Smartphones and the Silver Mind: A Study in the Time of Corona
Suchetna Chakraborty and Dip Sankar Banerjee

Over the last year, the human race is witnessing the lash of novel coronavirus (Covid-19) pandemic that has already claimed over a million lives all over the world. It poses a great risk to the elderly people, especially in the age group of 60 and above, and to those with comorbidities like diabetes, hypertension, heart, and lung disease. As per the research published by The Lancet Infectious Diseases[1], the mortality rate is maximum for senior citizens. Quite interestingly, according to ‘World health report on aging and health-2015’ by the World Health Organization, it is predicted that by 2050 the world’s population shall be 2 billion people over the age of 60 years, which is almost double the number today.

According to the tenets set down by the World Health Organization (WHO), the well-being of elderly people requires independence, participation, care, self-fulfillment, and dignity. In this age of globalization, it is common for elderly people to live alone. Surprisingly, mental health is the most neglected and under-treated aspect of human well-being for a long time. The problem is particularly challenging as in most cases, patients are unaware of their medical condition or are often obsessed with societal prejudice in dealing with mental disorders. The requirement of mental health monitoring for the geriatric community has hardly got any attention until recent times. The existing solutions to treat the ailment through psychological intervention, rehabilitation, and cognitive behavior therapy along with medicine-based diagnosis do not seem feasible in the foreseeable future. The habitual world is going to change post-Covid-19 pandemic period with increased self-isolation and quarantine life. Even though the elderly were living almost a similar isolated life for some time, research and development for technological aids to improve their quality of life are massively distanced from recent advancements.

With the proliferation of fast and reliable communication technologies and the realization of the Internet of Things(IoT) services, it is possible to remotely monitor the mental health parameters of self-isolated elderly people and allow early-stage detection to enable preventive responses. Smartphones are witnessing prime adoption rates since their inception. Modern-age smartphones, with a wide range of in-built sensors and high-speed internet connectivity through cellular networks or WiFi, have emerged as promising IoT devices. Smartphones have become an essential part of human life that effectively handles the existential crisis, especially under isolated living conditions during the current pandemic. Unfortunately, the elderly population, in general, is deprived of its highly engaging smart services due to cognitive disability and difficulty in adopting new technology. This further brings new challenges in maintaining a healthy mental state under present circumstances.

Worldwide, efforts such as City4Age[2], SMART4MD[3], My-AHA[4], Frailsafe[5], and SECURE[6] aim to develop Information Communications Technology (ICT) frameworks towards promoting healthy aging and independent living for the geriatric community. Analyzing the Activities of Daily Living (ADL) through either video surveillance system[7] or wireless sensor networks[8] have been long used for remote health monitoring of the elderly. Recent studies[9] have asserted that smartphone-based mental health interventions are more effective to assess mental health disorders of users through continuous behavior analysis. Analyzing smartphone usage patterns[10,11] to derive the user’s mood fluctuation or to assess the stress level of the user through monitoring day-to-day activities can be very effective. Data from wearable, ambient, or smartphone sensors, as well as social network activity traces, are usually analyzed using machine-learning algorithms to find anomalies in the user’s regular behavior [12-14]. The success of these schemes are contingent upon factors such as digital literacy, internet penetration, and standard of living. As per recent statistics, around 40% of the urban elderly people are using smartphones and social apps for interaction with their kin. The usage pattern of the smartphone-based social app varies significantly based on the mental and physical wellness of elderly users along with other subjective parameters including the user’s socio-economic background, education level, tech-savvy nature, physical/mental activeness, social interaction interest, and linguistic proficiency. In this context, it is imperative to understand how the usage of smart devices, IoT environment, familial connections, physical condition, and mental well-being are tied together. The fundamental questions that we ask towards this are as follows:

- What are the general usage patterns for smart devices during lockdowns? Is it any different from pre-COVID days?
- What are the kind of connected apps that the geriatric community specifically finds interest in? Are they detrimental or benign?
- Are the smart device usage patterns somehow related to the socio-economic and health status of the individual? Does his personal and social standing have any relation with his engagements with smart devices?
- Are smart devices with its constant deluge of information acting as a savior or as a silent killer?

Towards the validation of the above-stated questions, we conducted an online survey with the motivation of finding out how the community, in general, is resorting to smartphone/IoT-based solutions. The questionnaire was created on Google forms without any fields for personal information and was expected to be filled out through a smartphone browser that indirectly simulates IoT enablement. The study was conducted for two weeks in the last week of June and the first week of July 2020. We received around 180 complete responses total among which there was approximately equal participation from the age groups of 18-49 and 50-86. Table 1 outlines the set of information that was collected. The respondents were a mixed group with around 44% in the age group of 50-60, 42% in 61-70, 13% in 71-80, and 1.3% above 80.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health and Lifestyle</td>
<td>age</td>
<td>Age of the subject</td>
</tr>
<tr>
<td></td>
<td>communication</td>
<td>If regularly connected with family and friends</td>
</tr>
<tr>
<td></td>
<td>living condition</td>
<td>Living conditions at home</td>
</tr>
<tr>
<td>Smartphone Usage</td>
<td>usage duration</td>
<td>Daily smartphone usage times</td>
</tr>
<tr>
<td></td>
<td>social media</td>
<td>If uses social media apps</td>
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<tr>
<td></td>
<td>finance</td>
<td>If uses apps for finance and business news</td>
</tr>
<tr>
<td></td>
<td>health app</td>
<td>If uses any kind of health monitoring app</td>
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</tbody>
</table>
### Social Media Usage
1. **social_media_app_opening**
   - Average time for daily social media app usage before lockdowns
2. **social_media_lockdown**
   - Average change in social media app usage during lockdown periods
3. **messenger_apps_usage**
   - Frequency of average messenger apps usage
4. **app_usage_mental_state**
   - If mobile app usage changes with mental state
5. **monitoring**
   - If uses any health monitoring app

