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Co-creation Model to Design Wearables for Emotional Wellness of Elderly

MUHAMMAD USMAN WARRAICH, IRUM RAUF & ANNA SELL

Abstract Ways to influence emotions have always been an area of interest within the scientific community. The objective of this research is to find the role of technology in order to improve emotional wellness for the elderly population. We conducted a qualitative and quantitative study with the help of interviews and a survey. A sample of 24 respondents is selected randomly from the elderly population. The results showed a strong correlation between emotional, psychological and social wellness dimensions and elders comfort with the use of technology. Based on our study, we present a co-creation model to design wearables for monitoring and improving emotional wellness for elderly. There is a need for focused efforts to develop digital interventions for emotional wellness for elderly. It is important to include elders as co-designers to form effective solutions for elderly through a co-creation process.

Keywords: • Emotional wellness • Co-creation model • Elderly • Wearables • Personalized threshold • Unobstructive •

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1 Introduction

The emotional wellness of individuals emphasizes the importance of a positive outlook towards life circumstances, the capability to cope with stress and ability to maintain fulfilling relationships with others (Foster and Keller, 2007). With age, several factors contribute towards the emotional wellness of an individual, for example, loneliness, isolation etc. In addition, deteriorating health conditions may add extra stress to older adults (Garzo et al., 2010). WHO defines the mental health of individuals as an equally contributing part of the overall wellness of an individual and considers emotional wellness as one of the most important and overlooked parts of overall health (WHO, 2010). In recent years, we have seen a significant increase in efforts by individuals and healthcare sectors to promote digital solutions to increase overall wellness. The digital intervention to improve the emotional wellness of older adults is still an underexplored area (Warraich and Rauf, 2017). Research shows that emotional self-regulation helps to improve the quality of life in patients with different medical problems, like diabetes, immune functions, etc. (McCraty et al., 2010).

The need to provide digital interventions for emotional wellness is further highlighted as the segment which needs mental and emotional support is becoming large worldwide. According to Techcrunch (Techcrunch, 2017), in the year 2015, market sizes (USD) for meditation was 1 billion, yoga was 27 billion, addiction treatment was 35 billion, self-help was 10 billion and budget related to depression, stress and anxiety drugs was 22 billion. The annual cost of stress in the US alone is estimated to be 300 billion (Techcrunch, 2017). Regardless of this, 27% of the population living in EU countries have mental health issues. Out of this number, 74% of the patients are not getting any treatment or care services (Schoenberg, et al., 2014). The increase in stress across countries, cultures, and ages is creating high impact on healthcare cost. This, when combined with the aging problem which is growing worldwide (Sell et al., 2017), motivates the need for focused and efficient approaches to developing a digital solution for the elderly. In addition, when it comes to emotional wellness of older adults, their emotional health propagates to their caregivers (friends and families) creating negative feelings in individuals. Thus, the emotional wellness of elders provides an important measure of the wellness of a society.

Many software applications and digital devices currently exist that track activities, sleep quality, breathing patterns and other attributes of individuals to assist in improving the wellness of an individual e.g. Fitbit, Jawbon, Apple watch etc. Most of these digital interventions do not consider the needs of elderly which are entirely different from another age group.

In this paper, we study the emotional wellness of elders to identify factors that can contribute to the development of digital interventions for the elderly. We adopt the strategy for value co-creation by identifying the factors that contribute to emotional wellness of elders. We carry out with questionnaires and interviews and subsequently match with the outcome functionality offered by wearables. The process of value co-

creation emphasizes joint target sets for the entire process that give benefits to both the service providers and consumers of the service (Vargo et al. 2008). In doing so, we involve the target of our wellness services, i.e. the elder population as co-designers of the service. Co-designer is one of the co-creation approaches in which the users of the service are involved in the design of the service (Voorberg et al., 2015).

The paper is organized as follows: Section 2 explains motivation. Section 3 and section 4 explains research questions and research methodology respectively. The results of this research, on the basis of the research questions that we have formulated, are in section 5. In section 6, we discuss what we learned from the review and section 7 presents a co-creation model. Section 8 concludes the paper and discusses our future work.

