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Bo, Z. & Li, Y. (2017). Wearable medical devices acceptance and expectance of senior population in china. In *Proceedings of The 17th International Conference on Electronic Business* (pp. 241-251). ICEB, Dubai, UAE, December 4-8.



# Wearable Medical Devices Acceptance and Expectance of Senior Population in China

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**ABSTRACT**

The purpose of this paper is to investigate: 1. How well the senior population in China accept the wearable medical devices; 2. What kind of products the senior population in China would like to choose; 3. At what price the senior population are willing to pay. Collected information from secondary data resources to understand the wearable medical devices market in China and conducted online survey through professional survey software WenJuanXing to collect primary data from 217 elderlies (above 50 years old) in China. Based on the data collected by the online survey, half of the respondents are interested in using wearing medical devices. Top three concerns about the wearable medical devices are safety, veracity and reliability. About 56% of respondents are willing to pay no more than 600 RMB (about 90 USD) for the device itself. About 54% of respondents are willing to pay no more than 60 RMB / Month for the service (about 110 USD per year).

*Keywords:* Wearable medical devices, senior population, technology acceptance, e-health

*Corresponding author

## INTRODUCTION

The Chinese population is ageing fast. In 2010, there were 12.4% of the population in China over 60. However, forecasted by Statista (2016) the share of population aged 60 and above will reach 17.5% in 2020, 25.3% in 2030, 30.9% in 2040 and 36.5% in 2050. According to WHO: China Country Assessment Report on Ageing and Health (2015), there were about 168 million people over 60-year-old in 2010, however in 2040 the number will roll up to 402 million. This demographic trend is the result of falling mortality at younger ages, followed by decreasing fertility. Between 1950 and 2015, the total fertility rate per woman declined from 6.11 to 1.66. Over the same time, the overall mortality rate declined (from 22.2 to 7.2 per 10 000 population) resulting in a steady increase in life expectancy.

In term of demographic characteristics and their geographical distribution, in 2010, regions with higher oldest old proportion expanded largely in the East coastal area in China. In the meanwhile, provinces including Sichuan, Guangxi, Guizhou, Hunan, Hubei and the Northeast also emerged much higher proportion of oldest old compared with 2000 (Wang *et al*., 2016).

Globally, older persons already constitute a large share of the population in the more developed regions. According to United Nation's World Population Ageing Report (2015), in 2015, close to one in four people living in developed regions was aged 60 years or over, and it is projected to continue to rise such that, in 2050, older persons will account for one in three people in the developed region. In 2050, there will be 24.6% of Asian population over 60 years old, 34.2% in Europe which is the highest ratio among all the regions.

However, insufficient resources are available for the care of the elderly. Too few geriatric hospitals and nursing homes are available, which could lead to suboptimum geriatric medicine, rehabilitation, psychiatric, and palliative care services (Wang & Chen, 2014). At the end of 2014, there were 212 million people over the age of 60 in China. Over 40 million of them were disabled. For every thousand people over the age of 60, there were 26 nursing home beds available in China. That is compared to the 50 to 70 beds available for every thousand people over the age of 65 in developed countries, reported by China Research Center on Ageing (2015).

### Wearable Medical Devices

#### *Definition of wearable medical devices*

Wearable technology was not newly born, one early piece of widely adopted wearable technology was the calculator watch, introduced in the 1980s. Wearable technology was early used in health field was the hearing aid. The first wearable hearing aid using vacuum tube technology went on sale in England in 1936, and a year later in America. Wearable devices are rapidly advancing in terms of technology, functionality, and size, with more real-time applications (Crawford, 2016) Currently in US the FDA draft guidance for low risk devices advises that personal health wearables are general wellness products if they collect data on weight management, physical fitness, relaxation or stress management, mental acuity, self-esteem, sleep management, or sexual function. There are hundreds of wearable devices in the world fall into different categories (see Figure 8).

A wearable medical device may be defined as a biosensor that collects physiological data, such as heart rate, temperature, blood pressure, blood oxygen level, glucose level, etc. Most of the time a device is with remote/wireless communication, as

part of any wearable item that attaches to the body. Wearable medical devices may also be developed to predict diseases attack. Predictive wearable tech is also coming to health care in an effort to foresee oncoming sickness and medical emergencies before they happen. Developers hope that successful harnessing of wearable tech's forecasting powers will lead not just to fewer trips to the doctor, but, more broadly, to significant improvements in public health and safety (Lavendusk, 2016).

***Market of wearable medical devices across the world and major companies***

The demand for wearable medical devices and remote patient monitoring systems is increasing, and the global market is expected to reach $612 billion in the next eight years, according to a new report from San Francisco-based Grand View Research on Connected Health And Wellness Devices Market (2016). Smart watches will dominate initial sales within the wearable device category according to many sources, with the Apple Watch accounting for perhaps 40 percent of units shipped (Moar, 2017)

In many developed countries, healthcare expenditures are reduced by using telemedicine or telehealth in alliance with wearable devices, such analytics enable health systems to identify potential health issues in real time. The Affordable Care Act or Obamacare is pushing the value-based care model and technology provides the support needed for the program to succeed and the US government to save money. Telehealth is one such healthcare distribution method within the Population Health Programs model using wearable technologies to help bring down US healthcare costs. The healthcare data can be continuously collected and transformed since users generally wear the device 24 hours a day. However, a great deal research and development is required to ensure that the data generated is managed correctly (Donovan *et al.*, 2009) and is of a high quality (O'donoghue & Herbert 2012) And to build up users' confidents and to help them to use the devices comfortably is essential for any products in this particular market.

