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The Study of Subjective Pressure Sensation Developed by Foundation Garment

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Abstract: The subjective wearing pressure sensation developed by foundation garment was surveyed and reported in this paper. Wearing experimental procedure was designed and fifteen female undergraduates were employed as subjects for this study. We obtained results of subjective wearing pressure sensation and shaping effect assessment through the questionnaire. Firstly, we studied the correlation between pressure evaluation, shaping effect assessment and time. Secondly, we analyzed the overall pressure sensation and different body part pressure sensation developed by corsets, three main factors were extracted from the 15 positions through statistical analysis, the subjective regression formula Y = -0.807 +0.499 X1 + 0.187 X3 was gained. The overall subjective pressure sensation had significant correlation with the waist (X1) and near waist (X3) pressure evaluation.

Keywords: Comfort of pressure sensation, subjective wearing sensation, factor analysis .

1. Introduction

Foundation garment is one of the lingerie for body shaping such as corsets, girdles and waister-nippers. Women show high interests in their functional role to shape the body more ideally by redistributing the body fat now. However, at the same time people often complain against the uncomfortable feeling caused by the excessive negative pressure. On the one hand, many studies (Sugimoto, 1991; Nagayama, 1995; Takasu, 2000; Yoshiaki, 2000; Okura, 2000; SUGITA, 2002; Nakahashi, 2005; Liu, 2008; Jin, 2008) have demonstrated that the pressure had negative or positive physiological effects on the body [1-7], we also did a complete research between clothing pressure and physiological variables [8].

On the other hand, Subjective assessment is also very important for the assessment of clothing comfort, which is a complex synthesis of psychological and physiological response of individuals and of the physical properties of the clothing materials, many studies have focused on the predictability between objective physical factors of fabrics and subjective preference [9-11]. But many fundamental problems haven't been clarified which can give supports to designg comfortable clothing, such as which parts of body are more sensitive to the pressure sensation. In this paper, we developed a wearing experimental procedure and investigated the relationship between the overall subjective pressure sensation and different body parts pressure sensation using factor analysis. This can give a suggestion for the design of foundation garment, and also we can explain that the overall pressure sensation for these clothing were mainly composed by what part wearing sensation of the body, so we can give reasonable plan for garment ease, and the placement of hard material such as strong whale bones.

2. Experiment

2.1 Test Samples and Sizes

Some test samples were supported by the Beijing Aimer Lingerie Co., Ltd., there were eight corsets and eight girdles sample all together for the experimental, and all the foundation garment had different structures and more than 3 sizes, as shown in Figure 1. The size and materials used for foundation garment are shown in Table 1.

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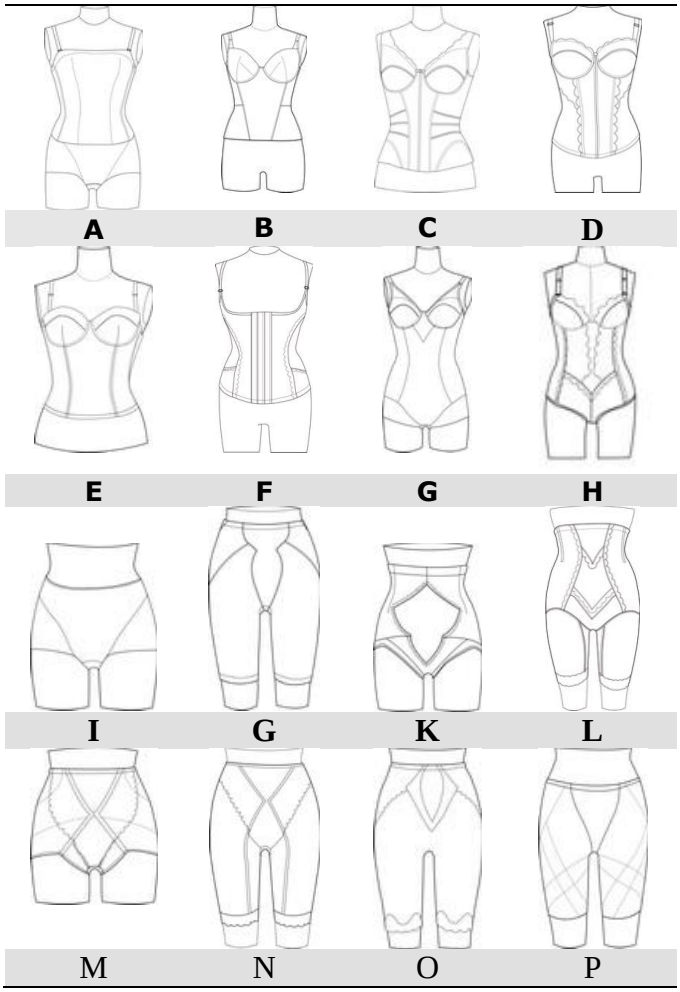


