

Skills trained by coaches of Canadian male volleyball teams: A comparison with long-term athlete development guidelines

Jonathan Chevrier¹, Martin Roy¹, Sylvain Turcotte¹,
Diane M Culver² and Sarah Cybulski²

Abstract

Volleyball Canada and Volleyball Quebec developed long-term athlete development models in order to guide volleyball coaches concerned with athlete development. These models propose guidelines about the development of skills. However, it has yet to be determined whether coaches apply long-term athlete development guidelines in their coaching practice. Therefore, the objectives of this study were to describe the amount of time devoted to the various skills trained by four volleyball coaches of different levels and to compare these training skills with the long-term athlete development guidelines. The results of this multiple case study ($n = 4$) indicated that based on long-term athlete development guidelines, (a) college and university coaches over-trained technical skills; (b) high school coaches and university coaches undertrained individual tactical skills; and (c) high school coaches over-trained team tactical skills. Corrective measures that might help coaches apply the long-term athlete development guidelines are changes in the access to training facilities, competition schedules, and coach education programs.

Keywords

Coach education, scholastic sport, tactics, talent development, technique, varsity sport

Introduction

It has been acknowledged that achieving a high level of competition generally requires a long training process, which could take many years, and most experts and practitioners agree that this process should be rigorously periodised.^{1,2} This is why, in 2004, Sport Canada asked sports scientists to create a long-term athlete development (LTAD) model to upgrade Canadian athletes' performances at the international level. The LTAD is defined as:

a training, competition and recovery program based on developmental age — the maturation level of an individual — rather than chronological age. It is athlete-centred, coach driven and administration, sport science and sponsor supported. The Canadian Sport for Life (CS4L) – LTAD framework is inclusive, addressing the needs of those individuals with a disability... ensures that developmentally appropriate skill development, training, competition and recovery programs are provided throughout an athlete's career... impacts the entire sport community, including participants, parents, coaches, schools, clubs, community recreation programs... (Canadian Sport Centres,³ see p. 15)

Nevertheless, since the introduction of the LTAD model in national sport organisation (NSO)^a and provincial sport organisation (PSO),^b only one study has explored whether coaches are able to apply LTAD guidelines in their practice.⁴ Given the importance that Canadian sport funding bodies have placed on the LTAD and its influence in other countries (e.g. USA, UK), it seems important to examine its implementation by coaches.

Reviewers: Ian Renshaw (Queensland University of Technology, Australia)
Kevin Till (Leeds Beckett University, UK)

¹Faculté des sciences de l'activité physique, Université de Sherbrooke, Québec, Canada

²School of Human Kinetics, University of Ottawa, Ottawa, Ontario, Canada

Corresponding author:

Diane M Culver, School of Human Kinetics, University of Ottawa, 125 Université Privé Ottawa, Ontario K1N 6N5, Canada.

Email: dculver@uottawa.ca

Canadian male volleyball player development

In December of 2004, experienced volleyball coaches, players, and administrators in Canada gathered to discuss the current and desired states of volleyball and what needed to be done in order to achieve the ideal state. Following this meeting, Volleyball Canada (VC), in partnership with Sport Canada, made a strategic decision to embrace and implement the LTAD model. It was noted that despite the hundreds of thousands of Canadians playing volleyball at all levels from primary schools to the international level, indoors and on beaches, this popularity had not yielded international competitive success. Indeed, Canada appeared to be going backwards compared to other volleyball nations. The VC LTAD expert committee also uncovered several challenges that could help to explain why Canadian volleyball teams have experienced less success on the international level and on technical and motor skill development compared to the most powerful volleyball nations.⁵ While the VC LTAD expert committee did not specify the reasoning, which was likely based on their collective anecdotal experience, they asserted that Canadian volleyball teams have less success in international competitions, and in the development of technical (e.g. set, smash and other specific volleyball skills) and motor (e.g. speed, agility, coordination) skills compared to the most powerful volleyball nations. As an aside, some of these challenges and their consequences had been detected more generally across sports by Sport Canada.³

For example, at the “training to train” (T2T) stage (athletes aged 12–16 years) of the LTAD model, VC stated the following specific challenges: (a) developing athletes tend to under-train and over-compete when compared to top volleyball nations, (b) training programs tend to focus on competition preparation instead of overall volleyball and motor skills development, and, resulting from these two issues, and (c) too many competitions in relation to training (ratio of training to competition too low) that may lead to athletes getting position-specific training instead of all-round development.⁵

Issues in the “learning to compete” (L2C) stage (athletes aged 17–19) detected by VC were: (a) too much emphasis on specialization at the expense of continued refinement and improvement of volleyball and motor skills and (b) training that focusses too much on preparation for competition and not enough on volleyball and motor skills development.⁵

Finally, the difficulties with the “training to compete (T2C)” stage (athletes aged 20+) are: (a) an annual training period that is too short (e.g. Canadian inter-university sport (CIS)^c/Canadian Collegiate Athletic Association (CCAA)^d programs last six months); (b) athletes under-training when compared to athletes

from top volleyball nations; (c) no year-round training, which would normally allow for appropriate and gradual improvements in technical, tactical, motor, and physical skills development; and (d) too much emphasis on position (setter, middle, power, etc.) specialization at the expense of continued refinement and improvement of volleyball and motor skills.⁵ Winning is important at this stage; however, winning should not overshadow the holistic development of the athlete.