There are two main kinds of healthcare wearable devices in the current market. The first is fitness wearable devices, which help users to track and monitor their daily fitness conditions such as steps, distance, calories burned, sleep, and diet. These fitness wearable devices such as Fitbit, Mi Band from Xiao Mi, are more suitable for the young and the healthy users. On the contrary, medical wearable devices are more likely to be adopted by the elder and patients who have chronic diseases. Wearable medical devices are generally designed for certain chronic disease such as diabetes, high blood pressure, cardiac disease. Various firms, including Google, Apple, Samsung, and some medical wearable devises start-ups are making efforts on researching various kinds of medical wearable devices.

***Wearable Medical Devices for Senior population***

wearable medical devices could help older people remain at home and stay independent by enabling elderly to manage their chronic diseases such as hypertension, diabetes mellitus, cardiovascular diseases. More importantly, by using the wearable medical devices older people would be able to predict adverse events and call for help during emergency.

Up to date there are only handful successful products for elderly in the market, with more and more start-ups coming. One of the promising products is CarePredict Tempo (Figure 9), which is currently slated for global release to care facilities later this year, and should be directly available to U.S. consumers in early 2017. CarePredict Tempo learns the normal daily activity patterns of seniors. It monitors and records these daily patterns over time. If these patterns begin to change in ways that could indicate a health issue may be developing, an alert is sent.

Another start up, Lively, has designed a safety watch as well (also called Lively Figure 10) that interacts with sensors located around the home and a central base station. There are two ways to wear Lively, wear the neck or either on the wrist. The Lively safety watch, which is available now for US $49.99 with monthly service charge at $ 14.99.

However, even there is such promising product, the elderly might not adopt the technology and accept the wearable medical devices. A study carried out in the UK in early 2015 among 1000 people reported that almost half (56%) said that wearable tech was "just a fad". Considering most of the seniors are afraid to access these high technologies, companies need to tailor the medical wearable devices and match the physical and mental needs of the senior population, to help them to overcome the fear of using devices and let the devices serve them better.

## METHODOLOGY

**Overview of design**

In this study, the author had conducted an online survey to collect first-hand information from senior population in China about their opinions towards wearable medical devices (Table 1). Original survey was in Chinese.

**Sample**

There were 217 respondents completed the survey during two-weeks period (16/08/16 -02/09/16).
Among the 217 respondents, there are 95 males and 122 females from 11 different provinces cross China.

**Sampling Technique**

Through snowball sampling and convenience sampling. The on-line survey was published through a Chinese professional survey platform WenJuanXing. Respondents filled in the questionnaire through smart-phone or computer on-line with/without their children's help.

**Restrictions/Limiting Conditions**

Although the research has reached the aim, there are still some limitations. Firstly, the time was constrained, this research was only conducted on a small group of population. Secondly, this research could not reach the elderly who has no access to internet.

Table 1: English version of Survey

| | |
|---|---|
| **Part 1 Basic Information** | 1. What is your gender?<br>2. Resident city?<br>3. How old are you?<br>4. What is your combined monthly income? (RMB)<br>5. Please give a score to your health status. 1→5, 1 stands for very unhealthy, 5 stands for very healthy. |
| **Part 2 Acceptance of Wearable Medical Devices** | 6. Have you ever heard about wearable medical devices?<br><br>7. Overall, how interested are you in using the wearable medical wearable devices? |
| **Part 3 Expectance of Wearable Medical Devices** | 8.Wearable medical devices may have those functions listed below, please give score to every function according to your own needs. Score 1→10, 1 stands for that this function is unnecessary at all, 10 stands for that this function is very much necessarily needed.<br><br>9. Do you prefer single function device or multiple functions device?<br><br>10. There are different kinds of way to wear them, please give score to each way according to your own comfort. 1→10, 1 stands for not comfortable at all, 10 stands for very comfortable.<br><br>11. In term of design, which of the factors are important to you. Please give each factor a score according to the importance. 1→10, 1 stands for not important at all, 10 stands for very important. |
| **Part 4 Willingness to pay** | 12. How much are you willing to pay for the device itself? (RMB)<br><br>13.If there is a professional team to monitor and analyse all the data collected by the devices, how much are you willing to pay for the service? (monthly/ RMB) |
| **Part 5 Open ended question** | 14. Do you have any concern about the wearable medical devices? |

## RESULTS

**Basic information**

***Age and Income (Table 2 & Figure 1)***

More than 70% of the respondents are 51-60 years old. This age group is not considered as elderly. However, this group of mid-aged people are retiring in 5 or 10 years-time and facing their elderly life. The wearable medical devices also need to 5-10 years to be accepted by the seniors. Thus, the 51-60 group are the most potential customers in the near future. In 2014 the average yearly income of elderly was ¥23930 (RMB) in urban area, whilst only ¥7621 (RMB) for elderly in rural area. In this research, there are 59 out of 217 respondents have very high monthly income, which is more than ¥6000 per month/ ¥72000 per year. On one hand, most of the respondents are from Guangdong province and certain cities with higher GDP per capital than the rest of China; on the other hand, 51-60 this group belongs to working group with stable monthly income, which will bring up the average income as a whole survey group.

