participated in an average of three and 9- to 12-year-old ice hockey players even in up to six sports other than their primary sport during the sampling years (Soberlak & Côté, 2003). Vaeyens and colleagues (Vaeyens, Gullich, Warr, & Philippaerts, 2009) also found that Olympic world-class athletes started training, competing, and participating in international competitions later and competed in more sports other than their primary sport than peers performing at a national level. Therefore, Côté and colleagues (2009) concluded that a sampling stage did not hinder future expert performance.

Following the sampling stage (12+ years), the DMSP (Côté, 1999; Côté et al., 2003, 2007; Côté & Fraser-Thomas, 2007) proposed two different trajectories. In the first, children are introduced to recreational sports participation with a focus on enjoyment and health benefits. The second trajectory involves children specializing in the adolescent years (13–15 years) and investing in just one sport at the age of 15–16 years. At this age, physical, cognitive, social, emotional, and skill development reaches its peak and allows athletes to start highly specialized training in a single sport with the main goal of improving performance (Patel, Pratt, & Greydanus, 2002).

A clear distinction between the advantages and disadvantages of early specialization and early diversification has been made (Bompa & Haff, 2009; Hecimovich, 2004). Specialization at an early age leads to faster target sport performance improvement and peak performance at the age of 15–16 years (Bompa & Haff, 2009). However, early specializing athletes often burn out because of repetitive strain (Gould, Tuffey, Udry, & Loehr, 1996) and a decrease in intrinsic motivation and enjoyment during their training sessions (Wall & Côté, 2007). Furthermore, early specializing athletes are at risk of social isolation, over-dependence, and overuse injury (Malina, 2010). Early diversifying athletes reach peak target sport performance at a slower rate and at a later age (Baker et al., 2003), but fewer appear to drop out (Fraser-Thomas, Côté, & Deakin, 2008) and they sustain fewer injuries (Bompa & Haff, 2009) than early specializing athletes because of a more gradual physical and psychological development (Côté et al., 2009). Also, athletes who had diversified early showed longer adherence to adult sports participation and had longer athletic careers (Baker et al., 2005). In 2000, the American Academy of Pediatrics (2000, p. 1) made a strong statement on early specialization: "Children involved in sports should be encouraged to participate in a variety of different activities and develop a wide range of skills. Young athletes who specialize in just one sport may be denied the benefits of varied activity while facing additional physical, physiological and psychological demands from intense training and competition".

To date, no research has investigated the differences in anthropometry, physical fitness, and gross motor coordination between children participating in just one versus more than one sport from an early diversification versus early specialization point of view. Therefore, the profiling of sampling and specializing 6- to 12-year-old boys might provide more insight into the effect of sampling various sports on these performance-related characteristics.

The main aim of this study was to examine differences in anthropometry, physical fitness, and gross motor coordination in 6- to 12-year-old boys participating in just one versus more than one sport in an organized and recreational context. We also wished to determine whether boys participating in many hours of sports per week in various sports activities possess better physical fitness and gross motor coordination. It was hypothesized that a positive effect of sampling various sports on physical fitness and gross motor coordination would become more apparent in the older age groups, and that the positive effect of many hours spent in sports would be apparent from a young age. Furthermore, it was also hypothesized that boys accumulating a high amount of training hours per week in more than one sport would possess better physical fitness and gross motor coordination.

Methods and materials

Study design and participants

The present research had a cross-sectional design involving three age groups (6–8, 8–10, and 10–12 years). Children from nine sports clubs involved in the SPORTAKUS project as well as 26 primary schools for general education throughout the Flemish part of Belgium involved in the "Flemish Sports Compass" (Vandorpe et al., 2011) participated in the study. This resulted in the profiling of the anthropometry, strength, flexibility, speed and agility, cardiovascular endurance, and motor coordination of 1162 children aged 6–12 years. Since no differences between the sexes were targeted in this study and to ensure sufficient statistical power due to the small number of girls, only boys were included. This resulted in a population of 735 boys aged 6–12 years: 161 boys aged 6–8 years, 310 boys aged 8–10 years, and 264 boys aged 10–12 years (Table I). The study received approval from the local ethics committee of Ghent University Hospital. Written informed consent was obtained from the parents or guardians of the children.

Table I. The time (hours:minutes) spent in sports per week by single sports participants and multiple sports participants (mean ± *s*, median).

