Blaženka Brlobašić Šajatović, Darko Ujević, Slavenka Petrak
University of Zagreb, Faculty of Textile Technology, Department of Clothing Technology, Zagreb, 10000, Croatia

Body Proportions of Football Players and the Untrained Population, and the Impact on the fit of the Trousers

Vpliv telesnih proporcev nogometašev in netrenirane populacije na prileganje hlač

Corresponding author/*Korespondenčna avtorica:*
Blaženka Brlobašić Šajatović, PhD
E-mail: blazenka.brlobasic@ttf.hr
ORCID: 0000-0002-2252-0037

Abstract

The aim of this research was to identify the differences in body proportions between football players and the untrained population, and their influence on trouser fit. By identifying the differences in body measurements, and comparing the empirical and constructional values of body measurements required for the construction of men's trousers, an attempt was made to prove the need for a change in the existing cut of trousers. A total of 324 men aged 15 to 26 years participated in the research. The survey involved 162 football players with an average playing experience of 10.7 years and 162 untrained subjects from the general population. A total of 19 variables were analysed relating to the study of the fit of men's trousers. The SPSS software package was used for statistical data processing. The results showed that the football players were slightly but not significantly, taller, that their chest girth was almost the same as untrained subjects, and that their hip girth was slightly smaller. The greatest and most significant statistical difference was in the mid-thigh girth, which is greater in football players, and the waist girth, which is smaller in football players. Due to the identified value of a statistically significant increase of the mean thigh girth in football players, the modelling of trousers in this area was performed. The performed modelling of men's trousers met the criterion of garment fit, and opens the possibility of cooperation with industry in terms of improving the making of cuts for the surveyed sport population.
Keywords: body measurement, garment fit, clothing construction, football players, trousers

Izvleček

Cilj te raziskave je dokazati razlike v telesnih proporcih nogometašev in netrenirane populacije in njihov vpliv na prileganje hlač. Po ugotovitvi razlik v telesnih merah in primerjavi empiričnih in konstrukcijskih vrednosti telesnih mer, potrebnih za izdelavo moških hlač, je bila potrjena potreba po spremembi obstoječega kroja hlač. V raziskavi je sodelovalo 324 moških, starih od 15 do 26 let. Sodelovalo je 162 nogometašev s povprečnimi igralnimi izkušnjami 10,7 leta in 162 netreniranih oseb splošne populacije. Analiziranih je bilo 19 spremenljivk, pomembnih za proučevanje prileganja moških hlač. Podatki so bili statistično obdelani s programskim paketom SPSS. Rezultati so pokazali, da so bili nogometaši nekoliko višji, vendar ne bistveno, prsni obseg je bil skoraj enak kot pri netreniranih osebah, kolčni obseg pa nekoliko manjši. Največja in najpomembnejša statistična razlika je bila v obsegu sredine stegna, ki je bil pri nogometaših večji, in pasnem obsegu, ki je bil pri nogometaših manjši. Zaradi ugotovljene vrednosti statistično značilnega povečanja povprečnega obsega stegna pri nogometaših je bilo na tem

delu izvedeno modeliranje hlač. Modelirane moške hlače so ustrezale kriteriju pravilnega prileganja oblačila in s tem se odpira možnost za sodelovanje z industrijo v smislu izboljšanja krojev za anketirano športno populacijo.
Ključne besede: merjenje telesa, prileganje oblačila, konstrukcija oblačila, nogometaši, hlače

1 Introduction

People are increasingly interested in the fit and comfort of garments, but such garments are very difficult to find on the market. Garment cuts were made according to the standard. However, such clothing does not fit the entire population. In the trained population, there are deviations in some body measurements in relation to the standard system of clothing sizes, causing garments not to fit. In the production of fashion and sportswear, anthropometric measurements are applied in the field of design and modelling, and are obtained using anthropometric measurements on a sample of a given population [1]. By applying the conventional method using anthropometric instruments on the basis of the ISO 3635 (2008), ISO 8559 (2012) and ISO 9407 (2008) standards, the basics of a unique definition of human body measurements for the clothing and footwear industry were obtained, and for the implementation of anthropometric measurements (HRN EN 13402 (1–3) 2008) [2–3]. Proportions or relationships can establish the correct interrelationship between individual body parts or individual measurements.