Figure 1 Structures of the foundation garment

Table 1 Size and Material Used for Garment

Sample ID	Knitted Structure	Main fabric content (%)	Garment size
A	Power-net	Ny84% U16%	70C 75B 80B
B	Tricot	Ny58% U23% C19%	75B 75C 80B 85B
C	Tricot	Ny87% U13%	75B 75C 80B 85B
D	Power-net	Ny10% U10%	70B 75B 80B 80C
E	Power-net	P40% Ny48% U12%	70B 75B 80B 80C
F	Tricot	Ny86% U14%	70B 75B 80C
G	Power-net	Ny83% U17%	70B 75B 80C
H	Tricot	Ny90% U10%	70B 75B 80C
I	Power-net	Ny72% U28%	W64 W70 W76
G	Tricot	Ny83% U17%	W64 W70 W76
K	Tricot	Ny69% U31%	W64 W70 W76
L	Power-net	Ny90% U10%	W70 W76
M	Tricot	Ny67% U14% C19%	W70 W76
N	Tricot	Ny67% U14% C19%	W70 W76
O	Tricot	Ny70% U30%	W70 W76
P	Tricot	Ny69% U31%	W70 W76

U: polyurethane, Ny: polyamide, C: cotton, P: polyester

2.2 Subjects

The subjects of this study were 18 healthy female graduates within the age range of 21-26 years. They were all about 161cm with the standard deviation 4.17 chosen among 300 students. We shifted 42 female graduates at first and took their body measurements through 3d body scanner, and 15 students were finally invited as experiment samples for their body measurements and wearing habit. Details of physical constitutions are given in Table 2, which were taken respectively by the Martin instruments only with non-elasticity underwear and nude upper body.

Table 2 Physical Constitutions of Subjects

	Min	Max	Mean	Std.
Chest girth	79.00	92.00	83.55	4.07
Bust girth	81.50	96.70	85.99	4.57
Underbust girth	69.60	81.00	74.63	3.04
Waist girth	64.50	84.50	71.23	4.96
Abdomen girth	75.10	94.70	83.80	5.02
Hip girth	86.10	109.30	94.89	5.89
Shoulder point to shoulder point	36.50	42.80	39.66	1.71
Back neck point to waistline	33.00	39.10	36.96	1.68
Height	154.90	171.00	161.30	4.17
body weight	47.75	73.30	56.16	6.64
BMI*	18.72	27.29	21.56	2.18

*BMI = Body weight (kg) / Height (m)2

2.3 Experimental Method

The experiments were conducted in an artificial climate chamber where the temperature was controlled at $27 \pm 1.4\,^{\circ}\mathrm{C}$ and the relative humidity at $32 \pm 2\%$. To minimize the effects of menstrual cycles and circadian rhythm on body's physical response, the experiment was carried out during the early follicular phase of each woman, and several garments were tested at the same time for each woman on each day.
In the experiment, we selected suited size of the foundation garment for the subjects according to their body measurements. Each subject entered the chamber 30 minutes or more before the start of the experiment so that she could become accustomed to the experimental environment. We asked subjects about pressure sensation at 15 positions on the torso and the shaping effect at several parts. The pressure sensation and the shaping effect were evaluated from -2-2 five-grade psychological scale, as shown in Figure 2.

