Towards Household Blood Glucose Meter in a Sample of Older People

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Abstract. This paper constructed a new model by integrating the product design factors into the Technology Acceptance Model (TAM), which aimed to investigate the relationship between the design elements of the household blood glucose meter and the use intention of the elderly users. 184 valid samples were collected and the software of SPSS 23.0 and SPSSAU online were used to test the model and hypotheses. The results are shown as below: (1) Older people's perceived usefulness (PU) and perceived ease of use (PEOU) toward household blood glucose meter has a significantly positive effect on their use intention (UT); Older people's perceived ease of use (PEOU) toward household blood glucose meter has a significantly positive effect on their perceived usefulness(PU); (2) The functional design(FD) factors of household blood glucose meter has a significant positive effect both on older people's perceived usefulness(PU) and on their perceived ease of use (PEOU), and it also has a positive effect on older people's use intention (UT) directly; The appearance design (AD) factors of household blood glucose meter has a significant positive effect both on older people's perceived ease of use (PEOU) and on their perceived usefulness (PU); And the interaction design (ID) factors of household blood glucose meter has a weakly negative effect on older people's perceived ease of use (PEOU) and has a weakly positive effect on their perceived usefulness (PU); (3) The past-experience (UX) of older people has no moderating effect between use perception and use intention (UT) of household blood glucose meter. Finally, some reasonable suggestions are given from product design based on the quantitative analysis to make the design of the home blood glucose meter more consistent with the cognition of the elderly users, so as to improve the interest of blood sugar self monitoring in elderly diabetes group, shape their healthy living and lifestyle.

Keywords: Design factors, household blood glucose meter, use intention, older people.

1. Introduction

Aging has brought new social problems, such as the rise in the number of aged diseases sufferers, and at the same time, the social attention of respecting and loving the elderly has also gradually strengthened. More and more industries are aware of the missing market in aged products; They are looking into the behavior intention of older people and take it as an essential basis for promoting product improvement [1–3]. The long-time consumption of highly processed foodstuff increases the risk of diabetes. Besides, the patients that suffer from type II diabetes mellitus (NIDDM) have tended to be younger in recent years. The household blood glucose meter shows its necessity in the daily life of diabetics because of its convenience [4, 5]. Common blood glucose meters include minimally invasive and noninvasive, and there have significant differences in use procedures and operation between them [5]. The market competition of household blood glucose meter comes from the use and purchase of different users in their previous experience. Objectively, the market competition of household blood glucose meters comes from different design factors. Previously, the research on blood glucose meters mainly focused on its measurement principle, measurement technology, and monitoring system [6-8]. There is a lack of research on the adaptive design of blood glucose meters from user perception and psychology. TAM was used to explain the decisive factors for the wide

acceptance of computer technology early. In recent years, it has been widely used to study users' acceptance behavior and perception attitude towards new products and services [9]. There are precedents of application research in many fields, such as wearable devices, mobile payments and app use [10-13]. The researches scope from online interaction factors to the factors of physical products. TAM gradually shows the application trend from entity to virtual, from mature fields to emerging fields. Tourism, medical treatment and agriculture [11-14] are the most common industry of TAM application. The purpose is to change the external factors of the product and service strategies by exploring the impact of different external variables on users' perception and acceptance attitudes to improve users' recognition and loyalty. Recently, the theoretical research on the combination of user perception and product design systems has also increased. For example, in his doctoral dissertation, Huang [15] took smart appliances as the research object, innovatively combined product design factors with the TAM, and a perception system of elderly smart product factors was built. He explored new theoretical methods for the experience design of intelligent appliances for the elderly and a new design practice was guided. Based on previous studies and design perspective, the three product design factors were integrated into TAM's external dependent variable system in this paper to explore the correlation between household blood glucose meter design and users' use intention, to identify the moderating effect of user past experience, and lastly, some reasonable suggestions for the design of household blood glucose meter for improving older users' use experience were put forward.