2 Wearables and Emotional wellness

2.1 Technology

Plenty of areas are emerging on the Internet. One of them is the Internet of the Future context which is known as Web Squared (Web 2.0) (O'Reilly and Battelle, 2009). The aim of web squared is to integrate web and sensing technologies together, to enrich the content. This is obtained with the help of information of user collected from the sensors (microphone, cameras, GPS, etc.) deployed in the user terminals. Web Squared can be one of the applications running on IoT (Internet of Things). IoT is connecting physical world of things with the virtual world of the Internet with the help of RFID, sensors, wireless communication devices and the software and the hardware platforms (Attridge et al., 2013). Wearables are increasingly being used as technological interventions to connect human world to virtual world through the use of sensors. Wearables refer to small electronic devices that are used as accessories that enable processing of personalized information (Sazonov et al., 2014). Technology interventions can improve user's wellness. They are very helpful in cost reduction for social services, medical care and furthermore, important technological remedies with different applications and devices are verified for decrease in mortality and increase in the quality of life (Schwartz and Andrasik, 2017). We are now living in a time where people can get their personal, real-time insights about stress, increase in heart rate, breathing and even headaches. Technical devices are acting like a coach (Tracker, 2017). According to WSJ, technology and innovations can make life better, though at the same time aging population and the right use of technology to make it more productive poses many challenges (WSJ, 2017).

2.2 Human emotions and technology

There are many wearables in the market and it is not easy to select the best wearable. Best activity tracker is based on the user needs. The wearable technology market is drastically increasing. In the year 2012, wearable technology revenue was approximately 8.5 billion dollars with 96 million devices (Techcrunch, 2017). By the year 2019, the revenue is expected to be 32 billion dollars with more than 230 million devices. Wellness wearables are attracting both individuals and organizations. All wearable supporting technologies

are playing an important role in the growth of these wearables. Applications where users can view the status of their activities and give them targets are a great support for wearable. Different physiological signs (e.g., facial muscle tension, blood volume pressure, skin conductance which measures electro-dermal activity, etc.) can be collected using wearables and sensors (Picard et al., 2001). This data can be interpreted as emotional data and analysed further by experts or intelligent applications to provide recommendations to users to improve their emotional wellness. The work presented by (Farooq et al., 2011) and (Korda and Itani, 2013) also show how physical health relates to mental health and emotional states. Sanches et al. (2010) presented stress management applications based on wearable biosensors. Their work suggests that instead of taking an expert role in interpreting bodily data, users should be mirrored back the short-term stress reactions to help them manage their stress better as every individual has a different stress coping ability.

There exists a considerable amount of research articles that address emotional wellness with wearables; however, most of them discussed this provision for the general audience e.g. (Sanches et al., 2010). Researchers discuss the provision of emotional wellness to individuals, however, when it comes to validation of the works, authors mostly validate their work on young adults or population in general e.g., (Gruebler and Suzuki 2014), (Majoe et al. 2007), Tajadura et al. 2015). Providing one-size-fits-all solutions, however, may not yield the best possible results nor can they fully exploit the potential that wearables have to offer. The complexities of human emotions have been explored by technologists for decades. The concept of using technology to monitor things like stress and happiness is not new. Many consumer technology products are developed with advanced biometric sensors so that they can seamlessly synthesize complex information taken from our bodies, minds and digital habits. Currently, some devices which are mainly designed to measure emotions are:

Spire Stone: Spire stone is a small molten rock which can be attached to a waistband and women can use with the bra strap. It uses your breathing patterns to determine if you are feeling calm, focused or tense (Spire, 2018).

Muse: It is a brain-sensing headband and it tells how to overcome distraction and provide real-time information (Muse, 2018).

Feel: A bracelet which uses body temperature, heart rate, and skin conductance to track emotion and provide information about better wellness (Feel, 2018).

Bellabeat Leaf Urban: A bracelet, necklace or clip for women that measures stress, breathing patterns, sleep quality and tracks menstrual and ovulation cycles (Bell, 2018).

Pip: It monitors changes in skin pores to track stress levels and then recommends strategies to reduce stress through activities in its companion applications (Thepip, 2018). Emotional wellness is subjective in nature and different individuals may have different reactions and coping abilities to untoward incidents in life. This is the reason, we can find many studies in the literature that provide targeted approaches that cater to different target groups, e.g., those that provide emotional wellness using wearables at work (Hänsel et al., 2016), in sports, e.g., (Jones et al., 2016) and for young adults e.g., (Fahim et al. 2014). However, there is an obvious research gap in research for wearables that address emotional wellness for the elderly (Warraich and Rauf 2017).

There are many health and wellness services in general that elderly population may use. However, we need to identify the need, as we know elderly people cannot perform physical activities as young people can do. People of this age have memory problems (dementia), lack of social interaction, mental wellness issues etc. These issues can be addressed and resolved by engaging them in physical, social and intellectual activities.

