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Problems of Designing of the Proportional Nursery of Clothes Taking into Account Age Dynamics of the Basic Dimensional Signs of Children and Teenagers

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I.INTRODUCTION

Intensive rates of development and growth of a children's organism, and, also the specific service conditions of products connected with dynamism of a way of life of children, promote small term of operation of children's clothes because of discrepancy of its sizes to changing anthropometrical characteristics of a body of the person. Sociological researches [1] testify that the main reason of purchase of new children's clothes is, as a rule, replacement of things from which the child has already grown (80 % of the interrogated respondents). Make replacement of the worn out garments and clothes expansion much less often.

The increase in service life of developed products and designing of optimum values of constructive increases is recommended as the basic means for intensive change of the sizes of a body at designing of clothes for children.

For increase in service life of children's garments application of wear proof materials, elements of a design and connecting seams which are steady against explosive loadings is desirable. To raise universality and durability of elements of clothes probably also at the expense of use of morphological transformation at designing of new models and designs of children's clothes [2,3].

The figure of the child is imperfect because of continuous development of a children's organism, its proportions change with the years and, naturally, render a great influence on a proportion choice in a suit. Proportions in a suit form harmony of separate parts and details of children's clothes. Therefore character of partitioning of a surface of clothes plays an essential role in art perception of an image of the child.

Growth process of a children's organism causes requirements on adaptation of a product to change of dimensional signs of a body of the person, styles and expansion of the basic criterion function. In this connection designing of children's clothes which as much as possible provides static and dynamic conformity to a children's figure, and also adapted for its continuous changes is an actual problem of modern sewing manufacture.

II.FEATURES OF AGE DYNAMICS.

Definition of mathematical dependences of a gain of dimensional signs.

For the purpose of optimization of static conformity of clothes features of age dynamics of anthropometrical signs of a body of children and teenagers are investigated. The analysis was spent on the basis of the experimental data (table) received in the way of one-stage measurement of children at the age from 7 till 16 years [4]. The pure gains received by the author (in cm and %) anthropometrical characteristics have limited информативность and are deprived any mathematical dependence.

As the sizes of a garment are defined by dimensional signs of a figure, definition of mathematical dependence between age of children and dimensional signs [5] could solve effectively a problem of rational calculation of values of increases on age dynamics.

Definition of mathematical dependences of change of size of a gain of leading dimensional signs of children and teenagers (length of body T_1, a grasp of breast T_{16}, a grasp of waist T_{18}) from age according to table in the environment of Microsoft EXCEL has shown, for example, that dependence of length of a body of boys on age (fig. 1) is expressed by the equation in the form of a polynomic of 6th degree:

$$y=0{,}0004x^6-0{,}0328x^5+0{,}6667x^4-5{,}87x^3+24{,}831x^2-47{,}659x+36{,}544$$

where y - value of a gain of length of a body, cm; x - age, years.

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Year a gain of the sizes of a body of children and teenagers
(M-boys, D-girls)
The table

The age period advanced in years	Length of a body, cm		Grasp of a breast, cm		Grasp of a breast, cm	
	B	G	B	G	B	G
7-8	8,3	5,4	1,6	2,5	2,9	2,4
8-9	4,4	7,4	1,8	1,2	1,4	1,7
9-10	1,8	4,4	6,7	1,9	1,3	2,6
10-11	10,5	2,7	2,4	3,0	4,8	2,7
11-12	3,2	2,3	1,9	1,8	2,7	0,6
12-13	5,3	9,5	4,2	4,3	1,5	2,9
13-14	5,9	4,4	2,3	3,0	1,1	2,1
14-15	4,6	1,5	5,4	1,6	3,1	0,9
15-16	0,8	0,7	0,6	1,6	0,8	0,3

Reliability of a line of approximation makes the lowest value R^2=0,4942 that was display of spasmodic increase in growth of boys at the age of 10-11 years with the maximum pure gain equal 10,5 cm.