VC LTAD model

In line with their mandate from Sport Canada to produce an LTAD model to address the aforementioned issues, the experts from VC created the VC LTAD model. To allow the athletes to reach higher levels of physical, mental, emotional, cognitive, and sports skills, the LTAD recommended guidelines for each of its nine developmental stages. VC’s LTAD model specifically recommends that each training stage has methodological guidelines concerning the principle goals of the stage, the main training activities, an appropriate ratio of training to competition, and an appropriate training volume (in hours). VC’s LTAD also recommends guidelines about volleyball activities distributed across a year relating to the number of hours and sessions devoted to volleyball and physical training, the total amount of time devoted to volleyball and physical training, and the content of practices.

The LTAD guidelines for the three stages included in the present study – T2T in high school, L2C in college,^c and T2C in university – are described below. The researchers of the present study chose these three stages because (a) the T2T stage is when males in the province of Quebec typically begin to play volleyball, (b) the researchers wanted to observe different stages to compare the LTAD applications between them, and (c) the convenience of accessing these three stages for the data collection. Furthermore, it is possible to adapt the VC LTAD guidelines and stages to Quebec because the stage ages correspond to the ages of high school to college to university in this province.

T2T (high school). Male athletes in this stage are in the ages of 12 to 16. During this stage, basic volleyball skills and tactics should be consolidated. During competitions, athletes play to win and do their best, but the major focus of training is on learning basic volleyball skills and tactics and successfully applying those skills and tactics in competitive situations, as opposed to actual competition success.⁵

L2C (college). Male athletes from this stage are in the ages 17 to 19. The main objectives of this stage are to optimize physical conditioning, volleyball-specific

skills, and position specific skills. In this stage, it is also important to commit to a pathway that will optimize performance, by focussing on modelling performance competitions in training. Individual and position-specific training is provided to players with training volumes and intensities gradually increasing to high levels.⁵

T2C (university). Male athletes from this stage are in the ages of 20 and over. The main objectives of this stage are to continue to optimize fitness preparation, volleyball-specific skills, position specific skills, and to focus on performance. Individual and position-specific training is provided to players with high volume workloads, but with increasing intensity. Volleyball skills are performed under a variety of competitive conditions during training and optimum preparation is emphasised by competition simulations.⁵

VBQ LTAD

Because VBQ is the provincial federation responsible for operations related to volleyball development by following VC guidelines, it wrote its own LTAD model for the provincial context. Also, VBQ was obliged to write its own LTAD to receive funds from the provincial government, and VBQ had to explain the LTAD guidelines, recommendations, and goals during the training of their coaches. This explains why VBQ LTAD hours are different from VC LTAD hours. Also, it is important to note that VBQ, as well as VC, is funded by the respective government sports administrator only if they use the LTAD model. However, the VBQ LTAD is largely inspired by VC in terms of stages, objectives, and coaching philosophy.⁶ VBQ added to the VC LTAD by specifying the training guidelines in terms of the percentage of time to be devoted to various athletic skills in each developmental stage (see Table 1).

The present study

Little is known about the ways in which the LTAD model is followed during practice and, as a result, it appears that research is required to help understand how coaches apply the principles of LTAD.⁷ Therefore, the overall purpose of this study was to examine if volleyball coaches applied LTAD guidelines in practice during a season, following the instruction they received during their National Coaching Certification Program (NCCP) formation. More specifically, the objectives of this study were (a) to describe the skills trained by the athletes in three different LTAD stages and (b) to compare the percentage of time allotted by the coaches in training sessions to each of the skill categories when they attempt to base their practice design on the VBQ and VC LTAD models guidelines.

Method

Participants

The lead researcher's Ethical Research Committee granted ethical approval before the study was undertaken. Coaches needed to meet the following criteria in order to be eligible for the study: (a) coaching male volleyball athletes, (b) working with one of the three different developmental stages, (c) having a minimum of NCCP Level 1,^f and (d) interested in participating in the study. Prospective coaches were found with the help of a volleyball club that was in close proximity to the lead researcher's university (convenience sample). The coaches were then contacted directly by phone and invited to participate in the study. During a first meeting, coaches were informed about the overall aims of the study and the requirements of participation. Coaches who were interested were supplied with a letter inviting them to participate, a consent form, and consent forms for their athletes (because they would be observed by the researchers). Four coaches, aged 21 to 47, who coached male athletes in high school ($n = 2$), college ($n = 1$), or university ($n = 1$) participated in this multiple case study.⁸ The high school coaches spent 6 to 7 h a week coaching and had a technical Level 1 training from the NCCP of Canada. The college coach spent 35 to 70 h a week coaching and was NCCP Level 3 certified. The university coach spent 60 to 70 h a week coaching and also had NCCP Level 3 certification.

