Status analysis and improvement of football physical training based on mathematical statistics

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ABSTRACT

Football in our country has been long-term lingered in low level because of all aspects of reasons. Many researches show that physical training level is one of the most important factors that effect on our country's football level. So this paper makes analysis of our countries football players' physical trainings from their body shapes, sports nutrition, and daily training such three aspects. Make statistics of the three aspects players data, make horizontally comparative analysis of data with biomechanical and sports principals, find out our countries players shortcomings in physical training and make improvements accordingly. Summary our countries football players shortcomings in physical training through researching, and work out scientific annual training plan fit for football physical training requirements, and make contribution to our countries football development.

Key words: Mathematical statistics, physical training, biomechanics, nutrition
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INTRODUCTION

Our country's football has always been lingered in low level for years. Though it has experienced reform process of football professionalism, Chinese football level status not yet has been changed. In 2004, Chinese men football ranked in 54th in the world. Until 2012, Chinese men football ranks reduced to the 77th, not made progress but even seriously reduced. We could not help thinking what on earth the real influence factor to our countries football level would be. To this, many scholars have already made lots of research reports from all aspects that aim to improve our country's football level. This paper adopts mathematical statistic method through collection lots of data to make analysis of our country's football physical training and put forward suggestions so that improve science of training and receive the results of twice with half the effort.

For our country's football physical training status, many scholars have made researches and analysis and put forward effective reform plan. XIE Ya-long [1] Point out our country's football existing issues as lack of fighting spirits, too strong non-physical factors, too small football awareness, too many low-level mistakes through comprehensive, and in-depth statement of football six features of high speed, fast pace, strong antagonism, wholeness, attack and super football star; Li Yong-Chun [2] Through comparison research of the 19th world cup European and Asia football players age, height and weight, find that no significant differences existing on their age but with significant differences in height and weight; Zhou Yi et al.(2010) Make research on 19th world cup football competition's load characteristics, point out that football's 90 to 120 minutes competition is a ball centered and major oxygen energy supplying process, players aerobic endurance levels have directly effect on football special endurance. It suggests that high level football players' physical training should emphasis on aerobic endurance, strength endurance as well as explosive force and speed these three aspects [3, 4].

On the basis of previous studies, this paper makes horizontal comparison with world strong teams in players body shape, sports nutrition and daily physical training such three aspects, finds out differences and make analysis.

Finally put forward reasonable suggestions, work out annual training plan to guide our country's football training.

CONTRASTIVE ANALYSIS OF CHINESE AND FOREIGN PLAYERS BODY SHAPE
It is well known that body shape is very important to basketball players. So is to football players. What kind of body shape is football required? Through statistics of each world football strong teams heights and weights data in the 19th south Africa World Cup, calculate its Quetelet index K and Quetelet index standard deviation S as the standard of football players body shape, compare with our country's football players' body shape, analysis the differences and find out the shortcomings of our country's football players body shape with biomechanics principal, put forward reasonable improvement suggestions [5].

Relative parameters definition and calculation: Quenelle index K：One of human measurement compound indexes, also called "Weight (M)—Height (H) index" or "obesity index". Computation formula as formula (1) shows.

$$K = \frac{M}{H} \times 1000$$

(1)

It represents weight per 1 cm height, as a relative weight or equal weight to reflect human girth, width and thickness as well as human tissue's density. It is the important compound index to evaluate body shape development level and uniformity.

Quetelet index standard deviation S： It's the measurement of deviation degree from each data to average value; the deviation is also called variation. Suppose total n players ， then its computation formula as formula(2)shows.

$$S = \left[\frac{1}{n-1} \sum_{i=1}^{n} \left(K_i - \overline{K} \right)^2 \right]^{\frac{1}{2}}$$

(2)

In formula (2) $\overline{K}$ is arithmetic average that calculated as formula (3) shows.

$$\overline{K} = \frac{1}{n} \sum_{i=1}^{n} K_i$$

(3)

Data statistics and analysis of body shape: Table 1 can be got through computational formula in 2.1 with statistics data of players' heights and weights.