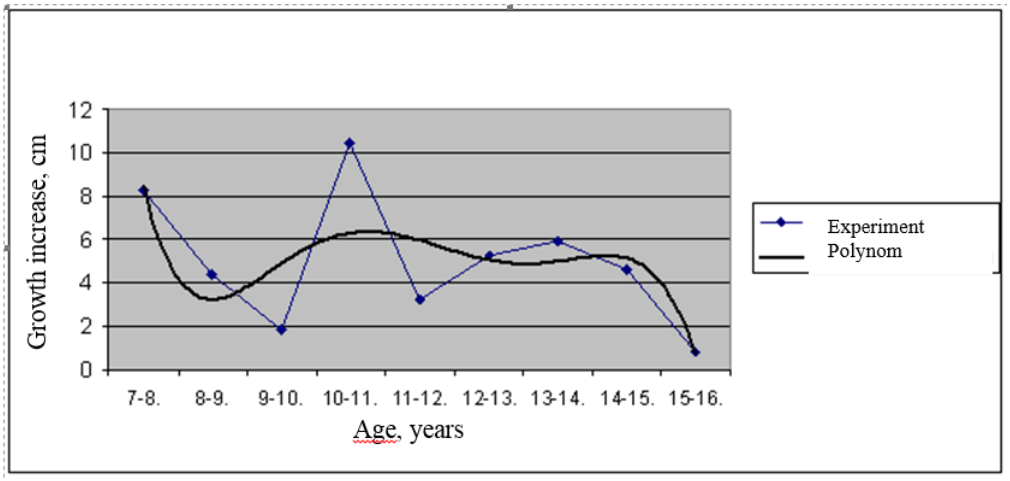

Fig. 1. Age dynamics of length of a body of boys

The analysis and processing of experimental data in the environment of Microsoft EXCEL distances graphic and mathematical dependences for a grasp of a breast and a grasp of a waist with reliability of a line of approximation accordingly for boys and girls: R^2=0,5617 and 0,7202, R^2=0,8197 and 0,7374. Such lowered values of reliability of a line of approximation do the given environment inefficient and consequently definitive processing of experimental values of the basic dimensional signs of children and teenagers spent by means of the methods of the spline-approximation [6] which have gained the greatest distribution at the mathematical description of graphic dependences of given experimental researches.

Sufficient degree of coincidence at use of splines-functions is reached by cubic splines. For calculation of the spline-function set on a grid $x1 < x2 < \ldots xn$, the ordered monotonously increasing sequence x_i, i.e. a spline- function is

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required *y: = y (x)* can be constructed only for unequivocal function. However the given lack is easily overcome if to use parametrical representation of curves.

For realization of a method of spline-approximation the mathematical program «Maple 6» is used.

In this case mathematical dependences of change of the basic dimensional signs of children and teenagers on their age are expressed polynomic by expressions of the third degree. Unlike Microsoft EXCEL environment for each dimensional sign are received a number of the equations describing communication of a random variable with not casual in certain interval values of argument that, certainly, considerably raises reliability of a line of approximation.

At the analysis of age changes of the longitudinal sizes of a body of children attracts attention spasmodic increase growth changes as total length of a foot, and shin between 6 and 7 years at children of both sexes, and also between 12 and 13 years only at boys. The size of annual changes on length of a foot at children of this age reaches 5 cm and more, on length of a shin - 2,8-3 cm. At girls second half of activization of growth of length of a foot is necessary for 9-11 years. Dynamics of change of length of a body and height top points of a breast at children is same.

On fig. 2 and 3 graphic interpretation of age dynamics of length of a body of children and teenagers is presented. The equations (1) and (2) describe change of a gain of length of a body of boys and girls accordingly in the specified ranges of values of age.

