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Identifying homogenous groups regarding situational-motor abilities of young football players

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Abstract
In practical kinesiology, be it in sports training or in classes of physical education, it is often necessary to split the total amount of subjects (relatively homogenous sample) into a smaller number of homogenous groups in order to both adjust and bring in line the exercise training programs with characteristics and abilities of individuals. The number of homogenous groups or taxa is an issue which is, in statistics, dealt with by means of procedures of classification that we call taxonomic or cluster analysis (Rađo and Wolf, 2002). This research is an attempt to classify the total sample of 164 football players aged 12 to 14 described with six situational-motor abilities, in an optimum number of homogenous groups that have same or similar abilities. The aim of research was to display a model for objective selection making with young football players; creating preconditions for a better specific football training programming with this age group was also a focus of this study. Results show that five homogenous groups were isolated out of the total sample number of young football players; these are distinct in the number of subjects and their level of situational-motor abilities. Further analysis of the five isolated groups showed a latent structure of the research field; it is distinct on the basis of the number of isolated factors and the position of evident variables on these factors.

Key words: **football players, taxonomic analysis, exercise training technology, homogenous groups**

Sažetak
U kineziološkoj praksi, bilo da se radi o sportskom treningu ili nastavi tjelesnog odgoja, često je nužno izvršiti podjelu većeg broja entiteta (relativno homogeni uzorak) na manji broj homogenih grupa kako bi se trenažni programi podesili i prilagodili prema karakteristikama i sposobnostima pojedinaca. Broj homogenih grupa ili taksona je problem koji se u statistici rješava postupcima klasifikacije koje nazivamo taksonomska ili klaster analiza (Rađo i Wolf, 2002). Ovo istraživanje je pokušaj klasifikacije ukupnog uzorka od 164 nogometaša uzrasta 12-14 godina, opisanih sa 6 situaciono motoričkih sposobnosti, na optimalan broj homogenih grupa koje imaju iste ili slične sposobnosti. Cilj istraživanja je bio da se prikaže jedan model za provođenje objektivne selekcije mladih nogometaša i stvaranja preduslova za kvalitetnije programiranje specifičnog nogometnog treninga kod ovog uzrasta. Rezultati pokazuju da se u ukupnom uzorku mladih nogometaša izolovalo pet homogenih grupa koje se razlikuju i u broju entiteta i u nivou ispoljavanja određenih situaciono motoričkih sposobnosti. Daljom analizom izolovanih grupa utvrđena je latentna struktura istraživanog prostora, koja se razikuje i prema broju izolovanih faktora i prema položaju manifestnih varijabli na tim faktorima.

Ključne riječi: **nogometaši, taksonomska analiza, trenažna tehnologija, homogene grupe**

Introduction

Footballers' motor abilities have so far been greatly analyzed and defined, but it is a fact that our knowledge of the variability of these abilities in the course of their ontogenetic development is still insufficient. Psychomotor abilities are predominantly genetically preconditioned; however, they are further acquired and changed through exercise training technology. This being the fact, there is the possibility to affect psychomotor ability improvement through appropriate exercise training means and methods. The motoric performance of any structural exercise in football (e.g. kicking, passing) is a complex action consisting of intellectual and motor abilities, technical and tactical knowledge i.e. it is the result of bodily activity linked to the optimal involvement of motor abilities. Therefore, the most acceptable definition of football motor abilities is that it is - the most rational and most intelligent, functional and deliberate performance of motor tasks with and without a ball in different in-game situations (Elsner and Metikoš, 1983). Situational-motor abilities have a common motor base defined by coordination, explosive power, movement and its frequency, preciseness and balance (Talović at al., 2010). Exercise training technology optimization with footballers of young age also depends on appropriate methodological information which are a precious resource in planning and further programming of training sessions (Čolakhodžić at al., 2008; Jelešković at al., 2008). These facts serve trainers as a benchmark to adapting their training sessions properly. In football praxis, especially with footballers of young age, the problem of large inhomogeneous groups of children regarding the level of acquired motor performance is frequently encountered. In such situations, children that are inferior morphologically, functionally or because of their motor abilities can't catch up with children that are superior i.e. children that are on a higher level regarding certain skills and characteristics. Superior children's capacities are, on the other hand, restrained. Exercise training process should aim at acquiring optimum level of physical preparedness and discovering an appropriate physical stress level which has to yield in the best result possible (Ćorluka and Talović, 2006). Modern football training, therefore, should include an individual approach in order for the individual to achieve their maximum potential. Due to these reasons, there is the need of creating homogenous groups in order for the exercise training technology to be adapted for the individual or individuals of similar properties. Homogenous group identification is based on same or similar properties and characteristics of children in the exercise training process. Thus acquired information serve for an optimization of transformation processes with young footballers, more quality comprehensive anthropological development, detection of advantages and reservations, secondary selection, and a more purpose-serving exercise training process programming in football. Such approach to exercise training technology will certainly have greater impact and result in a higher level of individual motor preparedness manifestation. In this context, the selection and specialization in football can't be appropriately conducted without scientifically founded information on the typology of young footballers included in a long-term sports program.