Many authors are engaged in research on garment fit. The use of hand measurements is recommended to determine glove size so that the user can easily find the proper glove size [4]. The purpose of a sizing system is to fit the majority of a given population whose body proportions fall within predetermined standard dimensions. A sizing system can be defined as a method or system used to create a set of clothing for a variety of people on the target market [5]. Based on anthropometric measurements, the development of a new Chinese bra sizing system was based on anthropometric breast measurement. Factor analysis is often employed to determine key dimensions from the statistical aspect of anthropometric dimensions that are influential to major factors explaining the total sample variance, with a high percentage selected as key dimensions [6–8]. The authors Paal and McCulloch et al. [9, 10] proposed an optimisation approach to construct an apparel sizing system based on a mathematical model. They determined that the proposed method for establishing a sizing system could satisfy three aspects: 1. increase the accommodation of the

population; 2. reduce the number of sizes in the system; and 3. improve overall fit in accommodated individuals. To obtain more comprehensive measurement variables, 3D body scanning is generally regarded as more complete. It would be ideal for measuring the entire population before defining the size range and body shape categorization of people. However, this is unrealistic in any sizing system development [11]. It is important to identify a representative sample of the population [12]. Based on the influence of sporting activities, there are changes in the morphological structure and relief surface of the body of persons who are actively involved in sports in relation to persons not active in sports. Through training, certain physical changes are achieved, which lead to changes in morphological structure, an increase in muscle mass and a decrease in fat tissue in certain body parts. With years of training, muscle mass can increase by between 30–60% [13]. Differences in body measurements and in body shape between basketball players and the untrained group of the general population of test subjects have been proven. Because of the shape differences, it is necessary to modify front and back block pattern parts, as well as the sleeves, in order to ensure additional ease allowance on increased areas and optimal garment fit [14]. According to research on the anthropometric characteristics of football players, other researchers obtained similar results with regard to body height, i.e. they concluded that the body height of football players does not differ significantly from the average height of the male population of the same age [15]. Differences were also found between the trained and untrained population, such as increased thigh circumference. Previous research on the anthropometric characteristics of football players relates to the study of anthropometric variables according to the instructions and regulations of the International Biological Programme (IBP). Anthropometric characteristics of the sport population have not been investigated from the aspect of the clothing industry. The aim of this research is anthropometric measurements of the sport population in accordance with the ISO 3635 and ISO 8559 standards, and the study of differences in relation to the untrained population and the impact of the identified effects on the fit of the trousers of football players.

2 Test subjects and research methods

A total of 324 men aged 15 to 26 years participated in the research. For the purposes of this research, the conventional method of anthropometric measurement was used to determine anthropometric sizes for young men (football players and the untrained population) in accordance with the ISO 3636 and ISO 8559 standards [8]. The survey involved 162 football players with an average playing experience of 10.7 years and 162 untrained subjects of the general population. The statistical analysis of the measured research variables was used to determine the main and design measurements for the two surveyed groups. Differences in body proportions between the two groups were defined. In order to meet the criteria of garment fit, the modelling of the front part of the trousers is shown for a group of football players (Figure 1).

The results of anthropometric measurements were processed using descriptive statistics, including an estimate of central tendency parameters (arithmetic mean and median) and dispersion (standard deviation, coefficient of variation, 95% confidence interval and data range). The correlation of individual body measurements and the suitability of standard procedures (mathematical expressions) for estimating body measurements depending on one and two predictors (basic body measurements) was verified using linear regression models with one and two predictors, respectively [16]. The modelling of computer body models for football players and the untrained population was carried out using the Optitex 3D software package, intended for construction preparation in the clothing industry. Body models were defined on the basis of the results of conventional anthropometric measurements, i.e. on the basis of average values of body measurements. Computer body models facilitated a clear visualisation of the bodies of the studied samples [1].