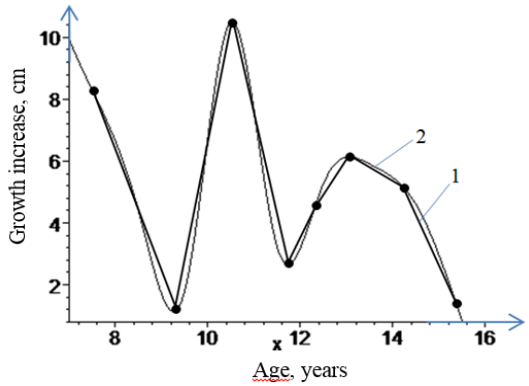

Fig. 2. Age dynamics of length of a body of boys: a 1-initial contour; 2 approximating spline

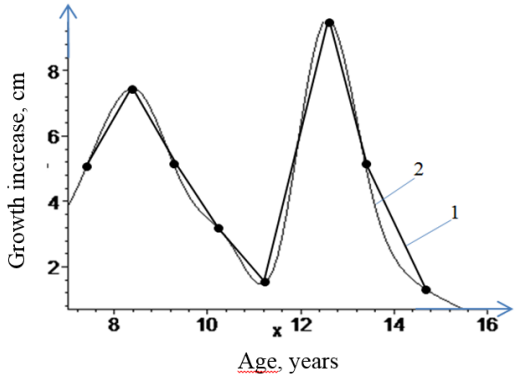

Fig. 3. Age dynamics of length of a body of girls: a 1-initial contour; 2 approximating spline

$$f_3 := \begin{cases} 377.6812317 - 141.5941511\,x + 18.46866404\,x^2 - .8208295128\,x^3 & x < 8.5 \\ -3445.233024 + 1207.669704\,x - 140.2682601\,x^2 + 5.404147905\,x^3 & x < 9.5 \\ 10444.16926 - 3178.457332\,x + 321.4293226\,x^2 - 10.79576727\,x^3 & x < 10.5 \\ -14183.96115 + 3858.151356\,x - 348.7238858\,x^2 + 10.47893776\,x^3 & x < 11.5 \\ 10452.61550 - 2568.781685\,x + 210.1398570\,x^2 - 5.720011313\,x^3 & x < 12.5 \\ -3651.174832 + 816.1279981\,x - 60.65291770\,x^2 + 1.501129344\,x^3 & x < 13.5 \\ 1726.315200 - 378.8697866\,x + 27.86543671\,x^2 - .6845090367\,x^3 & x < 14.5 \\ -2302.171918 + 454.6103076\,x - 29.61594911\,x^2 + .6369021313\,x^3 & otherwise \end{cases} \quad (1)$$

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$$f_3 := \begin{cases} 597.3960455 - 243.7281113\,x + 32.95906105\,x^2 - 1.464847158\,x^3 & x < 8.5 \\ -1729.574768 + 577.5557049\,x - 63.66256436\,x^2 + 2.324236193\,x^3 & x < 9.5 \\ 1576.750229 - 466.5469258\,x + 46.24297571\,x^2 - 1.532098547\,x^3 & x < 10.5 \\ -4600.631356 + 1298.419248\,x - 121.8490410\,x^2 + 3.804155961\,x^3 & x < 11.5 \\ 12415.94428 - 3140.687445\,x + 264.1602368\,x^2 - 7.384518760\,x^3 & x < 12.5 \\ -13401.27257 + 3055.444605\,x - 231.5303273\,x^2 + 5.833896281\,x^3 & x < 13.5 \\ 4522.377761 - 927.5888050\,x + 63.50918468\,x^2 - 1.451029946\,x^3 & x < 14.5 \\ 494.424848 - 94.21923665\,x + 6.035421352\,x^2 - .1297940075\,x^3 & otherwise \end{cases} \quad (2)$$

On fig. 4 and 5 dependences of a gain of a grasp of a breast accordingly for boys and girls are given. Schedules of dependences have periodic character. So, the maximum and a minimum of a gain of a grasp of a breast have periodic character and depend on an age range. It is revealed that spline-function application provides split-hair accuracy of approximation and that is very important, finds out more accurate arrangement of extrema, than at data processing in the environment of Microsoft EXCEL.