Table 2: Age

| | | |
|---|---|---|
| 51-60 | 157 | 72.35% |
| 61-70 | 39 | 17.97% |
| 71-80 | 13 | 5.99% |
| Over 80 | 8 | 3.69% |

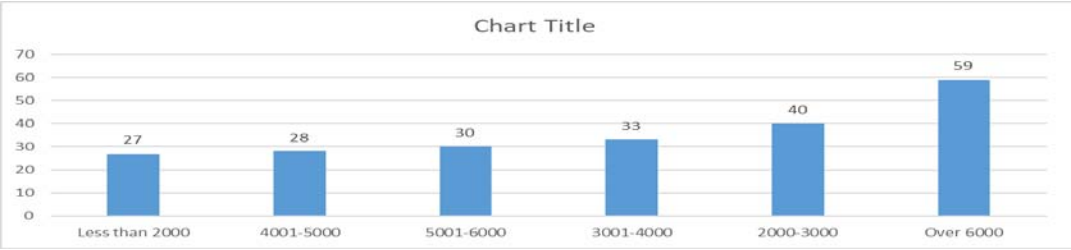


Figure 1: Respondents monthly income in RMB

***Health Status***

In the survey, all the respondents self-rated their own health status. 1→5, 1 stands for very unhealthy, 5 stands for very healthy. The mean of the whole is 3.32. 43.78% of the respondents are rated themselves at score 3--- Neither unhealthy nor healthy.

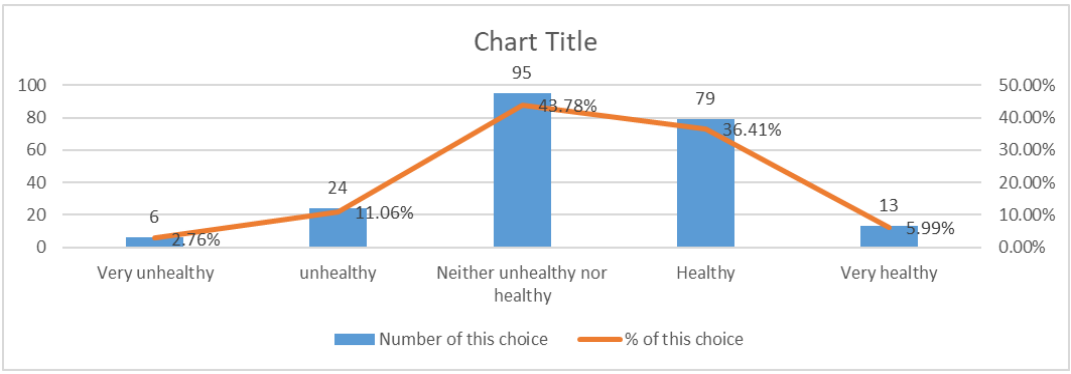


Figure 2: Health Status

**Acceptance of wearable medical devices**

***More than half of the respondents had never heard of the wearable medical devices.***

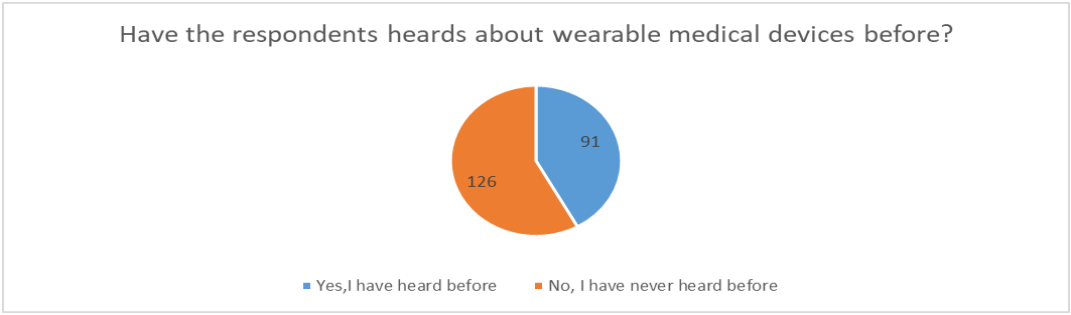


Figure 3

***The interests level in using the wearable medical wearable devices. (Mean 3.28 /5)***

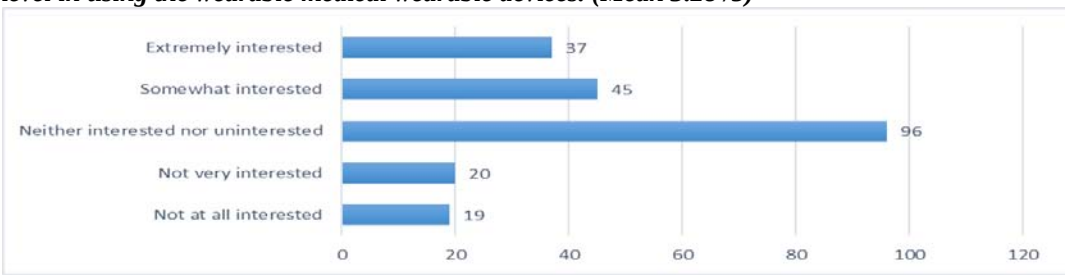


Figure 4

**Expectance of Wearable medical devices**

***Expected functions***

Major functions of wearable medical devices are listed in the survey, respondents rated the functions according to their own needs and expectation (Table 3). More than 80% of respondents would like to choose multiple functions devices.

Table 3

| Function | Mean (1-10) |
|---|---|
| **Call for help during emergency** | **7.57** |
| **Monitor heart rate, temperature, blood pressure, glucose level** | **7.51** |
| Enable medical supervision by family members | 6.84 |
| Promote healthy lifestyle and record the process of exercise | 6.77 |
| Anti-lost through GPS tracking | 6.38 |

***The ways that the respondents prefer to wear the devices (Table 4).***
Most of the respondents prefer to wear the wearables like watch.

Table 4

| | |
|---|---|
| **Wear on your wrist like watch** | **7.83** |
| Wear on your neck like necklace | 4.94 |
| Wear as clothes | 4.85 |
| Attach on your skin like small tattoo | 4.09 |
| Wear on your ankle or leg | 3.69 |
| Wear on your chest | 3.48 |
| Wear on your head | 3.07 |

***Important factors in term of design to the respondents. (Figure 5)***
In the survey, the author had listed 7 factors which may be important when seniors are choosing the devices. The most important factor is Stable performance to the respondents.