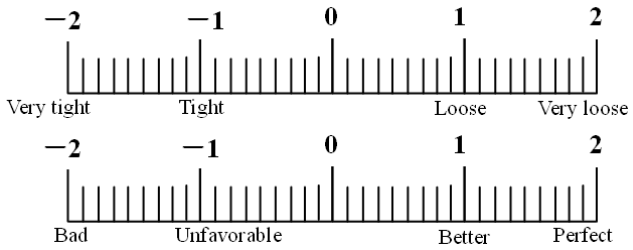
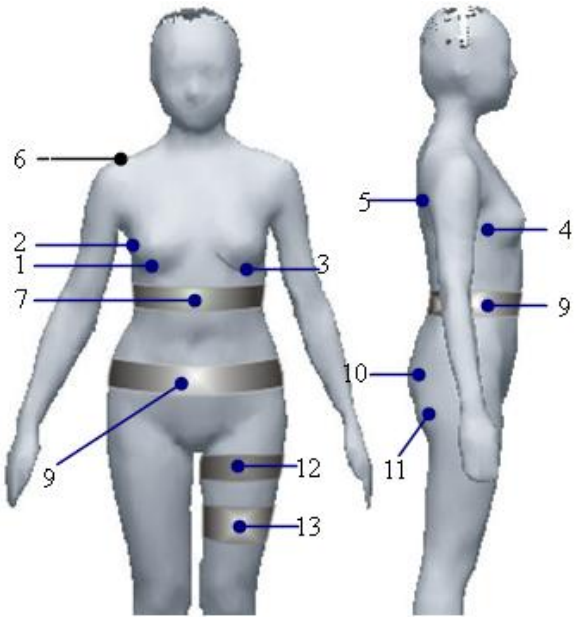


Figure 2 Psychological scale for pressure sensation and shaping effect evaluation

3. Result and Discussion

3.1 The correlation between pressure sensation, shaping effect assessment and time



1-Under bust area 2- Outer bust area 3- Wire pressure
4-Underarm（side） 5-Back 6-Strap
7-Stomach circumference 8- Abdomen circumference
9- Waist circumference 10-Hip point 11- Under hip point
12- Upper thigh circumference 13-Leg circumference

Figure 2 The positions of pressure sensation evaluation

We designed an experiment to give the pressure sensation and shaping effect evaluation for short and long time conditions. The positions of subjects evaluation were 13 parts on the body as shown in Fig. 2.

Each subject entered the chamber 30 minutes or more before the start of the experimental, and then took on the experimental foundation garment. The short time evaluation was tested after taking clothing for 30 minutes, and the long time evaluation was tested after 4 hours, the subjects can leave chamber during the long time test with daily action and back again at the fixed time.

During the experiment, the pressure sensation evaluation changed with time as shown in Fig. 3. In the short time test, the pressure sensation evaluations were most in the -2-0, because we selected suitable size for the subjects according to their measurement, the foundation garment inevitably gave negative pressure to the body, but we found that the pressure sensation evaluation at the back, under hip point and leg circumference positions was small. After subjects with the clothing for 4 hours, we found that most pressure sensation evaluations were lower because they were accustomed to the negative pressure at most parts of the body, especially at the bust area, most female felt little pressure because they feel bra pressure in the daily life. But at the stomach circumference, subjects felt more strong pressure than in short time test. At the leg circumference of girdle, subjects felt loose after a long time.

The shape beauty assessments were also surveyed in the experiment. The shaping effect assessment of most parts was changed during the long time test. But the shaping effect evaluations at the waist, abdomen and hip were lower than short time test, because subjects accustomed to the pressure, and elasticity of clothing material will release a little ease.