	Single sport participants		Multiple sports participants	
Age group	mean ± *s*	median	mean ± *s*	median
6–8 years (*n*=161)	2:42 ± 1:18	3:00	4:18 ± 1:54	4:00
8–10 years (*n*=310)	3:24 ± 1:42	4:00	5:36 ± 2:24	5:30
10–12 years (*n*=264)	4:12 ± 1:54	4:00	5:42 ± 2:18	6:00

Measurements

Anthropometry. A test battery for anthropometric profiling and the assessment of basic performance characteristics was used to obtain test data for each participant. The test battery included measuring body mass and height and tests used in the Eurofit Physical Fitness Test Battery (EUROFIT, 1988), the Bruininks-Oseretsky Test of Motor Proficiency 2 (Bruininks & Bruininks, 2005), and the Körperkoordinations Test für Kinder (Kiphard & Schilling, 1974). Height was measured to the nearest 0.1 cm using a portable stadiometer (Harpenden Portable Stadiometer, Holtain, Crymych, UK) and body mass using a digital weighing scale (TANITA BC-420SMA, Tokyo, Japan).

Strength. Muscular strength and strength endurance for all participants was assessed using the BOT2 sit-ups and knee push-ups test. Maximal static strength data and explosive strength were obtained using the EUROFIT handgrip strength test and standing broad jump.

Flexibility. Hamstring and lower back flexibility was assessed by the EUROFIT sit-and-reach test.

Speed and agility. Speed and agility were measured by the EUROFIT 10 × 5-m shuttle run test.

Cardiovascular endurance. Cardiovascular endurance was measured by the EUROFIT endurance shuttle run test.

Gross motor coordination. Data for the gross motor coordination were obtained using the KörperkoordinationsTest für Kinder (KTK; Kiphard & Schilling, 1974), which consists of four sub-tests: walking backwards along a balance beam, moving sideways on boxes, hopping for height on one foot, and jumping sideways. Scores for motor coordination were obtained through the transformation of the raw data of four KTK sub-tests into an age- and gender-specific motor quotient. In a general population, a motor quotient between 86 and 115 points indicates normally developing coordination (Kiphard & Schilling, 1974). For an elaborate description of the above tests, see Vandorpe et al. (2011).

A team of specifically trained supervisors scored each test. All tests were performed in bare feet and in a similar environment (indoor sports infrastructure) and were conducted over a 3-month period.

The nature of the sport(s) the boys participated in (type of sport, club membership, frequency of training) and the total time spent in recreational physical activity and in organized sports during the year in which the testing took place were obtained through self-reported physical activity assessment using the Flemish Physical Activity Computerized Questionnaire (Philippaerts et al., 2006). Due to the relatively young age of some of the participants, the questionnaire was completed with the help of their parents or guardians. Boys reporting participation in only one sport during the year in which the testing took place were labelled "single sport participants" and those reporting more than one sport were considered "multiple sports participants". The median for their respective age group was used to determine whether single sport participants and multiple sports participants spend many or few hours per week in sports. This subdivision resulted in the creation of four subgroups: single sports participants involved in few hours of sport per week; single sport participants involved in many hours of sport per week; multiple sports participants involved in few hours of sport per week; and multiple sports participants involved in many hours of sport per week (Table I).

Data analysis

The effect of the number of sports and of the amount of hours per week spent in sports. All data were analysed using SPSS v.15.0. To determine the effects of participating in one versus more than one sport and of participating in few or many hours of sports per week on anthropometry, physical fitness, and gross motor coordination, a two-way multivariate analysis of covariance (MANCOVA) with a Bonferroni correction for multiple comparisons was used. The number (one or more than one) of sports participated in and the amount of hours per week spent in sports were used as fixed factors, the test variables as dependent variables, and chronological age as a covariate.

Differences in test scores between the four subgroups. A *post-hoc* analysis consisting of a two-way MANCOVA with a Bonferroni correction for multiple comparisons was used to compare the test scores of the four subgroups (single sport participants involved in few hours of sport per week; single sport participants involved in many hours of sport per week; multiple sports participants involved in few hours of sport per week; and multiple sports participants involved in many hours of sport per week) for anthropometry, physical fitness, and gross motor coordination. The subgroups were considered as fixed factors, the test variables as dependent variables, and chronological age as a covariate. For all analyses, statistical significance was set at $P \leq 0.05$.

Results

Results (mean ± *s*, univariate *F*-values, and covariate *F*-values) of the two-way MANCOVA are reported in Table II for the three age groups separately.

