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Data Mining Based Research of Development Direction of Waist Protection Equipment

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Abstract [**Objectives**] To explore the trend of brands towards the design of waist protection products through data mining, and to provide reference for the design concept of the contour of waist protection pillow. [**Methods**] The structural design information of all waist protection equipment was collected from the national Internet platform, and the data were classified and a database was established. IBM SPSS 26.0 and MATLAB 2018a were used to analyze the data and tabulate them in Tableau 2022.4. After the association rules were clarified, the data were imported into Cinema 4D R21 to create the concept contour of waist protection pillow. [**Results**] The average and standard deviation of the single airbag design were the highest in all groups, with an average of 0.511 and a standard deviation of 0.502. The average and standard deviation of the upper and lower dual airbags were the lowest in all groups, with an average of 0.015 and a standard deviation of 0.120; the correlation coefficient between single airbag and 120° arc stretching was 0.325, which was positively correlated with each other ($P < 0.01$); the correlation coefficient between multiple airbags and 360° encircling fitting was 0.501, which was positively correlated with each other and had the highest correlation degree ($P < 0.01$). [**Conclusions**] The single airbag design is well recognized by companies, and has received the highest attention among all brand products. While focusing on single airbag design, most brands will consider the need to add 120° arc stretching elements in product design. At the time of focusing on multiple airbag design, some brands believe that 360° encircling fitting elements need to be added to the product, and the correlation between the two is the highest among all groups.

Key words Spine, Low back pain, Data mining, Airbag, Stretching, Fitting, Steel plate support, Bidirectional compression, Conceptual contour, Design

1 Introduction

At present, the occurrence of spinal low back pain (SLBP) is very common, and it is becoming an important factor that disturbs people's normal life. According to statistics, from 1990 to 2019, the global incidence, prevalence, and disability-adjusted life years (DALYs) increased by 50%, 47%, and 47%, respectively, and China was one of the three countries with the largest increase in these three items[1]. The structure of the waist is complex and there are many factors causing low back pain. Statistical data indicate that about 39% of low back pain is related to lumbar disc herniation (LDH)[2], and some of them are closely related to structural lesions of bone, muscle and fascia[3-4]. Waist protection devices are highly recognized for keeping the stability of lumbar function. Nowadays, there are numerous kinds of waist protection devices on the market, and the main design concept is to reconstruct the physiological function of the lumbar spine and its accessories while restoring the strength of the lumbar muscles[5]. In this study, through the Internet, we searched the design features of the existing waist protection devices included in the network, to explore the overall market trend in the field of low back pain treatment through induction and collation, so as to provide a reference for the development of follow-up products.

2 Data and methods

2.1 Software preparation Microsoft Excel 2023 was used to record the data; SPSS Statistics 26.0 and MATLAB 2018a were used to analyze the data; Tableau 2022.4 was used for mining and tabulation; Cinema 4D R21 was used for conceptual modeling.

2.2 Source and retrieval method of product characteristics We searched the general catalogue of various series of waist protection products released by Tmall, Taobao, Jingdong, Pinduoduo, Zhihu, TikTok and China Waist Protection Equipment Network (http://www.huyaoshebei.3.biz/) from the establishment of the database to June 2023. Search method: enter the words "waist protection" in search bar of the above 7 official website using the fuzzy search method.

2.3 Inclusion criteria of products (i) The product is used for the adjuvant treatment of spinal low back pain; (ii) the product contains other physical material structures in addition to the molding material; (iii) the product complies with the *Regulations on the Supervision and Administration of Medical Devices* (Revised in 2020, Order No. 739 of the State Council)[6].

2.4 Exclusion criteria of products (i) The product is not intended to be used as an adjunctive treatment for spinal low back pain or the product is intended to be used only for the treatment of pain in areas of the spine other than the lumbar region; (ii) the molding material of the product has only a single textile or fiber molded structure; (iii) the product will cause damage to the human body during use, in other words it does not comply with the *Regulations on the Supervision and Administration of Medical Devices* (Revised in 2020).