Data collection

In this multiple case study,⁸ the researchers used several data collection methods as a means of triangulation in order to reduce the risk of chance associations and systemic biases that can be the result of using only one data collection method.^{9,10}

First, a semi-structured interview guide^{11,12} was used to lead an initial interview with each coach ($n = 4$). The purpose of this interview was to gather information about the number of coaching hours per week, the number of practice and competition hours per week, the LTAD stage of the team, the NCCP level of each coach, the time devoted to the LTAD in NCCP training, and a self-evaluation of the coach about his LTAD knowledge.

Second, observations were made in order to describe the coaches' behaviours during practices¹³ and to validate whether the coaches actually did what they said they did.¹⁴ Therefore, observations were used to determine if there was consistency between training goals proposed by coaches and training tasks enacted during practices. The data collected during observations included the drills and the time devoted to the

development of technical skills (volleyball specific skills like set, pass, spike, serve, etc.), individual tactical skills (e.g. decision making by one player), team tactical skills (offensive and defensive schemes), and motor skills (agility, speed, coordination, etc.). The drills were categorised according to the objectives pursued by the coaches (e.g. if the objective of the coach was to develop the technical skill of serving and his feedback was oriented toward this volleyball technical skill, the drill was categorised as a technical skill drill, even if the serve was realised inside a game simulation drill).

Third, semi-structured interviews were also used before and after each practice observation. The before-practice interview gathered information about the development of technical skills, individual tactical skills, team tactical skills motor skills and annual planning. The after-practice interview gathered information about the time devoted to drills and the consistency between the practice goals and the skills trained during practice. Additionally, the after-practice interview afforded the researchers the opportunity to ask the coaches about anything observed that was in question, thus improving reliability.¹⁵

Lastly, over-the-phone semi-structured interviews were used to supplement observational data with three coaches. One coach from high school refused to participate in phone interviews. Each week, regardless of whether observation occurred or not, each coach was interviewed over the phone to gather information about: (a) the number of training hours devoted to technical and tactical skills, (b) the number of hours devoted to physical training, (c) the number of hours devoted to competition, and (d) the skills trained during practices. The phone interviews helped to create a holistic picture of the season's activities because it was impossible (due to a lack of finances and human resources) for the researchers to observe the coaches during all of their practices throughout an entire season. As well, the coaches' annual plans were examined to ascertain the amount of planned time for each of the above categories.

Data were collected from August to March. Eight practices (approximately one per month) for each of the four coaches ($n = 32$) were observed to gather information on the nature of drills performed during a volleyball season. Semi-structured interviews¹¹ of 15 to 20 min were conducted with the coaches before and after each of the 32 selected practices in order to ascertain the coaches' training goals. Eighty-six weekly phone interviews of 15 to 20 min were also conducted with three coaches to gather data for an entire volleyball season.

Data analysis

All audio-recorded interviews ($n = 150$) were transcribed verbatim. Each transcript was then analysed using deductive content analysis¹⁶; thus, the LTAD models from VC and VBQ were used as frameworks to create categories. The content analysis included three steps.

The first step involved reading all of the transcripts and creating lists of statements with pertinent information regarding the goals of each interview. The list of statements from the initial interviews related to (a) the number of coaching hours per week, (b) the number of practice and competition hours per week, (c) the LTAD stage of the team, (d) the NCCP level of the coaches, (e) the time devoted to the LTAD in NCCP formation, and (f) the self-evaluation of the coaches' LTAD knowledge. The statements listed from the before-practice interviews focussed on drills devoted to the development of technical skills, individual tactical skills, team tactical skills, and motor skills. Information about the time devoted to drills and the number of drills devoted to each skill was also sought in these interviews. As a second step, the researchers chose classification units (e.g. the number of practice and competition hours per week) based on the LTAD^{3,6} to loosely organise the lists of statements. Lastly, the researchers organised each statement into the final categories (based on the LTAD frameworks), seeking to obtain a synthesis of the statements. Additionally, a guide developed by VBQ⁶ was used to analyze the data collected through the observations in order to determine time devoted to technical skills, individual tactical skills, team tactical skills, and motor skills.

Trustworthiness

In order to seek trustworthiness, the researchers conducted a pilot study to test the data collection process¹⁷ with three coaches who did not participate in the present study. This pilot study was used to adjust the interview questions¹⁸ and the observation guide.⁶ Afterward, an expert in coaching science expert validated the data collection procedure. Furthermore, all interviews were audio recorded and transcribed verbatim to enhance descriptive validity,⁹ and all practices were video recorded to ensure that the researcher's analyses were accurate. All the observations were conducted by the lead researcher, who had 10 years' experience as a high performance volleyball coach at the time of the study, was certified NCCP Level 3, and is a learning facilitator (or course conductor) for VBQ and VC.