A total of 19 variables were studied: body height (1), chest girth (2), waist girth (3), hip girth (4), trouser length (5), crotch length (6), seat depth (7), waist height (8), hip height (9), knee height (10), ankle joint height (11), hip depth (12), total seat length (13), inside upper leg length (14), upper leg girth (15), middle leg girth (16), knee girth (17), girth under the knee (18) and lower leg girth (19). These are variables relating to the examination of the fit of men's trousers (Figure 2).
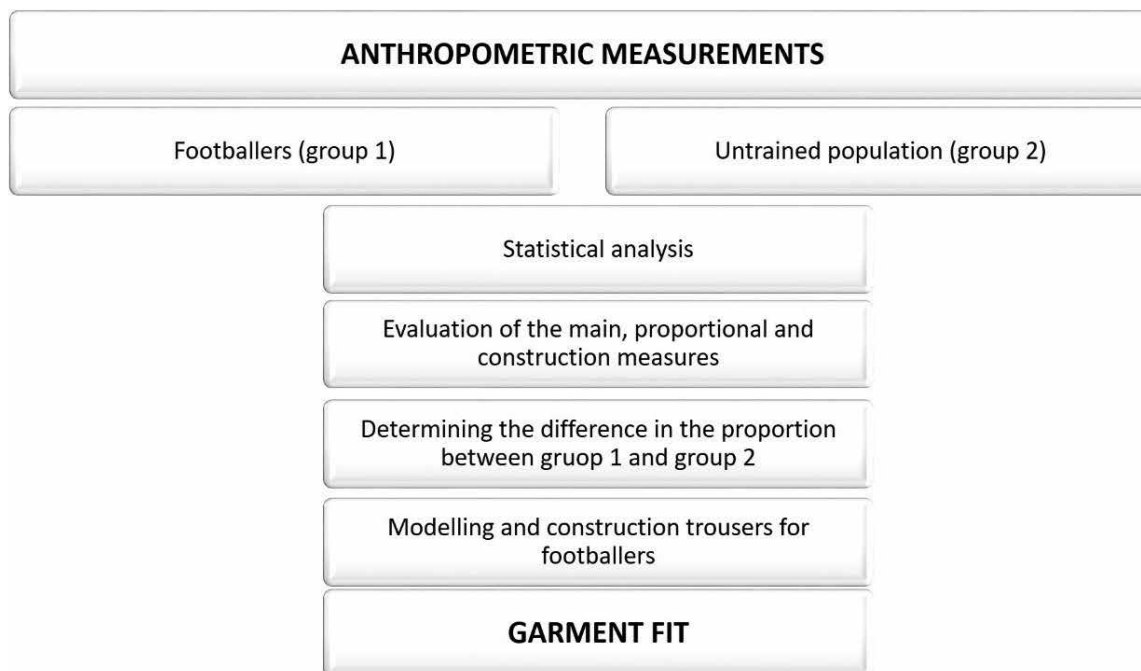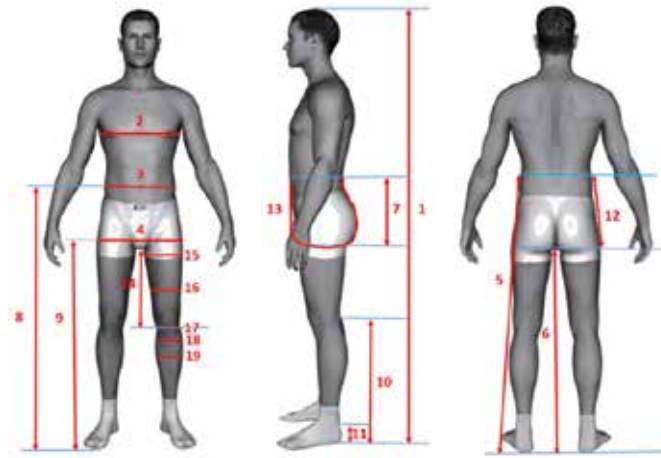

Figure 1: Research plan

Figure 2: Researched variables

3 Results and discussion

The correlation of individual body measurements and the suitability of standard procedures (mathematical expressions) for estimating body measurements depending on a predictor were verified using linear regression models. The differences between the groups were tested using variance analysis.

Table 1 shows the indicators for the distribution of body measurements of football players and untrained groups of the general population measured using the traditional method of anthropometric measurement.