Methodology

From a time perspective, this survey has the property of a transversal study with the aim to identify homogenous groups in situational-motor abilities with footballers aged 12 to 14 in Bosnia and Herzegovina.

Sample of subjects

The research was conducted on a sample of 164 pioneer football league players aged 12 to 14 who compete in football leagues in Bosnia and Herzegovina. The sample consists of the following clubs: F.K. "Sloboda" – Tuzla; N.K. "Jedinstvo" – Bihać; H.N.K. "Branitelj" – Mostar; F.K. "Bjelopoljac" – Potoci. Only subjects who are healthy (i.e. subjects without morphological, psychological or other aberrations), and subjects who are registered footballers with a three-year period (at least) into the exercise training processes of the respective club have eventually been taken in account.

Sample of variables

All tests and measurements of the sample of subjects were conducted in the club's respective sport centers. In accordance with the method of International Biological Program (IBP), anthropometric measuring was conducted in early-morning hours from 9 am to 10 am in order to avoid variations of certain body parts and. Standard measuring tools previously gauged and checked were used in the course of measurement. Situational-motor abilities were tested from 2 pm to 5 pm, in accordance with regular training activities. All subjects were properly dressed in appropriate sports outfits. Motor abilities were measured on checkpoints with proper pauses between tests in order for subjects to rest. The six chosen variables hypothetically covered the latent field of situational-motor abilities: ball manipulation, assessment of ball handling speed and ball shot power. All tests are standardized and published (Gabrijelić at al., 1983); all tests have previously determined metric characteristics and are applicable onto our sample age.

1. Horizontal bouncing off wall, 20 sec. (SNKOST)
2. Shooting at wall after ball bounced off ground (SNKUPO)
3. Ball handling speed (slalom) (SNKSLA)
4. Ball handling speed (semicircular) (SNBVPO)
5. Ball handling speed, 20 m after getaway (SNBV20)
6. Shot power, header (SNESGL)

Data processing methodology

Collected data was processed with a computer program called SPSS (V 12.0). Homogenous groups in the field of situational-motor abilities were identified by means of hierarchical cluster analysis. The "nearest neighbor'' technique was used to gather groups. Based on the graph (dendrogram) of incipient successive joining of entities we were able to determine the number of groups the subjects should be split into. Next, we applied the K-means (Quick cluster) analysis which is suitable for studies with a vast number of subjects (Rađo and Wolf, 2002). The structure of isolated clusters in the latent field was conducted by means of factor analysis. Beginning with intercorrelation variable matrices, we used Principal component analysis; direct oblimin transformation was used as the base bias of the transformations.

