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Test method and evaluation index of thermal and wet comfort of garment structure

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Abstract: Clothing thermal and wet comfort as the modern clothing industry design and manufacturing of the main content of the discussion, its direct impact on the historical behavior of consumer groups to buy clothing. According to the test research of thermal and humid comfort of clothing in recent years, the human body, clothing and environment as a system of mutual influence, mainly discusses the coupling effect of humidity and heat, can ensure the thermal balance between the human body and the external environment. Therefore, on the basis of understanding the current research status of clothing thermal comfort test, this paper deeply discusses the common test methods according to the existing characteristics of clothing structure, and determines the evaluation indicators mastered by combining with practical cases, in order to provide effective basis for clothing structure design in the new era.

Keywords: garment structure; Comfort; Performance testing; Index of evaluation

1. The introduction

In the construction and development of modern society, in order to further improve the comfort of clothing, research scholars have strengthened the testing and research of thermal and wet comfort of clothing based on the accumulated experience of the previous clothing structure design, and mastered a variety of test methods and evaluation indicators combined with practical cases. In essence, the comfortable state of human clothing refers to the wearer's subjective perception and judgment ability on the basis of neurophysiology, psychology and physics. Nowadays, when researching clothing thermal comfort, researchers will start from the two aspects of clothing and fabric, and put forward more perfect evaluation indicators based on a comprehensive grasp of relevant data. From an objective point of view, it is necessary to use mechanical equipment to detect and analyze the heat and humidity transfer performance of clothing, mainly measuring and studying some physical indicators of clothing and physiological indicators of human wearing. From the subjective point of view, the comfort should be studied according to the experiment of human body wearing clothes. Since this form of evaluation varies from person to person, there is no uniform standard for determining. This method, also known as psychological evaluation method, can supplement the objective evaluation method by asking the experiment-goers to rate the comfort of wearing different types of clothing in a specific experimental environment. Before the experiment, the staff should first design the evaluation questionnaire, use language differences to describe the performance of the research object, assign the feeling intensity of the experimenter, select the professional terms that can accurately express the comfort, or establish scientific evaluation criteria, and then do a good test and analysis. In order to ensure the consistency of the perception standard and the expression standard of the whole experiment, before selecting the experimenter to participate in the experimental test, they should be organized to conduct unified training, pay attention to the human body's subjective sensory changes, and then use the mathematical method to obtain the final evaluation results.[1-3]

According to the analysis of the quarterly profit change curve of our textile and garment industry in recent years as shown in Figure 1 below, people have higher and higher requirements for clothing wear. In the early stage of development, the main reason is to avoid the cold. Therefore, both the clothing structure and the selected fabrics pay more attention to the durability of clothing. Therefore, the selection of fabrics and clothing design should consider its own function and comfort. Although the systematic research on clothing comfort at home and abroad only has a history of recent decades,

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scholars from various countries have put forward a variety of research topics in the field of textile and clothing, and preliminarily constituted the basic definition and evaluation methods.[4]