2.3 Needs and solutions

As more and more players arise in this space of emotional technology, the challenge is to discover novel ways to address the needs of digital devices that integrate well with user routines and behaviours.

Wellness service providers are providing customer solutions in order to monitor user's daily activities, sleep patterns and suggesting and guiding users accordingly. It is needed that these wellness activities should become a part of the users daily routine, i.e., healthy eating, healthy workout, and daily scheduling, socialization so that they remain active and healthy even in their later stages of life. Engaging in healthy behaviours, scheduled daily routines, and physical activities are part of wellness services that can slow functional decline in human behaviour and improve quality of life. Wellness services can assist in quitting different habits like smoking, drinking etc.

3 Research Questions

Based on our study of the literature, we identified the following objective and research questions for our study. Our primary objective is to identify factors that can contribute towards the emotional wellness of elderly with the help of digital technology. With this objective, we formulate the following research questions:

- What kinds of emotions are typical for the elderly?
- Does emotional wellness have any relations to psychological and social wellness?
- Can we use digital technology to improve emotional wellness?
- What could be a co-creation model for wellness wearables?

4 Research Methodology

In order to find answers to these research questions, we follow a two-step approach to study the factors that affect emotional wellness of elderly. In the first step, we conduct survey with a group of elders to get some understanding of their emotional, psychological and social wellness. In the second, step, we conduct interviews with the same participants to get a better understanding of their emotional wellness. The first step qualifies towards the quantitative study and the second step provides the qualitative study of the research problem. The details of the study are given below.

4.1 Participants

The participants of the study are elders from an elder meet-up place in Turku, Finland. In total 24 respondents participated in the study. All the respondent were volunteers and their permission was taken for this research study. We visited that place four times in order to complete the survey and interviews. Of 24 respondents, 14 were female and 10 were male. The average age was 68 years and the range was from 50 to 81. All the participants were familiar with the use of computers.

4.2 Survey

The survey was carried out with a questionnaire to collect data on the perceived understanding of elders on emotional, psychological and social wellness, followed by the questions on the use of technology. Emotional wellness recognizes *the positive sense of self-regard*, psychological wellness addresses *one's perception that he/she will experience positive outcomes to the events and circumstances of life* and the social wellness is defined as *the perception of having support available from family or friends in times of need and the perception of being a valued support provider (PWS)*.

The questionnaire had 20 questions: the wellness dimensions questions were 18 in total with 6 questions in each dimension and 2 questions were for the use of technology. The questions are scored from 1, "Strongly disagree" to 6, "Strongly agree" (Matell et al., 1972). The wellness dimension questions were from the Perceived Wellness Survey (PWS) presented by Adams et al. (1997). The PWS survey has been widely used in the literature e.g. (Carter, 2004) (Bezner and Hunter, 2001).

4.3 Interviews

The questionnaire was followed by individual interviews of the participants. The semi structured interviews (design research) were conducted with open-ended questions and the interviewer made notes on the answers and their general behaviour towards the study, i.e. how willing they were to share their personal information. The interview questions are formulated to study participant's interest towards various interventions of wellness and self-awareness.

4.4 Threats to Validity

The survey and the interviews were conducted with utmost care to get clear insights into the factors influencing emotional wellness and the elder's attitudes towards technology; however, there may be certain things that may effect the validity of the results.

The participants of the study are all from socially and financially independent segments of the society. These participants were selected to see the behaviour, habits and mental state of individuals from a 'happy' society. The selection of the participants may affect

the results; however, utmost care has been taken to involve participants from both genders and covering a relatively-wide range for elderly, in order to better reflect the society. In addition, small sample sizes reduce the power of tests and increases the margin of error. The can make the results meaningless. However, we try to address this by reducing the diversity of the study participants.

5 Results

5.1 Survey Results

The survey results show a strong correlation between emotional and psychological wellness, (0.6), emotional and social wellness (0.55) and psychological and emotional wellness (0.65). This means that all these factors collectively affect an individual's outlook towards life.

We further analysed the results of questions individually for each dimension. Collectively, on average the answers of participants for each dimension were above 4. This means that the participants generally perceived themselves to be emotionally, socially and psychologically well. We further divided our participant's data into two categories Gender-wise, and Age-wise, < 70 and >= 70. The results of the questions are shown in Figure 1.