### Mental Health State
1. **A**
   - Subject feels he/she may contract COVID
2. **B**
   - Subject feels his/her life is severely restricted owing to COVID
3. **C**
   - Subject feels drastic changes in society due to COVID and may not fall back to older ways
4. **D**
   - Subject feels worried regarding financial downturns
5. **E**
   - If subject has any other reasons for worry apart from COVID

<table>
<thead>
<tr>
<th>Table 1: Survey questionnaire and parameters collected.</th>
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<tbody>
<tr>
<td>1. <strong>social_media_app_opening</strong></td>
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<td>2. <strong>social_media_lockdown</strong></td>
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<tr>
<td>3. <strong>messenger_apps_usage</strong></td>
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<tr>
<td>5. <strong>monitoring</strong></td>
</tr>
</tbody>
</table>

### Figures

**Figure 1:** Smartphone and app adoption correlations of the old and young population with age

In order to understand and implicitly answer the questions raised earlier, we can observe the survey results shown in Figure 1. This clearly demonstrates the smartphone adoption and usage patterns of the general population. In Figure 1, we can see the correlations of different smartphone apps that the subjects are more prone to use across their ages. While the majority of the received responses show equal ease at adopting the smartphones across all age groups, however still some usage patterns can be seen in the data. We can see some natural trends like, with the increase in age, the tendency to use wearables, and health monitoring apps tend to decrease for both age groups. The social media usage times decrease drastically with increasing age. This demonstrates that with increasing age, the involvement in social media is mitigated. On the other hand, the young population shows an opposite behavior in usage patterns of smart IoT devices and social media specifically in the post lockdown period. It is an understandable trend. The older population on the other hand does not digress from the trend observed during pre-lockdown.

**Figure 2:** Usage patterns pre- and post- lockdown

In Figure 2, we can see six broad categories across which the apps used by the subjects were recorded. We can intuitively infer some observations. While it is natural that the young population is more interested in apps pertaining to social media, games, and entertainment, the elderly show more interest in apps relating to news, health, and finance. A significant amount of increase in usage rate can be observed across all six categories during the lockdown periods. This is quite natural to understand that home confinement has led people to increase their screen time and also diversify into exploring newer apps. A staggering rise of around 233% is seen in the connected apps of the health category, which indicates a dramatic increase in health awareness among the population. A general section of people who were earlier not dependent on such technology also moved to adopt them in order to monitor their health regularly and stay healthy in general. Finally, to answer our last question on whether smart devices are acting as a catalyst to influence our mental health, we perform an Ordinal Logistic Regression on the various parameters detailed in Table 1. The ordinal model provides the odds ratio of the mental health state (which is the dependent variable) with the other parameters. Figure 3 shows the odds ratio that has been found through the model. As an example, from the principle of the odds ratio, we can deduce that if the ratio for “chronic” is 1.44, then the subject, with some form of chronic disease, is 1.44 times more likely to be mentally stressed in comparison to a subject who is not having any chronic disease. The ratios on the negative axis show the chances on the lower side. Among the survey takers, we also tried to capture the general feeling of anxiety through asking some questions regarding the pandemic, specifically through the parameters A-E as described in Table 1. We observe here that for “A”, where the subjects generally feel that they may contract Covid-19 someday are almost 5.71 times more likely to be stressed in comparison to the others who keep a more positive outlook. So, from this analysis, we can clearly deduce that the smartphones, internet, and wearable devices are actually aiding people in coping with the evolving situation. This becomes clearer when we observe the odds ratio for “social_media” where we can see that being connected over social media is actually lowering anxiety and aiding people to cope in a more healthy manner.

**Figure 3:** Odds ratios for development of mental stress relative to smartphone interactions.

Overall, we summarize the following findings from the survey as follows:

- Smartphone usage has increased for elderly people during the lockdown period.
- Elderly people are more stressed about concerns relating to their health conditions.
- User’s mental state and smartphone usage have no observable correlation.
- Personal entertainment, communication, and social media are the top three most popular apps among the elderly.

Towards future research we envision developing a smartphone-based pervasive solution for monitoring and early detection of mental health conditions like stress, depression, and anxiety. The open research challenges involved are in the design of low-cost wearables, infrastructure agnostic on-device computations, subject specific learning algorithms, context aware data fusion, data annotation techniques of capturing ground truth, and management of sensitive data while maintaining privacy. Acknowledgements: We would like to acknowledge the contribution of other collaborators in this work. Dr. Rajesh P Bamburg, Principal Scientist in the AI &IoT Lab, CSIR-CMERI, Durgapur and Mr. Smayamoy Chakraborty, MSc in Statistics, University of Calcutta.

References:

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