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Morphological diversification of female judo athletes

Władysław Jagiełło^{1ABCDEFG}, Roman Maciej Kalina^{2ADEF}, Georgij Korobielnikow^{3AB}

Authors' contributions:

A Study design
B Data collection
C Statistical analysis
D Data interpretation
E Literature search
F Manuscript preparation
G Funds collection

¹ Jędrzej Śniadecki Academy of Physical Education and Sport in Gdańsk, Poland

² Faculty of Physical Education, Rzeszow University, Poland

³ National University of Ukraine on Physical Education and Sport, Ukraine

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Summary

Study aim:

Cognitive purpose of the research is an attempt of defining morphological diversification of Polish female representatives in judo with regard to weight categories.

Material/methods:

The research included female representatives of Poland in judo (n=13). Age of the tested ranged from 18 to 19 years. Anthropometric measurements were conducted during grouping of the national team. All together 20 basic somatic features were measured. The results of the measurement underwent basic statistic analysis.

Results:

In result of the conducted research characteristic features of body build of female judo competitors of various weight categories were revealed and internal proportions of factors of body build were determined.

Conclusions:

The important factor determining morphological diversification of female judo competitors are weight categories. Female judo competitors of heavy categories are characterized first of all by bigger body build. Body build of female competitors of middle weight categories is the most similar to comparative group. Female competitors of light categories are characterized by generally smaller body build. Proportions of external features show, that in all weight categories particularly strong muscles are on forearm and weak on shin.

Key words:

judo competitors • morphological diversification • internal proportions

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Author's address:

Prof. Władysław Jagiełło, Academy of Physical Education and Sport in Gdańsk, ul. Wiejska 1, 80-336 Gdańsk, Poland, e-mail: wjagiello1@wp.pl

BACKGROUND

Problem of morphological diversification of high class sportsmen is one of the most current problems of modern sport anthropology and theory of sport [6, 9, 11, 28]. As a result of numerous studies, thesis has been formed according to which as the period of training that is the level of mastery increases, decrease of diversification of morphological factors occurs. That is the reason why the research done on sportsmen classified as the world elite within given sport discipline provide the most accurate information on characteristic features of their build [1, 19, 24, 25, 26].

However, not in all disciplines such features are easy to be determined. It concerns among others, judo. Majority of contemporary researches thus, do not take into consideration specific character of this discipline – division into weight categories. “Pattern” of body build is determined without considering division into weight categories, provides in the cognitive sense, with little objective knowledge and is totally useless from the training point of view.

Many specialists share the opinion that the type of body build in judo is connected first of all with individual style of fighting and the choice of technique [13, 14, 29]. The knowledge of the internal proportions of body build factors provide us with extremely essential information in this aspect. Many scientific publications confirm that the knowledge of these proportions constitutes very precious research material, particularly with reference to sportsmen [8, 12, 15, 18].

In connection with this the *main cognitive aim* of research is an attempt of determining morphological diversification of female representatives of Poland in judo, with regard to weight categories and solving the following questions:

- 1) What somatic features determine specific body build of female competitors?
- 2) What internal proportions of body build are characteristic for them?

MATERIAL & METHODS

Methods

Anthropometric measurements were conducted according to the accepted rules [5], using standard instruments. Moreover, five indices were specified: slenderness, Rohrer, Quetelet II, Manouvrier and pelvis – shoulder.

Total fat of body in the percentage of mass of body was calculated according to equation of Brożek and Keks [2]. Densities of body were calculated on the basis of subdermic fat measurements by means of predicting equation of Piechaczek [21]. All in all 20 basic somatic measurements were taken.

Profiles of body build of female judokas were conducted by the method of standardization of features. The comparative group was constituted by the students of Warsaw Technical University [22].

Evaluation of internal proportions of body build was conducted by the method of natural indices by Perkal [20] with modifications by Milicerowa [18]. With this end in view the following was determined: factors of build (m), index of general size of the body (M), internal proportions of body build (natural indices for each factor of build), uniformity of build (index of inter individual variation), code of internal proportions of the group (point scale of natural indices by Perkal), internal proportions of features of build within each of the factors.

In the result of literature analysis and practical experience in training of the best judokas in the world, female competitors were divided into three traditional weight categories: light (48-52 kg), middleweight (57-63 kg), heavyweight (over 70 kg) [7, 16].