2.5 Database entry specifications The information about the products that meet the inclusion criteria found in the network was entered into an Excel sheet. Then, the row and column were set,

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with the "brand" as the row indicator and structure item as the column indicator, such as "including single airbag", "including left and right dual aigbags", "including multiple airbags", "including upper and lower dual aigbags", "including steel plate support", "including bidirectional compression", "including lumbar spine 120° arc stretching"[7], "including lumbar spine sagittal 26° fitting"[8], "including horizontal 360° encircling fitting". In the Excel sheet, the corresponding characteristic elements in the product design were marked with "*". To avoid duplication of information, products of the same model with the same name released by each platform were processed as single entry.

2.6 Statistical methods The frequency of the design structure information contained in the product was counted by Excel, the statistical analysis was carried out with the aid of SPSS 26.0 and MATLAB2018a, and the drawing was plotted by Tableau 2022.4. "*" was encoded as "1", which means "considered", and a null value was encoded as "0", which means "not considered". After sorting out the information, frequency analysis and descriptive analysis were carried out to analyze the concern of the field. The larger proportion of "1" in a certain field indicates that the structural design concept is more concerned in various brands. A higher average value in a certain field means more concerned in each brand, and more frequent occurrence of the related clinical symptoms. Pearson correlation test was carried out to test the correlation between a field and other fields. If there is a correlation, it means that the two design concepts will be considered together in the design of brand products, and the significance level of the test is 0.05 (two-sided). Besides, the darker part in the Pearson correlation test indicates that the correlation is strong and there is a centralized pairing relationship.

2.7 Using 3D software to design the appearance of a conceptual waist protection pillow Through Pearson correlation test, the market dominant design trend was obtained, which was introduced into the computer CINEMA 4D R21 to simulate planning and modeling. Then, we dynamically and randomly adjusted the renderer (turning on the RS dome lamp to illuminate the RS area light, RS area light 1 and RS area light 2; turning on CURVE COVE; setting the 3D coordinate axis and setting the radius to 10 cm, the intensity to 100% and the width to 50%), auxiliary material, topological deformation and geometric symmetry. The appearance design includes the contour of the waist protection pillow, the number and shape of the airbag filled inside, and the placement position of the electric inflator. The final design was determined and saved for later use in industrial preparation of physics experiments.

3 Results and analysis

3.1 Product inclusion We carefully browsed all the 17 700 link pages of the products retrieved from the whole network, and according to the inclusion and exclusion criteria, and finally included the product designs of 137 independent brands.

3.2 Frequency and analysis of brand design focus after classification The frequency of design focus direction of each brand after classification was shown in Table 1.

Table 1 Frequency statistics of product design focus directions for each brand after classification

Name	Option	Frequency	Percentage %	Cumulative percentage %
Single airbag	0.0	67	48.91	48.91
	1.0	70	51.09	100.00
Left and right dual aigbags	0.0	101	73.72	73.72
	1.0	36	26.28	100.00
Multiple airbags	0.0	124	90.51	90.51
	1.0	13	9.49	100.00
Steel plate support	0.0	102	74.45	74.45
	1.0	35	25.55	100.00
Bidirectional compression	0.0	92	67.15	67.15
	1.0	45	32.85	100.00
120°arc stretching	0.0	111	81.02	81.02
	1.0	26	18.98	100.00
Sagittal 26° fitting	0.0	108	78.83	78.83
	1.0	29	21.17	100.00
Horizontal 360° encircling fitting	0.0	117	85.40	85.40
	1.0	20	14.60	100.00
Upper and lower dual aigbags	0.0	135	98.54	98.54
	1.0	2	1.46	100.00
Total	137	100.0	100.0	

As indicated in Table 1, among the products of 137 independent brands, 70 brands contained single airbag design (51.09%), 36 brands contained dual aigbags design (26.28%), 13 brands contained multiple airbags (9.49%), 2 brands contained upper and lower dual aigbags (1.46%), 35 brands contained steel plate support (25.55%), 45 brands contained bidirectional compression (32.85%), 18 brands contained lumbar 120° arc stretching (18.98%), 29 brands contained lumbar sagittal 26° fitting (21.17%), 20 brands contained lumbar horizontal 360° encircling fitting (14.62%), and there was brand overlap in each design feature unit. More than 50% of the samples selected "1.0" in the product design containing a single airbag brand (Fig. 1). In addition, the proportion of 0.0 samples was 48.91%. Among them, the proportion of "1.0" was the largest among the nine design fields, so this field was the most concerned by various brands.