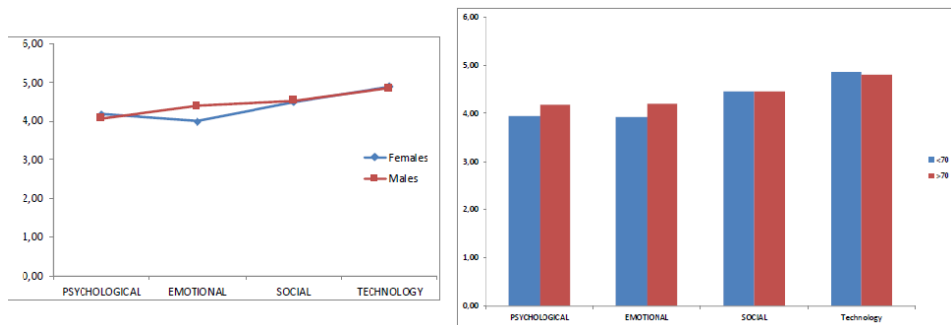


Figure 1: Results of survey-(Left) Gender-wise (Right) Age-wise

Gender-wise

We compared the average answers for each dimension gender-wise. While both the genders scored almost the same on psychological ($F=4.1$, $M=4.2$) and social ($F=4.53$, $M=4.50$) wellness, the female participants scored relatively less than male on emotional wellness ($F=3.8$, $M=4.4$). The question that scored the least for the female was: *I will always be secure with who I am*. Females also generally scored less in all the other questions of emotional wellness, compared to male participants. The male group scored highest on the question, *"In general, I feel confident about my abilities"*, whereas this question scored second lowest in the female.

Age-wise

The age-wise categorization was done as < 70 and ≥ 70 . This categorization was done to reflect a difference between data of elderly in both early and later stages of aging. The elderly group that is also known as the young-elderly age group (Carlsson and Walden, 2015) (Warraich, 2016) is generally found to be the healthier portion of the elderly population that has not declined in their cognitive and functional abilities. The distribution of data, with 70 as the middle line, also resulted in an equal number of participants in both categories. The average answers on each dimension were scored as: Psychological: < 70 : 3.95, ≥ 70 : 4.18, Emotional: < 70 : 3.9, ≥ 70 : 4.21, Social: < 70 : 4.45, ≥ 70 : 4.45.

Thus both categories, generally scored equal in all the dimensions, indicating a healthy society with a good social care system.

5.2 Results of Digital Use

According to Duh et al. elderly can benefit from engaging with technology. They need more attention to get familiar with the use of technology. Ijsselsteijn et al. (2007) suggested a digital interface game design in which they had addressed the functional limitations with age. They also explained the requirements to design digital interface for elderly, which can be enjoyable and easy to use. In this work, to study the role of technology for the elders, the following two questions were asked: “*Do you think that the use of technology distracts you?*” and “*Do you think technology/social media is the only reason that you are in touch with your friends?*”. These questions were asked to see whether technology has positive or negative effects on this age-group and to study their use of technology.

The results showed that technology does not have a negative effect on this age group. In the current era of digital revolution, technology is said to play a critical role for the lost of focus and distraction in the younger generation. However, since the elderly age-group has lived their lives before the digital-boom age, the use of technology does not have an adverse effect on them and they can use it more intelligibly. This is an important finding since all the elder that were part of the group were educated and computer literate giving them enough hands-on on today’s technology. Despite this, the elders did not feel that technology distracts them.

In addition, although the role of social media in people’s life is increasing, the elders did not consider that it to play any major role in staying close to their friends.

We observed that for emotional support, elders generally talked with their friends, or family members, in most cases grandchildren or they participated in religious or meditation activities. The majority of the participants also showed interest in identifying and adopting new healthy habits. The general observation by the interviewer also showed that elders were talking about technology, smartphones, social media and computers. They were technology friendly and wanted to learn and experience new services and were also willing to change habits if they are healthy for them.

6 Discussion

In this section, we attempt to answer the research questions in the light of study result.

6.1 Emotions Experienced by Elders

Elders belong to the age group of society who are generally not active contributors to society and are going through the aging process. This can lead to emotionally unwell elders which can lead to physical and social problems. However, our study indicates that if the elders are offered means to stay active, their emotional wellness can be more stable than that of the middle-aged and young adults. This is further supported by (Warraich and Rauf, 2017) in which elders were found to be more emotionally and psychologically well than other age groups. This can be linked to the fact that with age, people's expectations towards life become less and they learn to be satisfied with what they have compared to younger adults who are expecting more from life and get disappointed on getting results (Etxeberria et al., 2017). This is also evident from our survey results in which the question "*In the past, I have expected the best.*" scored the lowest among all questions showing disappointment.