2. Theoretical basis and research hypotheses

2.1. Identify the internal variables through the Technology Acceptance Model (TAM)

A research object is regarded as an information system in TAM, and from the system, the users' perception towards a given object is affected by its external factors and resulting in attitudes of use, purchase and decisions of adoption or acceptance. Based on the theory of rational behavior, Davis proposed the model in 1989. Although in the follow-up research about its application, many researchers had constantly adjusted the model according to their research contents, the two core variables of perceived usefulness (PU) and perceived ease of use (PEOU) have not changed. The feature of TAM is that it can match different external variables to expand itself to build a multi-factor system more suitable for the information characteristics of a given research object. The original architecture of the TAM is shown in Figure 1.

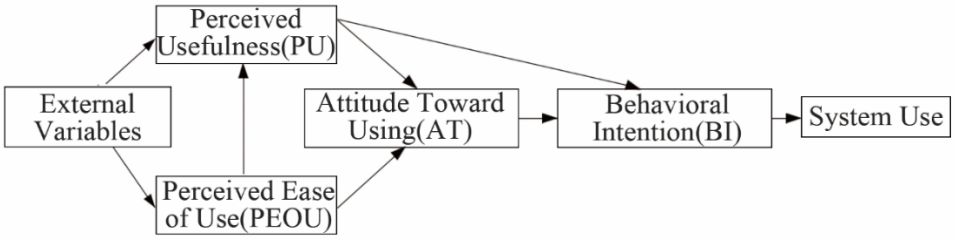

Figure 1. The Technology Acceptance Model.

PU can be interpreted as the older people's subjective perception of a household blood glucose meter. It is users' judgment on the matching degree between product functions and their own needs through the external factors of the product. PEOU refers to the older people's judgment on the ease of using a household blood glucose meter and the time cost that must be paid to achieve the use target. The use intention (UT) refers to the older people's interest in using a household blood glucose meter and the degree of desire to use it. Davis believes that the internal variables PU and PEOU directly affect the user's use attitude (AT) and behavior intention (BI), and the PEOU has a significant positive effect on PU. Fenech and O'cass [16] also took online shopping as the research object in their articles and verified the relatively stable relationship. Based on the model and existing researches, some hypotheses can be proposed as follows:

H1: Older people's PU towards a household blood glucose meter had significant positive effect on their UT to it.

H2: Older people's PEOU towards a household blood glucose meter had significant positive effect on their UT to it.

H3: Older people's PEOU towards a household blood glucose meter significantly affected their PU.

2.2. Identify the external variables from the household blood glucose meter design factors

The function is the first element of the product, and the foundation [17] and functional design (FD) rank first in terms of product design. To measure blood glucose is the most basic requirement of users for a household blood glucose meter. Therefore, the function design of the household blood glucose meter will affect the user's judgment of its use UT. As a prerequisite factor, appearance design (AD) can first arouse users' perception, including the color, material, and shape of a household blood glucose meter. AD can often convey helpful information and establish users' first impression of a household blood glucose meter [17]. In addition, the opening mode, graphic display, voice feedback, vibration, and other interactive design (ID) factors of the blood glucose meter also significantly impact the user's use efficiency. Especially for the elderly users, who generally have varying degrees of fear of intelligent electronic products [18], interaction design intuitively affects their operation interest and mood, and the influence of interactive design factors is more evident when the household blood glucose meter has the trend of intelligent design in recent years. The FD, AD and ID are the three main aspects of household blood glucose meter design factors, and they were incorporated into TAM as external variables to construct further the design-technology acceptance model of household blood glucose meter in this paper, as shown in Figure 2. The following hypotheses are put forward based on the model:

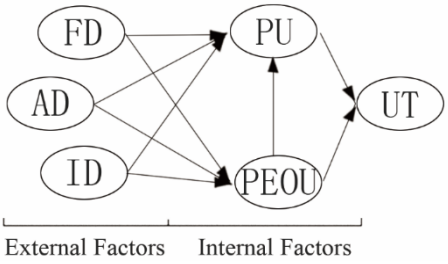

Figure 2. Technology Acceptance Model of household blood glucose meter.

