Emotional Design of Home-smart Breast Health Products Based on Analytic Hierarchy Method

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Abstract: Objective: To establish the design demand index of household intelligent breast health products from the emotional perspective, and to combine digitalization with breast health products. Design a home-smart breast health product that can meet the needs of users. Methods: The expert interview method and questionnaire method were used to screen the design index elements and establish the design level index model. The analytic hierarchy method is used to calculate the weights of each indicator element to guide design practice. Conclusion: From the emotional point of view, the use of the analytic hierarchy method can reduce the ambiguity of the design process, digitize the abstract demand factors, make the design process more rigorous and reasonable, and also provide a quantifiable reference for the design of family smart breast health products.

Keywords: Breast health; Emotional design; Fuzzy analytic hierarchy process; Intelligent technology

1 Introduction

According to the latest global cancer data released in IARC2020, female breast cancer surpassed lung cancer as the most common cancer for the first time, far surpassing other cancer types in women. Breast cancer is a malignant tumor that seriously threatens women's physical and mental health[1]. Every year, the number of new cases of breast cancer in China reaches 300000, and the age of breast cancer patients is significantly earlier [2]. Relevant studies have shown that active prevention, early diagnosis, and early treatment can effectively reduce the incidence of disease, but patients often delay the disease because they do not pay enough attention to the hospital. Therefore, how to use product design to mobilize women's enthusiasm for paying attention to their breast health is particularly important. This study aims to construct a hierarchical index model of home-smart breast health products from an emotional perspective to derive design priorities to provide reference for breast health products, to mobilize women's enthusiasm to pay attention to their breast health and effectively reduce the incidence of new breast glands.

2 Breast health physiotherapy products and emotional design

2.1 Design status of breast health physiotherapy products

Health physiotherapy generally refers to physical therapy, that is, physical effects that can change the human body through human or natural factors, not only to prevent or treat diseases but also to facilitate the self-regulation of human functions[3]. After COVID-19, people's health awareness has been significantly improved, and the pursuit of health has gradually shifted from medical diagnosis and treatment to health monitoring and disease prevention. At present, the common breast health products on the market are divided into three categories according to different functions [3][4], see Table 1. There are many types of breast health physiotherapy products on the market, but the homogenization of products is more serious, and it is not possible to balance functional and emotional development. Most of the current research on breast health at home and abroad focuses on drug development, improvement of breast health product styling, and design of smart underwear, such as the first breast smart bra developed in the United States in 2012, which determines the temperature changes caused by blood vessel blockage caused by cancer cells in the breast through the perception of subtle changes in breast temperature [5]. Ding Li developed smart underwear based on air cushion massage to detect whether the female breast is sick or not[6]. Lu Yi and Yao Jun proposed design principles such as arrangement and combination, geometric composition principles, and other design principles for the shape design of the breast detector [7].

Tab1. Classification of Breast Health Physiotherapy Products

classification	product positioning	functional characteristics	typical products
Detection class	monitoring of physiological indicators of the human body	Usually use a combination of software and hardware.	Infrared detector, nuclear magnetic resonance instrument, color Doppler ultrasound machine
Therapeutic class	has an auxiliary effect on the treatment of diseases	Has medical function and safety.	Red light therapeutic instrument, pulse mammary gland therapeutic instrument
Health care	relieves fatigue	Promote blood circulation, mainly massage.	Breast patches, breast unclogging massagers
	beauty care	Regulate and improve physical function	Negative pressure health device, chest beauty device

2.2 Emotional design

Emotional design is a product design method proposed by American psychologist Donald Norman that focuses on the emotional needs of users and optimizes the user's product experience. Norman applied the "three-level theory" as a design approach to product development. The three-level theory divides user emotions into three levels: Visceral, Behavior, and Reflective. The visceral layer is the instinctive and direct information acquisition and feeling of the user's brain, such as the shape, color, and material of the product; The behavior layer pays more attention to the functional feedback methods of users and products when using products, such as the functionality and ease of use of products; The reflection layer refers to the product that stimulates the user's resonance in thinking, feelings

and other aspects when used. At present, the research on emotionalization at home and abroad mainly focuses on emotional computing, perceptual engineering, human-computer multi-channel interaction, etc., forming a theoretical system based on three-level theory, perceptual engineering, and emotional computing[8].

