Training duration may not be a predisposing factor in potential maladaptations in talent development programmes that promote early specialisation in elite youth soccer.

Abstract

Purpose To determine whether training duration is a predisposing factor in potential maladaptations in talent development programmes that promote early specialisation in elite youth soccer.

Methods Training times and type of one-hundred-and-eighty-four elite soccer players, from the under 9 (U9) to under 21 (U21) age groups (age 9.4 to 18.4 yrs.; stature 1.38 to 1.82 m; body mass 32.2 to 76.2 kg) was recorded.

Results Total training time progressively increased between the U9 (268 ± 25 min/week) and U14 (477 ± 19 min/week) groups with the majority of training time (96.5 ± 3.9%) consisting of soccer training and matches. Total training time then subsequently reduced from U14 to U15 (266 ± 77 min/week) groups, with no differences in training time between U15 and U21. Only U15 to U21 players completed resistance training; this inclusion coincided with a reduction in soccer training and match play when compared to time spent in these activities for younger groups (73.8 ± 3.2% of total training).

Conclusion Data suggest that although the majority of training is focused on technical development, the training duration as a whole is unlikely to contribute to potential maladaptations in talent development programmes in elite youth soccer.

Keywords: Athletic training; development; LTAD; adolescent

Introduction

Professional soccer clubs place great importance on training young players to perform in their first team squad. The developmental requirements of young soccer players are multi-factorial as their performance depends on components including technical, tactical, psychological and physiological indices. Whilst there is substantial research on senior players (1–4), there is limited data clearly outlining the processes relevant to development of young players. This is especially the case for information regarding the specific structure of their training programs.

An ergonomic perspective on elite youth soccer indicates training should involve a range of activities directly relevant to the sport's performance requirements. These can be broadly divided into two categories; exercises performed on the field of play (soccer-specific exercises) and non-soccer specific activities undertaken off pitch. On-field training generally mimics soccer match play to some extent and frequently involves soccer drills, actual match play or variations of both (5). Off-field training is generally designed to improve a player's athleticism without exact replication of soccer-specific movements. This often takes the form of exercises to improve efficiency and quality of movement with, or without the application of an external load (6).

The Elite Player Performance Plan (EPPP) is a programme adopted by elite soccer organisations that recommends structures for the programming of such training in developing players. The programme requires an increased volume of on-pitch training when compared with previous guidelines. Criticisms of the EPPP suggest it may encourage early sport specialisation, which may be related to sub-optimal development programmes. For example, a high volume of similar training may cause increased injury risk, social isolation and burnout (7,8). No data currently exists that attempts to quantify the training practices in elite

soccer academies with a view to contrasting them with the recommendations in the EPPP. This limits opportunities to determine the potential for this training to be associated with levels of activity that are considered to be maladaptive for the young player's path towards senior elite status.

The aim of this study was therefore to determine both the extent of training specialisation (e.g. solely, or primarily soccer based) and (b) training volume in an elite soccer academy by elite academy soccer players (ranging from U9 to U21 players) over an 8-week, in-season, period.

Methods

Players were recruited from under-9 (U9), U10, U11, U12, U13, U14, U15, U16, U18 and U21 age groups of an English Premier League, category one academy. One-hundred-and-eighty-four players were monitored over an 8-week period during the 2013-2014 season (Table I). Under-18 and U21 groups were engaged in full-time training, five days/week with one competitive (90-min) match/week. Under-9 to U14 and U15 to U16 age groups engaged in training on a part-time basis and participated in one (60- or 80-min) match/week respectively. This study conformed to the university ethics regulations and the Declaration of Helsinki.

****Table I around here****

To aid evaluation of weekly training structure, specific sub-components were categorised. Categories were soccer training (ST) and match play (combined to form *total soccer training,*

TST) and resistance training (RT) and non-resistance training based athletic development (NRT) (combined to form *total non-soccer training, TNST*). Soccer training was defined as a programmed session devised to enable players to cope with the demands of match play (9). These sessions focused on players' tactical understanding and/or technical ability as well as recovery training sessions completed following matches. Match play was organised soccer matches, against other clubs, with duration dictated by age group. Sessions using external load (barbells, dumbbells, resistance bands etc. but not opposition players) were defined as RT. Sessions designed to improve movement skills (mobility, stability and strength) without the use of external loads were defined as NRT. Days when players were not scheduled to report to the academy were defined as rest. Session durations were recorded using a mobile phone stopwatch or clock.

