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# Towards Functionalities of Self-Tracking Wearables, their Effects on Humans and their Application Areas: Where can We Improve?

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# Towards Functionalities of Self-Tracking Wearables, their Effects on Humans and their Application Areas: Where can We Improve?

*Completed Research*

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## Abstract

Self-Tracking wearables bear valuable opportunities, which unfold when the frame conditions invite users to keep track. In this work, we present the following six crucial functionalities of self-tracking devices: feedback, socializing, goal setting, self-monitoring, gamification and measurement itself. We describe effects that result from functionalities. Subsequently, we derive potential relations between functionalities and their main effects mentioned in literature. We identified sets of functionalities that are combined by the manufacturer so that a certain effect can be enhanced or attained. Furthermore, we put the functionalities of self-tracking devices in connection with lifestyle areas and show in which areas the functionalities are already applied and can be used in future. These findings are summarized in the result artifact and are based on a structured literature review, carried out with five prevalent databases. From the findings, we derived three scientific implications as well as three practical implications for wearable manufacturers and physicians.

### Keywords

Self-tracking devices, functionalities, effects, application areas.

## Introduction

The increasing relevance of fitness trackers is undisputed. In 2017, a turnover of 36 million was recorded and for 2022 a sales volume of almost 52 million is predicted (Statista 2019). People are attaching increasing importance to the process of digital self-measurement. This process is related to the use of fitness trackers. Known as self-tracking or self-quantification, people use wearables to take the initiative in recording and documenting their activities. In this way, users pursue personal health maintenance and prevention. Main reasons for using fitness trackers are the documentation of the training and the monitoring of the own body functions (Stiglbauer 2019). The increasing interest in the society leads to the fact that the topic is taken up increasingly in literature. In recent years, the number of acceptance studies in this context has grown significantly (e.g. Pfeiffer et al. 2016; Shin et al. 2019). Besides, a major part of the literature deals with question which influencing variables of wearables cause an effect on humans, such as an increased physical activity (e.g. Asimakopoulos et al. 2017; Kettunen et al. 2017; Sullivan and Lachman 2017). These variables are for example trust, system performance or social influence. Meanwhile, it is neglected which functionalities of a self-tracking wearable device is actually responsible for certain effects. Stiglbauer et al. (2019) identified the lack of reliable studies investigating the benefits of health wearables. Therefore, they investigated whether people actually gain benefits from fitness trackers. However, there is still a gap in a comprehensive approach showing which functionalities of self-tracking wearables affect humans and which functionalities cause only positive effects, negative or both. Further, there is a need of an overview, in which lifestyle areas functionalities of fitness trackers are applied. With regard to this contribution, we design a model using a systematic literature review in order to combine the existing knowledge of multiple authors and derived functionalities from the authors' influencing variables. Thus, we aim the following research questions (RQ):

*RQ1: Which are crucial functionalities of self-tracking devices and how do they affect humans?*

*RQ2: In which lifestyle areas are these already applied and where can they potentially be beneficial?*

To answer our research questions, we structure the paper as followed. First, section 2 contains the methodology for the systematic literature review in detail. This forms the basis for the result artifact and the discussion. In section 3, we derive crucial functionalities of wearables from the literature and explain those as well as their potential positive or negative effects on humans. Furthermore, we present the combination of different functionalities to attain or enhance effects on humans and show the present and potential future application areas of wearables. Further, in section 4, we discuss the findings and derive scientific and practical implications as well as needs for further research.

## Methodology: A systematic literature review

Our contribution is based on a systematic literature search according to vom Brocke et al. (2009). Initially, the aim of the literature review is determined, which results from the given research questions. Secondly, the key terms of the topic are worked out in order to finally formulate a search string, which is structured as followed: *("Fitness Tracker" OR "Activity Tracker" OR "Self-Tracking Device") AND ("Human Behaviour" OR "Human Behavior") AND (Influence OR Impact) AND Health*. The third step according to vom Brocke et al. (2009) is the literature search. In our contribution, this is mainly based on the procedure recommended by Webster and Watson (2002), in which the research process is divided into several searches. We conducted the literature search using following databases: AISeL, Google Scholar, ScienceDirect, Scopus and SpringerLink. In addition to keeping the references up-to-date, we defined exclusion criteria to ensure the quality and recency of the references. Thus, we included only articles published since 2014. In 2014, the Quantified Self movement enjoyed a high level of attention and was at the centre of the wearable technology industry (Haddadi and Brown 2014). Table 1 illustrates the findings of our literature search in the five databases under our exclusion criteria. It turned out that finally 28 articles are of importance for identification of functionalities and effects on human. Based on these articles, Webster and Watson (2002) recommend a backward search. Applying this, we found six further articles. Thus, the literature relevant to our RQs was expanded to 34 articles. It turns out that the majority are from 2016 and 2017 (nine each), although six articles from 2019 are already included. Since the literature search was conducted in August 2019, it can be expected that further interesting articles will follow in the second half of 2019. The literature review is composed of 20 journal articles from different journals, 13 conference papers and one book chapter.