An inter-observer reliability procedure was used between the lead researcher and an expert volleyball

Table 1. VBQ LTAD training guidelines, expressed by the percentage of time to be devoted to technical, individual tactical and team tactical skills.⁷

Training to train		Learning to compete		Training to compete	
Skills	Percentage in time devoted to training	Skills	Percentage in time devoted to training	Skills	Percentage in time devoted to training
Technical	40	Technical	35	Technical	23
Individual tactical	20	Individual tactical	30	Individualtactical	37
Team tactical	40	Team tactical	35	Teamtactical	40

coach during a pilot study. The expert coach had over 30 years of experience in coaching, was still active in coaching, had coached at various levels, had won several national championships, and had been a master learning facilitator for VBQ and the Coaching Association of Canada. The procedure was done in two steps. First, the researcher and the coach observed the same video recorded practice and completed a data collection guide without talking to each other to avoid influences. The researcher and the coach repeated this step for five observations. Second, the researcher and the coach's results were compared, and the inter-observer reliability was calculated to be 92%.¹⁹

An intra-observer reliability procedure was also completed during the pilot study. The lead researcher completed the data collection instrument during the observation of five live practices and also video recorded these practices. Seven days after the live observation, the researcher observed each video recorded practice and completed the instrument again. After this step, the researcher calculated the intra-observer reliability using the same formula as was used to determine the inter-observer reliability. The intra-observer was 96%.

Results

The findings of the study are presented in Tables 2 to 5. Tables 2 to 4 describe the skills trained by the athletes from the three different LTAD stages and show comparisons between them and the VBQ guidelines. Table 5 presents the synthesis of the data collected from the three coaches regarding the time prescribed by the VC and VBQ LTAD guidelines and the time devoted to various skills training by each coach.

Tables 2 to 5 show (a) the LTAD stage of the coach, (b) the percentage of time planned by coaches to develop various skills (e.g. goals pursued by coaches), (c) the percentage of time actually devoted to trained skills during practices (trained skills columns), and (d) the VBQ LTAD guidelines percentage of time devoted to the development of various skills.⁶

Table 2. Coaches A and B (T2T/high school).

Stage	Training to train				
	Time planned, %		Time actually devoted, %		LTAD guidelines, %
	Coach A	Coach B	Coach A	Coach B	
Technical	49	40	35	41	40
Individual tactical	4	4	5	6	20
Team tactical	47	56	60	53	40

Note: Percentage of time planned for skills and percentage of time actually devoted to skills versus LTAD guidelines.

Table 3. Coach C (learning to compete stage/college).

Stage	Learning to compete		
	Time planned, %	Time actually devoted, %	LTAD guidelines, %
Technical	36	48	35
Individual tactical	27	24	30
Team tactical	37	28	35

Note: Percentage of time planned for skills and percentage of time actually devoted to skills versus LTAD guidelines.

Table 4. Coach D (training to compete stage/university).

Stage	Training to compete		
	Time planned, %	Time actually devoted, %	LTAD guidelines, %
Technical	38	49	23
Individual tactical	9	16	37
Team tactical	53	35	40

Note: Percentage of time planned for skills and percentage of time actually devoted to skills versus LTAD guidelines.

Table 5. Time in hours prescribed from VBQ and VC LTAD guidelines and the actual time devoted to various skills, physical training, motor skills and competition,

Stages	Training to train (Coach B)	Learning to compete (Coach C)	Training to compete (Coach D)
	29 weeks	32 weeks	24 weeks
Season	Observed and reported	Observed and reported	Observed and reported
Skills training (hours)	74	149	152
Physical training (hours)	10	69	63
Motor skills (hours)	0	0	0
Competition (hours)	27	90	125
Total hours	111	308	340
LTAD guidelines VBQ	226	384	480
LTAD guidelines VC	340–715	390–920	700–1450
Ratio of training to competition – % [VBQ guidelines] (reported)	[70/30] (76/24)	[60/40] (70/30)	[70/30] (62/38)

Results from Table 2 reveal that the VBQ LTAD guidelines for technical skills training tend to be respected by the T2T (high school) coaches. However, these two coaches under-trained individual tactical skills. In fact, they spent four to five times less training individual tactical skills compared to the VBQ LTAD guidelines. Based on the LTAD guidelines, coaches from the T2T stage over-trained team tactical skills. The VBQ LTAD guidelines recommend that 40% of time be allotted to team tactical skills, yet coaches A and B spent, respectively, 60% and 53% of their time on team tactical skills. Based on the interviews, team tactical skills appeared to be of high importance to the coaches; they were preoccupied with offensive and defensive team tactics. At the expense of the development of individual tactical skills, because of the many competitions during season and the level of importance usually accorded these competitions, the coaches prioritized team tactical skills to be ready for tournament play.

In the case of the T2T Coach B, he began to train team tactical skills on October 25th to prepare his team to its first competition.

Our first competition will be on November 28th. I plan to simulate a match to show [the players] how it is. I want to see how they will react in a match situation and to be ready for the first tournament of the season.

Coach B's training goals during November were oriented toward team tactical skills. "We trained defense with game simulation... It was to show where you have to go in respect to your position on the court... It was to really train during game simulation because we had a tournament that weekend".

Table 3 shows that Coach C from the L2C (college) stage over-trained technical skills (13% more than what is recommended). With regard to individual tactical skills, he was the only coach in the study who tended to respect the VBQ LTAD guidelines. Coach C also tended to respect the VBQ LTAD guidelines concerning team tactical skills training.