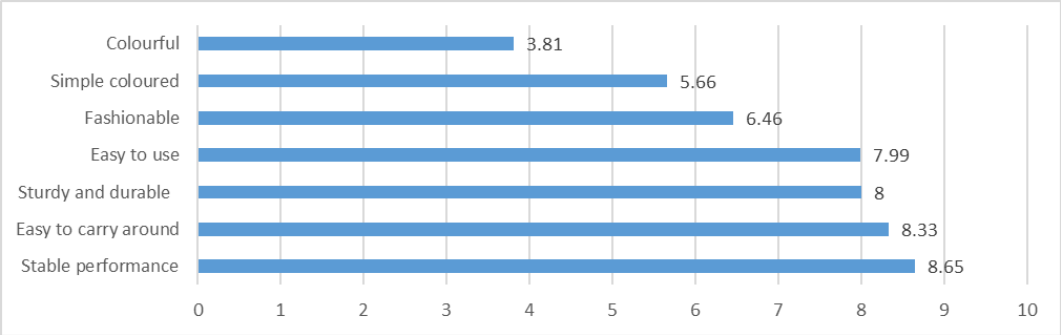


Figure 5

**Willingness to pay**
***Willingness to pay for the device itself (RMB/set)***
76 out of 217 respondents are willing to pay ¥200-¥400 for the device set. The other two larger groups are willing to pay less than ¥200 and ¥401-¥600

Table 5

| | | |
|---|---|---|
| Below 200 | 47 | 21.66% |
| 200-400 | 76 | 35.02% |
| 401-600 | 41 | 18.89% |
| 601-800 | 26 | 11.98% |
| 801-1000 | 19 | 8.76% |
| Over 1000 | 8 | 3.69% |

***Willingness to pay for service. (RMB/month)***
In this study, we assume that there is after sell service team to help customers analyse the data collected by the devices and alert family members during emergency situation. Thus, there is a fee for sustainable service.

Table 6

| | | |
|---|---|---|
| Less than 30 | 65 | 29.95% |
| 30-60 | 52 | 23.96% |
| 61-90 | 32 | 14.75% |
| 91-120 | 32 | 14.75% |
| 121-150 | 18 | 8.29% |
| Over 150 | 12 | 5.53% |
| Not willing to pay for this service | 6 | 2.76% |

**Concerns and feedbacks (see Figure 6)**
More than half of the respondents answered the last open ended question Q14. The top 3 concerns for the wearable medical devices here are safety, veracity and reliability. Figure 6 describes the frequency of major concerns are mentioned by the respondents.

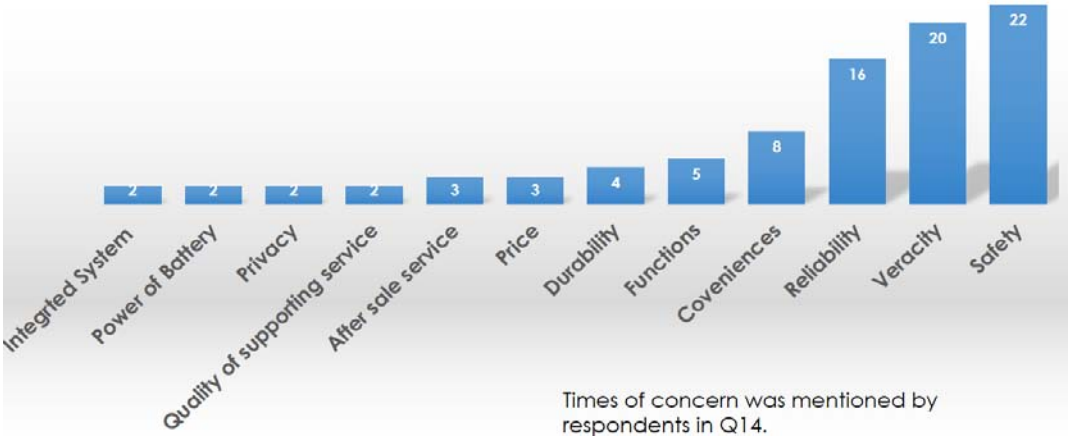


Figure 6

## DISCUSSION

***High Technology companies should not avoid senior population market in China. There is considerable demand for wearable medical devices from senior population in China. Providing proper information about the devices and introducing the products to the senior people through right channels is crucial.***

People tend to have this sterile thought about seniors: they should stay away from high technologies in case they get confused and they will give up eventually even they try to get in touch with the high tech. This kind of thoughts may go seriously wrong. High Technology companies should not avoid the senior population market.

Speaking of high technology and newly born items, there are two different group of elderlies in general. The first group (which leans toward younger, more highly educated, or more affluent seniors) has relatively substantial technology assets, and also has a positive view toward the benefits of online platforms. The other (which tends to be older and less affluent, often with significant challenges with health or disability) is largely disconnected from the world of digital tools and services, both physically and psychologically (Smith 2014). According to CNNIC's 37th Statistical Report on Internet Development in China (2016), there were about 123 million netizens in 2006, 0.98 million were over 60-year old; in 2011, there were 480 million netizens and 10 million were 60-year old above; by 2016, there are 710 million netizens, 26 million were 60-year old above. The senior netizen increased by 26 times within ten years. In US, by 2014 59% of seniors report they go online—a six-percentage point increase in the course of a year—and 47% say they have a high-speed broadband connection at home. In addition, 77% of older adults have a cell phone, up from 69% in April 2012.