H4a: The FD of household blood glucose meter has a significant positive impact on older people's PU to it;

H4b: The FD of household blood glucose meter has a significant positive impact on older people's PEOU to it;

H5a: The AD of household blood glucose meter has a significant positive impact on older people's PU to it;

H5b: The AD of household blood glucose meter has a significant positive impact on older people's PEOU to it;

H6a: The ID of blood glucose meter has a significant positive impact on older people's PU to it;

H6b: The ID of blood glucose meter has a significant positive impact on older people's PEOU to it.

2.3. The user’s past-experience is incorporated into the model as a moderating variable

TAM2 and TAM3 were developed based on TAM, and both of them were incorporated the past-experience of users into the variable system to improve the perception model [19-20]. The developed model adding the past-experience of users had been validated in many research areas, that the past-experience does have a moderating effect on user-perceived also been proved. The extensive experience of use can make users have more cognition in product characteristics. From the perspective of the variable type, the past-experience of the user belongs to the categorical data [21], which is usually used to explain the difference of cognition of a given relationship among users with different

past-experiences [22]. For the household blood glucose meter, the past-experience of users as a variable can be used to test whether the user's perception of the household blood glucose meter will be affected by previous use experience under the same external factors. Use experience (UX) is more in line with the characteristics of regulating variables, therefore, it is reasonable to take it as the moderator variable of the household blood glucose meter between PU and PEOU. In some previous pieces of literature, user's past-experience has been tested as a moderator variable many times, which is considered to have a significant moderating effect between users' perception of a research object and their use intention of the object [21-23]. Users with rich experience in using a specific type of products will inevitably experience comparison with previous products when making decisions, while inexperienced users will pay more attention to the reputation of products when selecting products [24]. Based on the results of previous researches, UX was introduced into the model, as shown in Figure 3, and the following hypotheses can be deduced based on the adjusted model:

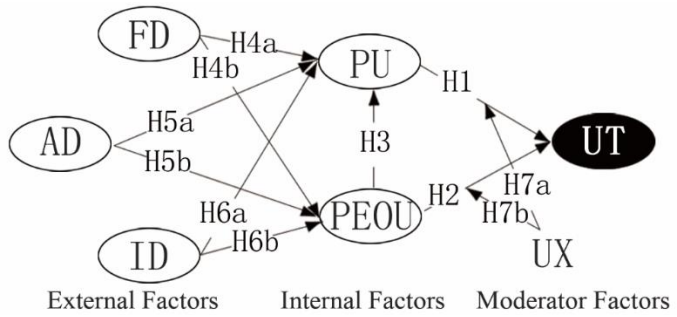

Figure 3. Household blood glucose meter Design & Experience—Technology Acceptance Model

H7a: The older people's UX has a significant positive moderating effect between their PU toward the household blood glucose meter and their UT to it;

H7b: The older people's UX has a significant positive moderating effect between their PEOU toward the household blood glucose meter and their UT to it.

3. Methods Research and Design

3.1. Questionnaire design

The design of the questionnaire referred to the mature scale of previous similar studies and redesigned and combined it with the design factors of the household blood glucose meter and the perceived characteristics of potential users. PU and PEOU mainly refer to the designed questions in some previous researches [9, 25, 26]. The part of PU is composed of two questions: "Do you agree with the opinion that using a household blood glucose meter can make you better master your health." And the part of PEOU is composed of three questions, including: "Do you agree with the opinion that the design of a home blood glucose meter makes it easy for you to use it." The design factors of household blood glucose meters are similar to smart appliances. Therefore, Huang [15] has become the most important reference when selecting the questionnaire items of the household blood glucose meter design factors. The part of FD is composed of three questions, including: "The function design of home blood glucose meter is the most important design factor for me." The part of AD is composed of three questions, and those were composed of one problem of color, one of shape and one of material of household blood glucose meter. There have three items in the part of the ID, including "The interaction design of home blood glucose meter is the most important design factor for me." At last, in the part of use intention, three items refer to the questions that have appeared in previous literatures [9, 27], including "I'd love to try using a home blood glucose meter to measure my blood glucose." There are 6 test variables drawn from TAM and product design factors, and 17 test items are identified, as shown in Table 1:

Table 1. Test items on design and perceived variables of household blood glucose meter

Rang	Observed variable	Test variable	Test item	Reference
1	Perceived Usefulness	PU1	Using a household blood glucose meter can make me better master my health	Davis et al. [9], Kim et al. [25], He and He [26]
2		PU2	Using a household blood glucose meter can help me improve my health	
3	Perceived Ease of Use	PEOU1	The design of a household blood glucose meter can make me feel that I will get the skill to use it in a short time	
4		PEOU2	The design of a household blood glucose meter can make me feel that it is effortless to use	
5		PEOU3	The design of a household blood glucose meter can make me quickly understand the meaning of test results	
6	Functional Design	FD1	The function design of a household blood glucose meter is the most critical design factor for me	Huang [15]
7		FD2	I hope I can use most of the functions of a household blood glucose meter	
8		FD3	The reasonable functional design will make me prefer to use a household blood glucose meter rather than go to the hospital for measurement	
9	Appearance Design	AD1	I like the household blood glucose meter, which has a relatively stable shape style	
10		AD2	I like the household blood glucose meter, which has relatively simple and bright colors	
11		AD3	I prefer to use a household blood glucose meter with affinity materials and a good touch feeling	
12	Interaction Design	ID1	The interactive design of household blood glucose meter is my most concerned design factor	
13		ID2	I hope the operation display (e.g., voice, image or vibration) and buttons of the household blood glucose meter are clear at a glance	
14		ID3	I hope the user interface of the home blood glucose meter is simple and easy to understand, with few and simple steps	
15	Use Intention	UT1	I will try to use a household blood glucose meter	Davis et al. [9] Xu and Chen [27]
16		UT2	In addition to testing blood glucose, I will try to do more with an intelligent household blood glucose meter	
17		UT3	I look forward to purchasing and using a household blood glucose meter soon	

The 17 items in Table 1 were investigated by Likert 5 scale (i.e., "1" means "very disagree" and "5" means "very agree") in a questionnaire. In addition, the questionnaire also has two other parts. One part is used to collect the user's basic information such as age, gender and inhabitation. In contrast, the other part is designed to understand the older people's familiarity with similar products and also sets up some image survey items on the design factors of the household blood glucose meter. Finally, the questionnaire was discussed with experienced design professors and medical staff of the diabetes clinic. At the same time, a small sample of 10 people survey was also conducted to confirm this, and the respondents were randomly selected from the diabetic clinic.

3.2. Data collection

Because the subjects are generally older, the questionnaire survey is conducted offline. The paper questionnaire is distributed with the reference photos of mainstream household blood glucose meters collected in the market. The subjects can do this survey according to their perception of the prototype pictures and their experience in using similar products to ensure the accuracy of the data, which represents the subjects' willingness. The questionnaire survey lasted from March to October 2021, and the offline survey was completed with the cooperation of 6 doctors in Zhenjiang Third People's hospital. A total of 228 paper questionnaires were distributed, and all were recovered. After excluding the invalid questionnaires with incomplete or careless attitude caused by interrupted filling or external factors, the valid questionnaires were 184 in final, and the proportion of valid questionnaires was about 80.7%.