Results from Table 4 show that Coach D from the T2C (university) over-trained technical skills according to the VBQ LTAD guidelines. Individual tactical skills seemed to be under-trained. He devoted approximately half of the time recommended by the VBQ LTAD guidelines to training individual tactical skills. Coach D respected the VBQ LTAD guidelines concerning team tactical skills training. Team tactical skills and technical skills appeared to be of high importance to him; as a result, he prioritized team tactical skills to the detriment of individual tactical skills. For example, he said:

Our goals were to pursue our serve receiving development; our defense and our technical aspect of the spike because we are miserable at it. And the other goal was to continue our team coordination to adjust some elements we saw in the last tournament, last weekend. (October 25th to October 31st week.)

Overall, the results concerning goals show that the coaches followed goals directed towards technical and team tactical training. These goals were pursued by three coaches (A, B, and D) more than 90% of the time and more than 75 % of the time for Coach C. Team tactical skills training is a priority during the volleyball season and three coaches expected to train it during the majority, or nearly the majority, of their

season (A = 47%; B = 56%; D = 53%). It is interesting to note that coaches in the T2T stage followed similar goals as the coach in the T2C stage regarding training skills, regardless of the difference in the age of the players (12–16 versus 20+, respectively) and their volleyball sport experience between these two stages (one to two years of practice for T2T – high school athletes versus three to eight years of practice for T2C – university athletes).

Table 5 presents (a) the developmental stages, (b) the number of weeks in a season, (c) the total volume of activity (skills, physical, motor, and competition activities), and (d) the ratio of training to competition of the three coaches who participated in the full study (initial interview, before- and after-practice interviews, practice observations, and weekly phone interviews). Coach A only participated in the observations and before- and after-interviews. The data about volume, therefore, are not complete for Coach A, which explains why Coach A does not appear in Table 5. Table 5 presents time prescribed (VBQ and VC LTAD guidelines) and the actual time devoted to various skills (trained skills), physical training, motor skills, and competition.

The first element to acknowledge in Table 5 is that none of the coaches respected the VBQ and VC LTAD guidelines concerning the total volume of activity composed of trained skills, physical training, motor skills training, and competition. Coach B (T2T – high school), Coach C (L2C – college), and Coach D (T2C – university) were 49% (111 h vs. 226 h^g), 80% (308 h vs. 384 h), and 71% (340 h vs. 480 h) compliant with the VBQ LTAD guidelines, respectively. These proportions were lower when compared to the VC LTAD guidelines, being respectively 33% or 16% (111 h vs. 340 to 715 h), to 79% or 33% (308 h vs. 390 to 920 h), and to 49% or 23% (340 h vs. 700 to 1450 h), for Coaches B, C, and D. It is important to note that the vast difference between the lowest and highest VC LTAD guidelines in hours can be explained by the differing contexts of Canada's provinces. VC decided to recommend a number of hours attainable by all provinces.

Based on the interviews, the coaches attributed their difficulties in following the VBQ and VC LTAD volume guidelines to two factors: the amount of training hours allotted by school institutions and the competition schedule put in place by the Réseau du Sport Étudiant du Québec (RSEQ).^h Thus, Coaches B, C and D are dependent on school administrators who are responsible for the provision of gymnasiums and training hours for each sport at the school, college, or university athletic program. For example, Coach B expressed this many times during the after-practice interviews:

I was watching the clock and I didn't have the time to call a last play and the practice was already

finished... I'd like to have more time to let [the players] play, but with three hours per week, I do what I can.

Even though the training volume could be considered insufficient according to LTAD guidelines, Coach C deliberately reduced his training volume during six weeks for various reasons. For instance, during an exam session he reduced the amount of training time because "the guys were near their exams and they had schoolwork to do. They did not train volleyball skills during this week." Coach C also decided to reduce training volume during the Christmas break. He explained:

It was an active rest period. Therefore, during this week, they didn't practice volleyball because it was Christmas break and all the guys were home. The only thing they had to do was strength conditioning. They had four conditioning sessions during this week.

Another factor that was used to explain a volume reduction was a competition outside the province:

December 31st we took the airplane for [city name]. For sure airplanes caused tiredness. So it is considered like an active rest. January 1st [was] also an active rest day because I asked the guys to do a little bit of cardiovascular conditioning at the hotel because no gymnasium was available for volleyball training.

Transition periods also reduce training volume given that they were often a period of rest. As Coach C said, "There was no training, everybody was off. No strength conditioning, no volleyball, really off. I wanted to create a little transition period before a second mesocycle of six weeks."

However, not all of the coaches took this approach. Despite exam time, Coach D used almost all of the gymnasium time made available by his university's athletic department. Coach D kept almost the same training volume during exams, except for a slight reduction (120 minutes instead of 150 minutes): "...the goals were to keep the guys in touch with the ball and to work on defense. With the exam week, I wanted to achieve these two goals."

The other factor that made the VBQ and VC LTAD guidelines difficult to follow for the coaches was the competition schedule put in place by the RSEQ. Coaches B, C, and D had to follow the competition schedule set by the RSEQ administrators. At the beginning of the season, coaches received their competition schedules and they had to plan volleyball, strength, and motor skills training accordingly. To illustrate, Coach D said:

I start [my] plan by identifying my ultimate competition and then I place the other competitions backward until

the beginning of the season. At my ultimate competition, I want my players to be able to do that, that, and that. "That" is the level needed to win a national championship, that's it.