Table 1: Each team body shape index

Country	Average height $\overline{H}$	Average weight $\overline{M}$	Quetelet index K	Quetelet index standard deviation S
China	182.8709	73.5664	402.2860	87.5467
Spain	182.6414	76.1356	416.8584	46.7431
Germany	182.4426	77.7543	426.1850	35.5478
England	181.8475	75.4577	414.9504	47.2465
Portugal	183.0743	78.4587	428.5621	55.5745
Italy	182.4683	76.6436	420.0379	50.3378
Brazil	182.5866	75.8625	415.4878	45.6593

It can be seen from Table 1 that our country's football players heights have no significant difference from that of world strong team, which indicates that body shape already taken into consideration when select players. However, Quetelet index K obviously lower than that of world strong team that indicates our country's football players belong to the thinner type. From biomechanics principal, it can be acknowledged that thinners would directly cause that players at a disadvantage in a hard physical, they cannot work well while at the same time no able to restrict opponent playing so as to lead the weakness in whole game. The large Quetelet index standard deviation S indicates that football players possess poor overall consistency, individual differences among players is very big, and ignore Quetelet index influence in daily training. Therefore, Quetelet index should be taken into consideration in future training so as to make football players body shape scientific development.

Overall, our country's football players are tall but not strong. To football players, robust type would dominate in the competition, so that such robust type should be priority taken in future players selecting, players Quelete index improvement should also be emphasized in daily training so as to make our country's football players body shape more scientific.

ANALYSIS AND SUGGESTIONS IN SPORTS NUTRITION

Football is a kind of high strength sports; therefore it's very strict with collocation that meets nutrition demand. It can be acknowledged with biomechanics principal that players energy consumption can be divided into 3 parts, first is basal metabolism that refers to the indispensable energy to sustain human body basic physiological activity; second is sports consumption, according to research that one football competition would consume energy nearly 1287kilocalorie.Out of all sports items, its energy consumption only second to marathon, walk and other excessive long distance items. Football competition's energy consumption can reflect its training consumption; third is other life consumption. Football player's activity rank is 1.7 while a common person is 1.3. For instance, a man midfielder, its weight is 70kg, then his average daily energy consumption W would be:

$$W = (17.5 \times M + 615) \times 1.7 + 10\% \, \eta \qquad (4)$$

(η in formula(4)is heat effect)By formula (4), we can easily calculate average energy intake and consumption per sports day.

Scientific nutrition intake can build a well internal motor function environment for body function. To football players, our accustomed three meals a day is far from meeting the requests of nutrition intake. This paper takes consideration of players' nutrition intake from 3 aspects: 1.nutrition proportion balance, 2.reasonable catering, and 3. scientific drink.

Nutrition proportion balance: Professional football players' carbohydrate intake is 47% of their daily intake, while runner is 53% of that in their daily intake. When use weight toe express this items players' carbohydrate intake, professional football player is equal to 8 g/kg of weight/day, while runner is 6 g/kg of weight/day. Therefore, football players not only need to intake enough energy, but also should make proper nutrition collocations so that ensure the best body function state. However, to the detailed nutrition proportions, different researches get different results. Our country's authoritative "Sports nutrition" thinks that proportion of the 3 kind of substance should be 60%、15%、25%. But, the above data may not be absolute; the most important thing is make nutrition proportion collocations according to actual demands and effects of players training.