Determining Training Regimes

All training was monitored over an 8-week period for all players. Match and ST duration was recorded either by the principle investigator directly (U16 to U21 groups) or was communicated from the coach of the specific group to the investigator via email (U9 to U15 groups). All RT sessions were recorded on individual training programme cards issued to the players to record the details of each session. Exercise, set and repetition count was prescribed by expert accredited strength and conditioning coaches at the club. To determine RT regimes completed, session duration, exercise type and set number were evaluated for each player during each session. Duration was defined as the total minutes each resistance training session lasted. Exercise type was defined as whether it primarily had an upper- or lower-body focus. Set number was defined as the number of groups of repetitions completed in succession before a designated rest period. For U12 to U14 age groups NRT sessions required the coach to demonstrate an exercise, which was then copied by the group. This

resulted in all players in that group completing identical training sessions. These sessions were then quantified using the session plan for each training session.

Statistical analysis

Data were assessed for normality of distribution according to the Shapiro-Wilk's test. Statistical comparisons between age groups for TST and TNST were subsequently performed using a one-way between groups ANOVA/Kruskal-Wallis test where normal distribution of data were or were not found, respectively. Where main effects were present, Bonferroni *post-hoc* analysis was conducted to locate specific differences. Differences were also calculated and presented using 95% confidence intervals (95% CI). Additionally, effect sizes (ES) were calculated (difference between means divided by the pooled standard deviation) with the following quantitative criteria used: trivial < 0.2, small 0.21-0.6, moderate 0.61-1.2, large 1.21-1.99, and very large ≥ 2.0 (10). Analyses used SPSS for Windows (version 21, SPSS Inc., IL) where $P < 0.05$ indicative of statistical significance.

Results

Typically scheduled training occurrences for all training types, for all age groups in the period studied are displayed in Table II.

****Table II around here****

Total training time (all training types combined) increased from U9 to U14 age groups. Specifically, an increase was seen between U9 and U10 (95% CI = 104 to 132 min, ES = 5.2, $P < 0.01$) though not between U10 and U11 ($P = 0.864$). An increase in total training time was also seen between U11 and U12 (95% CI = 67 to 98 min, ES = 3.0, $P < 0.01$) but not between U12 and U13 nor between U13 and U14 ($P > 0.097$). From U14 to U15, a reduction

in total training time was observed (95% CI = 162 to 261 min, ES = 3.8, $P < 0.01$). No further differences were seen from U15 to U21 (P ranged from 0.262 to 0.887, Figure I).

Total soccer time followed a similar trend to total training time in increasing between U9 to U14. Specifically, differences were seen between U9 and U10 (95% CI = 104 to 132 min, ES = 5.2, $P < 0.01$), although not between U10 and U11 ($P = 0.864$). An increase in TST was also seen between U11 and U12 groups (95% CI = 36 to 65 min, ES = 2.0, $P < 0.01$) though no differences between U12 to U14 were seen ($P \geq 0.431$). From U14 to U15, a reduction in TST was seen (95% CI = 210 to 276 min, ES = 6.3, $P < 0.01$). Total soccer time was not different between any age group from U15 to U21 ($P \geq 0.4$). Total non-soccer time was zero in the U9 to U11 groups (due to non-participation). Duration of TNST did not differ between U12 and U13 ($P = 0.06$), although there was an increase from U13 to U14 (95% CI = 6 to 13, ES = 2.0, $P < 0.01$), and U14 to U15 (95% CI = 13 to 50 min, ES = 1.5, $P < 0.01$). No differences were seen in TNST between U15 and U21 groups ($P \geq 0.121$).

****Figure I around here****

Discussion

The aim of this study was to determine both the extent of training specialisation (e.g. solely, or primarily soccer based) and (b) training volume in an elite soccer academy. Data confirmed that although total training time was largely composed of on-field soccer-related activities, and so reflected a high degree of early specialisation, when compared to guidelines the total volume seemed unlikely to be detrimental to the development of the players in the club in question.

Our data provide the first account of training duration and distribution across all age groups within a professional academy system. Training for U9 to U11s consisted entirely of ST and match play. From U9 to U14, approximately 97 ± 4% of training comprised these activities with the remaining time spent undertaking non-soccer training specific activities. Such a focus on technical/tactical development is supported by previous research, which illustrates that positive effects on fitness and motor control were associated with high exposure to sport (11). The greater time afforded to technical development through soccer specific activities provides a clear foundation for players to attain a suitable level of competency in the specific skills required in the game (12). It has also been suggested that such low/moderate structured technical training is more suitable for younger athletes for optimising development (in this case ST and matches) (13). Others, however (14,15), have suggested this period of childhood may be better suited to optimising physiological adaptations to non-soccer training. For example, a combination of NRT and RT may be more beneficial for fundamental gross motor co-ordination (e.g. rapid changes in direction while maintaining body control) required by sports including soccer (16,17).