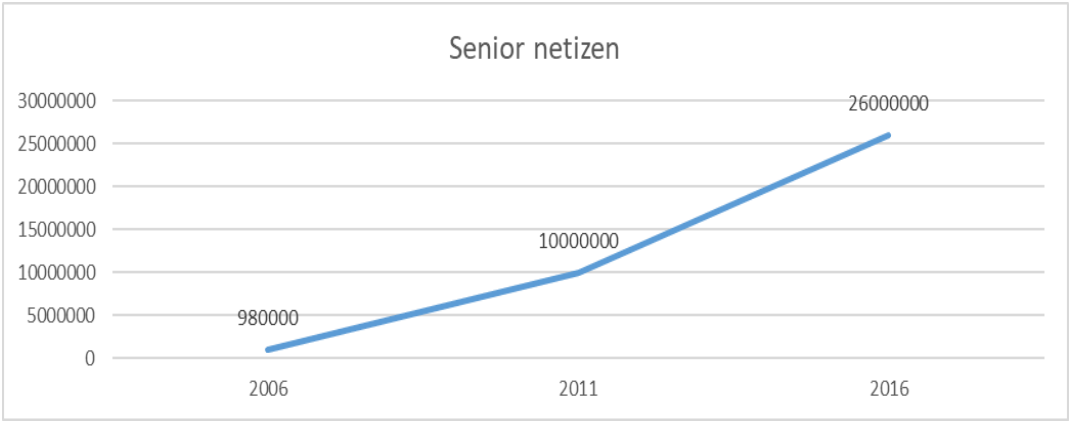


Figure 7: Senior netizen in China increase by ten times over the last ten years

In this perticular pilot study, data shows that 17.05% of the respondents are extramly interested and 20.74% are somewhat interested in using the wearable medical devices. 44.24% of them chose to 'waiting and see'. Compare the Group 1 who *have heard of the wearable medical devices* with the Group 2 who *have never heard of the wearable medical devices*, we can tell that Group1 are more likely interested to try out the devices: fistly, roughly about 15% of Group 1 were not interested, whilst

20% in Group 2; secondly, aound 43% of Group 1 are interested in using the devices, however, there are 34% in Group 2, which almost 10% less.

Therefore, YES, there is a demand for wearable medical devices in senior population in China. Providing proper information about the devices and introducing the products to the senior people through right channels will increase the interest level of the new high tech devices.

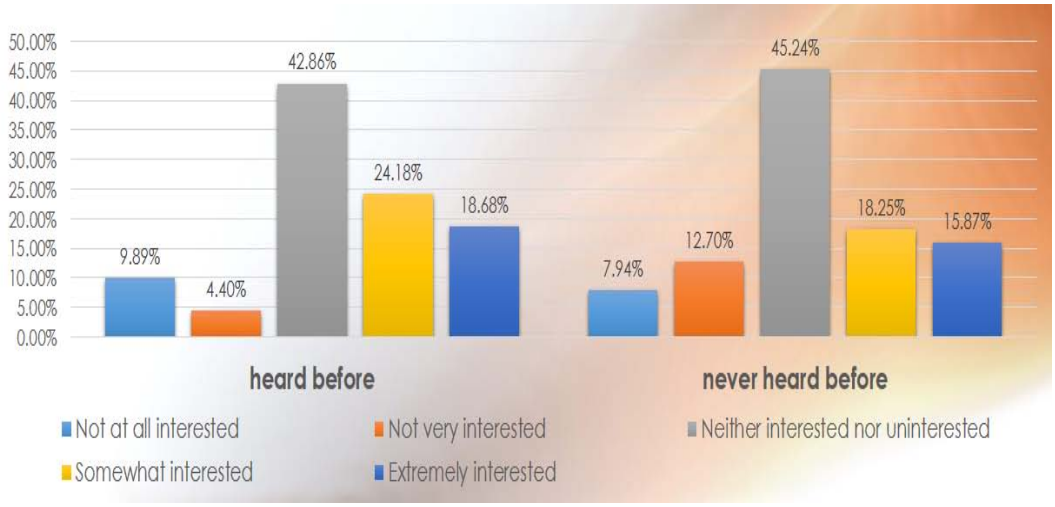


Figure 8: Compare Group1 vs Group2

About the relationship between acceptance and age, in this study one of the conclusions is: 'younger' senior people are more interested in the wearable medical devices. Two age groups are compared (Age group 1: over 60-year old; Age group 2: aged 51-60) in Figure 9 on the interest level of the wearable medical devices through T-test and one tail P value < 0.05, two groups have significant difference on wearable medical devices (Figure 10). Thus, Age group 2 are more willing to use the devices.

