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Abstract: This paper discusses anthropometric data obtained through 3D body scanner technology, aiming the dimensioning of Portuguese children´s measurements for the design of clothing. The study comprises boys and girls from the Northern Region of Portugal aged between two and ten years old. The main objective of this part of the study was to evaluate the possibility of grouping children with six and seven years old in a same garment size, proposing the same body measurements in the final standard measurements table. In addition to the children's anthropometric measurements, it was checked the body conformation of the children and the possibility of identifying the main biotypes. As a preliminary result, through cluster analysis it was found that it is possible to combine these children in the same group in the proposed standard measurements table.

1. Introduction

Is very recent in the history of garments the perception of its construction as a design project. As soon as clothes started to be perceived that way, other concepts were being introduced, incorporating new scientific knowledge from Anthropometry and Ergonomics, combined with the science of comfort and safety. When it comes to children's clothing, the process requires more attention from the designer, considering the body characteristics of these users, not only accessing reliable and consistent measurements tables, but also being aware of their body shapes. Many authors have been dedicated to analyze the body, its shape and scale, but only a few study children's body aiming the design of clothing. Hence, the characteristics of the user must be observed and evaluated, studied to meet the requirements of functionality, usability and comfort combined with the aesthetics of the product [1].

The purpose of this paper is to identify the main body shapes of the Portuguese children at the ages of six and seven years old and investigate what steps can be taken in consideration in identifying the ways that published studies used to deal with clothing for adults. In addition, this study aims to identify whether it is advisable to set a medium size in the table of measurements, answering the body shapes of these children.

The adoption of engineering skills in the process of garment´s product development becomes necessary for the definition of the required measurements and consequently a production quantification associated with the new methodology, considering more rational approaches in the sense of three-dimensionality [2].

To do so, the use of 3D body scanner technology supported the creation of a database with statistical sampling of body segmentation, resulting in the definition of new measurement

tables, with real measurements of the children under study, enabling the development of specific patterns and its subsequent optimization for garment production.

2. Materials and methods

Children's data was obtained through an anthropometric survey of children in the Northern Region of Portugal of both gender, using the technological capacities of the 3D body scanner KBI-Kinect Body Imaging. About 700 children from two to ten years of age were measured, in an ongoing larger PhD study in Fashion Design at University of Minho. Nevertheless, as mentioned before, for this paper, was only considered the data for children with six and seven years of age.

Thus, the final sample in this age group was 305 children, 161 aged six and 144 aged seven. Data was not separated by gender, because the published measurements tables do not differentiate boys and girls until the age of nine [3]. The existing studies for the analysis of biotypes of adults consider the following measurements: height and girths of bust, waist and hips [4] [5]. For this study, in addition to these measurements, it was also considered, the weight, in an attempt to evaluate how much the weight may influence the definition of the biotypes of these children. In this study, it was also analyzed the body images of the children obtained through the use of 3D body scanner. The scanning process was repeated three times for each child.

3. Anthropometric data collection with 3Dbody scanner technology

3D body scanners provide with great accuracy the necessary measurements for clothing design. These systems have a software for acquisition and processing of anthropometric data collected and all volumetric data in a few seconds, making the process efficient, effective and fairly fast, when compared with the traditional manual methods. When the study involves children, these technologies are even more important, as children have more dificulties in remaing colaborative during a long manual measurement process. Also, in these systems there is no phisical contact with the child during the process. A database with statistical sampling of body segmentation enables standardization of measurements tables, with accurate measurements of the human body, including a greater number of children, and thus enabling the design of more reliable patterns and the optimization of garments production.

The 3D image captured by the KBY System can display an error of 2 to 3 mm deep if the distance between the individual and the scanner is not in accordance with the parameters, or if the infrared camera is not calibrated correctly with the Kinect sensor. The calibration of the system is critical for the accuracy of the measurements and should be performed whenever a new study starts or if there is an inappropriate movement of the sensors [6]. The calibration process involves the use of a target, positioned in the middle of each pair of sensors, according to the instructions of the supplier [7]. The child must be positioned between the two groups of Kinect sensors, on a rug with a center mark, instructed not move for a few seconds, following the voice command at the end of the acquisition. Figure 1 illustrates the placement of each individual in the center of the two group of sensors.