Coach C was similar,

I try to plan backward. I fix my goal with my final competition and I go backward until the beginning of the season. Afterward, I do my best to follow my plan and to prepare my players to be at their peak of performance during that competition. Therefore, I must plan the different mesocycles to achieve a peak of performance at the strength, mental, technical, and tactical level during that specific competition.

Coaches who wanted more competition had to undertake personal initiatives and take part in tournaments or matches outside of their leagues. This occurred with Coaches C and D who went to Alberta and Ontario, respectively, during the December holidays to compete against other teams.

The second element to note on Table 5 is the lack of time devoted to motor skills training by all the coaches. During this study, no drills were devoted only to motor skills (speed, agility, coordination, and balance). Motor skills were only integrated with volleyball skills during volleyball practice. The LTAD guidelines recommend for motor skills, dependent upon the LTAD stage, either developing in T2T, optimizing in L2C, or maximizing in T2C.^{3,6}

Also, it is important to note that when asked during the initial interview, "What is your knowledge about LTAD guidelines on a scale from one to five? One is very limited, 2 is limited, 3 is average, 4 is good and 5 is very good." Coaches A, B and D answered "very limited" and Coach C answered "limited" with regard to their comprehension of LTAD models and guidelines. Finally, all the coaches from this study were aware that VC and VBQ wanted them to apply LTAD guidelines.

Discussion

This study describes the nature (i.e. technical, individual, and team tactical aspects) of the skills trained by coaches in three different LTAD stages during volleyball practices over a full season in Quebec. Results revealed that the time devoted to training technical skills in T2T stage (high school) were respected according to the VBQ LTAD guidelines. However, technical skills were over-trained in the L2C (college) and T2C (university) stages; individual tactical skills were under-trained in the high school and university stages and team tactical skills were over-trained in the high school stage. When the results were compared to the

amount of time coaches are restricted to regarding their developmental stage, the LTAD guidelines were not respected because the amount of hours devoted to volleyball skills was insufficient. With these results in mind, this section of the article will discuss how realistic it is for coaches to apply the LTAD guidelines and the capacity of the current sport system to apply LTAD models.

Is it realistic for coaches to apply the LTAD guidelines?

This study brings into question the feasibility of applying the LTAD guidelines. For example, coaches were questioned about how realistic or desirable it is for a young athlete aged 12 to 16 to train 226 or 340 to 715 h a year.^{3,6} The results revealed that the T2T high school team actually trains 84 h a year. Even if these results (shown in Table 5) come from only one team in the study, they are quite possibly transferable to other volleyball teams of the same stage and of the same level in the province of Quebec because they operate in the same context as the teams studied.

The LTAD guidelines also include physical and motor skills training and conditioning (see Table 5). We believe that it is difficult for a coach with limited knowledge and/or competence in physical and motor skills training and conditioning to respect these guidelines. These guidelines also require the availability of gymnasiums in schools and a commitment from the athletes to meet the number of hours recommended. Thus, it is challenging for a coach who has access to a gymnasium for only a few hours a week (from 3 to 13 h, depending on the LTAD stage) to respect LTAD guidelines, which recommend sometimes two or three times that training volume. Quebec's school curriculum, furthermore, offers a variety of activities,¹ and this may contribute to the reduced time devoted by an athlete to any one sport.

Another limit to LTAD application is that LTAD models are linear models, meaning that they apply well to athletes who begin training in the first stage learning to train at 9 to 12 years old. This might help to explain why it is difficult for coaches to respect the LTAD guidelines given that male volleyball athletes in Quebec usually begin volleyball later⁶ in comparison to the LTAD stages. In this regard, they certainly have a developmental disadvantage according to the LTAD guidelines. For instance, a 17-year-old volleyball player who begins to play in college enters the sport at the prescribed L2C stage. However, the skills of this athlete are very likely similar to athletes at the T2T stage, or even the preceding learning to train stage. This athlete would then be tardy in the development of technical skills, individual and team tactical skills,

motor skills, physical training, and fundamentals. This might help to explain why it is difficult for coaches to respect the LTAD guidelines given that male volleyball athletes in Quebec usually begin volleyball later⁶ in comparison to the LTAD stages. While it has been recommended that young athletes play a number of different sports,^{20,21} this was not the focus of the present study. Therefore, as regards the development of volleyball players, the above situation puts such players at a different developmental level. It seems that the overtraining of technical skills seen in the university and college coaches' programs could be a sign of late participation and development in men's volleyball. This observation provides some support to the notion that university and college athletes who played volleyball for three to eight years had not acquired the basic technical skills to play at their level.

There is also an important difference between the LTAD guidelines of VC³ and VBQ⁶ regarding the number of hours devoted to training and competition. Part of the explanation for this difference relates to the national and provincial contexts. VC wrote the LTAD guidelines to be applied by all of the provinces in Canada but did not consider the fact that each provincial context may be different. VBQ wrote their LTAD guidelines directly applicable for its provincial context where male volleyball players begin playing in high school.