Table 1: Basic parameters of the distribution of body measurements of football players and untrained groups of the general population

Body measurements (cm)	Football players (cm)			Untrained populations (cm)			Differences	t	p
	X ± SD	Min	Max	X ± SD	Min	Max			
Body height	180.3 ± 5.64	166.5	193.0	179.4 ± 5.25	170.0	190.0	0.87	1.437	0.152
Chest girth	92.8 ± 5.42	81.0	108.0	92.7 ± 8.03	74.0	113.5	0.19	0.250	0.803
Waist girth	79.1 ± 6.11	68.0	104.0	81.5 ± 9.32	61.0	110.0	−2.46	−2.809	**0.005**
Hip girth	97.5 ± 4.94	84.0	112.0	98.3 ± 7.07	86.0	119.5	−0.78	−1.152	0.250
Trouser length	111.9 ± 5.84	90.0	125.0	110.0 ± 5.76	90.0	120.0	1.88	2.916	**0.004**
Crotch length	83.8 ± 4.31	72.5	98.5	83.1 ± 4.45	69.0	96.0	0.73	1.437	0.136
Seat depth	26.0 ± 4.42	17.0	35.0	25.3 ± 4.52	15.5	35.0	0.69	1.395	0.164
Waist height	110 ± 5.87	97.0	125.0	108.9 ± 4.98	96.0	119.0	1.01	1.677	0.094
Hip height	91.0 ± 4.55	79.5	102.5	90.5 ± 4.69	75.0	105.3	0.51	0.989	0.324
Knee height	52.2 ± 3.20	42.0	59.8	51.9 ± 3.69	42.2	63.0	0.38	0.987	0.324
Ankle joint height	5.1 ± 0.74	3.4	7.0	5.4 ± 0.85	3.5	7.5	−0.34	−3.835	**<0.001**
Hip depth	21.0 ± 1.87	17.0	26.0	20.9 ± 4.31	12.0	33.0	0.07	0.199	0.842
Total seat length	73.2 ± 6.76	57.0	92.0	72.7 ± 9.62	48.0	97.0	0.47	0.513	0.608
Inside upper leg length	33.6 ± 3.39	25.0	42.0	31.9 ± 4.14	18.5	42.0	1.70	4.049	**<0.001**
Upper leg girth	57.1 ± 3.86	47.0	69.0	55.0 ± 5.66	42.0	74.0	2.16	4.008	**<0.001**
Middle leg girth	52.1 ± 3.35	45.0	62.0	47.1 ± 5.51	45.0	62.0	5.02	9.910	**<0.001**
Knee girth	38.5 ± 2.0	34.0	46.0	38.3 ± 3.06	33.0	51.5	0.22	0.779	0.436
Girth under the knee	34.8 ± 2.07	30.0	43.0	34.9 ± 2.55	26.5	43.0	−0.04	−0.156	0.876
Lower leg girth	37.3 ± 2.66	28.0	44.0	36.7 ± 3.40	27.0	49.0	0.63	1.868	0.063

The results showed that the football players were slightly but not significantly taller, that their chest girth was almost the same as untrained subjects and that their hip girth was slightly smaller. The greatest and most significant statistical difference was in the middle leg girth, which is greater in footballers, and in the waist girth, which is smaller in football players. The scatter plots of pairs of the main body measurements of football players and the untrained group of the general population are shown in Figure 3 and confirm that these variables are linearly related to each other in both samples. According to the presented relations, there are no significant deviations between the main body measurements. These also do not result in changes in the construction of trousers. Figure 4 shows the empirical distribution of the statistically most significant differences in middle leg girth.
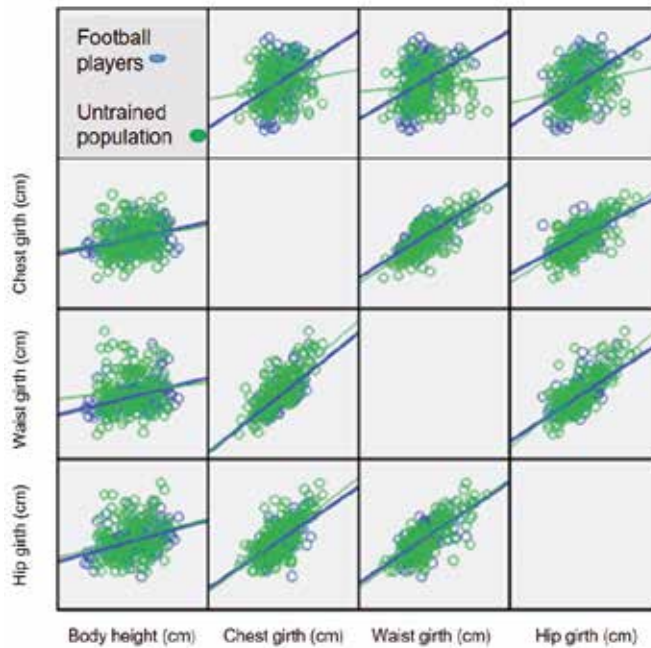