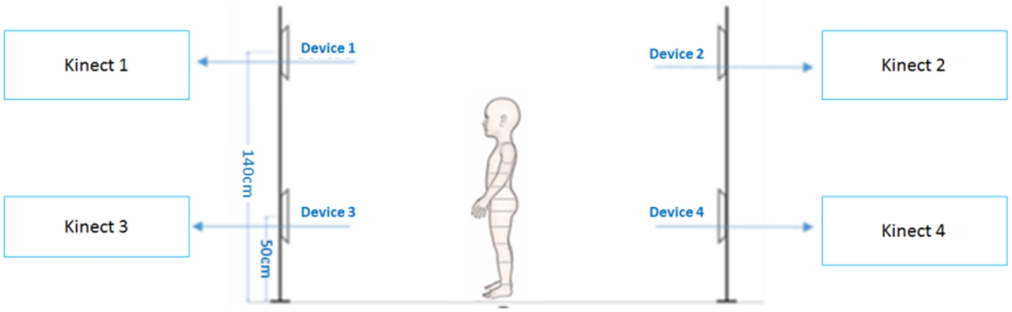

Figure1. Child positioned between the two groups of Kinectsensors - KBI System.

The 3D body scanner offers a range of variables and combinations of fundamental and complementary measurements of the human body, arranged according to the representation of Figure 2.

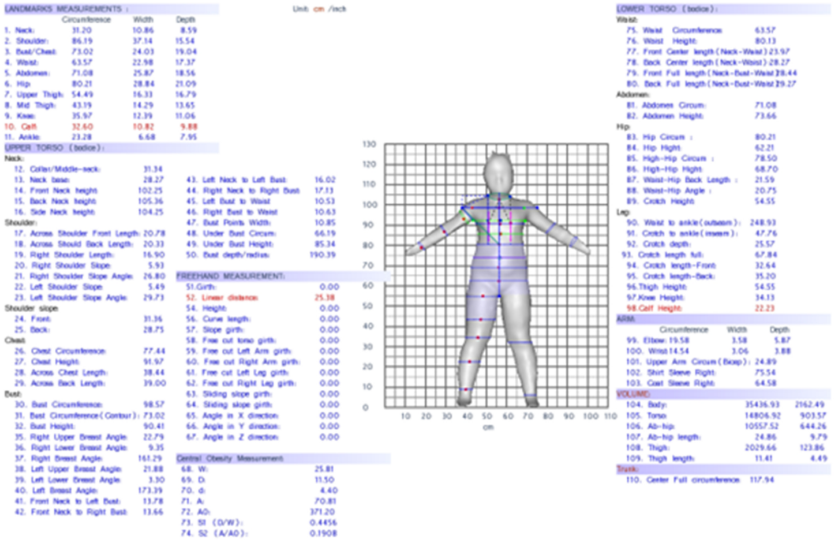

Figure 2. Measurementsand 3D body image obtained by the KBI-System.

The KBI System automatically provides 101 measurements of length and girth of the human body, as well as volume measurements of the main parts of the body.

4. Results

Most authors in this area work mainly with measurements of stature and bust girth and waist and hip girths. In this study, it was decided to add weight, considering that weight may interfere directly in the type of biotypes representing this population. Special attention was also given to the abdomen girth, usually more prominent in children, because of the body development, when compared with adults. By the age of ten, boys and girls begin to present the first traces of adolescence, changing significantly their body shapes. In this study was only considered the Portuguese children with six and seven years old. Therefore, the data in the tables bellow present descriptive measurements of this age range only.

Groups definition through cluster analysis

The multivariate cluster analysis technique was used to form homogeneous groups according to the variables studied. After a detailed analysis of all data, three main groups were considered. These groups are formed by children with similar body characteristics in the age ranges of 8-9 years (Group 1), 6-7 years (Group 2) and 4-5 years (Group 3). Nevertheless, the data used in these groups are not formed exclusively by children from a certain age group. There are children that have features of different age group and, therefore, belong to different groups. For example, a tall and heavy child of 6-7 years old, with high girth value scan be classified in Group 1. Initially six groups were formed, with children divided in these six groups as shown in Chart 1.

Chart 1 represent the distribution of children in their respective groups, defined by cluster analysis, according to the values of the Principal Components 1 and 2, generated by the method of principal components multivariate technique, which summarizes the information of the variables considered in the study in a small number of variables [8].

Observing the resulting distribution, it is possible to refer that the 3 groups are very clear, with each groupperfectly separated for the age ranges from four to nine years old. In Chart 1, group 2 is very clearly identified suggesting an adequate grouping of children with six and seven years old. With this distribution more than 70% of them were allocated to Group 2.