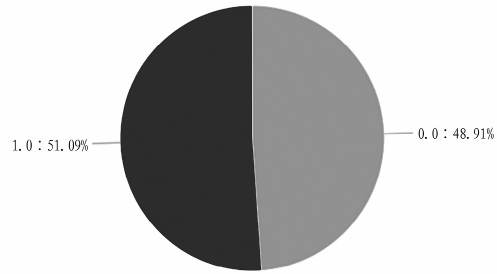


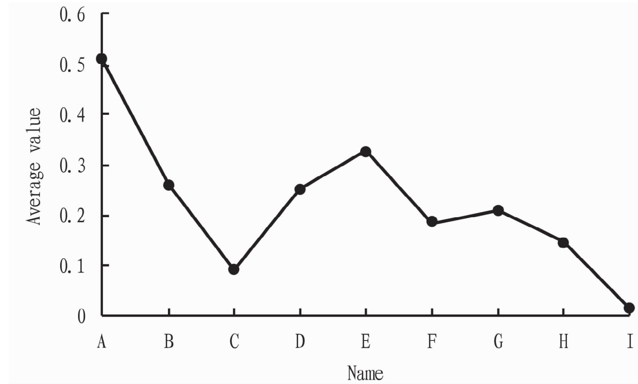
Fig. 1 Frequency distribution of single airbag design

3.3 Statistical and descriptive analysis of basic indicators of product design focus of each brand after classification The classification of product design focus of each brand was shown in Table 2.

Table 2 Statistics of basic indicators of the design focus of each brand after classification ($n = 137$)

Name	Min.	Max.	Average	Standard deviation	Median
Upper and lower dual aigbags	0.000	1.000	0.015	0.120	0.000
Multiple airbags	0.000	1.000	0.095	0.294	0.000
Horizontal 360° encircling fitting	0.000	1.000	0.146	0.354	0.000
120° arc stretching	0.000	1.000	0.190	0.394	0.000
Sagittal 26° fitting	0.000	1.000	0.212	0.410	0.000
Steel plate support	0.000	1.000	0.255	0.438	0.000
Left and right dual aigbags	0.000	1.000	0.263	0.442	0.000
Bidirectional compression	0.000	1.000	0.328	0.471	0.000
Single airbag	0.000	1.000	0.511	0.502	1.000

From Table 2, it was found that all data did not contain outliers, and the average value and standard deviation of the single airbag design were the largest in each group, with the average value of 0.511 and the standard deviation of 0.502; the average value and standard deviation of the upper and lower dual aigbags were the lowest in each group, with the average value of 0.015 and the standard deviation of 0.120. Therefore, the single airbag design was recognized by the brands and received the highest attention among the products of all brands (Fig. 2).



NOTE A. single aigbag, B. left and right dual aigbags, C. multiple aigbags, D. steel plate support, E. bidirectional compression, F. 120° arc stretching, G. 26° fitting, H. 360° encircling fitting, I. upper and lower dual airbags.

Fig. 2 Comparison of the average values of basic indicators of the design focus directions of each brand after classification

3.4 Pearson related statistics of product focus design directions for each brand after classification The Pearson related statistics of product focus design directions for each brand after classification were shown in Table 3 and Fig. 3.