Results of the research underwent basic statistical analysis and arithmetic mean (\bar{X}) was evaluated as well as standard error ($\pm SD$), variation coefficient ($V\%$), correlation coefficient and relevance of differences (test t).

Material

The research included junior female judo representatives of Poland ($n = 13$). Anthropometric measurements were conducted during grouping of the national team (Władysławowo – Cetniewo on 13 February 2004). Age of the competitors ranged from 17-19 years ($18,15 \pm 0,68$), mass of the body ranged 46-100 kg ($66,05 \pm 17,56$) and the height – 151-183 cm ($168,23 \pm 8,89$). The length of training time of female judokas was 3-9 years ($7,0 \pm 1,2$) and was considerably varied ($V\% = 27,35$).

RESULTS

Body build of representatives of Poland in judo is varied depending on represented weight category. From chosen twenty somatic features of female competitors essential differences with reference to comparative group were revealed in eight features



Table 1. Body build features of female judo representatives of Poland in various weight categories and students of Warsaw Technical University and evaluation of relevance of differences n = 13

Somatic features	Students (n = 153)		Judo competitors								
	X	±SD	Light (n = 5)			Middle (n = 4)			Heavy (n = 4)		
			X	±SD	t	X	±SD	t	X	±SD	t
Mass of the body	57,41	7,72	49,600	2,510	-6,081***	63,750	1,893	5,592**	88,925	8,142	7,652***
Body height	166,23	6,2	161,060	6,882	-1,658	168,0	5,401	0,644	177,425	5,045	4,353**
Body height in sitting posture	88,1	3,18	85,500	2,622	-2,166*	90,250	0,866	4,269**	92,875	2,287	4,075**
Length of upper limb	70,67	3,2	69,200	2,564	-1,250	73,125	2,955	1,637	77,875	2,780	5,096**
Length of lower limb	78,14	4,09	75,560	4,565	-1,247	77,750	5,965	-0,130	84,550	3,073	4,078**
Shoulders width	35,96	1,62	34,200	2,423	-1,613	36,975	1,343	1,484	37,550	3,088	1,026
Pelvis width	27,98	1,46	25,800	1,498	-3,204*	28,350	1,529	0,478	30,875	2,016	2,853*
Elbow width	6,01	0,3	5,880	0,277	-1,028	6,125	0,150	1,459	7,250	1,190	2,082*
Knee width	8,81	0,43	8,400	0,339	-2,635*	9,175	0,275	2,570*	10,175	0,435	6,198**
Forearm diameter	22,36	1,42	22,900	1,517	0,785	25,000	0,707	7,102***	27,500	0,408	21,948***
Shin diameter	35,32	2,66	32,200	2,308	-2,960*	35,625	0,750	0,706	41,375	2,175	5,463**
Body density	1,043	0,006	1,045	0,008	0,546	1,035	0,004	-4,228**	1,022	0,005	-9,028***
Fat in percentage of body mass, %	23,37	3,14	20,840	2,956	-1,879	24,673	1,434	1,714	29,842	1,828	6,823**
Active tissue in percentage of body mass, %	76,63	3,14	79,160	2,956	1,879	75,327	1,434	-1,714	70,158	1,828	-6,823**
Body surface	1,633	0,128	1,494	0,070	-4,234**	1,730	0,027	5,654**	2,098	0,098	9,247***
Indicator of slenderness	43,22	1,74	44,404	1,164	2,196**	42,653	1,624	-0,688	40,405	1,696	-3,275*
Rohrer indicator	1,25	0,16	1,192	0,095	-1,313	1,353	0,163	1,244	1,598	0,203	3,411*
BMI indicator	20,76	2,44	19,139	0,688	-4,437**	22,659	1,956	1,903	28,304	3,093	4,839**
Manouvrier indicator	88,695	3,769	88,333	3,446	-0,230	86,189	7,188	-0,695	91,031	2,145	2,095
Shoulder – pelvis indicator	77,809	4	75,895	9,093	-0,469	76,845	6,784	-0,283	82,839	11,230	0,894

* p<0.05 ** p<0.01 *** p<0.001

in light categories, six in middle categories and seventeen in heavy (tab. 1). The amount and level of relevance of differences in body build of female judo competitors indicates upward tendency alongside weight category.