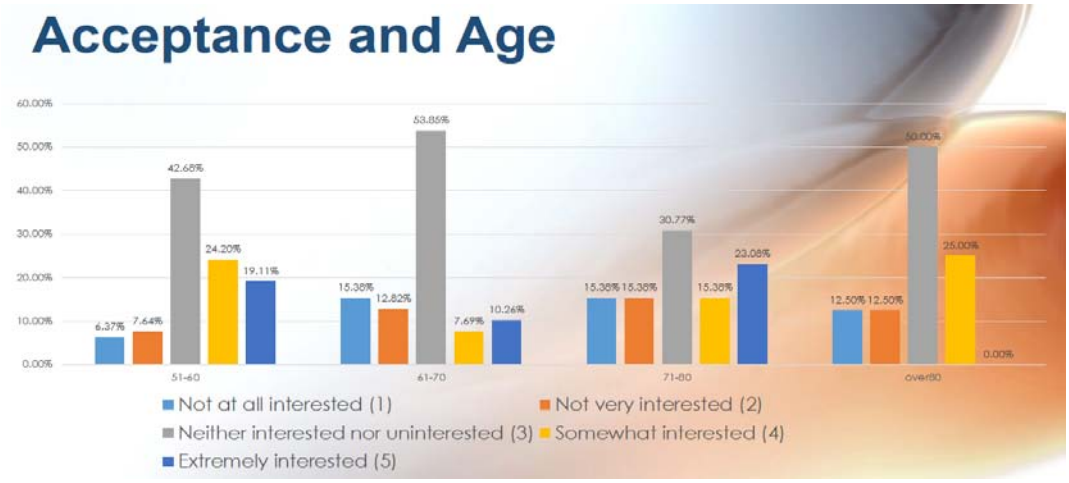


Figure 9

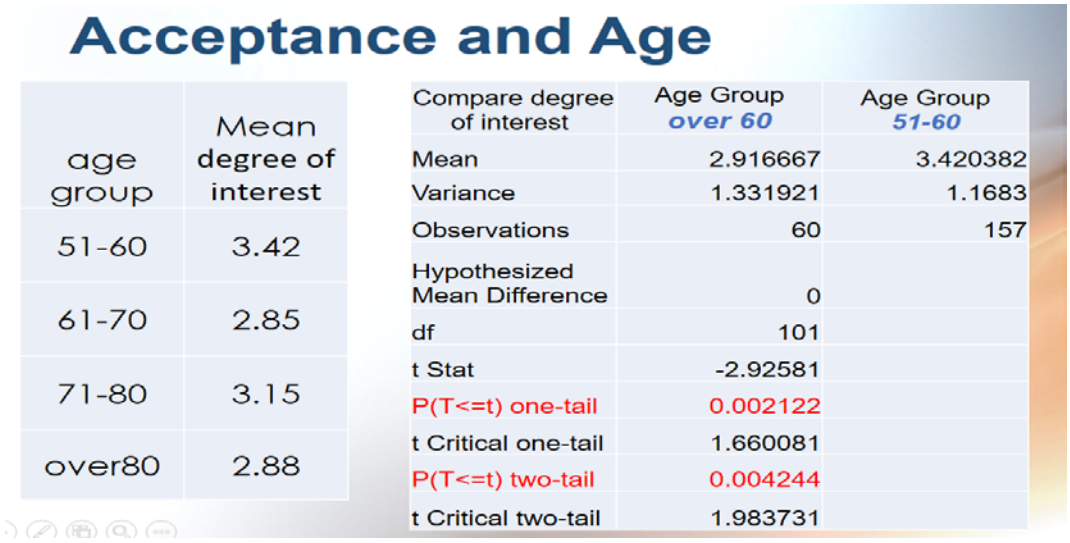


Figure 10

Another conclusion is revealed from analyzing the data by comparing different income groups on the interest level--- higher income senior people are more likely willing use the device. From the graph below (right part of Figure 11), the higher the income, the higher ratio in the group are interested in the devices. And in this study, male participants are more interested compared to female participants (Figure 12).

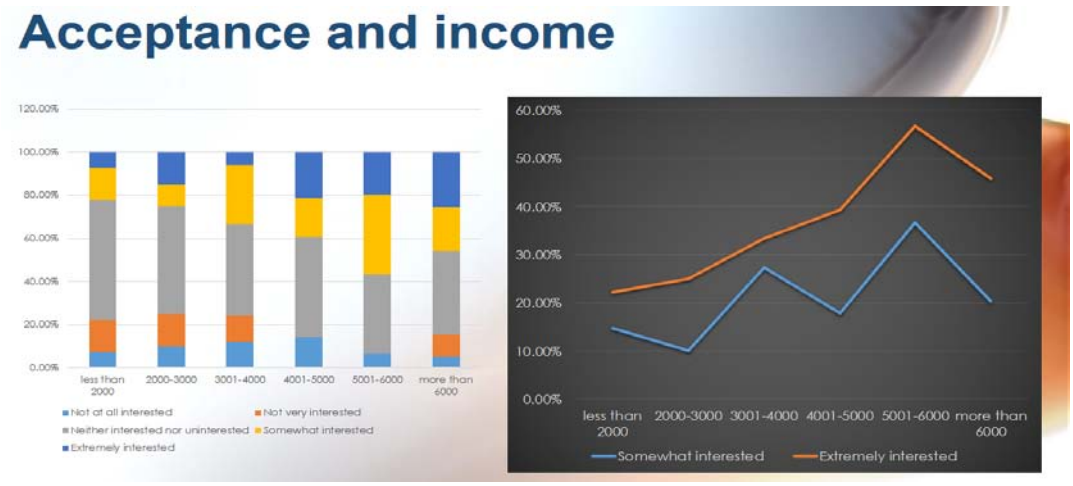


Figure 11

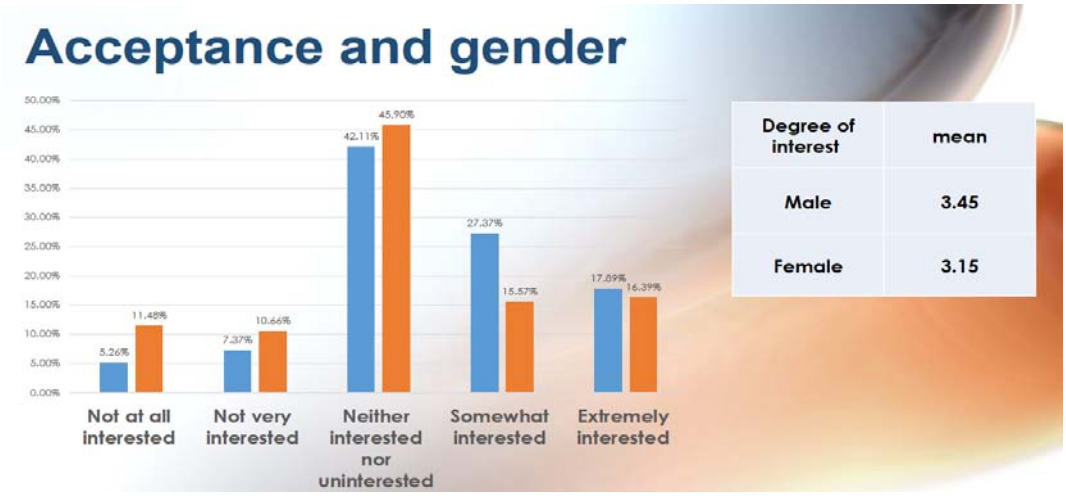


Figure 12

***Seniors see high technology as both friends and foes, it depends on how the products are designed. Companies need to understand the senior population needs and design well-tailored products for them.***