6.2 Emotional vs. Social vs. Psychological Wellness

The three dimensions studied show strong correlation with the limitations of small samples. We looked at each individual data in detail to find out values that did not correlate well with each other, i.e., scoring high in one dimension and not in the other. We found that those participants that did not mention involvement in any activity did not seek emotional support or did not show any interest in improving current habits, scored considerably lower in all or more than one of the wellness dimensions studied, compared to more active participants.

6.3 Role of Digital Technology for Emotional Wellness

The use of digital technology, in the lives of elders is very selective and they are not very aware of the functionality and use of technology. The limited use of technology is evident from the survey results. The elders in the study are willing to change their habits to improve their overall health. Thus, we see that the limited use of technology but a willingness to change one's behavior for better physical and mental health provides good opportunities for digital intervention to improve emotional wellness.

7 Reflections on Sample

The participants of our study are taken from a meet-up place for elderly that is allocated by the city of Turku in Finland. Finland is among the world's best places for the wellness of elderly (Kang et al., 2008). The elders in Finland have more access to social benefits including services like meet-up benefits, financial support, etc. For this reason, we believe that our study with elders generally showed positive results for emotional, psychological

and social wellness. From the reflections of the participants, we identified attributes that can contribute to developing a co-creation model for wearables for the elderly.

8 Co-Creation Model

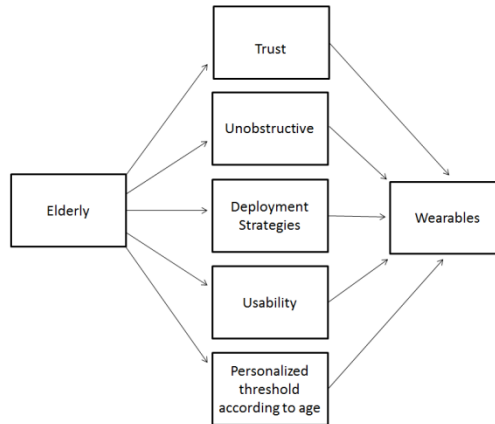


Figure 3: Co-creation Model for Wearables for Elderly

The value co-creation provides opportunities for digital services that benefit both the service provider and consumer of the service, emphasizing joint target sets for the entire process (Vargo et al. 2008), (payne et al. 2008). Based on our studies and reviewed literature, we propose a co-creation model for wearables for elderly. Below, we discuss the factors identified:

Unobstructive: Our user studies show that elders are comfortable with technology, however, since they are from the pre-digital boom era, they do not rely much on technology and they do not find it distracting. This implies that a technology intervention that could be obstructive in their daily life and could distract them continuously may not be adopted or welcomed by the elderly. Wearables can be designed to be unobstructive as a passive recorder of individual's activities and to notify or interact with the user when important.

Social Needs: The word cloud in Figure 2 shows 'friends' as the main intervention that elders use to feel better, followed by 'talking' and 'walking'. This shows that elders put a lot of emphasis on their social needs; interacting with friends and talking about their problems to friends and family. Thus, the wearables should be designed in such a way that they fulfill the social needs of adults without being distracting, uncomfortable and obstructive.

Deployment Strategies: Adoption of wearables is significantly affected by the deployment strategies used to encourage users towards their use. Preusse et al. (2017) suggests deployment strategies for wearable activity trackers like creating tutorial videos that facilitate the learning of new/ difficult features, allowing trial-of-use periods etc. These deployment strategies should be customized towards elders. At a certain age, elderly people may develop bad eyesight, arthritis and stability problems among others.

The elderly person may not be able to hold a mouse, click a mouse or press a button. Their performance on a computer is generally slower. Similarly, the design of wearables and their use can be complex or simple. Elders should be encouraged to participate in technology-related interventions. They can embrace different information technology applications if given appropriate and customized training. The interventions should be designed with hardware and software features that address potential functional limitations and inexperience of elders with wearables as digital interventions.

Usability: Most interfaces proposed so far for smart watches offer limited accessibility to older adults: screens are small and the information is often shown with small characters; small buttons are used to navigate in the interface. Differences between younger and older people should be taken into consideration during application development (Hough and Kobylanski, 2009). Designing an interface that takes into account common impairments of older adults is important to increase the desirability of the whole product. Choosing the best modalities to interact with the wearables could reduce errors and thus frustration during the utilization. In order to figure out user need and design applications according to his/her desires, it is important to know what is needed by analyzing user behavior. Joe et al. (2016) described older adult's behavior towards multifunctional technology and expectations and preferences that can maximize the usability of the technologies. It has been concluded that participants are positive toward a multifunctional wellness tool and users are willing to use it if they can have reliable health-related information on the device. Changes in behavior and lifestyle is a long-term process endeavor that permeates daily life (Consolvo et al., 2009). If designers have not done it properly then it will result in abandoned technology. Technology has high potential to support and motivate healthy living (Grimes et al., 2010).