Reasonable catering: If 2/3 of players' energy per one day comes from carbohydrate, it means that nearly 2400 Kilocalories calories comes from carbohydrate. It's 600g carbohydrate that needs. A 75kg players carbohydrate requests is 600g.According to food nutrition control formula,100g rice including nearly 25g carbohydrate, if the whole 600g carbohydrate takes from rice, then players should eat 100/25×600=2400 g per day. It's very difficult to let players eat up the whole rice in traditional three meals. If converts it into other carbohydrate included fruit, vegetables and so on, it may be bigger. During the heavy training periods, players are not permitted to intake lots of food immediately before or after training, therefore it is quiet necessary to eat in small quantities more times, and food should be condensed with lower volume weight. Catering to players can be made according to above analysis as Fig.1.
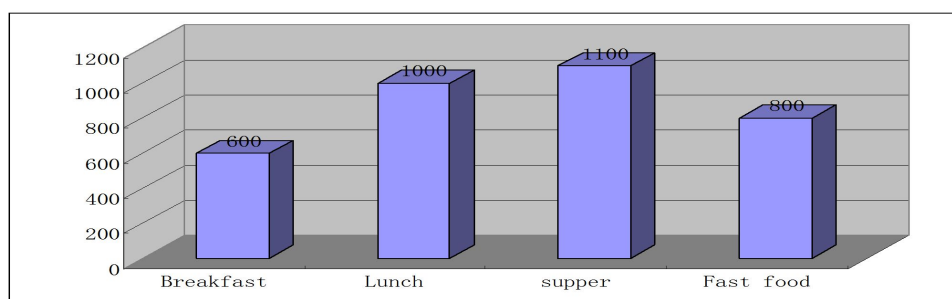

Fig.1: Energy allocation of meals and fast food

Make players catering to detailed food with Fig.1, get Table 2.

Table 2: Players daily catering standard

		Energy	Basic food collocation
Breakfast		600	Noodles 100g，cakes 50g、egg 2，porridge 200g
Lunch	meal	1000	Vegetables 150g，beans 70g, potato 20g、fish 3g，noodles 16g
	Extra meal	400	Rice 200g，egg 40g
Supper	Extra meal	1100	Vegetables 125g，beans 160g，shrimps 25g，mushrooms 35g，pig large intestine 30g
	meal	400	noodles 240 g
Tot. energy		3500	

Scientific drink: 65% of human body composition is water. It is the area of substance dissolving and storing, while also the necessary environment to make physiological reactions. Water can also maintain osmotic pressure, Ph. scale and temperature. Two approaches to normal drink that is food and beverage. To players, they have large demand of water due to perspire a lot. Players form into good habits of timely drink not wait to feel thirsty at that moment they may already get dehydration. Dehydration would seriously affect sports effects and performance. Players should drink 8 times and 200-300g per time at least per day; in training process, drink once in the interval of 15 to 20 minutes; it might as well drink purified water. Experiments proof that specially-made sport beverage would more slow entering into blood than common water. According to American sports medical joint associations official appraising, presently all famous sports beverage has little effects on supplying human load water and salt loss. Therefore, players should first supply water and water is most important.

DAILY PHYSICAL TRAINING ANALYSIS
To football players, its characteristics are strong combat, high speed, endurance. Therefore, this paper makes data test at some high level team and statistical analysis from the three aspects. Find out our country's players shortcomings by comparing with foreign excellent players data so as to make improvement in future training.

Strength quality diagnose: Relative concepts and evaluation standard to players strength quality diagnose are as following with knowledge of biomechanics.

Pedal and stretch force: the maximal force in slow pedaling, can express a kind of absolute force.

Pedal and stretch / weight: it's ratio between pedal & stretch force and weight, can express a kind of relative force.

Flexion differences between left and right: Percentage of legs knee joint flexor strength. Percentage of difference between left and right flexor strength covers knee joint strength, the small the better.

Extension differences between left and right: Percentage of differences between left and right extensor strength covers knee joint extension strength, the small the better.

Flexion and extension ratio: knee joint flexor and extensor strength ratio, represents the balance of knee joint agonist and antagonist.   More than 60% is qualified.

Through data statistics of our country's high level team with above diagnose items, get Table 3.