Multivariate

Age appeared to be a significant covariate in all age groups ($P < 0.01$). No significant multivariate interaction effect was found in any of the age groups. MANCOVA revealed a significant multivariate effect of the number of sports in the 10–12 year age group ($F = 2.107$, $P = 0.026$) on measures of

Table II. Results of anthropometry, physical fitness, and gross motor coordination in the three age groups separately for single sport participants (SSP) and multiple sports participants (MSP) (mean ± *s* plus *F*-values).

	SSP		MSP		*F*-values			
Age group	Few hours	Many hours	Few hours	Many hours	No. sports (NS)	Hours per week (HW)	NS*HW	Covariate
6–8 years	(*n* = 39)	(*n* = 20)	(*n* = 23)	(*n* = 17)				
Body mass (kg)	24.9±3.7	24.9±3.2	25.7±5.0	25.9±3.4	1.968	0.223	0.114	20.534**
Height (cm)	125.8±6.0	125.6±7.2	125.6±7.2	128.1±6.5	1.676	0.154	0.397	51.243**
SAR (cm)	20.5±4.6	19.8±6.6	18.3±5.6	20.5±4.3	0.440	0.440	1.811	0.024
KPU (*n*/30 s)	19.4±6.1	20.9±5.4	20.8±5.6	22.1±6.9	1.579	0.493	0.222	23.583**
SUP (*n*/30 s)	16.0±7.3	14.5±6.2	14.0±9.2	16.8±8.6	0.042	0.006	1.161	10.955**
HGR (kg)	14.3±3.4^{a}	14.7±2.7^{a,b}	14.7±3.4^{a,b}	17.3±4.5^{b}	5.673*	3.586	1.685	19.406**
SBJ (cm)	119.7±19.8	123.5±115.3	117.3±17.8	133.2±22.0	0.480	5.298*	1.582	40.718**
SHR (s)	24.2±2.1	23.1±1.5	23.6±1.7	23.6±2.9	0.064	0.759	2.604	13.568**
ESHR (min)	4.9±2.3	4.9±2.3	5.0±2.1	5.2±2.3	0.352	0.124	0.015	19.139**
MQ (points)	101.6±14.4	107.8±13.9	101.0±13.7	110.1±12.7	0.216	5.822*	0.024	22.991**
8–10 years	(*n* = 119)	(*n* = 32)	(*n* = 43)	(*n* = 38)				
Body mass (kg)	30.2±5.6	32.1±4.0	30.1±3.8	30.1±5.4	1.423	1.426	1.003	15.006**
Height (cm)	135.0±7.0	137.2±4.6	135.5±5.2	135.6±6.8	0.100	1.434	0.452	41.131**
SAR (cm)	18.5±5.5	18.7±4.8	18.7±5.9	20.3±4.5	1.193	1.446	0.615	2.731
KPU (*n*/30 s)	24.8±5.6	27.2±5.4	27.0±6.1	27.0±5.8	1.198	1.869	1.948	0.236
SUP (*n*/30 s)	20.7±5.8	22.6±5.9	22.2±6.5	23.6±7.1	1.909	2.851	0.024	2.371
HGR (kg)	18.3±3.4	19.1±2.9	19.2±3.3	19.3±3.2	1.777	0.772	0.073	18.782**
SBJ (cm)	135.5±17.5^{a}	145.7±17.2^{b}	139.7±18.4^{a,b}	143.2±16.3^{a,b}	0.141	6.749*	1.510	1.066
SHR (s)	22.5±1.8^{a}	21.3±1.1^{b}	22.0±1.6^{a,b}	21.8±1.7^{a,b}	0.005	8.011**	3.294	12.587**
ESHR (min)	6.0±2.2^{a}	6.8±2.2^{a,b}	6.4±2.3^{a,b}	7.1±1.9^{b}	1.848	5.299*	0.009	8.703**
MQ (points)	99.4±12.8^{a}	106.6±10.5^{b}	102.4±13.4^{a,b}	107.1±13.2^{b}	0.860	9.775**	0.464	0.038
10–12 years	(*n* = 38)	(*n* = 75)	(*n* = 33)	(*n* = 38)				
Body mass (kg)	36.4±6.6	36.0±5.6	36.5±8.6	36.3±5.8	0.180	0.109	0.038	7.559**
Height (cm)	144.6±7.5	145.1±5.9	145.2±7.5	145.4±6.7	0.766	0.118	0.021	28.474**
SAR (cm)	15.6±4.7	18.0±5.7	16.5±5.9	18.1±4.9	0.338	5.343*	0.222	0.013
KPU (*n*/30 s)	28.2±6.4	29.3±6.6	30.1±6.2	31.0±6.4	4.197**	1.001	0.007	7.825**
SUP (*n*/30 s)	23.5±5.8	25.4±7.3	25.2±6.7	27.1±8.8	3.744	3.013	0.037	19.227**
HGR (kg)	22.8±4.0	23.4±4.4	24.0±4.1	23.7±4.3	2.410	0.070	0.274	19.992**
SBJ (cm)	147.3±17.2^{a}	155.1±20.5^{a}	153.1±15.7^{a}	163.7±15.4^{b}	8.906**	11.480**	0.570	14.487**
SHR (s)	21.7±1.5^{a}	21.1±1.3^{a,b}	20.8±1.3^{b}	20.9±1.3^{b}	10.502**	1.366	1.467	17.397**
ESHR (min)	6.6±2.9	7.7±2.3	7.9±2.1	7.9±2.0	5.650*	2.196	1.463	11.755**
MQ (points)	98.5±13.1^{a}	103.4±9.9^{a}	102.9±13.1^{a}	110.8±10.1^{b}	14.043**	14.211**	1.170	12.403**