Table 3 Pearson related statistics of product design directions for each brand after classification

Name	Correlation & P	Single airbag	Left and right dual aigbags	Multiple airbags	Steel plate support	Bidirectional compression	120° arc stretching	26° fitting	360° encircling fitting	Upper and lower dual aigbags
Single airbag	Correlation coefficient	1.000**	−0.610**	−0.331**	0.037	0.000	0.325**	0.078	−0.133	−0.124
	P value	0.000	0.000	0.000	0.664	0.998	0.000	0.365	0.121	0.147
Left and right dual aigbags	Correlation coefficient	−0.610**	1.000**	−0.193*	−0.312**	−0.206*	−0.204*	−0.147	−0.200*	−0.073
	P value	0.000	0.000	0.024	0.000	0.016	0.017	0.087	0.019	0.399
Multiple airbags	Correlation coefficient	−0.331**	−0.193*	1.000**	−0.190*	−0.173*	−0.157	−0.046	0.501**	0.168*
	P value	0.000	0.024	0.000	0.026	0.043	0.067	0.595	0.000	0.049
Steel plate support	Correlation coefficient	0.037	−0.312**	−0.190*	1.000**	0.659**	0.058	0.393**	0.042	−0.071
	P value	0.664	0.000	0.026	0.000	0.000	0.501	0.000	0.624	0.408
Bidirectional compression	Correlation coefficient	0.000	−0.206*	−0.173*	0.659**	1.000**	0.018	0.360**	−0.025	−0.085
	P value	0.998	0.016	0.043	0.000	0.000	0.833	0.000	0.771	0.323
120° arc stretching	Correlation coefficient	0.325**	−0.204*	−0.157	0.058	0.018	1.000**	0.114	−0.042	0.096
	P value	0.000	0.017	0.067	0.501	0.833	0.000	0.186	0.627	0.263
26° fitting	Correlation coefficient	0.078	−0.147	−0.046	0.393**	0.360**	0.114	1.000**	−0.164	−0.063
	P value	0.365	0.087	0.595	0.000	0.000	0.186	0.000	0.056	0.464
360° encircling fitting	Correlation coefficient	−0.133	−0.200*	0.501**	0.042	−0.025	−0.042	−0.164	1.000**	−0.050
	P value	0.121	0.019	0.000	0.624	0.771	0.627	0.056	0.000	0.559
Upper and lower dual aigbags	Correlation coefficient	−0.124	−0.073	0.168*	−0.071	−0.085	0.096	−0.063	−0.050	1.000**
	P value	0.147	0.399	0.049	0.408	0.323	0.263	0.464	0.559	0.000

NOTE * $P < 0.05$, ** $P < 0.01$.

3.4.1 Pearson correlation analysis of single airbag design direction. From Table 3 and Fig. 3, it can be seen that the correlation coefficient values between single airbag and left and right dual aigbags, multiple airbags and 120° arc stretching were significant. Specifically, the correlation coefficient between single airbag and left and right dual aigbags was −0.610, indicating that there was a significant negative correlation between single airbag and left and right dual aigbags ($P < 0.01$); the correlation coefficient between single airbag and multiple airbags was −0.331, indicating that there was a significant negative correlation between single airbag and multiple airbags ($P<0.01$). Combined with the average value analysis, most brands, while focusing on the single airbag design, believed that the left and right dual aigbags design or multiple airbags design was relatively general, or even bad. The correlation coefficient between single airbag and 120° arc stretching was 0.325, indicating that there was a significant positive correlation between single airbag and 120° arc stretching ($P<0.01$), and while focusing on single airbag design, most brands would consider the need to add 120° arc stretching elements to product design.