Table 3: Strength measurement data

Name	Pedal and stretch force Kg	Pedal stretch/weight times	Left flexion and extension ratio %	Right flexion and extension ratio %	Left and right flexion differences %	Left and right extension differences %	Triple jump *m*
1	270	3.38	60.78	52.83	10.17	-3.77	7.4
2	150	2.03	50.91	50	-13.33	-14.06	7.45
3	202	2.57	56.06	57.14	14.49	17.86	8.7
4	210	2.92	50	44.83	20.69	10.35	8.6
5	227	3.24	34.85	33.85	4.44	1.54	7.4
6	123	1.75	38.46	41.43	-14.81	-7.14	7.65
7	192	2.63	40.82	59.7	0	46.27	7.9
8	192	2.43	47.43	46.84	0	-1.27	8.55
9	190	2.38	34.74	42.17	-5.88	14.46	7.9
10	240	3.16	47.67	47.83	-7.06	-6.52	8.4
11	220	3.17	47.95	47.95	0	0	7.75
12	187	2.75	41.67	46.88	-18.1	-6.25	8.15
13	213	3.35	34.85	35.48	4.44	6.45	7.35
14	205	2.53	40.7	44.44	-2.82	6.17	7.3
Average value	201.5	2.74	44.78	46.53	14.34	15.05	7.89

Foreign researches think that the qualified standard of left flexion and extension ratio and right flexion and extension ration is 60%~65%, that of left and right flexion differences, left and right extension difference is 10~15%, while triple jump is 8.55m. It can be seen from Table 3 that only one player in the team is qualified in left flexion and extension ratio, while all right flexion and extension ratios are failed, which indicates the whole teams muscle flexion and extension balance is undesirable. According to biomechanics principal, it can be acknowledged that muscles imbalance would effect on motions coordination and even lead to sports injury. Therefore, teams' strength training balance is needed urgently to strengthen and improve. In the structure of strength as left and right extension differences, if standard as 15%, our country's players' legs are wholly balanced.

Functional strength refers to the measurement of basic strength efficiency when make movements. Set triple jump is the most suitable item to test functional strength. It can reflect human's multiple sports ability, as speed, sensitive and speed-power so on. From Table 3, it can be seen that the testers average triple jump value is 7.88m which is far behind the qualified standard of 8.55m. The whole team has poor functional strength which needs to be improved.

Speed quality diagnose: Relative concepts and evaluation standard to players speed quality diagnose are as following with knowledge of biomechanics.

Starting speed deviation：It refers to individual starting accelerate ability =accelerated speed (0~37m) — maximum speed (37~74m), the smaller the better.

speed endurance deviation：Refers to individual speed endurance=sprint (74~110m) — maximum speed (37~74m), the smaller the better.

run-up 37m speed：Refers to individual highest running speed. It represents as interlude 37m consumed time.

Through players data statistics according to evaluation standard, get Table 4.

Table 4: Speed testing data

type	0~37m	37~74m	74~110m	Whole journey 110m	Starting speed deviation	Speed endurance deviation	set triple jump
1	5.11	4.34	4.89	14.34	0.77	0.55	7.4
2	5.06	4.35	4.58	13.99	0.71	0.23	7.45
3	4.76	4.12	4.42	13.3	0.64	0.3	8.7
4	5.23	4.52	4.78	13.83	0.45	0.32	8.6
5	5.33	4.56	4.62	14.51	0.77	0.06	7.4
6	4.85	4.5	4.71	14.06	0.35	0.21	7.65
7	4.97	4.34	4.78	14.09	0.63	0.44	7.9
8	4.76	4.3	4.29	13.35	0.46	-0.01	8.55
9	4.91	4.05	4.47	13.43	0.86	0.42	7.9
10	4.72	4.34	4.44	13.5	0.38	0.1	8.4
11	4.91	4.36	4.67	13.94	0.55	0.31	7.75
12	4.82	4.32	4.66	13.8	0.5	0.34	8.15
13	4.91	4.24	5.19	14.34	0.67	0.95	7.35
14	5.31	4.5	4.66	14.47	0.81	0.16	7.3
Average value	4.93	4.35	4.65	13.93	0.61	0.31	7.89

At the same time contrast with examples of Brazil team's measurement value (as Table 5)

