User Engagement with the User Manuals of Smart Medical Wearable Technologies and Relevant Questions of User Behavior

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Abstract. In this paper, engagement with smart medical wearables and with their user manuals, as well as related user behavior are studied. A research questionnaire containing 15 single-choice questions was completed by 1381 test participants to address relevant topics of the investigated area, including trust in measured medical data, device calibration, technical terminologies and function discovery in the documentation, information sources beyond the documentation, and wearing such devices to bed. The questionnaire particularly focused on device functionalities and characteristics that initially led to the purchase of the smart medical wearable.

Keywords. smart medical wearable technology, technical communication, user manual, user behavior, user preference

1. Introduction

The emergence of smart wearable devices introduced numerous novel use cases in the past decade. One of the most important usage contexts is enabled by smart medical wearable technologies – namely, the ability to perform prompt and accurate medical measurements without the need of specialized equipment and medical professionals. The latter characteristic of such devices is thoroughly investigated by the scientific literature [1]–[3] – particularly when directly comparing with dedicated medical devices [4]. Moreover, in the recent years, smartwatches and smart bands were proven contributive to the early detection of COVID-19 [5]–[7].

Albeit smart medical wearables – similarly to most modern digital devices – are designed with the aim to achieve intuition, user manuals (UMs) may be necessary to

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assist the user. In an earlier work [8], the utilization of smart medical wearables was studied, along with their UMs. Usage contexts (e.g., sports, work, etc.) and measurement categories (e.g., heart rate monitoring, step counting, etc.) were addressed, as well as UM-related preferences, user behavior, and user experience. As the data was collected in the era of the COVID-19 pandemic, the most popular function was determined to be the measurement of blood oxygen level. However, the achieved results also highlighted open questions. For example, the data indicates a gap between those who wear such devices to bed and those who use them for sleep monitoring (i.e., the other reasons were not covered by the study).

In this paper, we address underinvestigated research questions related to the usage of smart medical wearables and their UMs via a questionnaire. The devices are approached from the perspective of primary purchase function (PPF) – in essence, the capability or characteristic that was dominant for the purchase of the device. The research questionnaire studies trust in measured medical data, device calibration, technical terminologies and function discovery in UMs, information sources beyond the UM, as well as wearing such devices to bed. In contrast to the earlier research effort [8], the test participants were not distinguished by their connection to UMs (i.e., the data provided by technical writers and regular users is not clustered separately).

The remainder of this paper is structured as follows. Section 2 details the methodologies used by our research. Section 3 introduces the obtained results. The results and their implications are discussed in Section 4. Section 5 concludes the paper and highlights the potential future research questions related to the investigated topic.

2. Methods

We addressed the investigated research topics via a questionnaire which consisted of 15 single-choice questions with textual or numerical answers. For numerical assessment, we used either 11-point absolute (ranging from 0 to 10) or comparative (ranging from -5 to 5) scales. Specific meanings were assigned to the extremes of the scales – depending on the question – as well as to the middle in the case of comparative scales. For absolute scales, -1 denotes the "not relevant" answer option in the presentation of the obtained results, while for comparative scales, 0 is the neutral option.

The questionnaire contained the following questions: How many smart medical wearables have you had so far? How many smart medical wearable user manuals have you accessed so far? What was your primary reason (referred to as "primary purchase function" in later questions) to buy a smart medical wearable? How much do you trust your smart medical wearable in terms of medical measurements? How often do you calibrate your smart medical wearable device? How useful is the information in the user manual regarding device calibration? How useful / necessary do you think medical technical terminologies are in user manuals of smart medical wearables? How useful was the user manual for finding information about the primary purchase function in the document? How useful was the user manual for using the primary purchase function? How useful was the user manual for discovering device functions that you were not aware of? Which device function or action wasn't properly covered by the user manual (of which the device is capable and you needed it)? In case you are not able to find something in the user manual, what is your primary source of information? Where is the user manual in
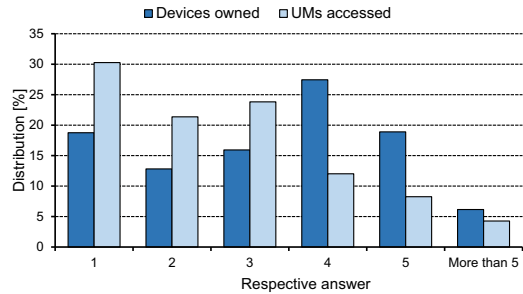
Figure 1. Number of devices owned and user manuals accessed by test participants.
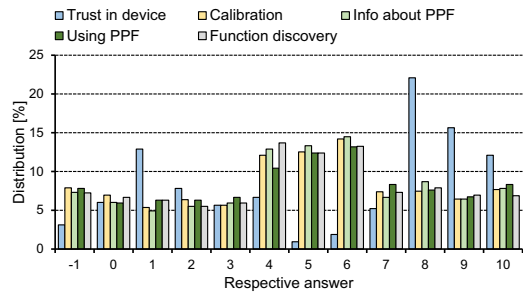

Figure 2. Trust in device, and usefulness of user manual for calibration, for finding information regarding PPF, for using PPF, and for function discovery.

the order of sources? How often do you wear smart medical wearables to bed (i.e., sleep with a smart medical wearable on)? In case you don't wear a smart medical wearable to bed for the purpose of sleep monitoring, what is the primary reason? The answer options to the questions above are presented in Section 3, together with the achieved results.