3.3. Sample description statistics

Among the 184 valid samples had been collected, 84 of them are come from male subjects, accounting for 45.7%, and 100 of them are come from female subjects, accounting for 54.3%; Among them, the youngest is only 57 years old, and the oldest is 81. There are 2 people in the range of 55-59 years old, which are belong to the “new older”, accounting for 1.09%, and 141 people in the range of 60-69 years old, accounting for 76.63%, 41 subjects were over 70 years old, accounting for 22.28%. In terms of personal income, 38 subjects with a monthly income of 3000 yuan or less, accounting for 20.7%, 101 subjects with a monthly income of 3001–5000-yuan, accounting for 54.9%, 27 subjects with a monthly income of 5001–8000-yuan, accounting for 14.7%, and 18 subjects with a monthly income of 8000 yuan or more, accounting for 9.8%. In terms of educational background, there are 14 people with primary school education or below, accounting for 7.6%, 94 people with junior middle school education, accounting for 51.1%, 60 people with senior high school education, accounting for 32.6%, and 16 subjects with a bachelor degree or above, accounting for 8.7%;

The offline survey also investigated the understanding of household blood glucose meters. The results showed that 13.9% of the subjects didn't familiar with the household blood glucose meter before; 77.4% of the subjects had been exposed to similar products, and only 18.7% had a detailed understanding of household blood glucose meter, even a smart one. In the survey on the user past-experience of household blood glucose meters, 41.3% of the subjects had not used the household blood glucose meter, 54.3% of the subjects had used or were using an ordinary one, and only 4.3% of the subjects said they were using an intelligent household blood glucose meter.

3.4. Reliability and validity analysis of the questionnaire

The survey data were imported into SPSS 23.0, the overall consistency of 17 test items passed the test, and all of the 6 observed variables with their items had passed the consistency test. Their Cronbach's α values are all higher than the standard value of 0.7, which indicates that the questionnaire and the internal of the 6 observed variables have good reliability.

Confirmatory factor analysis (CFA) was used to test the validity of the questionnaire. It indicates that the data has passed the test of convergent validity when the data meet the following three criteria at the same time: 1) The factor load (i.e., Std. Estimate) occupied by each item in its observed variable should be greater than 0.5; 2) The combined reliability (CR) value is greater than 0.7, and 3) The observed variable square difference extraction (AVE) value greater than 0.5 [28-31]. The standard load coefficient of test items PEOU3, FD3, AD3, ID1 and UT3 on their observed variables are less than 0.5, so they were deleted. The overall consistency of the remaining 12 items and the internal consistency of each observed variable can still be verified by Cronbach's α. The reliability and convergence validity indicators of each observed variable are shown in Table 2.

Table 2. Revised items of questionnaire and their reliability and validity test values

Observed variable	Item	Std. Estimate	CR Value	AVE Value	Cronbach's α Value
PU	1	0.737**	0.791	0.656	0.785
	2	0.876**			
PEOU	1	0.916**	0.882	0.790	0.882
	2	0.861**			
FD	1	0.890**	0.844	0.731	0.842
	2	0.819**			
AD	1	0.773**	0.715	0.556	0.714
	2	0.717**			
ID	2	0.773**	0.830	0.711	0.825
	3	0.909**			
UT	1	0.726**	0.750	0.601	0.746
	2	0.822**			

Note: ** represents when $p < 0.01$.

It is proved that the questionnaire has good discriminant validity when the square root of AVE of all variables is greater than the absolute value of the correlation coefficient between these variable and other variables [28, 31]. For the 6 observed variables composed of 12 items, as shown in Table 3, the square root values of AVE in diagonal grids are greater than the maximum value of the absolute value of correlation coefficient between variables, so it is judged that the questionnaire has good discriminant validity.

Table 3. Pearson correlation coefficient and the square root of AVE

	PU	PEOU	FD	AD	ID	UT
PU	**0.810**					
PEOU	0.378	**0.889**				
FD	0.318	0.395	**0.855**			
AD	0.299	0.359	0.404	**0.746**		
ID	0.085	-0.083	-0.039	-0.092	**0.843**	
UT	0.061	0.142	0.173	0.003	-0.069	**0.775**