Results and discussion

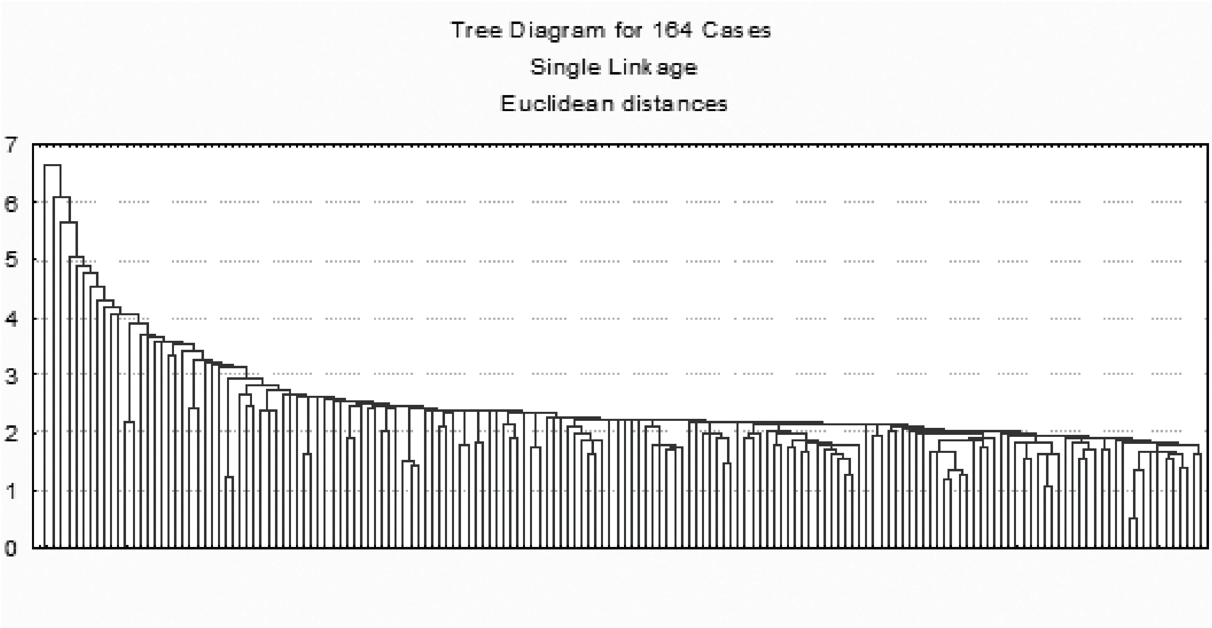
Table 1 shows basic descriptive variable parameters with footballers aged 12 to 14. The table also shows body weight and height where we can see the average value of subjects' height of footballers this age in Bosnia and Herzegovina (159.30±9.5 cm and 48.25±10.2 kg). Compared with other studies done so far - Kurelić at al. (1975); Bilić, Rađo, Ramadanović, Talović (2003); Čolakhodžić at al. (2008) - we can state that our subjects have average values regarding height and weight which is appropriate for the given age group. If we compare the results of situational-motor abilities with studies done so far – Kvesić 2002; Bajramović, 2007; Bajramović at al., 2008) - we can notice that subjects of this study showed less effective performance on variable SNKSLAf i.e. evaluation of ball manipulation ability. Regarding the second variable on ball manipulation ability (SNKOST) subjects showed better results as compared to subjects from the above mentioned studies. Varibles on ball handling speed (SNBV20) and header power (SNESGL) show that our subjects have achieved similar values as compared to other studies. Henceforth, we can conclude that results from situational-motor abilities on our sample of subjects don't vary significantly from results of studies carried out so far.

Table 1. - Basic descriptive variable parameters

Variable	N	Min.	Max.	Mean	Dev. Lev.
AVIS	164	140.20	181.00	159.3012	9.53467
AMAS	164	31.20	86.40	48.2555	10.27429
SNKSLA	164	11.22	23.59	15.2642	2.26222
SNBV20	164	3.34	6.22	4.4390	.51661
SNBPVO	164	13.31	22.31	17.3622	1.78884
SNKOST	164	6.00	18.00	13.2927	2.52588
SNKUPO	164	2.00	20.00	8.5488	3.80556
SNESGL	164	2.90	11.60	6.5928	1.49555

The incipient hierarchical joining and matching of subjects is shown on Illustration 1. We can notice the number of homogenous groups that were formed in the field of situational-motor abilities.

Illustration 1. - Techniques of joining on Euclidean distances, dendogram



Variance analysis (Table 2) on incipient hierarchical grouping shows whether there is variability between groups and within groups. Value F indicates that our subjects show statistically significant difference on three variables testing situational-motor abilities at the significance level $p<.01$ (SNBVPO, SNKOST, SNKUPO). At a $p<.05$ level of statistical significance, the groups differ on the variable assessing header power (SNESGL). Subjects in given groups statistically don't differ on the variable of ball handling (SNKSLA) and the variable of ball handling speed (SNB20V). Results show that subjects grouped in the two incipient clusters don't belong to the same group on the level of situational-motor ability manifestation.