Table 5：Brazil team speed testing data

type	0~37 m	37~74 m	74~110 m	Whole journey 110 m	Starting speed deviation	Speed endurance deviation	set triple jump
Chinese average value	4.93	4.35	4.65	13.93	0.61	0.31	7.89
Brazilian average value	4.9	4	4.4	13.3	0.9	0.4	7.98
Qualified standard	4.7	4.2		13.3~13.6	0.6~0.7	0.15~0.25	8.55

Compare strength with set triple jump performance. We are only slightly stronger than Brazil in starting speed deviation and speed endurance deviation, while weaker than Brazil in others. Especially our strength is obviously stronger than the opposite side but jump ability and multiple speed quality weaker than them. It is easily found that Chinese football players have better basic strength, while functional strength as speed strength quite weak. It indicates that defects exist on the transformation from our basic ability to sports efficiency. It should be improved in

future training.

Endurance quality diagnose: In the game, football players need to run in whole ground that takes a long time, so that endurance is very important.12 minutes running is the best item to test endurance. This paper adopts Germany and Brazil evaluation standard (Table 6) to judge our country's players endurance, and the comparison of Chinese and foreign players 12 minutes running performance as Table 7 shows.

Table 6: Foreign 12 minutes running evaluation standards

Germany professional players 12 minutes running reference standard		Brazil football textbook 12 minutes evaluation standard	
Running distance(m)	function evaluation	Running distance(m)	function evaluation
3350	Excellent	3300	Excellent
3260~3350	Good	3100~3300	Good
3160~3259	Medium	2900~3100	Normal
3060~3159	Below normal level	2700~2900	Bad
3060	Bad	2700	Worse

Table 7: Chinese and foreign players 12 minutes running performance data comparison

Region	Europe	Brazil	Domestic foreign aid	Chinese Top player
performance	3400	3500	3271	3261

From Table 6, it can be seen that Chinese players' endurance quality can be regarded as middle-upper level with these European and American standard. But from the comparison of Chinese and foreign players 12 minutes performance, it can be seen that the differences still existing between Chinese players and foreigners in endurance quality. It takes that as standard, Chinese players' level evaluation is basic qualified, while comparing with foreign top excellent players still has a long way to go, that need strengthen training and continuously improving.

Football players' physical training plan: Due to professional football competition conditions and process have obviously annual seasonal cycle features, the minimum cycle is one year, therefore this paper works out annual training plan as Table 8 with professional football time requirement and features.

Table 8: Annual training plan based on time features

	July to August		from September to May in next year	June in next year
	Before season		In season	After season
Preparation stage normal basic especially for endurance training	Improvement stage training, strengthen physical quality with important points by football special method	Special training techniques and tactics training	Competition training For competition, apply learning techniques reasonably, further perfect it into subconscious motion	rest

Combine Table 8 with above physical training speed, strength, endurance results and suggests, our country's detailed football players' annual training plan can be worked out as Table 9.

Table 9： Football players' annual training plan

| Chinese annual plan | January | February | March | April | May | June | July | August | September | October | November | December |

CONCLUSION

This paper made analysis on our country's football players' body shape, found that our country's football players on a whole is tall but not strong and at a disadvantage of intensive body combat, therefore body shape training should be strengthened; Research on diet showed that our country's players intake less significant nutrition, this paper worked out nutrition recipe fit for our country's football players by researching foreign players nutrition intake with biomechanics knowledge; Found out that our country's football players have better basic strength but its balance undesirable through statistics analyzing of physical ability and comparison with that of foreign players. Strength was imbalanced developed, strength coordination training should be paid attention in future training; discovered that our country's football players although emphasized on starting running speed but ignored the

maximum running speed and speed endurance training through speed data testing, it indicated that our country's players had bias on speed quality recognition that led to bias on training method, therefore players education level should be strengthened, and thoughts on sports science should be improved; Finally worked out annual training plan by integrating our country's football players issues in training together with biomechanics principal, made some contribution to our country's football development.

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