3 Evaluation model of emotional products for breast health

Analytic hierarchy is a systematic approach to complex problems, which can be modeled hierarchically to derive the relative importance of decision scenarios[9]. The specific operation process is shown in Figure 1.
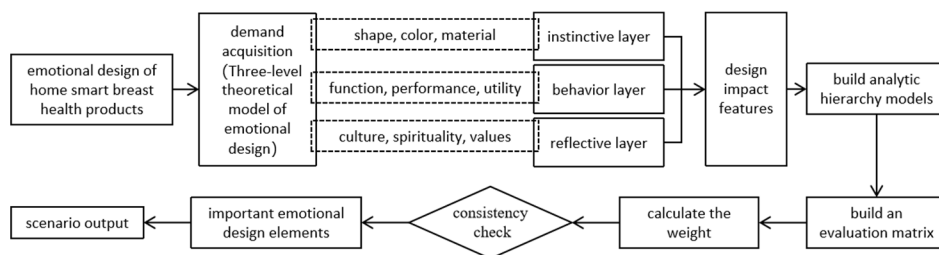

Fig1 research process

3.1 Establish a hierarchy of design indicators

The selection of home-smart breast health product design indicators is a collection of many factors involved. When selecting design indicators, through questionnaire surveys, in-depth interviews, and collecting relevant expert opinions, A total of 173 questionnaires were distributed to female students and patients from design majors, and 150 valid questionnaires were obtained, and the validity and reliability analysis of the questionnaires was carried out, and the KMO value was 0.825 and the Kronbach coefficient was 0.810, both greater than 0.8, so the questionnaire data were referenced. the KJ method is used to classify and sort, and the design index elements are supplemented and screened. Through the above method, the family breast health product hierarchy is finally determined: the target layer is represented by A. The criterion layer includes four elements. There are 14 elements in the sub-criterion layer, This is shown in Figure 2. Among them, safety and aesthetics are summarized as the emotional design of the visceral layer, functionality, and usability are summed as the emotional design of the behavioral layer and the emotional design of the reflective layer is based on the comprehensive consideration of the above four aspects.
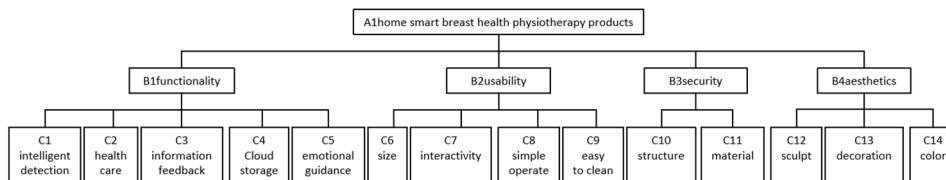

Fig2 Hierarchical index model of household intelligent breast health product design

3.2 Construction and inspection judgment matrix

The relative importance between the elements of the criterion layer and various sub-criterion layers can be compared to construct the target judgment matrix and each criterion judgment matrix. Based on the indicator model shown in Figure 2, a questionnaire survey of 15 female experts was conducted. Including 3 product designers, 9 master's students majoring in design, and 3 breast nodule patients. The 1~9 numerical judgment scale table proposed by Professor Saaty is used to compare the design index factors and construct the judgment matrix. The importance of numerical representation is shown in Table 2.

Tab2 Determines the meaning of matrix rules

numerical value	factor i compared to factor y
1	Equally important
3	Slightly more important
5	Obviously important
7	Strongly important
9	Extremely important
2，4，6，8	The middle value of two adjacent judgments

Tab3 target judgment matrix of the optimal scheme

A	B1	B2	B3	B4
B1	1.000	1.662	1.076	4.260
B2	0.602	1.000	1.120	3.110
B3	0.929	1.597	1.000	4.876
B4	0.235	0.322	0.205	1.000

The judgment matrix was constructed separately for all questionnaires, and the geometric weighted average was used to obtain the optimal solution target evaluation matrix, Due to the limited space, only the judgment matrix of the target layer is shown, as shown in Table 3. Regarding the determination of the index weight value, the matrix constructed by 12 experts in the first round passed the consistency test, and the recovery rate of the valid questionnaire was 80%, which proved that the questionnaire structure was reasonable. Experts who fail the consistency test are scored and counted again until the opinions of all industry experts reach a consensus and pass the consistency test. After two rounds of questionnaire scoring, all industry experts passed the consistency check. The results are shown in table 4.

Tab 4 consistency test results

Index	λ_{max}	CI	RI	CR	Consistency test result
A	4.005	1.662	0.089	0.002	pass
B1	5.041	1.000	1.120	0.009	pass
B2	4.020	1.597	0.890	0.007	pass
B4	3.006	0.322	0.520	0.003	pass

3.3 Hierarchy Index Weight Calculation

According to the values in the optimal solution target judgment matrix, the weights and absolute weights of each indicator layer level are obtained. The absolute weight can directly reflect the importance of design factors. The hierarchical weights and comprehensive ranking

data of various indicators for the design of household intelligent breast health products are shown in Table 5.