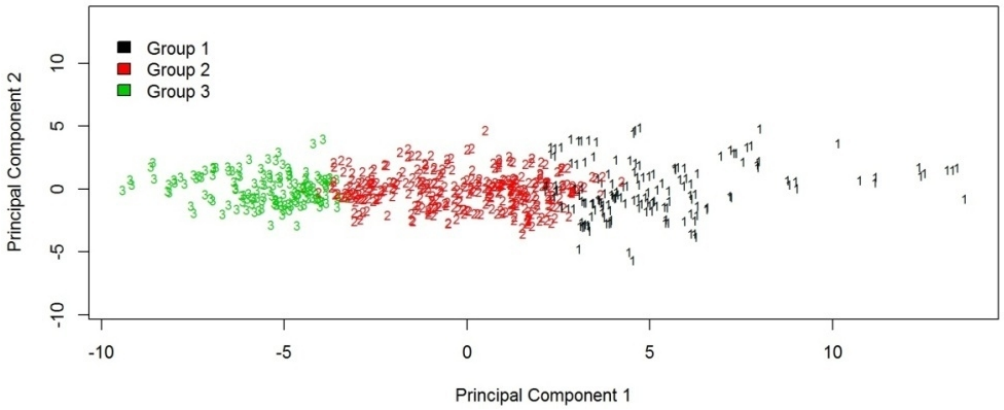

Chart 1. Distribution of children by age according to three groups defined by multivariate cluster analysis method, Legend: Group 1 (8-9y) - Black; Group 2 (6-7y) - Red; Group 3 (4-5y) – Green.

Tables 1, 2 and 3 present the descriptive measurements for each considered variable: minimum; maximum; first quartile; median; third quartile; and mean.

Table 1 presents data of 6-7 year old children as a group and Tables 2 and 3 present individually the measurementsof children with 6 and 7 years old, respectively.

The descriptive measurements considered for this study were: weight (kg), height (cm), bust girth (BG), waist girth(WG), abdomen girth(AG), hip girth (HG) of children in Group 2.

Table 1. Descriptive measurements of 6-7 year old children (Group 2).

Grupo 2 / Variables	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum
Weight (Kg)	16.1	22.5	25.5	25.19	27.8	34.5
Height (cm)	104	118	124	123.17	129.00	140
BG	52.48	60.47	62.69	62.74	64.98	73.64
WG	49.33	56.90	59.57	59.85	62.28	72.69
AG	54.79	63.01	65.44	65.68	68.23	76.34
HG	58.46	66.75	70.20	69.95	72.53	78.73

Legend: Bust girth (BG); waist girth(WG); abdomen girth(AG); hip girth (HG).

The descriptive analysis of the measurements of the children with 6 and 7 years old individually is represented in Tables 2 and 3.

Through the percentiles of the measurements under study it was found that 50% of six year old children have weight up 23.90 kg; stature of up to 118 cm; bust girth up to 61.26; waist girth up to 58.14 cm; abdomen girth up to 63.29 cm and hip girth up to 67.32 cm.

Through the percentiles of the measurements under study it was found that 50% of seven year old children have weight up to 27.70kg; height up to 128cm; bust girth up to 64cm; waist girth up to 61.10 cm; abdomen girth up to 67.25 cm and hip girth up to 72.29 cm.

Through boxplot, represented in Chart 2, it is possible to observe how the measurements behave in terms of dispersionallowing the comparison of the two age groups. Three measurements build the central box: First quartile (bottom line of box); Median or second

quartile (internal line, thicker); and Third quartile (upper line of box). The upper and lower bars of the chart after a dotted line represent the minimum and maximum values of the data. The points below the bottom bar or above the top bar represent the outliers [7].

Table 2. Descriptive measurements for six year old children.

Measurements	Weight (Kg)	Height (cm)	BG	WG	AG	HG
Minimum	17.1	108	52.5	49.3	53.6	57.1
1st quartile	20.9	114	59.3	56.1	60.6	64.0
Median	23.9	118	61.3	58.1	63.3	67.3
Mean	24.1	119	62.0	59.1	64.1	68.0
3rd quartile	26.4	124	64.2	61.4	66.8	71.7
Maximum	36.0	130	78.2	77.7	82.0	83.6
Standard deviation	4.16	5.44	4.58	5.25	5.52	5.59

Table 3. Descriptive measurements for seven year old children.