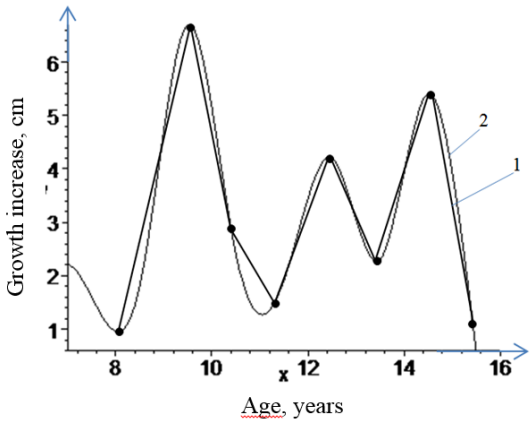

Fig. 4. Age dynamics of a grasp of a breast of a body of boys: a 1-initial contour; 2 approximating spline

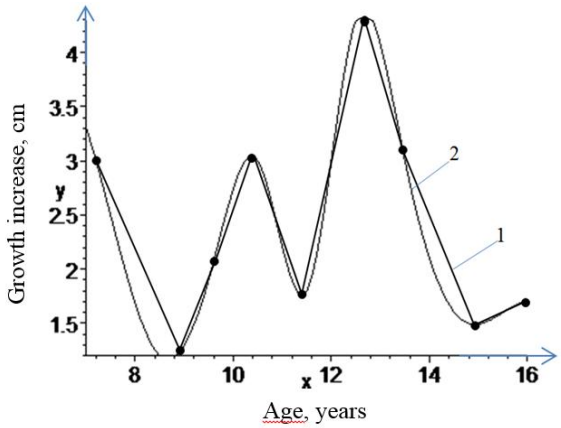

Fig. 5. Age dynamics of a grasp of a breast of a body of girls: a 1-initial contour; 2 approximating spline

$$f_3 := \begin{cases} -816.2995985 + 330.7002280\,x - 44.32938964\,x^2 + 1.970195095\,x^3 & x < 8.5 \\ 3556.989612 - 1212.813610\,x + 137.2604736\,x^2 - 5.150976013\,x^3 & x < 9.5 \\ -4917.892037 + 1463.464805\,x - 144.4530438\,x^2 + 4.733708808\,x^3 & x < 10.5 \\ 1469.379824 - 361.4700126\,x + 29.35027222\,x^2 - .783856778\,x^3 & x < 11.5 \\ 4228.902647 - 1081.345532\,x + 91.94814348\,x^2 - 2.598287830\,x^3 & x < 12.5 \\ -9004.098812 + 2094.574819\,x - 162.1254845\,x^2 + 4.177008914\,x^3 & x < 13.5 \\ 13352.71230 - 2873.605426\,x + 205.8878668\,x^2 - 4.909740500\,x^3 & x < 14.5 \\ -9425.665053 + 1839.162306\,x - 119.1305974\,x^2 + 2.561948331\,x^3 & otherwise \end{cases} \quad (3)$$

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$$f_3 := \begin{cases} -169.5692860 + 72.30527318\,x - 9.872540341\,x^2 + .4387795707\,x^3 & x < 8.5 \\ 218.9738125 - 64.82758506\,x + 6.260737092\,x^2 - .1938979758\,x^3 & x < 9.5 \\ 1135.756125 - 354.3377892\,x + 36.73549542\,x^2 - 1.263187742\,x^3 & x < 10.5 \\ -3274.611645 + 905.7672880\,x - 83.27451194\,x^2 + 2.546653763\,x^3 & x < 11.5 \\ 5044.717890 - 1264.492591\,x + 105.4437384\,x^2 - 2.923440450\,x^3 & x < 12.5 \\ -3882.154497 + 877.9567825\,x - 65.95221144\,x^2 + 1.647118211\,x^3 & x < 13.5 \\ 84.338456 - 3.48609573\,x - .6601463952\,x^2 + .03496845683\,x^3 & x < 14.5 \\ 1065.880718 - 206.5638055\,x + 13.34521290\,x^2 - .2869938258\,x^3 & otherwise \end{cases} \quad (4)$$

4 fig. 4 and 5 equations describing dependence of a gain of a grasp of a breast of a body of children and teenagers from their age, are presented in the form of (3) and (4).