Profiles of body build of female judokas within three traditional weight categories are presented by figure 1. Direct measurements of body of competitors go up alongside weight categories, what is natural phenomenon. Differences among competitors and the control group however, not in all cases appear with the same intensity.

From among all weight categories, female competitors of heavy categories get distinguished mostly by generally bigger build (height, mass and body sur-

face) both with reference to other competitors and to the comparative group. What is worth noticing in their build is the width of the elbow – and in this respect they outgrow their friends from middle weight categories by 3,75 standardized value (Z) and those who do not train by 4,1 Z and forearm diameter – difference from female judokas of middle weight categories is 1,76 Z and with those who do not train 3,62 Z. Characteristic feature in their build is also quite significant knee and pelvis width and diameter of shin outgrowing analogical for female middle weight categories judokas indicators, relevantly by 2,37 Z, 1,73Z and 2,16 Z and with reference to non training female students by 3,17 Z, 2,0 Z and 2,28 Z. Taking into consideration proportion of body mass to height – on the basis of so called indicators –these female competitors represent strong type of build (acc.to

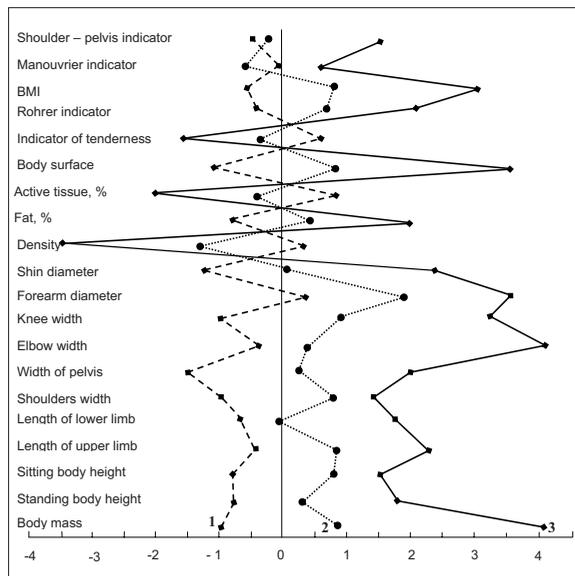


Figure 1. Profiles of body build of female representatives of Poland in judo, n=13. Designating weight categories: 1 – light (48–52 kg), 2 – middle (57–63 kg), 3 – heavy (over 70 kg).

slenderness indicator), defined as stout/ obese (acc. to Rohrer indicator) and significant overweight (BMI). Besides female competitors of heavy weight categories are classified as long legged (acc. To Manouvrier indicator) with outstandingly female type of build (pelvis –shoulder indicator). Small body density is also worth noticing (-2,17 with reference to female competitors of middle weight categories and - 3,5 Z with reference to non training) connected with high fat deposition of female competitors of heavy weight categories reaching 29,84% of body mass.

Body build of female competitors of middle weight categories is mostly similar to the comparative group – average value 20 normalized features Z is 0,31. The biggest differences in the body build of female competitors of middle weight categories with reference to representatives of light categories concern width of elbow – difference 1,80 Z (with reference to non training female students – 0,85 Z), pelvis width – difference 1,75 Z (with reference to non training students – 0,25 Z), shoulder width – difference 1,71

Table 2. Factors of body build.

Factor	Weight categories		
	light	middle	Semi heavy and heavy
Length m_1	-0,62	-0,16	1,32
Stoutness m_2	-0,15	1,39	3,04
Fat deposition m_3	-2,79	0,42	5,82
Indicator of general value M	-1,19	0,55	3,4

Z (with reference to non training students – 0,63 Z), and forearm diameter – difference 1,48 Z (with reference to non training students – 1,86 Z).

Female judokas of middle weight categories represent strong type of build (acc. to slenderness indicator) or defined as athletic (acc. to Rohrer indicator) and proper body mass (BMI). Moreover, female competitors of middle weight categories are classified as long legged (acc. to Manouvrier indicator with outstandingly female type of build (pelvis- shoulder indicator). They are also characterized, with reference to female competitors of light weight categories as well as non training female students, by definitely lower values of body density, relevantly by 1,65 Z and 1,33 Z.