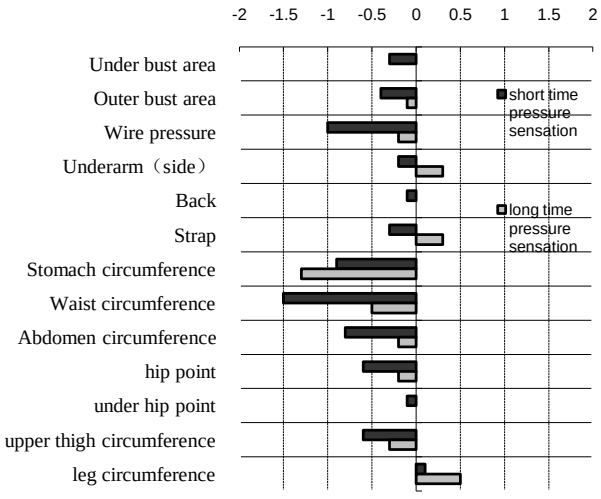


Figure 3 The pressure sensation evaluation changed with time

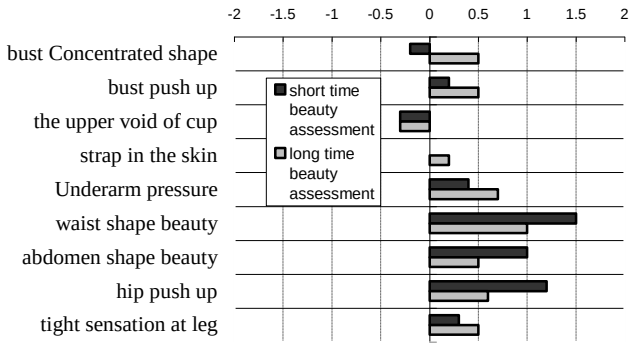


Figure 4 The shaping effect assessment changing with time

3.2 The overall pressure sensation and the body parts developed by corsets

We designed an experiment for investigating the overall pressure sensation and the different body parts. The overall and 15 parts (shown as Table 3) of the body subjective pressure sensation with different corsets were asked. We obtained factor matrices using KMO& Bartlett's Test and principal factor solutions, which constitute the proportion of the test variance ascribed to the action of the common factors. Using factor analysis, three factors were extracted from fifteen components. After rotating the factor axes the structure of the test relations was more clearly indicated. The results of factor matrices rotated by the Varimax method are shown in Tab.3, the three factors obtained were sufficient to describe the data. The side waist, front waist, back waist, side area at the bust line (below the armpits), side area at stomach circumference could be explained by common factor (Factor Ⅰ), named the Factor of waist pressure sensation. The Factor Ⅱ named the Factor of bust wire and back pressure sensation was constituted by the outer bust, side bust, middle between bust points, wire pressure, and back. The Factor Ⅲ named the Factor of near waist pressure sensation was constituted by the front, side and back area at abdomen circumference, front and back area at stomach circumference.

Table 4 shows the correlation coefficients between the overall pressure sensation and the parts of the body, we found that the overall pressure sensation had significant correlation with Factor Ⅰ and Factor Ⅲ. So we concluded that the overall pressure sensation had a significant correlation with the waist pressure and near waist pressure.

Liner regression analysis showed that variables for the pressure sensation at waist (X_1) and the pressure sensation at near waist (X_3) were good predictors for the overall pressure sensation assessment (Y), as shown in Tab.5. Regression equation was $Y= -0.807+0.499\ X_1+ 0.187X_3$.

Table 3 Rotated component matrix

	Component		
	1	2	3
Side waist(at waistline)	.904	.097	.360
Front waist (at waistline)	.840	.283	.407
Back waist (at waistline)	.834	.130	.459
Side area at the bust line (below the armpits)	.755	.580	-.115
Side area at stomach circumference	.658	.152	.578
Outer bust	.108	.912	-.010
Side bust	.301	.904	-8.747E-05
Middle area between bust points	.099	.877	.316
Wire	.124	.875	.302
Back	.319	.629	.459
Front area at abdomen circumference	.100	-.034	.924
Back area at stomach circumference	.500	.319	.708
Front area at stomach circumference	.525	.281	.696
Side area at abdomen circumference	.515	.202	.690
Back area at abdomen circumference	.464	.361	.690

Table 4 Correlation coefficients between the overall pressure sensation and the parts of the body

	the Overall Pressure Sensation	Factor Ⅰ	Factor Ⅱ	Factor Ⅲ
the Overall Pressure Sensation	1	.783(**)	.088	.480(**)
Factor Ⅰ	.783(**)	1	.000	.000
Factor Ⅱ	.088	.000	1	.000
Factor Ⅲ	.480(**)	.000	.000	1

Correlation is significant at the 0.01 level (2-tailed).

Table 5 Coefficients analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t
		B	Std. Error	Beta	
1	(Constant)	-.792	.038		-20.712
	Factor Ⅰ	.519	.039	.907	13.316
2	(Constant)	-.807	.029		-28.178
	Factor Ⅰ	.499	.029	.873	17.055
	Factor Ⅲ	.187	.033	.286	5.594

4. Conclusions

In this study, the overall wearing comfort of pressure sensation and different parts of body were surveyed, the main conclusion are described as follows.

1. The wearing comfort of pressure sensation and the shaping effect assessment changed with time.

2. The overall wearing comfort of pressure sensation had a significant correlation with the 15 parts of the body pressure sensation. The 15 parts of the body pressure sensation could be described by three factors, they were the Factor of waist pressure sensation (Factor Ⅰ), the Factor of bust wire and back pressure sensation (Factor Ⅱ), and the Factor of near waist pressure sensation (Factor Ⅲ).

3. From the correlation coefficients and step regression analysis, we could conclude the whole wearing comfort of pressure sensation had a significant correlation with two factors of the three, we can give the regression equation was $Y= -0.807+0.499\ X_1+ 0.187X_3$. This showed that the whole pressure sensation assessment (Y) had significant correlation with variables for the pressure sensation at waist (X_1) and near waist (X_3). This can give a foundational suggestion for the design of these clothing, such as the ease suggestion and positions of strong whale bone.

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