Note: SAR, sit-and-reach test; KPU, knee push-ups; SUP, sit-ups; HGR, handgrip strength; SBJ, standing broad jump; SHR, 10 × 5-m shuttle run test; ESHR, endurance shuttle run test; MQ, motor quotient.
*$P < 0.05$; **$P < 0.01$; different superscripts are significant at the 0.05 level.

anthropometry, physical fitness, and gross motor coordination. Furthermore, a significant multivariate effect was found for the number of hours spent in sports per week in the 8–10 year age group ($F = 2.145$, $P = 0.022$) and the 10–12 year age group ($F = 2.456$, $P = 0.009$) on anthropometry, physical fitness, and gross motor coordination.

Anthropometry

A two-way MANCOVA showed no significant interactions for body mass or height. There was also no main effect of the number of sports or the hours spent in sports per week for any of the age groups.

Strength

No significant interaction effect of the number of sports and the hours spent in sports per week were found for knee push-ups, sit-ups, handgrip strength or standing broad jump in any of the age groups. A significant effect of the number of sports on handgrip strength was revealed for the 6–8 year age group and on knee push-ups and standing broad jump for the 10–12 year age group. Boys participating in more than one sport scored better on these tests than boys participating in only one sport. A significant effect of the hours spent in sports per week on standing broad jump performance was observed in all age groups. Boys who spent many hours per week in sports jumped further than boys who spent few hours per week in sports. According to the *post-hoc* analysis, in the 6–8 year age group, multiple sports participants involved in many hours of sport per week had significantly better handgrip strength than single sport participants involved in few hours of sport per week. Furthermore, in the 8–10 year age group, single sport participants involved in many hours of sports per week performed significantly better on the standing broad jump than single sport participants involved in few hours of sport per week. In the 10–12 year age group, multiple sports participants involved in many hours of sport per week outperformed all other groups (Figure 1A).

Flexibility

No significant interaction effect was found for the sit-and-reach test in any of the age groups. And no main effect of the number of sports was found for any of the groups. In the 10–12 year age group, a significant effect was observed of the hours per week spent in sports on sit-and-reach performance. Boys who spent many hours per week in sports performed better on the sit-and-reach test than those who spent few hours per week in sports.

Speed and agility

For the 10 × 5-m shuttle run (SHR) test, no significant interaction effect was found in any of the age groups. A significant effect of the number of sports on SHR test performance was observed for the 10–12 year age group. Boys participating in more than one sport were faster than boys participating in only one sport. A significant effect of hours per week spent in sports on SHR test performance was observed for the 8–10 year age group. Boys who spent many hours per week in sports were significantly faster than boys who spent few hours per week in sport. In the 8–10 year age group, single sport participants with many hours of sport per week were significantly faster than those reporting few hours per week. In the 10–12 year age group, multiple sports participants who spent both few and many hours in sports per week were significantly faster than single sport participants who spent a few hours in sports per week.

Cardiovascular endurance

No significant interaction effect was apparent in any age group. In the eldest age group, a significant effect of the number of sports on endurance shuttle run (ESHR) performance was observed. Boys participating in more than one sport showed better cardiovascular endurance than boys participating in only one sport. In the 8–10 year age group, a significant univariate effect of the hours per week spent in sports on ESHR performance was revealed. Children with many hours per week spent in sports had better cardiovascular endurance than children with few hours per week. In the 8–10 year age group, *post hoc* analysis revealed a significant difference in ESHR performance between single sport participants reporting few hours per week in sports and multiple sports participants with many hours per week.