Competitors of light weight categories are characterized generally by the smallest body build (average value 20 normalized features Z is -0,51). The characteristic feature in their body build is definitely lower value, with reference to comparative group, pelvis width -1,49 Z, shin diameter -1,17 Z and shoulder width -1,09 Z. They represent medium type of body build (acc. to slenderness indicator) or defined as leptosomatic/slender (acc. to Rohrer indicator) and underweight (acc. to BMI). Female judokas of light categories are classified as medium length limbed (acc. to Manouvrier indicator) with medium stress on female body build (acc. to pelvis shoulder indicator). It is worth noticing that the body of female competitors is small fat deposition which equals 20,8% of body mass.

The analysis conducted in this way shows general profile of build of female judokas in three pre-arranged weight categories with reference to comparative group, however it brought little information about internal proportions of these groups. In order to define these proportions, method of natural indicators by Perkal [20] was introduced, modified by Milicerova [18]. The values of factors of build confirm in more generalized way observations conducted on normalized values of isolated feature (table 2).

Among the distinguished three factors in light and middle weight categories factor of stoutness is dominating (stoutness of skeleton and musculature) and in heavy factor of fat deposition and stoutness.

Female competitors of light weight categories are characterized by generally smaller body size comparing to the reference group (M = -1,19). Low value of fat deposition factor ($m_3 = -2,79$) is definitely outstanding factor of this weight category. Factor of length is also smaller ($m_1 = -0,62$). Only the factor of stoutness is similar in its value to control group.



Female competitors of middle weight categories are characterized by the most similar values of factors and general body size ($M=0,55$) to comparative group. Judokas of this group differ mostly from comparative group by stoutness of build ($m_2 = 1,39$). Other factors are similar in both groups.

Female judokas of heavy weight categories differ from comparative group significantly by bigger body size ($M = 3,4$). The factors that distinguish this group in the outstanding way is fat deposition factor ($m_3 = 5,82$) and factor of stoutness ($m_2 = 3,04$). Length factor is also quite considerable ($m_1 = 1,32$).

By analyzing mutual proportions among factors of body build of female judokas of various weight categories, big differences of particular groups of body build features are revealed (fig. 2). From among three weight categories the most proportionally built are judokas of light weight categories. Value of indicator of intergroup variability is very small (0,11). All elements of this build have proportional contribution.

Competitors of middle weight categories are characterized by small changeability within group (0,27). Measurement features and fat deposition are the most proportional to general body size.

Female competitors of heavy weight categories are distinguished with the greatest specificity of body build from among all female judo competitors (indicator of changeability within group equals 1,01). The distinguishing element of general body size is very small

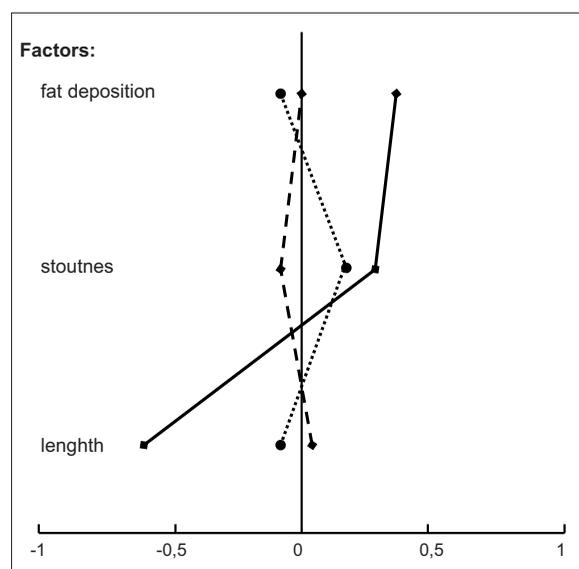


Figure 2. Natural indicators of factors of body build of female competitors of Poland in judo, $n=13$. Designation of weight categories as presented at fig. 1.

length features and big fat deposition – proportionate to general body size. Stoutness is the most proportionate element in general body size.