Table 3 shows the arithmetic means of variables of isolated clusters by means of hierarchical cluster analysis. A comparison of variables indicates that there are significant differences between the formed groups, which additionally supports results from variance analysis from Table 2.

The dendogram analysis shows five distinct homogenous groups of subjects which is a precondition for further analysis and aplication of K-means technique in subject classification. Table 4 shows the univariate analysis of the five group's respective variances by means of K-means technique. Based on the test's statistical significance F, which shows differences in intergroup and intragroup variance, we can conclude that subjects in the groups statistically significantly differ in each variable on a $p<.01$ level of significance.

Tables 5 to 10 and Illustration 2 show arithmetic means of variables with respective groups, descriptive statistics of isolated groups, group belongingness, and distance to the centroid of isolated group.

Table 2. - Variance analysis, situationa-motor abilities

Variable	Between SS	df	Within SS	df	F	p
SNKSLA	8.857	1	825.3212	162	1.7384	.189198
SNB20V	.653	1	42.8498	162	2.4699	.117996
SNBVPO	24.611	1	496.9789	162	8.0225	.005207
SNKOST	267.030	1	772.9209	162	55.9681	.000000
SNKUPO	1467.424	1	893.1854	162	266.1516	.000000
SNESGL	9.799	1	354.7808	162	4.4742	.035939

Table 3. - Arithmetic means of variables with isolated groups

Variable	Cluster No. 1	Cluster No. 2
SNKSLA	14.98809	15.45979
SNB20V	4.36397	4.49208
SNBVPO	16.90191	17.68823
SNKOST	14.80882	12.21875
SNKUPO	12.10294	6.03125
SNESGL	6.88323	6.38708

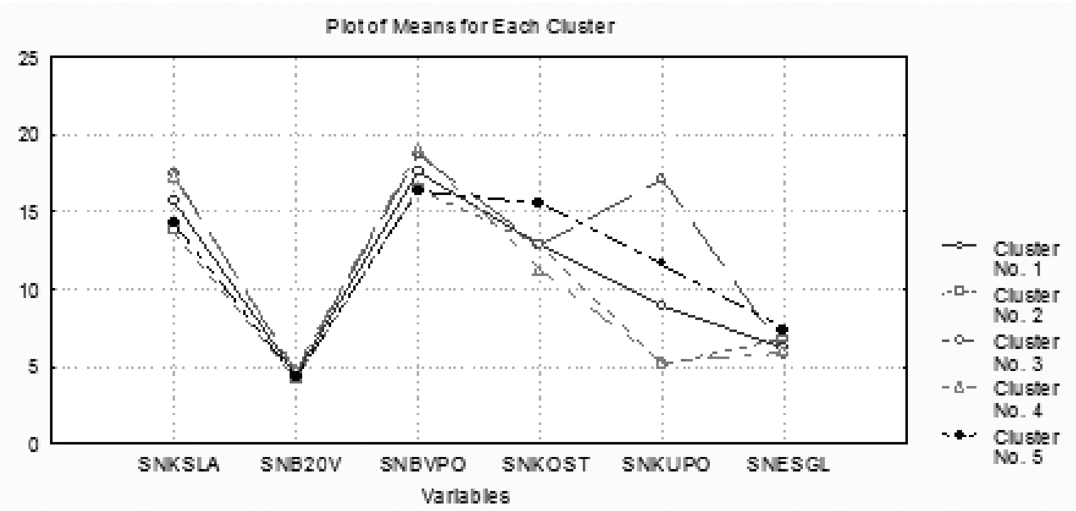
Table 4. - Results of univariate variance analysis on five isolated groups by means of K-means technique

Variable	Between SS	df	Within SS	df	F	p
SNKSLA	315.346	4	518.8315	159	24.1601	.000
SNB20V	7.119	4	36.3841	159	7.7776	.000
SNBVPO	186.156	4	335.4340	159	22.0601	.000
SNKOST	390.284	4	649.6671	159	23.8796	.000
SNKUPO	1872.843	4	487.7666	159	152.6253	.000
SNESGL	60.277	4	304.3028	159	7.8737	.000