Gross motor coordination

No significant interaction effect was observed in any age group. A significant effect of the number of sports on gross motor coordination (motor quotient) was revealed in the 10–12 year age group. Boys participating in more than one sport possessed a higher motor quotient than boys participating in one sport. An effect of the hours spent in sports per week on motor quotient was observed in all age groups. In all age groups, boys who spent many hours per week in sports possessed a higher motor quotient than boys spending few hours in sports per week. In the 8–10 year age group, *post-hoc* analysis revealed that single sport participants reporting few hours per week in sports had a significantly lower motor

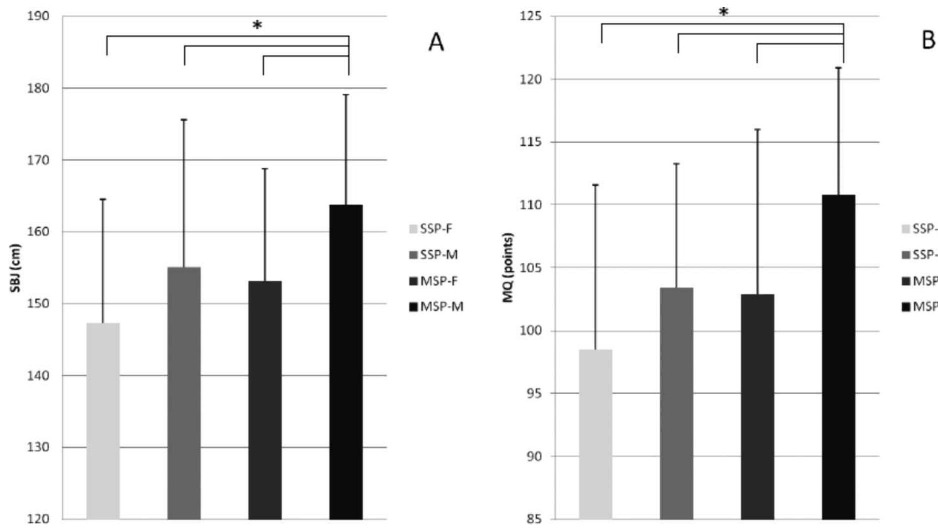

Figure 1. Differences in standing broad jump distance (SBJ, cm) (A) and gross motor coordination (MQ, points) (B) between single sport participants and multiple sports participants who spent few or many hours per week in sports per week: 10–12 year age group. *Significant at $P \leq 0.05$.

Note: SSP-F = single sport participants/few hours per week, SSP-M = single sport participants/many hours per week, MSP-F = multiple sports participants/few hours per week, MSP-M = multiple sports participants/many hours per week.

quotient than single sport participants and multiple sports participants with many hours per week. In addition, in the 10–12 year age group, multiple sports participants with many hours per week had a significantly higher motor quotient than all other groups (Figure 1B).

Discussion

The aims of this study were to assess differences in anthropometry, physical fitness, and gross motor coordination between boys specializing in and sampling sports, and to determine whether boys participating in many hours of sports per week in various sports activities possess better physical performance measures and gross motor coordination.

Effect of the hours spent in sports per week

We observed significant effects of hours per week spent in sports on standing broad jump and motor quotient in the 6–8 year age group; on standing broad jump, 10 × 5-m shuttle run test, endurance shuttle run test, and motor quotient in the 8–10 year age group; and on sit-and-reach test, standing broad jump, and motor quotient in the 10–12 year age group. The positive effect of the amount of practice on performance was established by "the power law of practice" introduced by Newell and Rosenbloom (1981) and later by the "theory of deliberate practice" (Ericsson et al., 1993). The present study emphasizes the acute positive effect of spending many hours per week in sports. The results support the hypothesis of Bompa and Haff (2009) and Hecimovic (2004) that early specialization is characterized by a more rapid improvement in performance in the target sport than early diversification. Furthermore, athletes specializing in just one sport or skill may become more proficient at that skill than an athlete who practises these skills periodically, as is the fact in early diversification (Wiersma, 2000). This advantage of early specialization may be the reason many youth coaches believe that not specializing early is foolish, since athletic careers are short (Wiersma, 2000). Therefore, submitting young athletes to a stringent training regime with many hours of sports per week is a sensible choice. This is especially the case in sports where the attainment of peak performance at a young age encourages early competitive sports participation such as figure skating (Starkes, Deakin, Allard, Hodges, & Hayes, 1996) and gymnastics (Law, Côté, & Ericsson, 2007).