Figure 3: Scatter plots of height, chest, hip and waist girth of football players and the untrained group of the general population (N = 324)
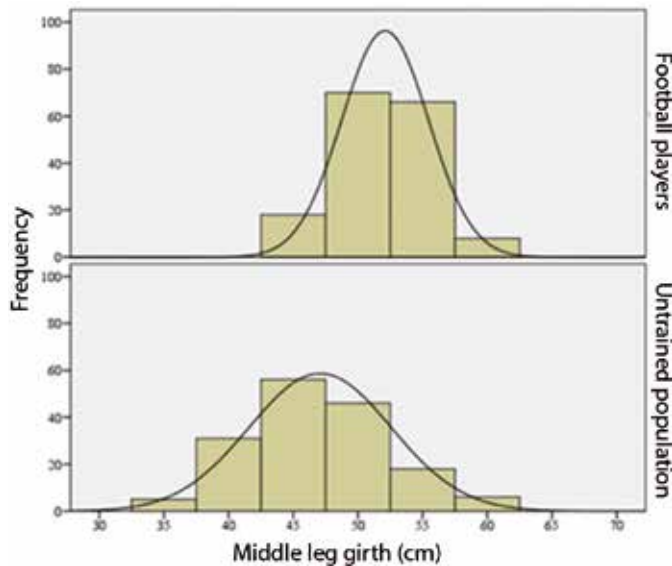

Figure 4: An empirical distribution of the statistically most significant differences in middle leg girth

On the basis of the results of statistical data processing, computer-aided 3D body models were created, separately for the group of football players and separately for the untrained group. Each 3D model shown was designed according to the mean values of body measurements. Figure 5 shows the body models of a football player and an untrained subject, showing their significant differences in body shape (e.g. in the middle leg girth, upper leg girth), which affect the cut of a football player's trousers.

a)   b)

Figure 5: 3D computer body models created according to the mean values of body measurements: a) untrained population, b) football players

Table 2 presents the main, proportional and structural body measurements required for the construction of men's jeans. The main body measurements (body height, chest, waist and hip girth) were obtained on the basis of anthropometric measurements. The values of the main body measurements were used to calculate the construction measurements (trouser length, crotch length, seat depth, front trouser width, back trouser width, front seat width and back seat width). Mathematical expressions were used to calculate them. Based on the ratio between measured and calculated proportional body measurements (trouser length, crotch length and seat depth), the deviations of the body from the standard body shape were determined, and changes or adjustments to existing structures were necessary. The other previously mentioned proportional body measurements were difficult to measure accurately, so their values were determined solely based on mathematical formulas.

A constant of 40 cm was determined for measuring the circumference of the trouser leg [17].

Table 2: Main, proportional and structural body measurements for the construction of men's trousers

Variables	Construction measurements
Main body measurements	
Body height (Bh)	-
Chest girth (Cg)	-
Waist girth (Wg)	-
Hip girth (Hg)	-
Proportional and construction measurements	
Trouser length (Tl)	Tl = 5/8 Bh - from 4 to 5 cm
Crotch length (Cl)	Cl = ½ Bh – 4.5 cm
Seat depth (Sd)	Sd= Tl - Cl
Front width of trousers (Fwt)	Fwt = ¼ Hg
Back width of trousers (Bwt)	Bwt = ¼ Hg + from 2 to 3 cm
Front width of seat (Fws)	Fws = 1/20 Hg
Back width of seat (Bws)	Bws = 1/10 Hg + from 1 to 3 cm
Circumference of trouser leg	Ctl cca 40 cm

As shown in Table 3, the group of football players is different from the untrained group of subjects of the general population. The body measurements are described using arithmetic mean (), standard deviation (s), coefficient of variation (CV), reliability confidence interval (95%) and data range (minimum and maximum values) (Table 3).