Perhaps, VC and VBQ should consider proposing guidelines that take into consideration that athletes might be participating in extra-curricular sports leagues. For example, an athlete can train with a team during the school season, train with a second team outside of school (e.g. in a club competition network), and with a third team during the summer at the provincial or national level. By adjusting the training volume guidelines according to athlete profiles, it may be easier to obtain a guideline representative of an athlete's reality and, thus, facilitate the application LTAD guidelines by coaches, sport, and school administrators.

The capacity of the current sport system to apply LTAD models

The results showed that coaches experienced some difficulties with regard to respecting the LTAD guidelines. It may be difficult for them to acquire the procedural knowledge^{22,23} required to apply LTAD guidelines. In this study, the coaches' understanding and knowledge about LTAD models were limited or erroneous, something that was revealed in the initial interviews. As mentioned, the coaches answered "very limited" (n=3) and "limited" (n=1) to all of the questions related to their comprehension of LTAD models and

guidelines during the interview. With these results, it is relevant to wonder if coach education programs on LTAD are sufficient for coaches to be able to apply the LTAD guidelines.

A study of cross-country ski coaches working with athletes 3 to 6 year old found that the integration of LTAD principles into their coach education for these stages (active start and fundamentals) enabled coaches to both explain the core principles of the model and explain how they used these in their coaching.⁷ In volleyball, coaches are informed about the LTAD guidelines when they receive their NCCP certification Levels 1 and 2. After their certification, coaches are left alone in their practice environment. VC and VBQ have assumed that coaches adapt their practice to meet the LTAD guidelines, which they may (or may not) have assimilated during NCCP workshops. As Martens²⁴ said, "knowledge obtained from experts and scientists are integrated into formation activities by hoping that coaches will memorize it and apply it directly in their practice and activities." However, this supposition rarely applies, and many studies have shown that participation in formal coach education activities does not necessarily change a coach's competencies.²⁵⁻²⁷ Moreover, information taught during formal coach education courses is often not actualised in practice.^{28,29} Given the findings of Banack et al.,⁷ it might be worth examining how cross-country Canada supports its coaches once they leave the formal workshop and begin to practice.

Based on the present data and the current challenges with applying the LTAD guidelines, at least for the volleyball contexts studied, it seems necessary to put forward programmes and initiatives to better inform coaches about the LTAD guidelines and how to apply them, since the Canadian federal and provincial sport administrators have decided to tie funding for sports to the use of this model. For example, VC and VBQ could organise mentoring programs,³⁰ supervision programs,³¹ or communities of practice.³²⁻³⁴ These programs may help to support coaches in achieving the following three goals: (a) applying LTAD theory to practice,³⁴ (b) reflecting on how to apply LTAD guidelines in practice, and (c) developing sport skills^{35,36} connected to LTAD guideline applications.

To bring these mentoring, supervision, or community of practice programs to fruition, VC and VBQ could identify mentors, supervisors, and/or community of practice facilitators who have demonstrated their competence in these fields in order to afford supervision opportunities.³¹ The goal of this kind of supervision would be to assist coaches in the application of LTAD guidelines in practice. An evaluation of the feasibility of these initiatives, however, is needed in order to assess the most efficient solutions, based on

the available resources, to help coaches improve their practice.

To encourage and enhance the application of LTAD guidelines, VC and VBQ could try to put projects in place like grants to LTAD friendly programs, recognition galas, and rules or score systems adapted to development. It should be noted that VBQ³⁷⁻³⁹ is trying to implement these kinds of initiatives. Of course, it is necessary to ask if these actions are realistic and desirable. For example, a coach's recognition comes from victories and championships^{34,40,41} and not from athlete development by adhering to LTAD guidelines. This situation may be explained because the recognition of wins and losses equates to the amount of funding received by NSOs and PSOs. According to Charest,⁴² funding criteria are mostly "based on: (a) competition network development; (b) high-level athlete performance and (c) the elaboration of excellence and participative development models" (p. 86). Such criteria could impact coaches who attempt to apply LTAD guidelines to assist with their athletes' development and who favour an LTAD over early sport specialization.

By changing the "win at all cost" paradigm, coaches may be more able and willing to follow LTAD guidelines. Sport and school administrators could also prioritise LTAD application by merging LTAD with health and physical education curricula in their schools. To do this, they might integrate LTAD into their public policies and provincial or territorial educational missions, allowing for greater access to training hours. This paradigm shift could take a few years to implement and would require a much greater alignment between political, sport, and school stakeholders than that which currently exists.⁴³

It could also be beneficial to implement the LTAD-multisport school program, which focuses on physical, mental, emotional, and cognitive development of student-athletes.⁵ This program aims to develop the fundamental and overall sport skills necessary to achieve high levels of sport excellence within school athletic programs and health and physical education courses.⁴⁴ This type of school program could simultaneously expose young athletes, aged 9 to 16, to multiple sports such as volleyball, gymnastics, athletics, and weightlifting.