The effect of sampling various sports

In this study, differences between boys participating in just one or in more than one sport were mainly observed in the 10–12 year age group for knee push-ups, standing broad jump, 10 × 5-m shuttle run test, and motor quotient. Boys participating in more than one sport performed better for each of these variables. The fact that differences were only revealed in the eldest age group is supported by the fact that when diversifying early, improvement in performance is slower than when specializing early (Bompa & Haff, 2009; Hecimovich, 2004). Also, boys participating in more than one sport were exposed to a greater number of physical, cognitive, affective, and psycho-social environments than boys participating in one sport only. As a result, these children possess a broad range of physical, personal, and mental skills needed for future successful sport specialization during adolescence (Côté et al., 2009). These findings, however, do not necessarily imply that better physical fitness and gross motor coordination are the direct result of sampling. It might also be that the best athletes choose to participate in more than one sport because their excellent physical fitness and motor coordination allows them to cope more easily with new and challenging environments (Skinner & Piek, 2001). To establish a clear causal relationship between the sampling of more than one sport before the age of 12 and physical fitness and gross motor coordination, longitudinal research is required.

Multiple comparisons

In the 10–12 year age group, we found significant main effects of number of hours spent in sports and number of sports participated in on standing broad jump and motor quotient. The results show that the multiple sports participants with many hours per week jumped further and had a higher motor quotient than all other groups (Figure 1A, B). This suggests that in the eldest age group, in contrast with the two youngest age groups, participation in many hours of sports per week in more than one sport might be important for developing standing broad jump performance and gross motor coordination. These data suggest that sampling various sports before the age of 12 years could be beneficial in developing strength and coordination if a sufficient amount of time is spent in sports activities. However, longitudinal research, preferably also involving children up to 16 years of age, could provide further insights in this matter.

The clear advantages of this study are its sufficiently large sample size for all age groups, its representativeness of the general Flemish population, and its unique approach. This approach differs from most current research on the early diversification versus early specialization debate through its emphasis on anthropometry, physical fitness, and gross motor coordination and not on differences between elite and sub-elite athletes or on sport-specific measures of performance.

Finally, this study has also revealed some shortcomings. The first is an inability to separate the total amount of accumulated time in sports activities into time spent in deliberate practice or deliberate play. Ford and colleagues (2009) made this distinction, with organized sports activities characterized as "deliberate practice" and unorganized activities as "deliberate play". Future research should therefore make a clear distinction between hours spent in deliberate practice and hours spent in deliberate play when investigating differences between youngsters specializing in one and those sampling more than one sport. Furthermore, not including retrospective training history for more than one year assumes that children have not changed their training history much in the course of their athletic career, thus assuming little change in sports participation over the years.

In conclusion, spending many hours in sports per week has an acute positive effect on explosive strength and gross motor coordination from as young an age as 6–8 years. This positive effect was apparent throughout each of the age groups. However, a positive effect of sampling various sports on explosive strength, speed and agility, cardiovascular endurance, and gross motor coordination is delayed until the age of 10–12 years, suggesting a more latent effect of participating in more than one sport on physical fitness and motor coordination. Longitudinal research might provide further insights in this matter.

Recommendations

Excellent motor coordination in general (Hands & Larkin, 2002; Schott, Alof, Hultsch, & Meermann, 2007) and a well-developed physical fitness in particular in, for example, soccer (Castagna, Manzi, Impellizzeri, Weston, & Barbero Alvarez, 2010), gymnastics (Douda, Toubekis, Avloniti, & Tokmakidis, 2008), handball (Mohamed et al., 2009), and ice-hockey (Burr et al., 2008) seem to be important factors in the development of elite athletic performance. Based on the results of this study, spending many hours in more than one sport might be beneficial in helping to develop strength and motor coordination. It is therefore important that children before the age of 12 years are encouraged by their coaches, parents, and other training professionals to participate in sports other than just their "primary sport", preferably in combination with many hours per week spent in those sports. This requires an awareness on the part of coaches, parents, and training professionals of the advantages and disadvantages associated with early specialization and early diversification. The establishment of an umbrella organization such as an omnisports club is important in this matter, since it not only provides children with experience in sports other than their main sport, but also provides the opportunity to increase the number hours spent per week participating in sports.

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