4. Studies and Analysis

4.1. Study 1: To study older people's use intention toward household blood glucose meter

Study1 aims to test hypothesis1 to hypothesis6, analyzing the main effect on older people's perception of functional design (FD), appearance design (AD), and interaction design (ID) of the blood glucose meter. The structural model shown in Figure 3 is constructed from the 6 observed variables designed by the questionnaire and has met the requirements of reliability and validity. In the further test, SPSSAU online analysis software is used to test the model-fitting degree (i.e., R-squared), and the model is adjusted according to the MI index of the impact relationship. Finally, the modified model and the correlation coefficients between observed variables are obtained, as shown in Figure 4:

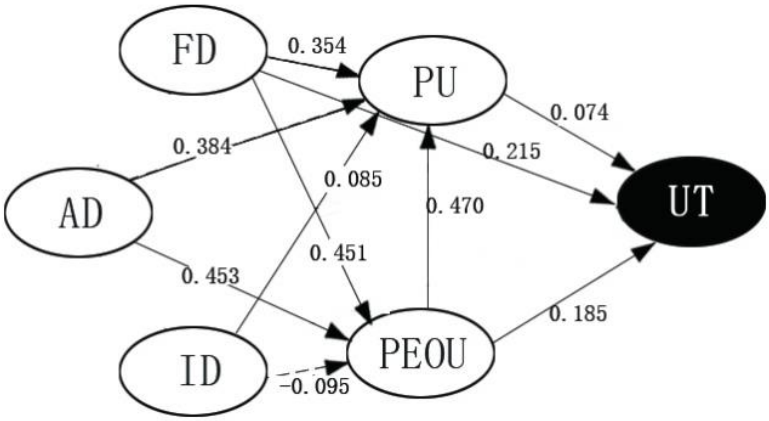

Figure 4. The modified household blood glucose meter model associated design factors with TAM

The indexes of the model-fitting degree (i.e., R-squared) are shown in Table IV. The main indexes, including the ratio of chi-square and freedom degrees (i.e., x^2/df), GFI, RMSEA and other main indexes, are higher than the standard, which indicates that the model is well in its model-fitting degree.

Table 4. The indexes of model-fitting degree test

Index	x^2/df	GFI	RMSEA	RMR	CFI	NFI	NNFI
Standard	< 3	> 0.9	< 0.10	< 0.05	> 0.9	> 0.9	> 0.9
Test value	0.803	0.974	0.000	0.034	1.010	0.963	1.017

The correlation coefficients between observed variables and their statistical significance (Sig. value) can intuitively reflect the relationship between them and assist in the judgment of hypothesis1 to hypothesis6. H6b (i.e., I→PEOU) are not supported with the correlation of -0.095 by the older people sample, and the other 8 hypotheses are supported. In addition, the observed variable FD shows a positive impact on UT (0.215) directly, which shows that the functional design of the household blood glucose meter has a significant positive effect on older people's willingness to use it.

4.2. Study 2: Testing the moderating effect of users' past experience on users' "perception→use intention(UT)."

Study 2 aims to test hypotheses 7a and 7b. Using the hierarchical regression method of SPSS analysis, the data of the user's past experience (UX) of household blood glucose meter collected in the second part of the questionnaire are included in this study to test its moderator effect between user perception (i.e., PU and PEOU) and UT. The four cross-items are composed of UX with its two items and PU, UX with its two items and PEOU, respectively, as shown in Figure 5, which are regarded as the object of this study. Their response to UT will reveal the results.

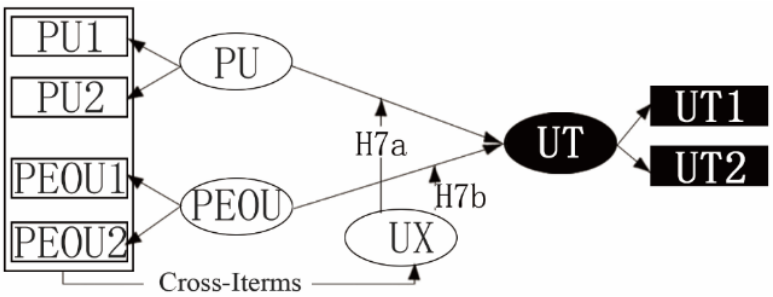

Figure 5. User experience moderator effect model.