3. Results

The total number of test participants was 1381, 683 (49.46%) of which were male and 698 (50.54%) of which were female. Test participants were from the age range between 18 and 63, and the average age was 36.22. The results were obtained from 16 countries, namely Albania, Belgium, China, Egypt, Greece, Hungary, Iran, Ireland, Italy, Montenegro, the Netherlands, Norway, Russia, Sweden, United Kingdom, and United States. The requirement for recruitment in the research effort was that the test participant owned at least one smart medical wearable and accessed at least one UM of such device.

The distribution of the number of smart medical wearables and the UMs accessed by test participants is shown in Figure 1. For general PPF, the leading answer was sport and exercise (23.17%), followed by appearance and accessory (14.05%), heart rate (13.03%), blood oxygen (12.67%), other activities (8.91%), other medical reasons (8.54%), blood pressure (7.6%), breathing (6.15%), body temperature (3.19%), ECG (1.38%), recommended by doctor (1.01%), and other reasons (0.29%). The trust in smart medical wearables in terms of medical measurements, and the usefulness of information in UMs regarding device calibration, for finding information about the PPF, for using the PPF, and
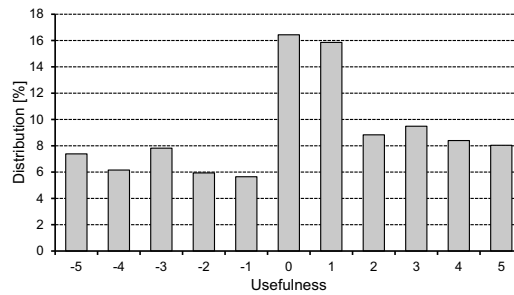
Figure 3. Usefulness of medical technical terminologies.

for discovering device functions are shown in Figure 2. For calibration frequency, the leading answer was weekly (22.74%), followed by every 3 weeks (19.19%), less frequently than monthly (14.27%), every 2 weeks (13.32%), monthly (11.15%), multiple times a week (9.99%), never (8.62%), and not applicable (0.72%). The results regarding the usefulness of medical technical terminologies are shown in Figure 3. As for functions that the device is capable of, yet are not properly covered by the UM, the leading answer was ECG (20.71%), followed by other medical functions (15.42%), breathing (14.77%), troubleshooting (11.08%), customization (10.86%), no such function or action (7.82%), heart rate (5.65%), blood oxygen (4.42%), other function or action (4.2%), blood pressure (3.91%), and body temperature (1.16%). If one could not find something in the UM, the leading answer for the primary source of information was the Internet (excluding the other options, e.g., vendor's website) (30.12%), followed by manufacturer (19.04%), friend or family (14.63%), vendor or shop (14.27%), other (13.69%), doctor or medical professional (5.79%), and full reliance on the UM (2.46%). Regarding the position of the UM in the order of sources, the leading answer was third (34.18%), followed by second (29.04%), first (19.26%), fourth (10.21%), later than fourth (4.42%), and never (2.9%). Concerning the frequency of wearing a smart wearable to bed, the leading answer was multiple times a week (22.81%), followed by every night (22.09%), less frequently than monthly (17.74%), multiple times a month (15.71%), weekly (15.06%), monthly (5.07%), and never (1.52%). As for the purpose of wearing a smart wearable to bed, the leading answer was sleep monitoring (22.29%), followed by wake-up alarm (17.3%), blood pressure (14.74%), heart rate (14.22%), breathing (10.41%), blood oxygen (6.01%), the feeling of wearing it (3.59%), accessory (2.79%), other reasons (2.71%), body temperature (2.13%), ECG (1.91%), and other medical function (1.91%).

4. Discussion

Figure 1 indicates a gap between the number of the devices owned and the number of UMs accessed; of those who answered with a specific number, less than 24% opened the UM of each smart medical wearable. As the data was collected after the peak years of the COVID-19 pandemic, blood oxygen saturation measurement was not a leading PPF. Figure 2 indicates a well-balanced distribution for the usefulness of information in UMs regarding device calibration, for finding information about the PPF, for using the PPF, and for discovering device functions. However, for the trust in the device in terms of medical measurement, approximately 50% of the collected results belong to the top 3

options, while nearly 27% are allocated to the 3 lowest options. This implies the impact of both positive and negative user experience in this context. Regarding the usefulness of medical technical terminologies in UMs, their reception is notably more positive than negative, although a third of the test participants considered them to be somewhat unnecessary, as shown in Figure 3. The obtained results reveal that even though sleep monitoring is the leading reason for wearing such devices to bed, this only constitutes 22.29%. Other medical functions are quite relevant as well, and using a smart medical wearable as a wake-up alarm is also rather common.

5. Conclusions

Based on the collected data, we conclude that about half of the test participants clearly trust the medical information collected by smart wearables, while roughly a quarter of them do not. To support measurement accuracy, a third of the test participants calibrate their devices at least weekly, but there is no notable impact of the UM on such tasks, which is also applicable to the other investigated UM purposes. A third of them find technical terminologies in such UMs unnecessary, while half of them deem the opposite, and the rest are neutral in this question. We also found that less than a quarter wears such devices to bed primarily for sleep monitoring. While the majority of the data is in alignment with the earlier results [8], blood oxygen measurement has become less of a dominant function since the COVID-19 pandemic. Regarding future work, the related trends during and after the peak years of the pandemic should be studied in more detail.

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