Limitations

It is important to keep in mind that the results of the present study cannot be generalised, but may be transferable.⁴⁵ Indeed, it would be unrealistic to believe that all volleyball coaches from Quebec and Canada only respect some of LTAD guidelines based on the data collected from four coaches in the same geographical area. For example, given that education is provincially

controlled in Canada, there are substantial differences between high school sport programs in the different provinces and territories. However, with this multiple case study, the goal was to provide an in-depth description of a few coaches' practices using a multiple-method approach. This helps to explain the recruitment choice of coaches from three different LTAD stages. Moreover, the researchers only observed 32 volleyball practices of four coaches during a season. However, full season data from the volleyball practices, physical training, and competitions were gathered with 86 weekly phone interviews. Thus, data were gathered from the coaches' points of view over one season. Finally, this study did not examine athletes' profiles and contextual variables, which could have been used to explain the nature of the proposed drills used by the coaches. For instance, a few athletes selected for provincial or national summer programs continued their development outside of the observed season, thereby certainly increasing their training volume.

Future directions

To explain the overall technical weaknesses of Canadian volleyball players, it may be worthwhile measuring the quality of training offered to the athletes with indicators like active learning time in physical education or opportunity to respond.^{19,46} Researchers could then determine whether these weaknesses are caused by late sport participation or not. Studies with an LTAD focus could describe coaches' intervention effectiveness and training process complexity, which would bring together contextual factors like player and team needs, sport legislation, and resources availability for coaches and athletes. Also, futures studies might explore the school institution and competition networks' (RSEQ, CCAA, SIC) scheduling processes because it is unsure of whether these organisations consider LTAD guidelines when they make-up schedules. To supplement the current study as well as the Banack et al. study⁷ LTAD applications could be explored in other sports, with more coaches and, data from other provinces could be added to the present study to provide a more holistic Canadian perspective for volleyball. Finally, another alternative could be the exploration of LTAD applications directly in physical education courses in high school and college to be able to detect how adolescent and young adult motor development is addressed.

Conclusion

The present study described how volleyball coaches in three academic sport settings applied, or not, the guidelines of their sport governing bodies (national and

provincial); a topic that has received little attention in the academic literature.^{4,47} The LTAD guidelines first emerged as a result of the difficulties regarding athlete development observed by Sport Canada,³ VC,⁵ and VBQ.⁶ These guidelines, based on recommendations by VC and VBQ, prescribe actions for coaches to take in order to enhance athlete development in volleyball.

The results showed that coaches could only control and apply some of the LTAD guidelines. In this study, coaches were in a position to plan practice content during the competitive season but were restricted by multiple factors (e.g. RSEQ control of the competition schedule). The amount of time devoted to various skills (technical, individual and team tactical) remains the main challenge regarding the implementation of the LTAD guidelines. However, this study reveals that coaches' LTAD knowledge is also limited. Thus, it is not surprising that the practice plan goals of three out of the four coaches were not oriented towards the LTAD guidelines. The college coach was the only one who approached adherence to the VBQ LTAD guidelines.

Given that sport administrators in Canada have decided that the implementation of LTAD guidelines is important, sport funding being dependent upon this, and given that coaches' knowledge regarding LTAD guidelines needs improvement, it may be beneficial to implement various complementary educational strategies beyond formal courses such as supervision, mentorship, and communities of practice for coaches. Moreover, in order to allow for adequate training and competition volumes, school institutions and competition networks should consider the LTAD guidelines when making their schedules and allotting funding for sport. These incentives could, perhaps, help coaches to apply the LTAD guidelines in the future.

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Notes

- a. National Sport Organisation (e.g. Volleyball Canada, Hockey Canada, Baseball Canada, etc.).
- b. Provincial Sport Organisation (e.g. Volleyball Quebec, Hockey Quebec, Baseball Quebec, etc.).
- c. CIS is the national governing body of university sport in Canada, comprising the majority of degree granting universities in the country.

- d. The Canadian Collegiate Athletic Association (CCAA) is the national governing body for organized sports at colleges in Canada.
- e. In Quebec, college refers to CEGEP, a version of tertiary education between high school and university, which regroups students aged approximately 17 to 19.
- f. The NCCP is Canada's national coach education programme. Volleyball Canada is one of the 67 National Sport Organisations who are NCCP partners. The volleyball NCCP Level 1 is for beginner coaches who will introduce volleyball to new players in a non-competitive context. The emphasis of the Level 1 is on the basic volleyball skills and fundamentals. In Quebec, approximately 3 h are devoted to the LTAD model during this workshop. The volleyball NCCP Level 2 is for intermediate coaches who will introduce players to a competitive path. In the Quebec Level 2 workshops, an average of 1 h is devoted to LTAD recommendations. The Level 3 is for high-level coaches who will develop players for competition and no time is formally allotted to LTAD recommendations during the workshop.
- g. The first number is the actual training hours of the coach and the second number is the LTAD recommendation.
- h. The RSEQ, which translates literally to Quebec School Sports Network, is in charge of the organization and planning of the sport competition in high school, college and university in the province of Quebec in Canada.
- i. Fifty-nine sports and physical activities are offered in Réseau du Sport Etudiant du Quebec not including "mini" (mini-volleyball, mini-basketball, etc.) variations.²¹ This situation influences gymnasium availability.

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