Table 5. - Arithmetic means of variables by groups

Variable	Cluster No. 1	Cluster No. 2	Cluster No. 3	Cluster No. 4	Cluster No. 5
SNKSLA	15.7385	13.70750	17.48000	17.21909	14.23413
SNB20V	4.50825	4.17639	4.62667	4.76152	4.31609
SNBVPO	17.5745	16.52528	18.73333	19.05788	16.34783
SNKOST	12.85	12.91667	12.88889	11.21212	15.54348
SNKUPO	8.850	5.16667	17.11111	5.24242	11.63043
SNESGL	6.203	6.82444	5.85778	5.87758	7.40739

Illustration 2. - Arithmetic means of variables with isolated groups



Five homogenous groups were defined and classified in the field of situational-motor abilities. The first group counts 40 subjects, group two counts 36, group three 9, group four 33 and group five counts 46 subjects. Variance analysis and statistic value F of the test show that isolated groups of subjects significantly differ on each variable applied. Group five with 46 subjects has highest values (according to arithmetic means) in ball handling speed, ball manipulation and explicitly good header power. Next is Group two (36 subjects) with a good ball handling speed, but with lower mean variables values for assessment on ball manipulation (SNKOST, SNKUPO and SNKSLA) and header shot power (SNESGL). Group one (40 subjects) consists of subjects with arithmetic means of variables on ball manipulation, ball handling speed and header shot power. The position of Group three (9 subjects) stands out due to the fact that it has best results on the variable of ball manipulation (SNKUPO) even this group, just like Group four, has low performance on other variables.

Table 6. - Descriptive statistics, Group one (40 subjects)

Variable	Mean	St. Dev.	Variance
SNKSLA	15.73850	1.911433	3.653577
SNB20V	4.50825	.497671	.247676
SNBVPO	17.57450	1.586990	2.518538
SNKOST	12.85000	1.610064	2.592307
SNKUPO	8.85000	1.331088	1.771796
SNESGL	6.20300	1.458538	2.127334

Table 7. - Descriptive statistics, Group two (36 subjects)

Variable	Mean	St. Dev.	Variance
SNKSLA	13.70750	1.312033	1.721430
SNB20V	4.17639	.410777	.168738
SNBVPO	16.52528	1.463347	2.141385
SNKOST	12.91667	2.047647	4.192856
SNKUPO	5.16667	1.502380	2.257144
SNESGL	6.82444	1.151408	1.325740

Table 8. - Descriptive statistics, Group three (9 subjects)

Variable	Mean	St. Dev.	Variance
SNKSLA	17.48000	3.033014	9.19918
SNB20V	4.62667	.287533	.08267
SNBVPO	18.73333	1.402400	1.96673
SNKOST	12.88889	3.855011	14.86111
SNKUPO	17.11111	2.891558	8.36111
SNESGL	5.85778	.918991	.84454

Table 9. - Descriptive statistics, Group four (33 subjects)

Variable	Mean	St. Dev.	Variance
SNKSLA	17.21909	1.925078	3.705924
SNB20V	4.76152	.578981	.335220
SNBVPO	19.05788	1.356859	1.841066
SNKOST	11.21212	2.394754	5.734847
SNKUPO	5.24242	1.785887	3.189394
SNESGL	5.87758	1.011805	1.023750

Table 10. - Descriptive statistics, Group five (46 subjects)

Variable	Mean	St. Dev.	Variance
SNKSLA	14.23413	1.659382	2.753549
SNB20V	4.31609	.457784	.209567
SNBVPO	16.34783	1.395343	1.946982
SNKOST	15.54348	1.486331	2.209180
SNKUPO	11.63043	1.947747	3.793719
SNESGL	7.40739	1.734740	3.009322

Through factor analysis in the latent field of functionally isolated clusters on the basis of taxonomic analysis, we have obtained the structure of isolated clusters in this field. Two isolated factors, based on matrix structure (Table 11), make the structure of isolated cluster one (40 subjects). The first isolated factor is a general situational-motor factor since all variables in this field, except the ball manipulation variable, have very high projections on the isolated factor. The second factor in this cluster can be interpreted as ball handling ability factor since the highest projection on the factor has variable (SNKUPO).