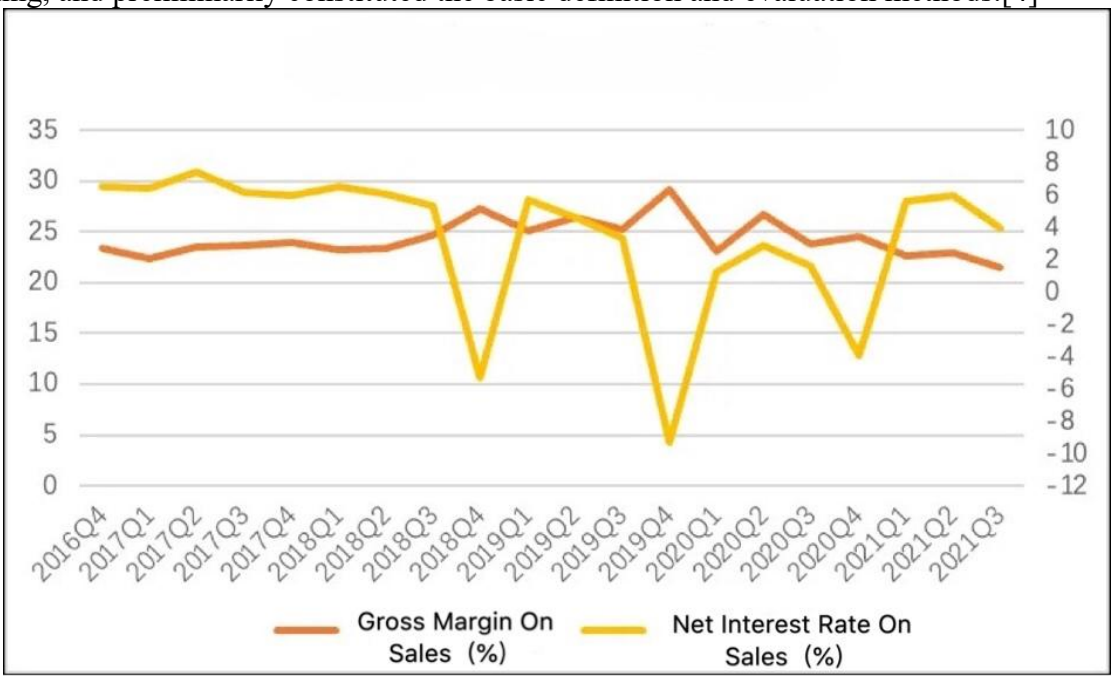

Figure 1. Quarterly profit change curve of Chinese textile and garment industry

As the focus of modern social construction and development, the comfort of clothing is mainly reflected in three aspects: the first is thermal comfort, the second is contact comfort, and the last is visual comfort. These concepts contain a wide range of content, practical research content is more. For example, in the early 1940s, some scholars put forward the thermal insulation index related to the physiological parameters, psychological feelings and environmental conditions of the human body, which is also known as the Crow number. In the early 1960s, some scholars put forward the moisture permeability index of clothing in their research. These two studies provided an effective basis for the study on the test method of clothing thermal comfort of clothing structure in the new era. [5]After the 1970s, the research of clothing comfort was mainly focused on the two aspects of heat and humidity. How to use qualitative and quantitative methods to make scientific judgment is the main issue discussed by scholars around the world. As the human body is an organism, it will continue to metabolize in the process of life. Human skin will emit heat and moisture to the natural environment to ensure a certain temperature of the skin surface. The comfort of wearing clothes depends on the balance between the heat and moisture generated by the body and the surrounding environment. According to experimental research, the temperature of comfortable clothing is mainly controlled between 31 and 33 degrees Celsius, and the relative humidity is controlled between 40 and 60 percent. In daily life, the thermal and wet comfort of clothing expected by human refers to the clothing can adapt to the specific changes of the natural environment and human activity state, so as to ensure that the clothing climate is maintained in a comfortable range. Therefore, in this paper, when studying the influence of clothing structure on the composition of clothing thermal comfort, it is necessary to clarify the test method of practical application, and then build evaluation indicators combined with specific cases to draw effective research conclusions.[6-7]

2. Methods

2.1 Evaluation of climate parameters

This method is designed according to the concept of clothing microclimate proposed by Takashi Harada et al. Researchers regard clothing microclimate as an important content of test and evaluation. By measuring the changes of climate temperature and humidity between clothing and

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simulated skin, the influence of clothing structure on the composition of human comfort can be fully demonstrated and corresponding evaluation indexes can be obtained. From the perspective of practical application, the evaluation indexes obtained by this method are relatively complex and lack sufficient balance during the test and research, so there are often many problems in the working state. In addition, human comfort can be demonstrated by simulating skin heat loss. For example, after studying and testing the moisture partial pressure, heat flow curve, temperature and other contents of climate, some scholars put forward a number of evaluation indexes, such as the rise of water vapor partial pressure and the area of moisture transfer, so as to provide an effective basis for studying the influence of clothing structure on the comfort composition of clothing thermal trainers.[8]

2.2 Physiological Evaluation

This method refers to the human body in a specific activity environment, by wearing different types of clothing, judge the change of human physiological parameters, and then evaluate the comfort of clothing. During the measurement, it is necessary to fully grasp the indicators such as body temperature change, sweating amount and oxygen consumption, so as to fully understand the influence of test clothing on the composition of human comfort. This method is one of the important technical means of garment ergonomics research in the current field of clothing, and has attracted the attention of scientific researchers at home and abroad. The physiological indicators included include average skin humidity, metabolic heat production, heat loss, heart rate, blood pressure, etc.[9]