Using point scale of natural indicators, codes of internal proportions of three weight categories of female judokas were achieved. Code of internal proportions of build of light category judokas carries value 4-4-4. That means, that general body size (M) is caused by average body length, average of stoutness and average of fat deposition. Code of internal proportions of light weight categories competitors is expressed by the following values: 2-6-4, and heavy: 1-3-7.

Measurements of internal proportions of features of build within every factor are the source of very important information on body build of female competitors. In all weight categories forearm is particularly strongly muscular, while the shin very little (fig. 3) Within features expressing stoutness of skeleton only within heavy weight category female judokas occurs distinct predominance of elbow width and no proportionate – with reference to general factor value – small shoulder and pelvis width. Within middle weight categories, features expressing stoutness of skeleton are more proportionate. Within light categories, features expressing stoutness of skeleton are more proportionate. Within light categories predominance of elbow width and small width of pelvis are demonstrated. Length factor within light weight categories is varied the least. Only slight predominance of upper limb (particularly in heavy weight categories) over lower occurs.

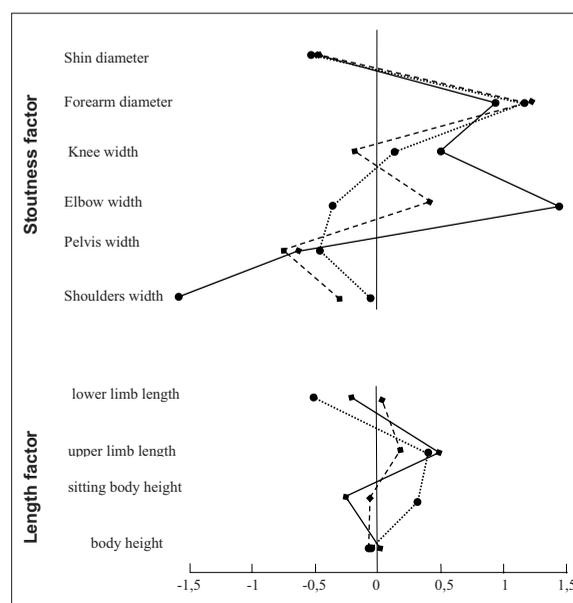


Figure 3. Natural indicators of somatic features within factors of female representatives of Poland in judo ($n = 13$). Designation of weight categories as at fig 1.

DISCUSSION

Morphological diversification of female competitors revealed in the result of research constitutes the resultant of two processes. On one side – process of sport selection and on the other side – effect of adaptation of organism to external factors that influence it.

Numerous scientific research on the example of judo confirm, that the general direction of development of body build indicates at very muscular competitors with little value of slenderness components and with slightly bigger value of fat deposition [3, 9, 10, 14].

Results of studies achieved by Sterkowicz and Żarów [27], concerning somatic build of female competitors Kyokushin Karate (representatives of Poland) constitute valuable comparative material. On its basis we can conclude great similarity in their body build to female judokas representing middle weight categories. The differences are slight and do not exceed one standardized value. Karate female competitors are only taller (not vital for statistic use) and have longer lower limb but have slightly narrower knee than female judokas in the same weight category. In other weight categories female competitors of both disciplines are vitally diversified as far as researched somatic features are concerned.

Female competitors in karate outgrow female judokas of light weight categories in all features determining the factor of length and stoutness. However, the biggest differences in body build among female judokas and female competitors in karate concern the group of heavy weight category female competitors. These differences, in favor for female judokas, are outstanding, particularly in width features and in diameters.

Such diversification in body build in both groups of female competitors seems to be fully justified by specifics of sport activity. Owing to the necessity of direct contact of fighters in judo, so with the necessity of overcoming great external resistance, musculature has particularly big meaning and what is connected with it considerable stoutness of skeleton. In karate more important are linear features ascertaining more effective performing the strike or kicks.

Besides the authors [27] state that the major changes in the body build were more clear in female competitors than in male competitors if we compare them with the average of population. Even though, in order to get high sport results greater changes in somatic structure appear in women, the authors however, are reserved to identify them with the phenomenon of masculation.

Pietraszewska [23] studies on female competitors practicing middle runs, basketball, swimming, handball and volleyball, confirm observations that were done previously. Considering somatic build, female competitors in judo of middle weight categories get mostly similar to female representatives of other disciplines. The author is also sceptic about the phenomenon of masculation of women practicing sport.