As a result of the implementation of the EPPP youth players now attend multiple weekly training sessions for both competition and training. ~~Furthermore~~Furthermore, the EPPP states that (depending on academy classification) academies should provide 4 to 8 and 12 to 16 hours contact time in U5 to U11 and U12 to U23 respectively. Ultimately, the increased training time required in the EPPP is aimed to enhance technical proficiency and enable greater opportunity for progression towards elite player status. Read et al. (2016) suggested that such strategies that are based upon the theory of accumulating 10,000 hours accumulated practice (18) may be flawed. Such volumes of training in maturing athletes may increase injury risk (especially during peak height velocity), social isolation and burnout (8). The

actual data presented here suggests that the academy in question seems to include overall training durations that are towards the conservative end of the 10,000hrs. Interestingly, a marked drop in total training is also seen from U14 to U15 age groups. This is counter-intuitive to what may be expected and it is proposed that this is a result of physical periodisation around matches (i.e. taper into and recovering from matches). This may suggest that the potential for issues associated with excessive specialised training loads (leading to maladaptations) is in reality small. It is difficult to accurately determine the reasons for the prescription of such total training volumes within the academy in question. Such programmes may reflect an acute awareness of the needs of the developing athlete and the dangers of excessive loading within the staff at the club. It is however, a limitation of this study that duration is used as a marker of volume. Continuations of this work should look to consider the intensity of work undertaken to help build a more complete picture of training completed. This may include the utilisation of such tools as global positioning system technology, which would allow a greater understanding of training load completed.

In summary, we provide novel data that illustrates a high level of early specialisation in the activities completed within a developmental programme at an elite soccer club. This amount of activity did not seem to be commensurate with training loads that have been considered maladaptive within the published literature conceptual on optimal training load (8). This suggests that overall training loads (volume) in young players, if completed at this level on a wider basis may not be a key concern. Further research should look to explore if such patterns are replicated in other organisations as well as investigate the potential importance of the inclusion of more diverse training stresses.

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Table I. Participant characteristics (mean ± SD) for the Under 9 (U9) to the Under 21 (U21) age groups (*n* = 184)

Age Group	Age (years)	Stature (m)	Body Mass (kg)	Body Mass In (kg/m^2)
U9 (*n* = 23)	9.4 ± 0.3	1.38 ± 0.07	32.2 ± 5.1	16.9 ± 1.2
U10 (*n* = 21)	10.4 ± 0.3	1.43 ± 0.07	34.4 ± 4.5	16.8 ± 1.2
U11 (*n* = 28)	11.4 ± 0.3	1.47 ± 0.07	37.1 ± 4.4	17.2 ± 1.3
U12 (*n* = 24)	12.4 ± 0.3	1.53 ± 0.08	41.7 ± 5.5	17.8 ± 1.3
U13 (*n* = 18)	13.3 ± 0.2	1.63 ± 0.10	47.7 ± 7.6	18.0 ± 1.5
U14 (*n* = 16)	14.5 ± 0.2	1.68 ± 0.07	56.9 ± 8.9	20.2 ± 1.8
U15 (*n* = 12)	15.3 ± 0.3	1.74 ± 0.05	61.2 ± 4.8	20.2 ± 1.6
U16 (*n* = 12)	16.4 ± 0.1	1.81 ± 0.08	70.0 ± 6.0	21.4 ± 1.3
U18 (*n* = 18)	17.4 ± 0.5	1.82 ± 0.06	76.2 ± 8.5	23.0 ± 1.7
U21 (*n* = 12)	18.4 ± 0.9	1.81 ± 0.07	72.4 ± 6.2	22.1 ± 1.8

Table II. Overview of typical training activities for Under 9 (U9) to Under 21 (U21) players. Session included are soccer training (ST), non-resistance training athletic development (NRT), matches (M), resistance training (RT) and days on which no formal training is completed (Rest).

	U9	**U10**	**U11**	**U12**	**U13**	**U14**	**U15**	**U16**	**U18**	**U21**
Mon	Rest	ST	ST	Rest	Rest	Rest	Rest	Rest	ST	M
Tues	ST	Rest	Rest	ST, NRT	ST, NRT	ST, NRT	ST	ST	ST, NRT, RT	Rest
Weds	Rest	ST	ST	ST	ST	ST	ST	ST, NRT, RT	ST	ST, NRT, RT
Thurs	ST	Rest	Rest	ST, NRT	ST, NRT	ST, NRT	ST	ST	ST, NRT, RT	ST
Fri	ST	ST	ST	ST	ST	ST	ST, NRT, RT	ST, NRT, RT	ST	ST
Sat	Rest	ST	ST	Rest	Rest	Rest	Rest	M	M	ST, NRT, RT
Sun	M	M	M	M	M	M	M	Rest	Rest	ST