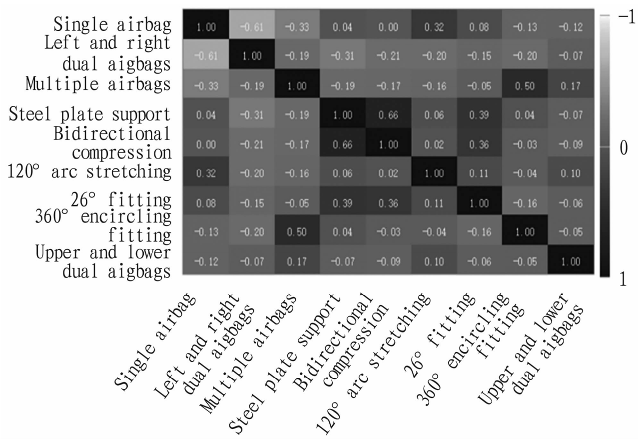


Fig. 3 Pearson related visualization overview of each design element

3.4.2 Pearson correlation analysis of left and right airbags design direction. As shown in Table 3 and Fig. 3, the correlation coefficient values among the left and right dual aigbags and single airbag, multiple airbags, steel plate support, bidirectional compression, 120° arc stretching, and 360 ° encircling fitting were significant. Specifically, the correlation between left and right dual aigbags and single airbag was −0.610, indicating that there was a significant negative correlation between left and right dual aigbags and single airbag ($P<0.01$). The correlation coefficient between left and right dual aigbags and multiple airbags was −0.193, indicating that there was a significant negative correlation between left and right dual aigbags and multiple airbags ($P<0.05$). The correlation coefficient between left and right dual aigbags and steel plate support was −0.312, indicating that there was a significant negative correlation between left and right dual aigbags and steel plate support ($P<0.01$). The correlation coefficient between the left and right dual aigbags and bidirectional compression was −0.206, indicating that there was a significant negative correlation between dual aigbags and bidirectional compression ($P<0.05$). The correlation coefficient between left and right dual aigbags and 120° arc stretching was −0.204, indicating that there was a significant negative correlation between left and right dual aigbags and 120° arc stretching ($P<0.05$). The correlation coefficient between left-right dual aigbags and horizontal 360° encircling fitting was −0.200, indicating that there was a significant negative correlation between left-right dual aigbags and horizontal 360° encircling fitting ($P<0.05$). Combined with the average value analysis, some brands believed that the design of single airbag design, multiple airbags design, steel plate support and bidirectional compression, 120° arc stretching, and horizontal 360° encircling fitting while focusing on the left and right dual aigbags was general or even bad.

3.4.3 Pearson correlation analysis of multiple airbags design direction. As shown in Table 3 and Fig. 3, the correlation coefficient values among multiple airbags and single airbag, left and right dual aigbags, steel plate support, bidirectional compression, horizontal 360° encircling fitting, and upper and lower dual aigbags were significant. Specifically, the correlation coefficient between multiple airbags and single airbag was −0.331, indicating that there was a significant negative correlation between multiple airbags and single airbag ($P<0.01$). The correlation coefficient between multiple airbags and left and right dual aigbags was −0.193, indicating that there was a significant negative correlation between multiple airbags and left and right dual aigbags ($P<0.05$). The correlation coefficient between multiple airbags and steel plate support was −0.190, indicating that there was a significant negative correlation between multiple airbags and steel plate support ($P<0.05$). The correlation coefficient between multiple airbags and bidirectional compression was −0.173, indicating that there was a significant negative correlation between multiple airbags and bidirectional compression ($P<0.05$). While focusing on the design of multiple airbags, some brands believed that the design concepts such as single airbag design, left and right dual aigbags, steel plate support and bidirectional compression were relatively general or even bad. The correlation coefficient between multiple airbags and 360° encircling fitting was 0.501, indicating that there was a significant positive correlation between multiple airbags and 360° encircling fitting ($P<0.01$). In other words, some brands would also consider adding the concept of horizontal 360° surround to product design while focusing on multiple airbags design, and the correlation between the two was the highest in all groups. The correlation coefficient value between multiple airbags and upper and lower dual aigbags was 0.168, indicating that there was a significant positive correlation between multiple airbags and upper and lower dual aigbags ($P<0.05$). In other words, some brands considered the concept of upper and lower dual aigbags design while paying attention to the design of multiple airbags, which is difficult to choose.