Proportional and structural measurements vary equally for both groups of test persons and range between 3% and 7.2%, with the exception of the seat depth, which varies between 17% and 18% for both methods of determination (manual or computational) (Table 3).

Structurally, the trouser length was calculated as 5/8 of the body height minus 4 to 5 cm. Statistically, this ratio can be estimated by linear regression with body height as a predictor. Table 4 lists the parameters of such an assessment, showing that trouser length can be predicted based on body height (p < 0,001) and that this explains 37.3% of the variability in trouser length. The obtained regression coefficient with body height is 0.659 cm, which is almost indistinguishable from the construction coefficient 0.625, i.e. 5/8. The

Table 3: Descriptive statistical analysis and comparison of average body measurements obtained from football players and a control group of the general population for the construction of men's trousers

Proportional and construction body measurements/cm	Group	N [a]	$\bar{x}$ [b]	S [c]	CV [d](%)	95% CI [e]		Range	
						h_1	h_2	Min.	Max.
Trouser length	Football	162	111.9	5.84	5.2	111.0	112.8	98.0	125.0
	Untrained	162	110.0	5.76	5.2	109.1	110.9	90.0	120.0
	Total	324	110.9	5.87	5.3	110.3	111.6	90.0	125.0
Trouser length (construction)	Football	162	108.2	3.53	3.3	107.6	108.7	99.6	116.1
	Untrained	162	107.6	3.28	3.0	107.1	108.1	101.8	114.3
	Total	324	107.9	3.41	3.2	107.5	108.3	99.6	116.1
Crotch length	Football	162	83.8	4.31	5.1	83.2	84.5	72.5	98.5
	Untrained	162	83.1	4.45	5.4	82.4	83.8	69.0	96.0
	Total	324	83.5	4.39	5.3	83.0	83.9	69.0	98.5
Crotch length (construction)	Football	162	85.6	2.82	3.3	85.2	86.1	78.8	92.0
	Untrained	162	85.2	2.62	3.1	84.8	85.6	80.5	90.5
	Total	324	85.4	2.73	3.2	85.1	85.7	78.8	92.0
Seat depth	Football	162	26.0	4.42	17.0	25.3	26.7	17.0	35.0
	Untrained	162	25.3	4.52	17.9	24.6	26.0	11.5	35.0
	Total	324	25.7	4.47	17.4	25.2	26.1	11.5	35.0
Seat depth (construction)	Football	162	28.1	5.14	18.3	27.3	28.9	8.5	40.0
	Untrained	162	26.9	4.98	18.5	26.1	27.7	10.0	42.9
	Total	324	27.5	5.09	18.5	26.9	28.0	8.5	42.9
Front width of trousers (construction)	Football	162	24.4	1.24	5.1	24.2	24.6	21.0	28.0
	Untrained	162	24.6	1.77	7.2	24.3	24.8	21.5	29.9
	Total	324	24.5	1.53	6.2	24.3	24.6	21.0	29.9
Back width of trousers (construction)	Football	162	26.9	1.24	4.6	26.7	27.1	23.5	30.5
	Untrained	162	27.1	1.77	6.5	26.8	27.3	24.0	32.4
	Total	324	27.0	1.53	5.7	26.8	27.1	23.5	32.4
Front width of seat (construction)	Football	162	4.9	0.25	5.1	4.8	4.9	4.2	5.6
	Untrained	162	4.9	0.35	7.2	4.9	5.0	4.3	6.0
	Total	324	4.9	0.31	6.2	4.9	4.9	4.2	6.0
Back width of trousers (construction)	Football	162	11.7	0.49	4.2	11.7	11.8	10.4	13.2
	Untrained	162	11.8	0.71	6.0	11.7	11.9	10.6	14.0
	Total	324	11.8	0.61	5.2	11.7	11.9	10.4	14.0
Circumference of trouser leg (construction)	Football	162	40.0	0.00	0.0	40.0	40.0	40.0	40.0
	Untrained	162	40.0	0.00	0.0	40.0	40.0	40.0	40.0
	Total	324	40.0	0.00	0.0	40.0	40.0	40.0	40.0

[a] *number of cases,* [b] *arithmetic mean,* [c] *standard deviation,* [d] *coefficient of variation,* [e] *reliability confidence interval (95%)*

regression constant (-7.5 cm) exceeds the construction constant (-4.5 cm) by about 3 cm. However, it is not statistically significant, which means that it is adjustable as needed.