2.3 Psychological Evaluation

This method belongs to the subjective feeling scoring method, which is a supplement and test to the objective evaluation method. However, there are great differences in the comfort indexes designed and mastered. Therefore, in the process of experimental analysis, it is necessary to comprehensively consider the scoring results of the experimenters, identify the specific scores of various clothing comfort feeling indexes, and then use mathematical methods for scientific treatment. The final comprehensive evaluation of different clothing structure comfort index score. For example, some scholars use psychophysical methods to explore the humidity evaluation results in clothing. Some scholars have proposed multiple attitude scales and wearing experiment schemes, focusing on the analysis of the physiological response of human body to sports clothing, preference characteristics, sensory perception, etc. When studying the psychological evaluation model, some scholars built Fanger thermal comfort equation and drew corresponding graphs. PMV refers to the influence of the change of thermal stress and environmental humidity generated by thermal load on the change of clothing and moisture permeability pressure. This method can fully demonstrate objective physical changes according to subjective feelings. It is an important technical means that combines subjective and objective factors. However, due to the influence of human factors, it is impossible to conduct quantitative analysis, so it is difficult to ensure the standardization and perfection of the final conclusion.[10-13]

3. Result analysis

3.1 System Analysis

In order to verify and analyze the influence of clothing structure on the composition of clothing thermal and wet comfort, the dummy technology was selected for the experiment in this study. The composition of the sweating dummy system is shown in Figure 2 below:[14]

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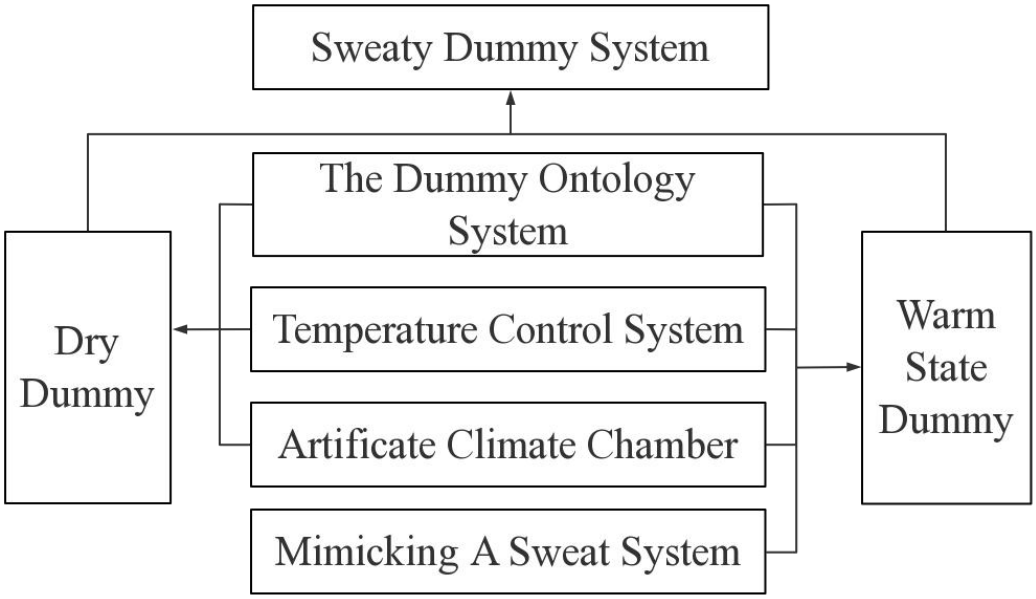

Figure 2 The structure of the sweating mannequin system

In the study of clothing thermal and wet comfort test, the family system has 34 independent heating zones for dynamic sweating, which can effectively simulate real human activities. The influence of clothing structure on the composition of clothing comfort performance is analyzed.