Check of a hypothesis of adequacy of mathematical models in the form of cubic splines checked by means of Fisher's F-criterion, preliminary having defined a dispersion of adequacy $S^2_{a\partial}$ and a dispersion of reproducibility S^2_y of experiment. For all mathematical dependences (1) - (4) at a significance value 0,95 the condition of adequacy of models when settlement and tabular values of criterion of Fisher are in conformity $F_p < F_t$ is satisfied.

Analyzing the found mathematical models and schedules of dependences of age dynamics of dimensional signs of a body of children and teenagers, it is necessary to notice that relative stability of age dynamics of length of a body of boys in a range of age from 11-12 years till 14-15 years, that it is not observed at girls takes place. Almost proportional dependence of a grasp of a breast on age is found out in girls at the age from 8-9 years till 12-13 years.

It is revealed that for all considered dimensional signs of a body the minimum dynamic gain corresponds to last age range of 15-16 years that testifies to the closing stage of physiological development of children and teenagers, and also about the transition beginning to adult age group.

III.COMPARISON OF A GAIN OF THE BASIC DIMENSIONAL SIGNS OF A BODY OF CHILDREN AND TEENAGERS

On fig. 6 the comparative estimation of a gain of the basic dimensional signs of a body of children and teenagers (girl) of the age period from 7-8 years till 15-16 years according to work [4] (fig. 6,) and results of processing of experimental data [5] (fig. 6,) is given. At comparison of the given measurements of children of Tashkent and the Russian Federation, and also state standards [7,8] operating in clothing industry, that fact pays attention that insignificant difference (smaller values) gain of length of a body and breast grasp is combined with the raised value (16,2 cm) gain of a grasp of a waist at the girls-studying Tashkent in comparison with girls of the Russian Federation at whom the gain of a grasp of a waist has made 10,17 cm.

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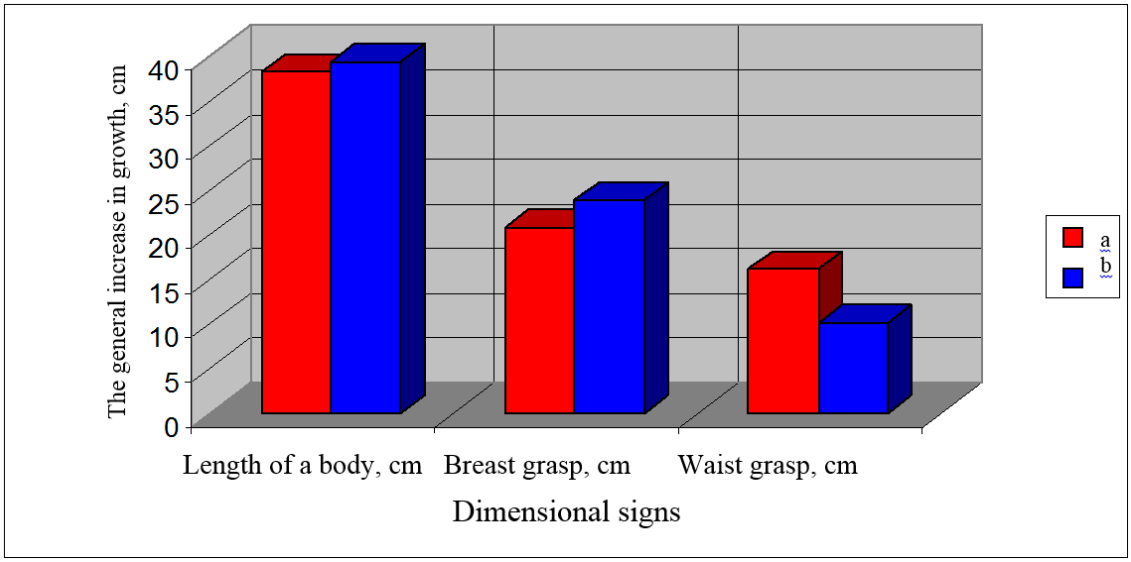

Fig. 6. A comparative estimation (a,b) a gain of dimensional signs of children and teenagers (girl) of the age period from 7-8 till 15-16 years under the data (a) - [4] and (b) - [1].