3.4.4 Pearson correlation analysis of steel plate support design direction. As shown in Table 3 and Fig. 3, the correlation coefficients between steel plate support and left and right dual aigbags, multiple airbags, bidirectional compression and sagittal 26° fitting was significant. Specifically, the correlation coefficient between steel plate support and left and right dual aigbags was −0.312, indicating that there was a significant negative correlation between steel plate support and left and right dual aigbags ($P<0.01$). The correlation coefficient between steel plate support and multiple airbags was −0.190, indicating that there was a significant negative correlation between steel plate support and multiple airbags ($P<0.05$). These indicate that while considering steel plate support, some brands believed that the design of left and right dual aigbags and multiple airbags was relatively general or even bad. The correlation coefficient between steel plate support and bidirectional compression was 0.659, indicating that there was a significant positive correlation between steel plate support and bidirectional compression ($P < 0.01$). The correlation coefficient between steel plate support and sagittal 26° fitting was 0.393, indicating that there was a significant positive correlation between steel plate support and sagittal 26° fitting ($P < 0.01$). While focusing on steel plate support, some brands would also consider adding bidirectional compression or sagittal 26° fitting elements to the product design.

3.4.5 Pearson correlation analysis of bidirectional compression design direction. As shown in Table 3 and Fig. 3, the correlation coefficient between bidirectional compression and left and right dual aigbags, multiple airbags, steel plate support, sagittal 26° fitting was significant. Specifically, the correlation coefficient between bidirectional compression and left and right dual aigbags was −0.206, indicating that there was a significant negative correlation between bidirectional compression and left and right dual aigbags ($P < 0.05$). The correlation coefficient between bidirectional compression and multiple airbags was −0.173, indicating that there was a significant negative correlation between bidirectional compression and multiple airbags ($P < 0.05$). Combined with the comparison of the average value, it can be seen that some brands, while paying attention to bidirectional compression, considered that the design of left and right dual aigbags and multiple airbags was relatively general or even bad. The correlation coefficient between bidirectional compression and steel plate support is 0.659, indicating that there was a significant positive correlation between bidirectional compression and steel plate support ($P < 0.01$). The correlation coefficient between bidirectional compression and sagittal 26° fitting was 0.360, indicating that there was a significant positive correlation between bidirectional compression and sagittal 26° fitting ($P < 0.01$). These show that while focusing on bidirectional compression, some brands would consider adding steel plate support or sagittal 26° fitting elements to the product design.

3.4.6 Pearson correlation analysis of 120° arc stretching design direction. As shown in Table 3 and Fig. 3, the correlation coefficient between 120° arc stretching and single airbag, left and right dual aigbags was significant. Specifically, the correlation coefficient between 120° arc stretching and single airbag was 0.325, indicating that there was a significant positive correlation between 120° arc stretching and single airbag ($P < 0.01$). Combined with the comparison of the average value, it can be seen that most brands also considered the need to add single airbag design elements to the product while paying attention to the 120° arc stretching. The focus of these two items ranked first in the average summation and will become the dominant product design in the future. The correlation coefficient between 120° arc stretching and left and right dual aigbags was −0.204, indicating that there was a significant negative correlation between 120° arc stretching and left and right dual aigbags ($P < 0.05$). These indicate that while paying attention to 120° arc stretching, some brands believed that the design of left and right dual aigbags was relatively general or even bad.

3.4.7 Pearson correlation analysis of sagittal 26° fitting design direction. As shown in Table 3 and Fig. 3, the correlation coefficient between sagittal 26° fitting, steel plate support and bidirectional compression was all significant, and the correlation coefficient values were 0.393, 0.360 and 1.000, respectively, all of which were greater than 0. It means that there was a positive correlation between 26° fitting and steel plate support and bidirectional compression. Combined with the average value analysis, some brands not only paid attention to sagittal 26° fitting, but also considered the need to add steel plate support or bidirectional compression design elements into the product design.

3.4.8 Pearson correlation analysis of 360° encircling fitting design direction. As shown in Table 3 and Fig. 3, the correlation coefficient between 360° encircling fitting and left and right dual aigbags and multiple airbags was significant. Specifically, the correlation coefficient between 360° encircling fitting and left and right dual aigbags was −0.200, indicating that there was a significant negative correlation between 360° encircling fitting and left and right dual aigbags ($P < 0.05$). Combined with the average value analysis, it can be seen that some brands, while paying attention to 360° encircling fitting, believed that the design of the left and right dual aigbags was relatively general or even bad. The correlation coefficient between 360° encircling fitting and multiple airbags was 0.501, indicating that there was a significant positive correlation between 360° encircling fitting and multiple airbags ($P < 0.01$). While paying attention to 360° encircling fitting, some brands considered that multiple airbag design elements need to be added to their products, and the correlation between them was the highest among all groups.