Information gathered in result of analysis of internal proportions of body build of judo female competitors significantly widens knowledge about features of their build. Among factors of body build of female judokas, factor of length is the most similar to comparative group. We should remember however, that the female students of Warsaw Technical University are characterized by the highest indicators of biological development among the academic youth. The greatest predominance, with reference to comparative group, female judokas achieve in stoutness factor even though it is also diversified with regard to weight categories. The most changeable factor of female competitors in judo body build is the factor of fat deposition, which takes on extreme values in light and heavy weight categories.

It corresponds with research on group of the best judokas in the world [10] – level of endomorphy in the best competitors is kept within low limits of accepted standards, however it is characterized by very high values in competitors of the highest weight categories, where there is no upper limit of body mass and its big value may constitute an asset. Research conducted on a group of female disco throwers confirm the fact, that in those disciplines, where significant influence on the sport result has body mass, the dominant type of body build of women is pyknic type of build [17].

Interpersonal changeability of female competitors doesn't indicate big values (besides heavy category: 1,01). So no significant predominance of one factor of body build upon another is exposed, what is characteristic for qualified competitors of some sport disciplines [4, 12].

Natural indicators of somatic features within the limits of factors provide us with important information on specifics of body build of female competitors in judo. In the stoutness factor the predominance of forearm diameter (over shin) and elbow width are demonstrated. In the length factor contribution of somatic features is more harmonious. Only slight predominance of upper limb length is noted and low contribution of lower limb.



Earlier research on wrestlers [15] revealed similar regularities in their build. In comparison to height, bodies of wrestlers are characterized by short legs and tendency to longer upper limbs and their reach. As far as the stoutness of skeleton is concerned, elbow is also more massive (proportionally) to knee. In the group of features characterizing skeleton width, tendencies of predominance of shoulder width over pelvis width occur. In the group of female judo players the last tendency is true only in light and middle weight categories. In heavy categories, clearly dominates (in this factor), pelvis width over shoulder width. The biggest diversification in the group of wrestlers occurs with reference to diameters, and the female judo group – skeleton width.

CONCLUSIONS

1. The important factor determining morphological diversification of female judo competitors are weight categories. The bigger the body mass the more distinct becomes change of body build into direction of body mass gain at the cost of loss of slenderness features. The greatest differences occur between heavy and light weight categories, the slightest between middle and light.
2. Female judo competitors of heavy categories are characterized first of all by bigger body build. The characteristic feature is also big massiveness of skeleton (significant elbow, knee and pelvis width) and strong musculature (big diameters of forearm and shin). Relatively low values of shoulder width form strongly expressed feminine type of body build. They represent somatotype defined as pyknic (in Kretschmer classification) and they are long legged. Besides big values of fat deposition indicators seem to be characteristic for competitors of this category.
3. Body build of female competitors of middle weight categories is the most similar to comparative group. Only forearm diameter significantly exceeds characteristic values for comparative group. Female judokas of this group represent the body build type defined as athletic (acc. to Rohrer indicator) and right body mass. Besides they are classified as long legged with outstanding feminine body build type. They are also characterized by definitely lower values of body density with reference to light weight categories as well as the non training students.
4. Female competitors of light categories are characterized by generally smaller body build. The feature characteristic in their build is definitely small value of pelvis width, diameter of shin and shoulders width with reference to the comparative group. They represent the type of body build defined as leptosomatic (acc. to Rohrer indicator) and underweight. Female judokas of light categories are classified as middle length limbs with average stress on feminine body build. The fact of low fat deposition is also worth noticing.
5. Analysis of internal proportions of body build of competitors revealed essential differences of individual groups. General body size of female competitors of light weight categories was caused by average intensity of length, stoutness and fat deposition features. In middle categories proportionately lower intensity of feature length, dominating contribution of stoutness factor and average of fat deposition. However in heavy weight categories very low contribution of length, average of stoutness and extreme of fat deposition are characteristic.
6. Proportions of external features show, that in all weight categories particularly strong muscles are on forearm and weak on shin. In the features expressing stoutness of skeleton, only in female judokas of light and heavy weight categories occurs evident predominance of elbow width and non proportionate – in comparison with general size of the factor – small pelvis width (light categories) and shoulders (heavy categories).

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