Thus, the analysis of age dynamics of variability of dimensional signs is represented very important as defining the external form of a body of children and teenagers, demands the differentiated approach at designing of clothes for children and teenagers depending on region. The received results prove the established technique of carrying out of mass anthropometrical inspections of the population on regions [9].

Considering the big dynamics of change of the basic dimensional signs of children of younger school age from (7-8 till 10-11 years) in comparison with the age period from 11-12 till 15-16 years, especially actual there are questions of maintenance of children of the given age range the clothes corresponding to the sizes and the form to a changing children's figure and capable to adapt for its constant changes.

The comparative estimation of a gain of the basic dimensional signs of children of younger school age according to [4] and [5] has shown (fig. 7 and fig. 8) that takes place biggest gain of a grasp of a waist at pupils of a city of Tashkent in comparison with the data of children of the Russian Federation.

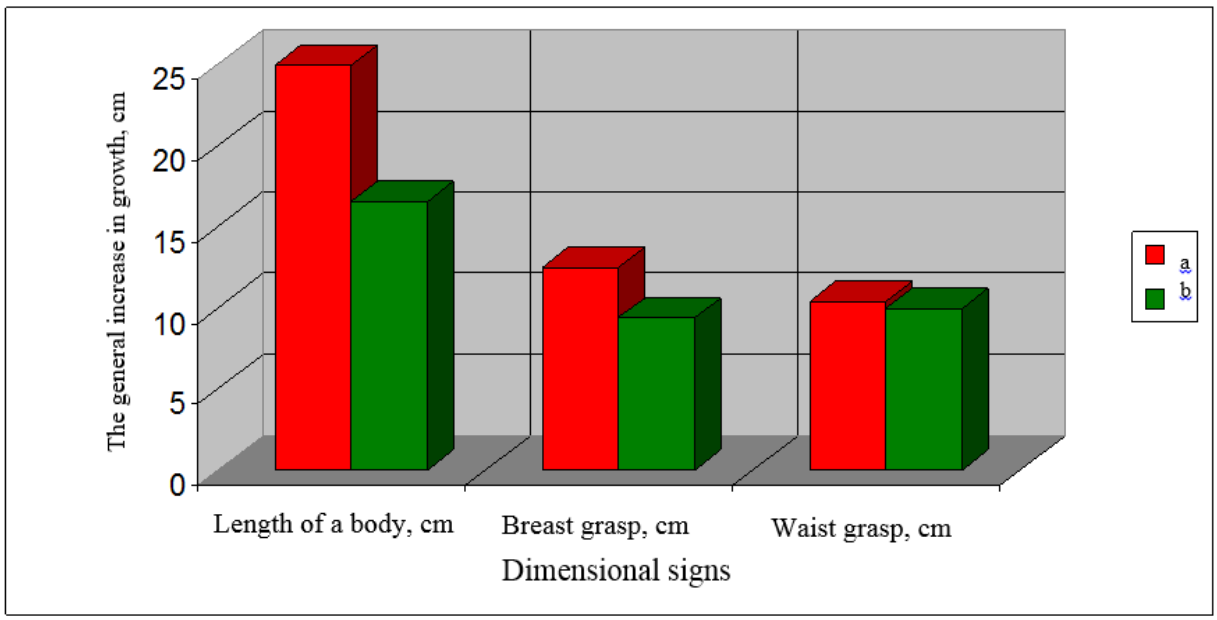

Fig. 7. A comparative estimation (a,b) a gain of the basic dimensional signs of children of younger school age (boys) from 7-8 till 10-11 years under the data (a) - [4] and (b) - [5].