3.4.9 Pearson correlation analysis of upper and lower dual aigbags design direction. As shown in Table 3 and Fig. 3, the correlation coefficient values between upper and lower dual aigbags and multiple airbags were 0.168 and 1.000, respectively, all of which were greater than 0. This means that there was a positive correlation between upper and lower dual aigbags and multiple airbags. Combined with the average value analysis, it can be concluded that some brands also considered the design concept of multiple airbags while paying attention to the design of upper and lower dual aigbags, which is difficult to choose.

4 3D shaping of the new waist protection pillow

According to the results of Pearson analysis, most brands think that it is necessary to add 120° arc stretching elements while focusing on single airbag design. Although multiple airbags and 360° encircling fitting considered by some brands, have the highest correlation, the average value is slightly lower, considering the comfort of the waist protection pillow and the cushioning and shock absorption effect, a single restart airbag lined with aramid fabric is installed in the pillow position of the new waist protection pillow[9], and one end of the airbag is connected to an electric inflator controlled by a computer chip and a touch key through a conduit. The other one end of air inlet of the electric inflator is close to an air grid placed at one side of the waist protection pillow. When the inflator operates, outside air is sucked in to fill the airbag, so that the airbag is lifted to support the lumbar vertebra structure of the human body. The middle point of the two spinous process tips of L3-L4 is taken as the upper vertex, an oblique dotted line is drawn from the upper vertex to the most convex point of the sacral spine, and an oblique dotted line is drawn from the upper vertex to the tip of the T6 spinous process, and the two lines need to form an angle[10]. Setting when the inflation is maximum, that is, when the airbag lifts the upper vertex to a certain height, the included angle formed by the above two dotted lines is 120 degrees (at this time, each lumbar vertebral body and lumbar intervertebral disc have different load variable angle stretching), as shown in Fig. 4[7,11]. The final appearance design implementation is processed by Cinema 4D software. According to the facts of the conditions, the 3D finalization of the final concept version of the waist protection pillow is obtained, as shown in Fig. 5 and 6.