| **Database** | SpringerLink | ScienceDirect | AISeL | Scopus | GoogleScholar | **Total** |
|---|---|---|---|---|---|---|
| **Total results** | 231 | 73 | 655 | 144 | 809 | 1912 |
| **Sorted by title** | 15 | 16 | 16 | 25 | 19 | 91 |
| **Without duplicates** | 15 | 15 | 16 | 22 | 11 | 77 |
| **Sorted by content** | 4 | 3 | 10 | 8 | 3 | **28** |

**Table 1. Findings of the literature search**

The fourth step of vom Brocke et al. (2009) concerns the analysis of the previously collected literature. For this step, we created a concept matrix according to Webster and Watson (2002). We understood functionalities as concepts and derived these from the literature-based influencing variables, which affect humans. One example is the *socializing* function, which we derived from the variable *social influence* (Pfeiffer et al. 2016). Altogether, we elaborated six functionalities. The concept matrix, which can be found in an external link[1], presents each functionalities we derived from each article.

[1] https://bit.ly/2x2HB09

## Results

With regard to the RQs, Figure 1 describes the structure of the results, which are part of this contribution. First, we outline six crucial functionalities and their potential effects in more detailed and show an overview, linking these to the individual functionalities. Second, we present the possible combination of the six functionalities to enhance certain effect. Third, we explain how the functionalities are currently applied in the areas of a healthy lifestyle.

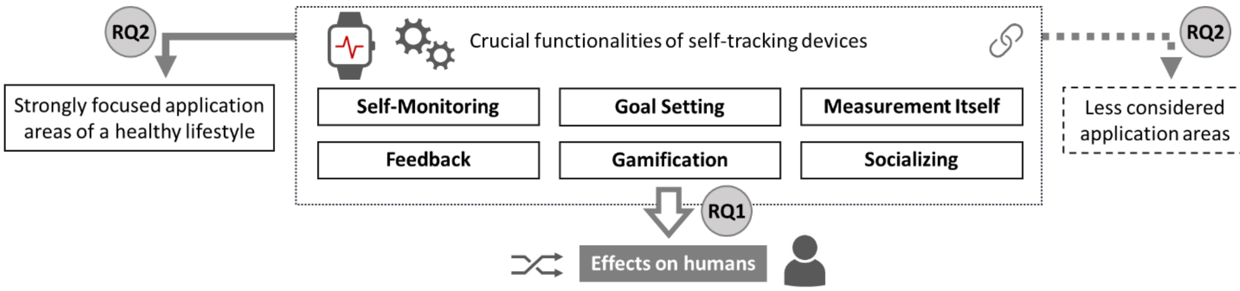


**Figure 1. Structure of the results**

### *Crucial Functionalities of self-tracking health wearables*

We derived six functionalities from literature-based influence variables, which were emphasized repeatedly: feedback, socializing, goal setting, self-monitoring, gamification and measurement itself. In the following, these are described according to the frequency of their mention in the literature, starting with the most frequently mentioned. Besides, positive and negative effects on humans were outlined slightly.

#### Feedback

The most frequently mentioned functionality in the literature is *feedback*. 24 of the 33 articles address this topic. This functionality offers the potential for assisting people to achieve certain fitness and health goals (Kettunen et al. 2017). Feedback occurs in various forms in the health sector. It can be divided into rewards and notifications e.g. for missing steps or medication reminders (Sullivan and Lachman 2017; Attig and Franke 2018). Feedback in the shape of rewards turns out to be a significant factor. The strongest effect on physical activity can be observed among elderly people (Mercer et al. 2016). The prevalence of feedback is not only shown by the frequent treatment in the literature. Lyons et al. (2014) prove that there is a possibility of receiving feedback in all fitness trainers they examined. However, there are differences in the design of the feedback. Wu et al. (2016) distinguish between haptic, visual and audible feedback. Besides, feedback should provide a motivating element (Asimakopoulos et al. 2017) and increase the user's interest in measured data by using an interesting design (Attig and Franke 2018). Sullivan and Lachman (2017) also confirmed that a consequent positive feedback is more helpful than a negative one.

#### Socializing

*Socializing* is considered similarly important as *feedback* and is dealt with 70% of the literature. This functionality, also named social influence, is often divided into social support and social comparison (Lyons et al. 2014). Social impact is defined as "is the extent to which consumers perceive that important others (e.g., family and friends) believe they should use a particular technology" (Venkatesh et al. 2012). Based on the evidence of this study, socializing is a significant factor for people beginning to use wearables (Venkatesh et al. 2012). This functionality is already applicable in 79% of all fitness tracking apps (Chen et al. 2017). The majority of people associate social impact in combination with wearables or fitness apps with sharing data on social media. The general importance of social media in today's world is undisputed. Especially social networks such as Facebook or Instagram are currently an important part of everyday life (Tu et al. 2019). However, this functionality does not only refer to sharing in familiar social networks. Sharing data in the individual networks of the wearable device, in specific communities and verbal data sharing is also of great importance. For example, 72% of users of a Jawbone wearable share their data by speaking with others and 36% even share this data online (Asimakopoulos et al. 2017).