The two most needed functions are "Call for help during emergency" and "Monitor vital signs such as heart rate, temperature, blood pressure, glucose level", rated at 7.57/10 and 7.51/10 respectively. And multiple-function products are more expected than single-function products.

'Call for help' function is more valued by elderlies when they are alone at home or outside. Most of the products in the market are focusing on this function. However, the product will not be sustainable by having single function, which will be easily substituted by a smart phone. 'Monitoring' function will attract more seniors with chronic diseases by helping them self-managing disease and providing factual, dynamic data for physicians during consultation.

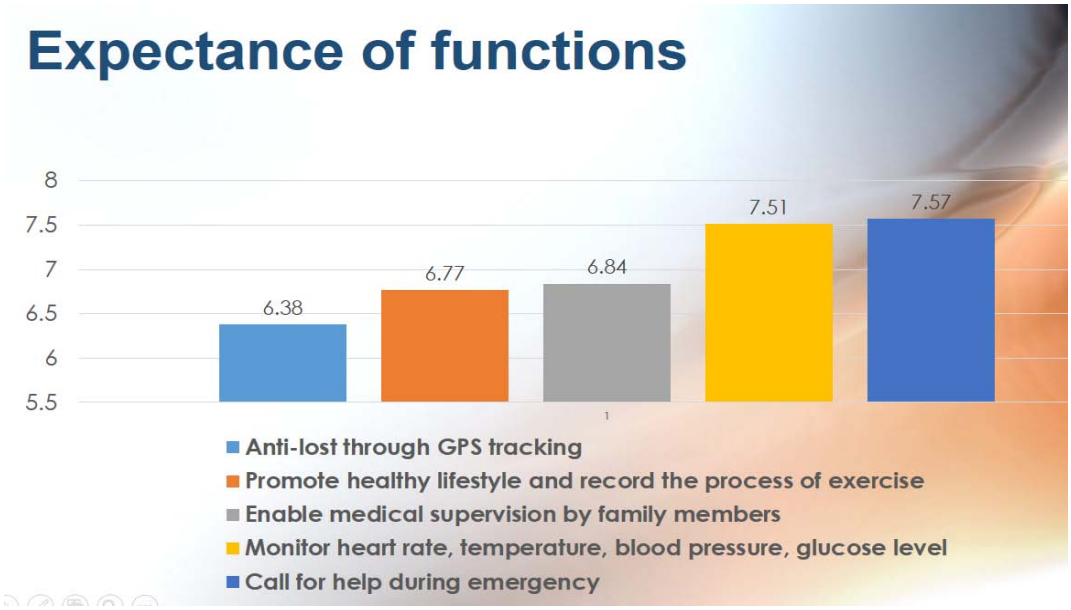


Figure 13

Figure 14 shows that the most popular way of wearing the devices is "wearing like a watch". The underlying reasons could be:
1. Major wearable products in the market now are mainly watch-like, such as Fitbit, Xiaomi Band, Gudong band, Jawbone, etc. Senior people tend to choose the products they are familiar with.

2. Wearing on the wrist is a most comfortable way especially for the elderlies who are used to wear watches.


Figure 14

Except from the above factors, other important factors will also contribute on the decisions the seniors will make on choosing the products. The top four factors chosen by the respondents are: 'stable performance', 'easy to carry around', 'sturdy and durable' and 'easy to use'. The appearance of the product is less important here.

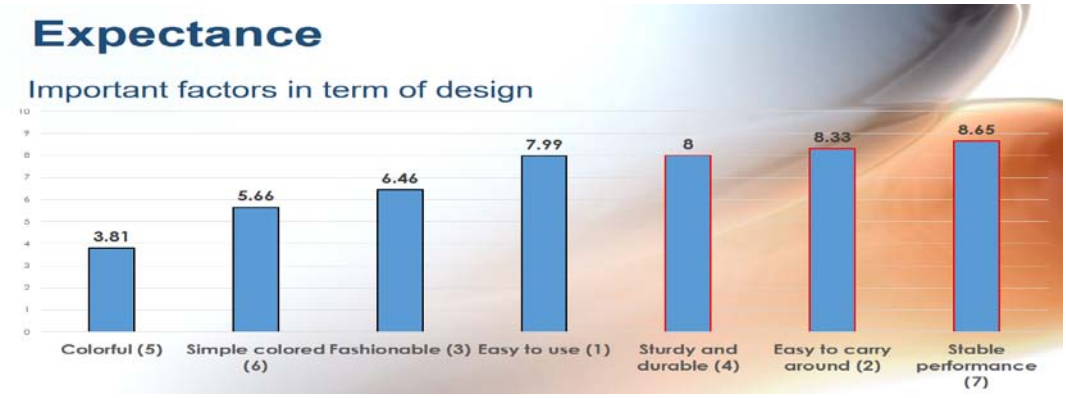


Figure 15

**Willingness to Pay**

About 56% of respondents are willing to pay no more than 600 RMB (about 90 USD) for the device itself. About 54% of respondents are willing to pay no more than 60 RMB/Month for the service (about 110 USD per year).