3.2 Test Indicators

The sweating dummy system is used to simulate and analyze the heat and humidity exchange process between human body, clothing and environment, which can be described and analyzed according to the thermal resistance, heat production, temperature and other indicators. Before the formal use, the basic connotation and parameters of each index should be determined, and the operation rules of the test and experiment should be fully mastered to provide an effective basis for the subsequent comprehensive evaluation of the thermal comfort performance of clothing. Comfort evaluation, as a subjective technical means, includes a variety of evaluation scales in the test and analysis. This study mainly starts with comfort degree and warm and cold feeling, as shown in Table 1 and Table 2 below:[15]

Table 1 Comfort evaluation scale

The ruler	4	>0	<0	-4
Subjective evaluation	Very comfortable	Comfortable	Not comfortable	Very uncomfortable

Table 2 Evaluation scale of cold and warm feeling

The ruler	4	3	2	1	-1	-2	-3	-4
Subjective evaluation	Very hot	Hot	Warmth	A little warmer	A little cooler	Cool.	Cold	Very cold

Meanwhile, the thermal and wet comfort test standards of the dummy are shown in Table 3 below:

Standard	GB/T 18398	ASTMF1291	EN342	ISO 15831
Scope of application	All kinds of clothes	Matching clothing	Individual and matching clothing for cold protection	Matching clothing
Fake human surface area	/	$1.8\pm0.3m^2$	$1.7\pm0.3m^2$	$1.7\pm0.3m^2$

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The height of the dummy		Should conform to the average of real population statistics	$1.7 \pm 0.1m$	$1.7 \pm 0.15m$	$1.7 \pm 0.15m$
Dummy skin temperature		32-35℃	32 ± 35℃	34℃	34℃
The dummy pose		Standing and dynamic walking	Standing	Standing and dynamic walking	Standing and dynamic walking
Environmental conditions	Humidity.	At least 10℃ below average body surface temperature	At least 12℃ below average body surface temperature	At least 12℃ below average body surface temperature	At least 12℃ below average body surface temperature
	Relative humidity	30%-50%	30%-70%	30%-70%	30%-70%
	Wind speed	0.15-8m/s	0.4 ± 0.1m/s	0.4m/s	0.4m/s
Garment area coefficient		/	Refer to iso9920	/	/
Calculation method of thermal resistance		Serial method	Parallel method	Parallel method or serial method	Parallel method or serial method

Table 3 Test standard comparison results of dummy

3.3 Result Analysis

In the above research tests, the dummy, as an internal influencing factor, directly determines the authenticity and perfection of the final test results. However, the dummy system itself has certain technical limitations, so this feature should be fully considered in the practical research. At the same time, as the research technology of the dummy test system is relatively complex, the practice cost is high, and the artificial climate environment is needed as the external support equipment, so the current research students propose to use the computer to construct the false dummy for research and analysis, which can not only reduce excessive experimental costs, but also accurately predict the heat exchange process between the dummy and the specific environment. Although the sweating dummy can be used in any experimental environment without mental influence factors, the final experimental results are more stable and the data error is small, which provides a reference for the optimization design of clothing structure. However, due to the high cost of relevant technology and many problems in practical application, the test results should be compared and analyzed with the real human experiment data. Therefore, comprehensive evaluation research can be realized. In the development of social and economic innovation in our country, with the continuous improvement of technical level in various fields, both dummy test technology and clothing comfort test research method will become more mature with the practice exploration, and then widely used in the field of textile and clothing, providing technical support for the development of more comfortable clothing materials and structures.

conclusion

To sum up, in the innovation and development of modern science and technology, people should design related experiments based on the influence of Chinese style clothing structure on clothing comfort, and organize more experts and scholars to participate in practical exploration, so as to provide effective basis for innovation and development in the field of Chinese clothing after discovering more valuable data information. At the same time, we should learn from the research

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results discussed by domestic and foreign research scholars, strengthen the cultivation of professional and technical talents, actively introduce advanced technical equipment and structural programs, gradually improve the development system of our textile and clothing field, master various comfort test methods and evaluation indicators, and pay attention to getting rid of the restrictions of traditional working concepts. Based on the development needs of the new era, we should create a more high-quality textile and garment research system, optimize the existing clothing structure and comfort, and pay attention to providing suitable textile and garment products for different consumer groups, so as to truly meet the innovation and development requirements of social residents.

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