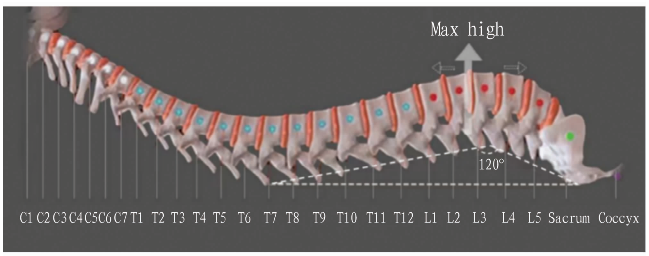


Fig. 4 Concept diagram of the action direction of waist protection pillow

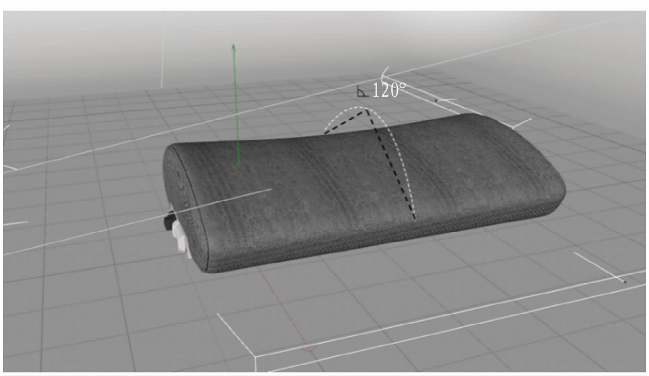


Fig. 5 Coordinate gray scale of 3D concept waist protection pillow

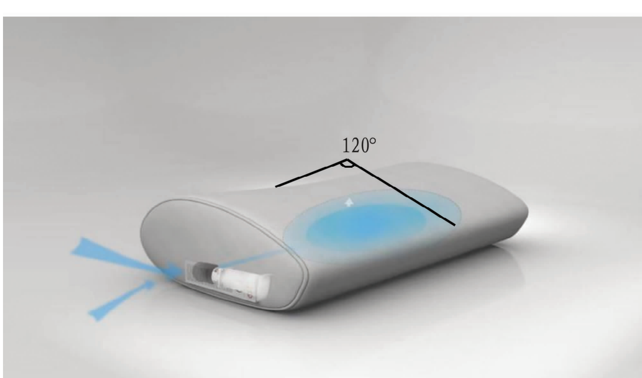


Fig. 6 Structural appearance diagram of 3D concept waist protection pillow

5 Discussion

As the hub connecting the upper body and the lower body, the waist plays a key role in supporting the body weight, so it is necessary to consider the ergonomics when studying and designing the waist products[1,12]. Through the comparison of the average values in data mining, we found that the single airbag design is the most concerned by most of the current brand waist products. Through Pearson statistics, we also explored the brand's attention to 120° arc stretching and found that there is a positive correlation with single airbag design. In the data statistics, Pearson experiment also indicated that some brands pay more attention to multiple airbags design and the association with 360° fitting, and this association is the highest in all pairwise comparison data, but this association is not enough to occupy the mainstream in the current waist protection equipment design market. In each step of the analysis, it is easy difficult to find that there are a lot of negative correlation data in the association rules. The logical level only represents the subjective preferences of their respective brands, and it is difficult to objectively express the positioning and expectations of the entire design market.

Traction is mainly to increase the lumbar space by physically stretching the spine, relieve the compression of lumbar nerves due to disc herniation, and eliminate muscle spasm so as to restore the disc[13]. The 120° arc stretching can stretch the lumbar intervertebral space and implement the maximum stress buffer to the lumbar vertebral body and intervertebral disc on the premise of fitting the lumbar curvature of the human body[7]. However, in the software simulation, we found that the process of the angular stress change of the single airbag in the fitting and stretching of the lumbar spine was global, lacking a centralized buffer for a single segment, and the control of the airbag in the design process needed to add a sensor-decompression feedback system to help eliminate the contraction resistance of the paravertebral muscles and avoid injury to paravertebral soft tissue[14].

In recent years, the introduction of far-infrared heating concept into the design of waist protection pillow products to increase the highlights of products has been valued by a few brands. However, due to the scarcity of materials and the market's respect for the concept of environmental protection, this concept has not been widely promoted. Studies have found that far-infrared materials such as graphene can activate water molecules, improve circulation, enhance tissue metabolism, and have important non-thermal effects[5]. Most of the far-infrared waist protection products on the network are heated in the whole lumbar region. In the research and development of new products, the treatment should be clearly targeted, and the radiation guidance for specific segments of lumbar and paravertebral tissues should be designed. Under the global mainstream trend of AI (artificial intelligence) to improve the quality of life, aiming at the existing Cinema 4D product sample, it is recommended to develop the internal control circuit design of waist protection pillow, add the sensing touch control of mobile phone App, and establish the direct control channel of mobile phone-airbag-control circuit-pillow surface, to reduce the interference of surrounding co-channel devices on the control functions of the waist protection pillow[15]. At present, the rapid growth of aging population makes low back pain an urgent problem to be solved[1,16]. As a product used in a large country with widespread low back pain, the safety of elderly patients should be fully taken into account while designing the product. In addition, for the biological availability of a medical auxiliary product, the corresponding situation requires many basic and clinical trials before it can be put on the market.

6 Conclusions

The application of data mining technology to the market research and development of medical products has made the network environment connected with the real world. Through the search and judgment of rules, it is found that there is the possibility of subverting human subjective intuition, but this subversion must make the objective more objective (discovering a large number of unknown rules). As doctors, we should raise the flag of scientific and technological progress, strengthen the research and development of new waist protection products, so as to benefit all the people and make this powerful medical technology flourish in China.

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