The conservative estimation of the wearable medical devices market for senior population in China by the author might reach $200 million USD/ year in 5-years-time if 5% of the senior population are using the wearable medical devices, device sold at $90 USD/set and $110 USD for monthly service.

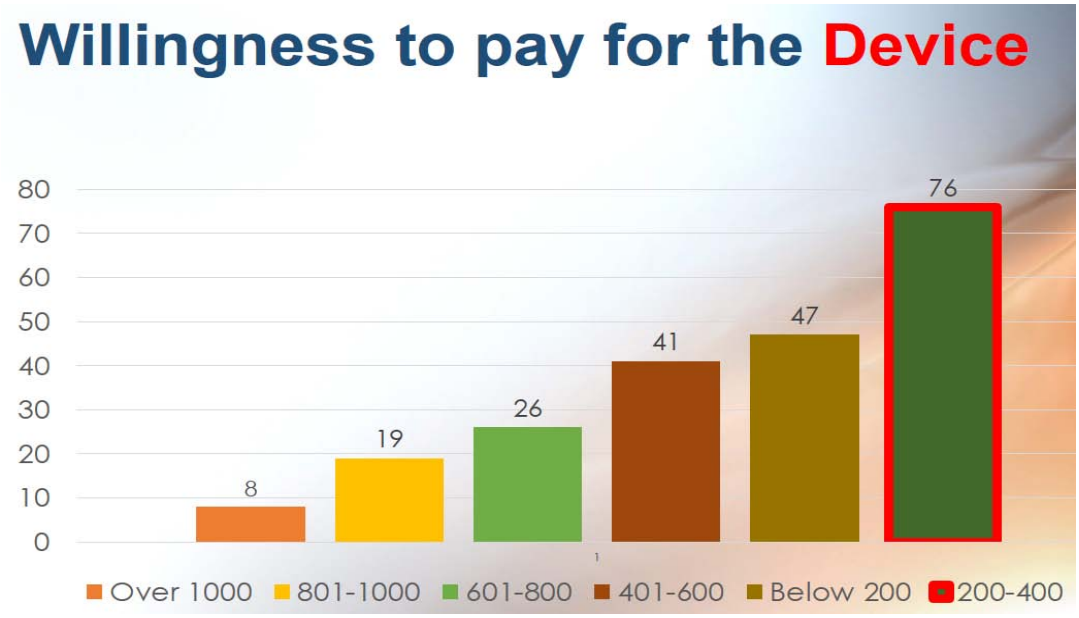


Figure 16

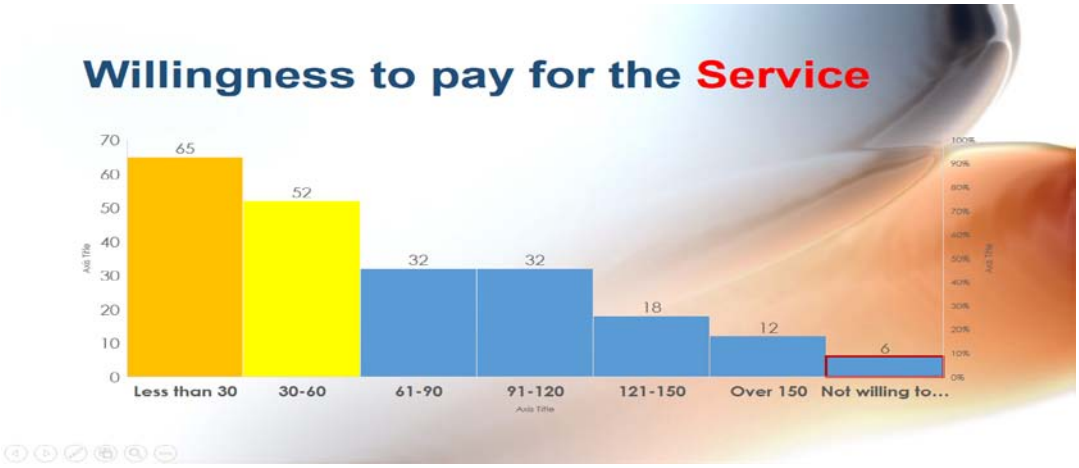


Figure 17

**Advice for companies to enter the market**

Without feasible business model, no product would stay in the market. One of the contributions of this study is to help companies to build a feasible business model to penetrate the senior population market. However, constrained by limited information provided by this study, more market studies are needed to be done for a sound business model. They are some key player in this particular market:

***Key players in the market***

Government: playing a role in regulatory and potential payer here.

- Healthcare institutes and healthcare professionals: Data collected by the devices is needed to be interpreted, otherwise data will make no sense to customer most of time
- Smart Senior-friendly Properties: potential payers.
- Pharma Companies: pharma companies will be interested in the data generated by the devices.
- Medical Devices Companies: producers/ competitors
- Insurance Companies: potential payers

## CONCLUSION

This study shows that senior population in China are willing to accept the wearable medical devices and there is demand in the market. Younger/ Richer elderlies are more interested in the wearable medical devices. Male are willing to pay more for the devices. However, the challenges to create successful products / to build feasible business models can be tremendous. The senior population in China are expecting the devices to be safe to health, easy to master, reliable and convenient to wear around. Functions like "Call for help during emergency" and "Monitor vital signs such as heart rate, temperature, blood pressure, glucose level" are more expected. Multiple-function products will be more popular.

To ally with professional medical teams or hospitals to monitor or interpret the data collected by the devices is a crucial key to keep the elderly using the devices. Otherwise data will become useless and the business will not be sustainable. The senior market in China is a mess market, wearable medical devices companies will generate considerable revenue and change the landscape of the health industries.

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