Tab5 Detailed data on the weights of index factors in the design of intelligent breast health products

Index		Hierarchical weight		Absolute weight	Comprehensive ranking
criterion layer	sub-criterion layer	criterion layer	sub-criterion layer		
B1 function	C1 intelligent detection	0.354	0.405	0.143	2
	C2 health care		0.268	0.095	4
	C3 information feedback		0.178	0.063	7
	C4 cloud storage		0.055	0.019	13
	C5 emotional guidance		0.095	0.034	9
B2 usability	C6 size	0.221	0.366	0.081	6
	C7 interactive.		0.146	0.032	10
	C8 simple.operation		0.382	0.084	5
	C9 easy to clean		0.105	0.023	11
B3 security	C10 structure	0.349	0.650	0.227	1
	C11 material		0.350	0.122	3
B4 aesthetics	C12 sculpt	0.075	0.564	0.042	8
	C13 decoration		0.134	0.010	14
	C14 color		0.302	0.023	11

The core elements of the design can be derived from Table 5. As shown in the table, in the first-level criterion indicator layer B1 function (0.354)> B3 security (0.349) > B2 practical (0.221) > B4 aesthetic (0.075), so for home smart breast health products, function and safety are more important than the other two factors. In the second-level benchmark indicator layer, the absolute weight value of the C10 structure is 0.227, ranking first, so structural factors should be considered first in the design.

4 Design practice

For women, humanized product design should not only have its practical value but also have strong attraction and connotation to meet their spiritual needs[10]. According to the results of the weight analysis of design elements, the emotional design principle is synthesized, based on the visceral layer, the shape of the flower is extracted from nature as the modeling basis and the soft and friendly material is selected to create a good wearing experience considering the particularity of the female physiological structure. At the behavioral level, users have a high demand for intelligent detection and treatment and health care, so it is equipped with pressure detection technology to judge breast health through the perception of the internal structure of the breast, and has a pulse massage function to promote blood flow through massage and effectively prevent breast lesions. At the reflection level, a reward mechanism is proposed to mobilize user enthusiasm from the emotional direction. The final renderings are shown in Figure 3.

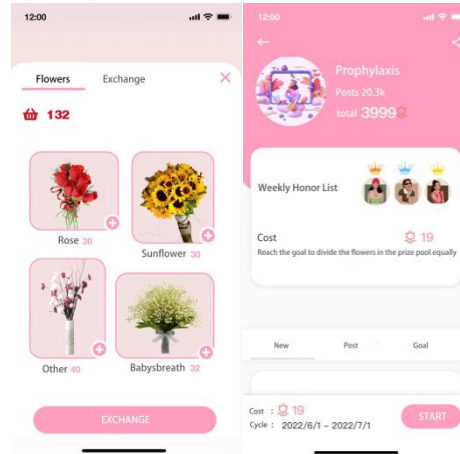**Fig 3.** Product design scheme   **Fig. 4** Some user interface

The "HuaYi" breast physiotherapy device includes the breast physiotherapy device and the "HuaYi" software. "Hua" comes from "a woman is as delicate as a flower", and "Yi" represents hope. "HuaYi" means a good hope for the health of women's breasts. The detection is realized by flexible pressure sensing technology, which determines the presence or absence of breast nodules through pressure detection, and the massage function is realized by pulse current. The first-level functions of the "HuaYi" app include recording data, creating to-do items, building information exchange circles, flower beds, etc. Figure 4 shows some user interface pages. Through the software, the time and number of times the product is used can be recorded, and the petals can be obtained by completing the smile task, active prevention tasks (drinking water, exercising, self-testing, etc.), and the cumulative number of petals can be exchanged for real flowers.

5 Conclusion

This paper applies the analytic hierarchy method to derive a set of design schemes for home-smart breast health products from the perspective of emotions. This method can reduce the ambiguity of user needs, accurately capture the core elements of design, digitize abstract demand indicators, and improve the rationality of emotional design of household breast health products. The data shows that in the design of home smart breast health products, structural stability, intelligent detection, mild material, and therapeutic health care should be taken as the design focus, to improve user satisfaction and enhance users' enthusiasm for breast health.

In this study, the analytic hierarchy model is mainly based on the design indicators of female experts with high involvement, which can guide the design practice of home smart breast products, but it is limited to theory, and the actual development of products is still in the preliminary stage, and in future design research, the actual development of products will be based on the data of this paper to better meet user needs. Turn theory into practice.

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