Structurally, the crotch length is determined as half of the body height reduced by 4.5 cm. Statistically, similar to the case of trouser length, this relationship can be estimated using linear regression with body height as a predictor. Table 4 lists the parameters of this estimate, showing that trouser length can be predicted based on body height (p < 0,001) and that 38.5% of crotch length variability was explained. The regression constant (-6.5 cm) exceeded the construction constant (-4.5 cm) by 2 cm, but was not statistically significant, i.e. it can be adjusted if necessary. Structurally, the seat depth was determined as trouser

Table 4: Estimate of trouser length (DHL) depending on body height (TV) using a linear regression model

Criterion	$R^{2\ a)}$	Predictor	Regression coefficient		
			$B^{\,b)}$	$\beta^{\,c)}$	$p^{\,d)}$
Trouser length	37.3%	Constanta	−7.532		0.378
		Body height	0.659	0.612	**<0.001**
Crotch length	38.5%	Constanta	−6.470		0.306
		Body height	0.500	0.622	**<0.001**
Seat depth	16.2%	Constanta	15.858		**<0.001**
		Tl-Cl	0.357	0.406	**<0.001**

a) coefficient of determination, b) regression coefficient, c) standardized regression coefficient, d) significance of the regression coefficient

length minus the crotch length. The estimate of seat depth values using a linear regression model with this difference as a predictor did not yield results comparable to the design method. Table 4 lists the parameters of this estimate that show that seat depth can be predicted by the difference between empirical values of trouser length and crotch length (p < 0,001), but only explains 16.2% of the variability of empirical values of the criteria, i.e. seat depth. The obtained regression coefficient with a difference is 0.357 cm, while the regression constant is 15.9 cm and is a significant component of the regression model (p < 0.001). The empirical values determined for football players and the untrained group, as well as construction values, have no statistically significant influence on the construction of the trouser cut. However, due to the determined value of a statistically significant increase of the middle and upper thigh girth in football players, it is necessary to model the trousers in this area. In order to meet the criteria of the fit of the trousers as a garment, there are also very influential and additional body measurements, in addition to the construction and main body measurements. One of those measurements is mid-thigh girth.

Based on the analysis of body measurements and the determination of differences, Figure 6 shows the modelling of a pair of trousers for a group of football players to improve the trouser fit.

The modelling of trousers is based on previously conducted analyses and differences in body measurements between these two groups of subjects. The analysis of the measurement results showed that the mid-thigh girth was on average 5 cm larger than in the untrained group of test subjects, and the necessary redesign of the basic cut of men's trousers in this area was carried out accordingly.

The construction of trousers according to the standard (for the untrained population) is drawn in blue, and the modelling of trousers for football players is drawn in red. The trousers were modelled in the area of the mid-thigh girth in such a way that, on the line representing the middle of the front of the trousers from the hip depth to the knee height, widening was performed by 3 cm and the trousers were widened at the side seams by 1 cm on each side. The difference in the middle leg circumference is 5 cm, and for this reason the pants are widened by that amount.
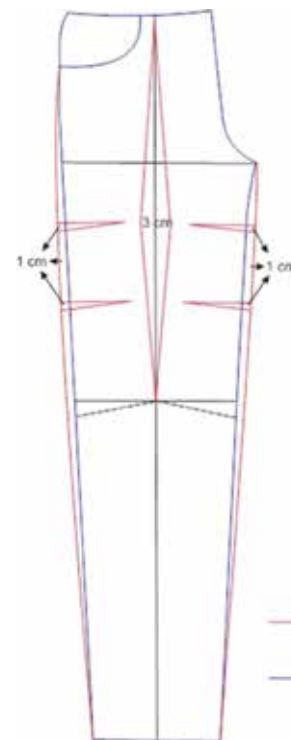

Figure 6: Modelling of the trouser cut in the area of the middle thigh girth of football players, - football players; - untrained populations

4 Conclusion

Differences in body proportions between the trained and the untrained group of test subjects were presented in this research. The largest statistically significant difference was found in the area of the mid-thigh girth. This variable has a significantly higher value among the surveyed football players and affects trouser fit. With this in mind, modelling and changes were made to the standard construction of the trouser cut to achieve a better fit. The garment fit criterion is defined by the parameters relating to the construction of the garment, which implies the correct joining of the garment in the sense that the garment has the appropriate size without being tightened anywhere on the body. The performed modelling of men's trousers met the criterion of garment fit, and opens the possibility of cooperation with the industry in terms of improving the making of cuts for the surveyed sport population.