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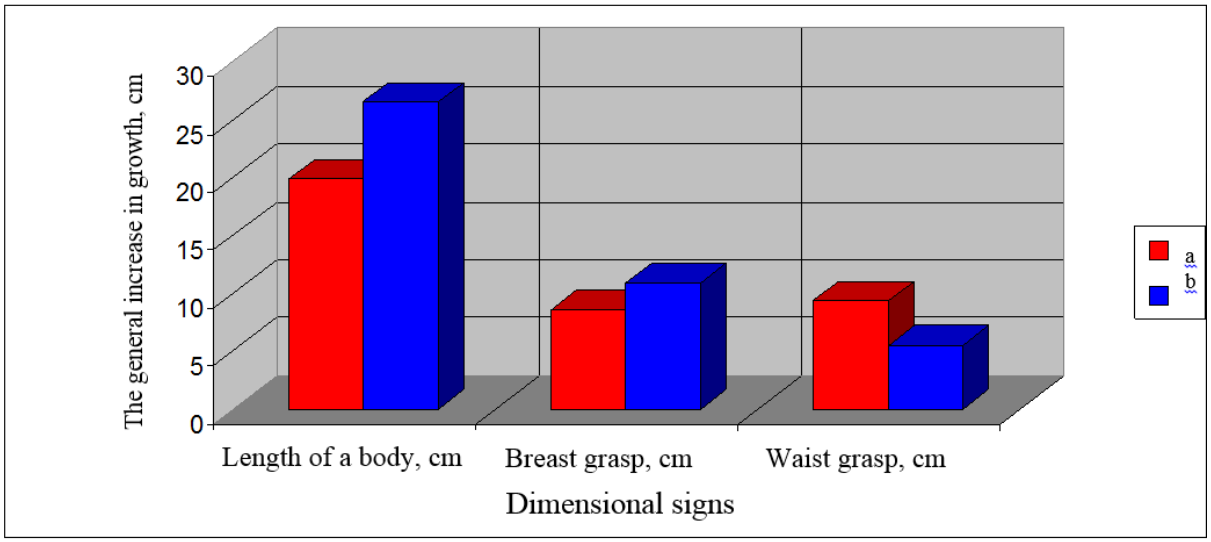

Fig. 8. A comparative estimation (a,b) a gain of the cores dimensional signs of children (girl) of the age period from 7-8 till 10-11 years under the data (a) - [4] and (b) - [5]

Thus boys have advantage in dynamics of growth of length of a body and a breast grasp, and girls, on the contrary, concede to contemporaries from the Russian Federation. Hence, creating the new republican standard on typical figures of boys and girls, it is necessary to consider a difference in dynamics of variability of dimensional signs of a body of children and the teenagers given in standards of Russia. It is necessary to consider also intensity of a gain of dimensional signs at designing of the children's clothes intended for export.

The received results give the grounds about necessity of calculation of an increase on age dynamics separately for children of younger school age from (7-8 till 10-11 years) and children of the age period from 12 till 16 years. The increase on age dynamics is a component of the general increase which besides age, also includes an increase on a package, a silhouette, a fashion, fiziologo - hygienic [6]. The size of the general increase can be calculated a method of crossing with set of sizes of values of other kinds of increases, and the main criterion of quality of clothes is ergonomics of a design, operational reliability, appearance of a product. Spasmodic increase ростовых changes at the age from 7-8 till 10-11 years give the grounds about necessity of wide application of transformed elements of a design for various kinds of clothes that can prolong term of operation of children's products.

IV.CONCLUSIONS AND RECOMMENDATIONS.

Thus, the information received as a result of the analysis of given experimental researches, can serve initial for designing of a proportional nursery of the clothes adapted for dynamics of variability of the basic dimensional signs of children and teenagers. It will allow to prolong term of operation of children's products and, accordingly, to reduce expenses of parents on purchase of new clothes for children.

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