There is not significant in the hierarchical regression model of the cross term PU1 * UX and PU2 * UX on UT1, as shown in table V. The third level model with the cross term is not better than the first two. Therefore, the past experience (UX) has no moderating effect between perceived usefulness and UT1 (try to use) in the elderly.

Table 5. UX's response parameters in "PU→UT1."

Model	UT1								
	R	R2	Adjusted R2	Se	R2 change	F change	F 1	F 2	Change of Significance F
1	.060[a]	.004	-.007	.997	.004	.327	2	181	.721
2	.105[b]	.011	-.005	.996	.008	1.365	1	180	.244
3	.125[c]	.016	-.012	1.000	.005	.411	2	178	.664
a. Predictor: (constant), PU2, PU1									
b. Predictor: (constant), PU2, PU1, UX									
c. Predictor: (constant), PU2, PU1, UX, PU1*UX, PU2*UX									

Then, the same method was used to examine the moderating effect between PU and UT2, PEOU and UT1, PEOU and uT2 of UX, and similar conclusions were obtained. Therefore, it can be inferred that the past-experience of the elderly does not have a moderating effect between their perception and use intention toward a household blood glucose meter, and the original hypotheses H7a and H7b were not supported.

4.3. Summary of Results

As shown in Table VI: H6b, H7a and H7b are not supported, and the other 8 original hypotheses and an added hypothesis(F→UT) were supported by the survey results.

Table 6. Hypothesis test results

Hypothesis	Variable	Standardized coefficient	Test results
H1	PU→UT	0.074	Supported
H2	PEOU→UT	0.185	Supported
H3	PEOU→PU	0.470	Supported
H4a	FD→PU	0.354	Supported
H4b	FD→PEOU	0.451	Supported
H5a	AD→PU	0.384	Supported
H5b	AD→PEOU	0.453	Supported
H6a	ID→PU	0.085	Supported
H6b	ID→PEOU	-0.095	Not Supported
H7a	UX→"PU→UT"	—	Not Supported
H7b	UX→"PEOU→UT"	—	Not Supported
Added hypothesis	FD→UT	0.215	Supported

H1, H2 and H3 are supported, indicating that TAM has good stability when applied to different research objects. Older people's perceived usefulness and perceived ease of use of blood glucose meter have a significant positive impact on their willingness to use a blood glucose meter, while users' perceived ease of use of blood glucose meter has a significant positive effect on perceived usefulness.

H6b are not supported. H4a, H4b, H5a, H5b and H6a are supported based on the developed model by the data analysis. The following summary can be given:

1) For the design of the household blood glucose meter, the function design shows a significant positive impact on the user's perceived usefulness (0.354) and shows a strong positive impact on the perceived ease of use (0.451). It can be indicated that most potential users want to complete more functions of a household blood glucose meter by themselves, at the same time, they expressed their fear of multi-functional products. In the second part of the questionnaire, an item was surveyed: "What other characteristics do you want in using a household blood glucose meter?". The answers to this question in 184 valid questionnaires were highly consistent, and 122 respondents chose the option of "We hope that the new product will set up a mechanism for third-party (e.g., children or doctors) to remote assistance." In addition, it is found that the function design of the household blood glucose meter has a significant positive impact on the user's intention to use (0.215), which can be inferred the

function is still the most concerned factor of older people, and they hope the function is easy to use by themselves.

2) For the appearance design of a household blood glucose meter, different users have different preferences and attitudes towards its appearance. Appearance design has a significant positive effect on the perceived usefulness (0.384), and has a significant positive impact on the perceived ease of use (0.453). This shows that the older people's attention to the appearance design of household blood glucose meter is mainly at the level of product ease of use, and convenient operation is the main direction of appearance design;

3) The interaction design of the household blood glucose meter has a weak positive impact on users' perceived usefulness (0.085) and has a weak negative effect on users' perceived ease of use (-0.095). As a whole, the elderly is relatively vague about the concept of interaction design, and only hope that the interaction design is simple and clear, so as to improve the convenience of operation. The result can be judged by combining the guiding items of interactive design in the second part of the survey, that the users want to minimize the steps of self-service operation, the interface for displaying information is simple and clear, and affinity material, part of elderly users, have apparent hope for third-party assistance.