Trust: An important point observed during our interview sessions was that elders were generally restrictive to talk about their emotional wellness. The developed digital intervention should be able to keep users motivated in the management of their wellness while also developing user trust in its use. Changes in behavior, routines and habits can be changed with time but an important aspect which needs to be addressed is trust.

Personalized thresholds: Existing digital interventions mostly generalize the treatment and recommendations or ask too many questions to personalize the experience that affects their usability. However, emotional wellness of an individual depends on various factors that may differ from one individual to another. Different aspects of one's personality, environmental factors, and behavior traits may affect the well-being of an individual and all the features collectively affect the emotional wellness (Foster and Keller, 2007). Wearable activity trackers, as technical interventions, have great potential to influence wellness of individuals in everyday life as they provide means to collect, quantify, analyze and monitor different attributes of the wearer and her environment. Thus, they can help to provide personalized wellness services to wearers. It is important that the analysis of the personal data of individuals is done on the thresholds suitable for elders since physical threshold values may vary with age.

9 Conclusion and Future Work

The elder population is increasing worldwide. It is important to address the emotional wellness of elders, which is an under-researched area since emotional wellness has propagating effects on other dimensions for wellness. In addition, low emotional wellness of elders cause negative feeling on their caregivers as well. Elders are generally considered to be challenging and it becomes difficult to change their habits and addictions with age. Loneliness is playing an important role in worsening the overall condition of elders. In this paper, we study different dimensions of wellness related to the mental health of elders and also their attitudes to digital technology. Our study indicates positive results and based on that we identify contributing factors that affect the emotional wellness of individuals. We present a co-creation model for wearables that contribute to emotional wellness of elderly.

The participants of the study are from Finland that is considered one of the best places in the world for the wellness of elderly; therefore, it is not possible to generalize the conclusions for older people across all of Europe. However, based on the lessons learnt from the study, different factors can be identified to develop digital interventions for emotional wellness of elderly. Further study designs can expand and include participants from different cultures in order to reach deeper conclusions.

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Appendix

Wellness Questionnaire

Age:

Gender:

Location (City/Country):

This survey is part of an ongoing research and the results published from it will be anonymous. Please fill carefully and thoughtfully consider each statement, then select the one response option with which you agree the most.

		Very Strongly Disagree				Very Strongly Agree	
1.	I am always optimistic about my future.	1	2	3	4	5	6
2.	I rarely count on good things happening to me.	1	2	3	4	5	6
3.	I always look on the bright side of things.	1	2	3	4	5	6
4.	In the past, I have expected the best.	1	2	3	4	5	6
5.	In the past, I hardly ever expected things to go my way.	1	2	3	4	5	6
6.	Things will not work out the way I want them to in the future.	1	2	3	4	5	6
7.	There have been times when I felt inferior to most of the people I knew.	1	2	3	4	5	6
8.	In general, I feel confident about my abilities.	1	2	3	4	5	6
9.	I sometimes think I am a worthless individual.	1	2	3	4	5	6
10.	I am uncertain about my ability to do things well in the future.	1	2	3	4	5	6
11.	I will always be secure with who I am.	1	2	3	4	5	6
12.	In the past, I have felt sure of myself among strangers.	1	2	3	4	5	6
13.	Members of my family come to me for support.	1	2	3	4	5	6
14.	Sometimes I wonder if my family will really be there for me when I am in need	1	2	3	4	5	6
15.	My friends know they can always confide in me and ask me for advice.	1	2	3	4	5	6
16.	My family has been available to support me in the past.	1	2	3	4	5	6
17.	In the past, I have not always had friends with whom I could share my joys and sorrows.	1	2	3	4	5	6
18.	My friends will be there for me when I need help.	1	2	3	4	5	6
19.	Do you think use of technology distracts you.	1	2	3	4	5	6
20.	Do you think technology/social media is the only reason that you are in	1	2	3	4	5	6

Interview Questions

1: What activities do you do that makes you feel better?

2: Do you seek emotional support when necessary and how?

3: Do you want to choose your own healthy habit if yes then what?