Table 11. - Situational-motor ability structure on cluster one in latent field, matrix

Variable	Component	
	1	2
SNKSLA	.472	-.419
SNB20V	.735	-.266
SNBVPO	.669	.317
SNKOST	.691	-.061
SNKUPO	.085	.878
SNESGL	-.706	-.165

Three isolated factors make the structure of isolated cluster two (36 subjects) in the field of situational-motor abilities, based on matrix of the structure in the latent field (Table 12). The first isolated factor is a mixed situational-motor factor; variables on the assessment of ball handling (SNKSLA, SNKUPO) and variables on the assessment of ball handling speed (SNBVPO, SNB20V) have the highest projections on this isolated factor. The second isolated factor with this cluster can be interpreted as ball handling factor since variable (SNKOST) has the highest projection on it. The third isolated factor is header shot power since variable (SNESGL) has the highest projections here.

Table 12. - Situational-motor ability structure on cluster two in latent field, matrix

Variable	Component		
	1	2	3
SNKSLA	.759	-.015	-.483
SNB20V	.583	-.540	-.515
SNBVPO	.848	-.067	.039
SNKOST	.056	.937	-.082
SNKUPO	-.781	.038	.161
SNESGL	-.121	-.017	.932

The structure of cluster three (9 subjects), based on the matrix of structure in the latent field (Table 13), also consists of three isolated factors. The first isolated factor is a mixed situational-motor factor with highest projections by variables on assessment of ball handling (SNKUPO) and header shot power (SNESGL). The second factor of this cluster can be interpreted as ball handling speed factor (SNB20V). The third factor is a mixed factor – ball manipulation ability (SNKSLA, SNKOST) and ball handling on semicircle (SNBVPO).

Table 13. - Situational-motor ability structure on cluster three in latent field, matrix

Varible	Component		
	1	2	3
SNKSLA	.405	.398	.422
SNB20V	.068	.958	.096
SNBVPO	.112	.262	.814
SNKOST	.457	-.206	.780
SNKUPO	-.937	.006	-.159
SNESGL	.886	.175	.383

By means of factorization of variables in isolated cluster four (33 subjects) and based on the matrix of the structure (Table 14), we see that the structure of this cluster consists of three isolated factors. The first isolated factor is a mixed situational-motor factor with highest projections by variables on assessment of ball manipulation (SNKSLA, SNKUPO) and header shot power (SNESGL). The second isolated factor on this cluster can be interpreted as mixed ball manipulation (SNKOST) and ball handling speed (SNB20V) factor. The third isolated factor is the ball handling speed in semicircle factor with highest projection by variable (SNBVPO).

Table 14. - Situational-motor ability structure on cluster four in latent field, matrix

Variable	Component		
	1	2	3
SNKSLA	.861	-.163	-.061
SNB20V	-.032	-.740	.498
SNBVPO	-.080	.052	.940
SNKOST	-.028	.819	.173
SNKUPO	.543	-.444	-.211
SNESGL	.708	.328	-.018

The structure of isolated cluster five (46 subjects), like with cluster one, consists of two factors. According to matrix of the structure (Table 15) we see that the first isolated factor is a clear-cut ball manipulation ability factor. The reason for this is that all variables from this field have very high projections on the isolated factor (SNKSLA, SNKOST, SNKUPO). The second isolated factor can be interpreted as a mixed ball handling speed and header shot power factor – variables (SNB20V, SNBVPO and SNESGL) have highest projections on this factor.

Table 15. - Situational-motor ability on cluster five in latent field, matrix

Variable	Component	
	1	2
SNKSLA	.798	-.066
SNB20V	.278	-.722
SNBVPO	.240	-.455
SNKOST	.853	-.217
SNKUPO	.353	-.220
SNESGL	.035	.819

Conclusion

Based on our results, we can conclude that the sample of 164 footballers was classified into five homogenous groups according to their situational-motor ability performance. Subjects were grouped from initial groups (clubs) and they significantly differ in number of subjects. Variance analysis proves that the newly formed groups statistically significantly differ on all variables on a $p<.01$ significance level. Analysis of the structure of isolated groups confirms the taxonomic analysis results – the respective structure of isolated groups differ both in number of isolated factors and position of variables on isolated factors. A detailed analysis of isolated groups is suitable for further training session improvement and their adaptation to the individual. In future exercise training programs, especially in secondary selection, it would be inevitable to work with homogenous groups of footballers. This model can serve secondary selection of boys (footballers) in order to achieve rationalization and efficiency of optimal transformational processes.

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