Measures	Weight(Kg)	Height (cm)	BG	WG	AG	HG
Minimum	20.1	108	57.3	52.3	59.0	61.5
1st quartile	24.8	122	61.2	58.8	65.0	69.1
Median	27.7	128	64.0	61.1	67.2	72.3
Mean	27.5	127	64.6	61.5	68.0	72.7
3rd quartile	29.7	132	67.0	63.9	70.8	76.4
Maximum	37.0	140	77.7	73.4	81.6	86.8
Standard deviation	3.40	6.00	4.46	4.38	4.36	4.89

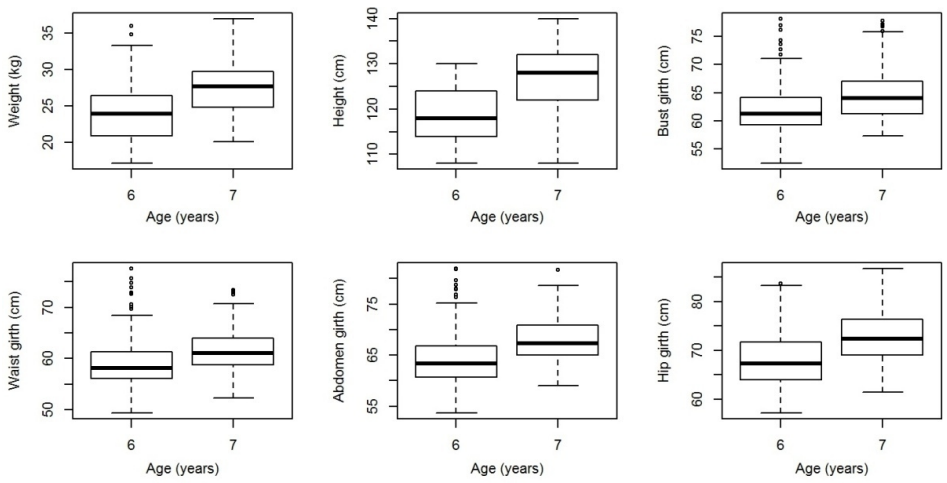

Chart 2. Boxplot of 6-7 years old children.

Through the Wilcoxon-Mann-Whitney test [9] significant differences were identified among children with six and seven years old for all measurements, requiring an individual treatment. There were clear differences in the measurements of their bodies. However, it was found that there is an intersection between points, i.e., children with six years more developed with the equivalent measurements of seven years, as well as children with seven years with

measurements equivalent to those of children with six years. Hence, there are children that have features of different age groups.

From this statistical analysis it will be possible to define the most appropriate sizing for the Portuguese children and build tables of standard measurements that best meet the needs of a larger contingent of children, contributing to the improvement of quality and comfort of children'sclothing.

All the statiscal analysis were executed using the software R [9].

5. Conclusions

With a multivariate cluster analysis it was possible to confirme the possibility of grouping boys and girls from the Northern Region of Portugal aged between six and seven years old in a same garment size, proposing the same body measurements in the final standard measurements table. Through the measurement of height, weight, bust, waist, abdomen and hip girths of Portuguese children, combined with the analysis of their 3D body shape, provided by the KBI 3D body scanner, it will be possible to define their proportions and identify the main children biotypes. With this information compatible mannequins of the Portuguese children can be produced, considering the results of this anthropometric study, providing relevant information for fashion schools and for the garment industry. The definition of new measurement tables tailored to a specific audience, built with a wide coverage of consumers, can generate a smaller number of returned products and meet users expectations. This fact contributes to increasing the efficiency and sustainability of this industry and increase consumer satisfaction.

This paper is part of a broader study, including other regions of the country, with the purpose of presenting to the fashion industry a proposal of sizing and definition of children's standard measurement tables, respecting more effectively their needs. This initiative is expected to provide greater clarification for the garment producers and for the users.

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References

[1] Bezerra G. Design de vestuário infantil com foco na ergonomia: desenvolvimento de uma metodologia de modelação a partir de um estudo antropométrico com base em digitalização 3D. PhD Thesis project, 2015. Supervisor: Carvalho, M.

[2] Gill, S. (2015). A review of research and innovation in garment sizing, prototyping and fitting.Textile Progress.

[3] Aldrich, W. 2009. Metric pattern cutting for children's wear and babywear. Fourth edition.W.B.

[4] Vuruskan, A., &Bulgun, E. (2011). Identification of female body shapes based on numerical evaluations. International Journal of Clothing Science and Technology, **23(1)**, 46-60.

[5] Simmons, K. P. (2003). Body shape analysis using three-dimensional body scanning technology.

[6] Barboza, R. B. D. M. G. (2016). Design de vestuário para jovens com Síndrome de Down, a partir de um estudo antropométrico com recurso à digitalização corporal 3D.

[7] KBI -Kinect Body Imaging - User's Manual.

[8]Zakaria, N. (2010). The development of body sizing system for school-aged children using the anthropometric data (Doctoral dissertation, Universiti Teknologi MARA).

[7] Bussab, W.O., &Morettin, P.A. (2013). Estatística Básica. Eighth Edition. Saraiva.

[8] Johnson, R.A., & Wichern, D.W. (2012). Applied Multivariate Statistical Analysis.Sixth Edition. Pearson.

[9] R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.URL https://www.R-project.org/.