The hypothesis test of H7 generally shows that the moderating effect of older people's past-experience on their perception and use intention is not significant. It also shows that the past-experience of the elderly will not affect their intention to use a household blood glucose meter, but they are more inclined to identify its usefulness and its ease-of-use features through the appearance of the product.

5. Findings and Conclusions

5.1. Theoretical contribution

Firstly, this paper constructs a new perception model by introducing the design factors into TAM's external factors, which means adding emotional leverage between older people and the objects. Sincerely, this paper uses the developed model to discuss the man-machine relationship of household blood glucose meters before being purchased and used. The research examines the impact of design factors on potential user from the effects of product design factors on users' perception, which fully embodies human-centered design thinking.

Secondly, the household blood glucose meter is a product, but different from ordinary daily necessities, the users of a household blood glucose meter have peculiarity on their perception, which is affected by resistant mood. Combining the product design factors with TAM and exploring household blood glucose meter design is a double promotion of the application of design theory and perception theory of older people.

5.2. Enlightenment for design practice

The functional design. Most of the demanders of household blood glucose meters are older people, full of questions about their use. On the one hand, they hope to use blood glucose meters with more functions independently to improve their lives; On the other hand, they are also worried about the increase of learning costs due to the multiple functions of a blood glucose meter, resulting in more troubles in life. Therefore, the appropriate addition of functions and the simple and easy operation of a household blood glucose meter can better stimulate users' willingness to use it. Reasonably transferring the learning cost of the household blood glucose meter has become an innovative design direction. For example, transferring the control task of the unnecessary function of the household blood glucose meter to the user's children through an app shares the user's own use pressure and allows the children to more directly understand the user's physical condition.

In appearance design, among the three factors (i.e., shape, color and material), the material is far less important than shape and color. A simple and stable shape style can increase users' confidence and directly stimulate users' willingness to use. Therefore, the appearance design of the household

blood glucose meter should take simplicity as the main orientation. It is better to choose bright colors for the household blood glucose meter design, and the color of a single case shall not exceed three, the findings of the semi-open survey in the second part can apply to this view.

The interaction designs. The interaction will exist more or less in the process of using the product, but the complex and error-prone operation will frustrate the users of the household blood glucose meter users and affect their willingness to use it. Therefore, the household blood glucose meter interaction design should also focus on simple and entity interaction, which will be better than virtual interaction. Referring to the survey data of the two items in the second part, it can be inferred that the interaction design with fewer operation steps, simple and clear screen display information and interaction with users' multiple senses (e.g., vision, touch and hearing) will be more acceptable.

5.3. Limitations of this study

Firstly, the number of respondents over the age of 60 accounts for 98.91% of the valid sample that we can define them as the elder people. Although the elderly is considered to be a group with common characteristics, there are also many personal differences, such as income level and regional differences, which cannot be completely excluded from the factors affecting the research results; More in-depth research can do more detailed grouping and comparative research.

Secondly, the semi-open survey in the second part of the survey can cooperate with the hypothesis test results to give targeted suggestions for the household blood glucose meter design, but its systematicness is still lacking and needs design. Further research could design semi-open interview questions according to specific products and characteristics to make co-joint analysis with quantitative research.

Thirdly, although the research conclusion has given more specific suggestions for the household blood glucose meter design, it has not been verified in combination with the actual design case. Combining multiple innovative design cases of household blood glucose meters to make fuzzy user evaluation and putting the evaluation results to support the research conclusion will be more helpful and persuasive to design practice on aging product design.

Acknowledgments

This work was financially supported by Anhui Province Philosophy and Social Science Planning Project under Grant. fund. No. AHSKQ2021D127.

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