References

1. BRLOBAŠIĆ ŠAJATOVIĆ, Blaženka. *Investigation of body proportions of trained and untrained population as factor in the processes of garment construction : Ph.D. Thesis.* University of Zagreb, 2014.
2. *HRN EN 13402-1:2008 Size designation of clothes -- Part 1: Terms, definitions and body measurement procedure (ISO 3635:1981, MOD; EN 13402-1:2001).* Zagreb : Croatian Standards Institute.
3. *Croatian Technical Report (HRI 1148:2012) - Anthropometric system - measuring and size designation of clothes and footwear.* Zagreb : Croatian Standards Insitute, 2012.
4. KWON, Ochae. Determination of key dimensions for a glove sizing system by analyzing the relationships between hand dimensions. *Applied Ergonomic*, 2009, **40**(4), 762–766, doi: 10.1016/j.apergo.2008.07.003.
5. *Sizing in clothing, Woodhead Publishing Series in Textiles.* Edited by S.P. Ashdown. Cambridge : Woodhead Publishing, 2007.
6. CHUNG, Meng-Jung, LIN, Hai-Fen, WANG, Mao-Jiun. The development of sizing systems for Taiwanese elementary- and high-school students. *International Journal of Industrial Ergonomics,* 2007, **37**(8), 707–716, doi: 10.1016/j.ergon.2007.05.004.
7. LAING, Reachel, HOLLAND, Elizabeth, WILSON,Cheryl Anne, NIVEN, Brian. Development of sizing systems for protective clothing for the adult male. *Ergonomics*, 1999, **42**(10), 1249–1257, doi: 10.1080/001401399184929.
8. ZHENG, Rong, YU,Winnie, FAN, Jintu. Development of a new Chinese bra sizing system based on breast anthropometric measurements. *International Journal of Industrial Ergonomics*, 2007, **37**(8), 697–705, doi: 10.1016/j.ergon.2007.05.008.
9. PAAL, Beatrix. *Creating efficient apparel sizing systems an optimization approach : Pd. D. Dissertation*, Cornell University, 1997.
10. MCCULLOCH, Charles, PAAL, Beatrix, ASHDOWN, Susan. An optimization approach to apparel sizing. *Journal of the Operational Research Society*, 1998, **49**(5), 492–499, doi: 10.1057/palgrave.jors.2600533.
11. WINKS, John. *Clothing sizes : international standardization.* Manchester : Textile Institute, 1997.
12. ASHDOWN, Susan. Sizing up the apparel industry. *Cornell's Newsletter for the New York State Apparel and Sewn Products Industry*, 2003.
13. MIŠIGOJ – DURAKOVIĆ, Marjeta, HEIMER Stjepan, MATKOVIĆ, Bojan. Morphological and functional characteristic of the student population ot the Univesity of Zagreb. Zagreb : University of Zagreb, Department of Kinesiological Anthropology and Methodology, 1998.
14. BRLOBAŠIĆ ŠAJATOVIĆ, Blaženka, PETRAK, Slavenka, MAHNIĆ NAGLIĆ, Maja. Analysis of body proportions of Croatian basketball players and the untrained population and their influence on garment fit. *Textile Research Journal*, 2019, **89**(23-24), 5238−5251, doi: 10.1177/0040517519849469.
15. MATKOVIĆ, Branka, JANKOVIĆ, Saša, MIŠIGOJ-DURAKOVIĆ, Marjeta. Morphological differences of elite Croatian soccer players according to the team position. *Collegicum Antropologicum*, 2003, **27**, 167–174.
16. PALLANT, Julie. *SPSS Survival manual.* 4th ed. Maidenhead : Open University Press, 2010.
17. UJEVIĆ, Darko, ROGALE, Dubravko, HRASTINSKI, Marijan. *Tehnike konstruiranja i modeliranja odjeće.* Zagreb : University of Zagreb, Faculty of Textile Technology, 2004.