## Goal Setting

*Goal setting* is dealt with in 21 out of 33 of the relevant literature findings. Goal setting is defined as the suggestion to a person to initiate changes in behavior through various measures (Sullivan and Lachman 2017). These measures often refer to physical activity. Originally, the principle of goal setting arises from the Goal Setting Theory of Latham and Locke (1979). In order to increase a person's performance with the use of goal setting, three major requirements are identified (de Laet 2017): (1) Goals should be difficult, but achievable, because difficult goals require more effort and thus lead to higher performance; (2) Goals should be precise, because this requires a clear strategy for goal attainment; (3) Goals should be set in the short term to prevent postponement. The last requirement also support to consolidate desired behavior (Chen et al. 2017). In addition to these three requirements, there are three starting points relating to the characteristics of targets. The first approach distinguishes between self-defined goals, predefined goals and participative goals. Contrary to expectations, the predefined goals are more effective than self-defined goals. The second approach differentiates between individual and impersonal goals while the third approach distinguishes between fixed and adaptable goals. For the latter two approaches, individual and adaptable goals are favored. Fixed and impersonal goals are often too ambitious, too low or unrealistic, which leads to suboptimal behavior and hinders an improvement in physical activity (Kari and Rinne 2018). The possibility of goal setting is usually available in current fitness trackers (Lyons et al. 2014). There are different types of goal setting in wearables. For example, a daily step goal, a daily calorie consumption, a distance to cover, or the daily sleep duration can be specified (Asimakopoulos et al. 2017). The literature has shown that goal setting is a driving factor with regard to an increase in physical activity and can influence people (de Laet 2017).

## Self-Monitoring

In literature, this functionality is discussed in 20 of 33 articles. With a focus on health, *self-monitoring* is considered to observe and document one's own health and athletic behavior and to use this data to improve one's own health and fitness (Rockmann 2019). Health wearables facilitate the tracking of one's performance significantly, as the data is available without great effort (Stiglbauer et al. 2019). In general, wearables are mainly used to measure taken steps, heart rate or sleep in everyday life or performance during sports activities. The majority of users wear their fitness trackers continuously to measure their parameters (Wieneke et al. 2016). Self-monitoring is more likely to be used by younger people, whereas older people tend to favor those functionalities, which focus on problem solving (Mercer et al. 2016). The following example illustrates the benefit of self-monitoring using a fitness tracker: A student at an American high school noticed a significantly higher heart rate compared to his normal heart rate observed by his fitness tracker. As a result, he went to a hospital, where a disintegration of the muscle tissue was diagnosed and treatment was immediately given. Thus, a necessary intervention was ensured (Chen et al. 2017). However, there may also be negative effects associated with self-monitoring. For example, if no improvements are made, users will increasingly notice this and a demotivating effect may occur (Rockmann 2019). A further criticism is that the user only concentrates on handling his data when doing sports and thus loses the connection to his environment (Toner 2018). However, the literature clearly highlights the advantage of this functionality in connection with self-tracking wearable devices.

## Gamification

The term *gamification* is associated with the idea of using playful elements in contexts that are not actually playful. In the context of health, Gamification should serve to influence people to be more active (von Entress-Fürsteneck et al. 2019). Out of the 33 articles covered in the literature review, the topic of Gamification is addressed within 13 articles. An example of gamification in fitness trackers is the obtaining of badges that are available for achieving certain targets. This can provide users with a high level of enjoyment (Matt et al. 2016). It has been found that game-based elements clearly lead to better health outcomes and/or more physical activity (Allam et al. 2015; Nelson et al. 2016; Tu et al. 2019), but these improvements from users through the use of game-based elements tend to be short-term (Chen et al. 2017). Moreover, the use of gamification is particularly suitable for children in order to give them a better understanding of healthy behavior. Three types of gamification can be differentiated: (1) gamification and the perceived value, which refers more to the fact that there are a variety of playful elements in recent wearables and fitness apps; (2) gamification and the emotional value of having more fun through possible rewards; and (3) gamification and the social value, which involves the social environment. In connection with social values, gamification brings the greatest benefit in the long-run (Tu et al. 2019).

**Measurement Itself**

This functionality receives the least attention compared to the others and is named in eight out of 33 articles. *Measurement itself* deals with the question whether wearing a fitness tracker alone and the associated consciousness of measuring one's own vital parameters has an influence on the user. Stiglbauer et al. (2019) believe that this factor has an effect on users' performance. This is shown by the fact that users, who are aware of measuring their data, such as their steps, cover more distance than users who are not aware of measuring their steps. Some users are even willing to return home to get their fitness tracker in case they forget it (Duus et al. 2017). In addition, some users experienced a reduction in physical activity or training performance when they did not wear their health wearables. This represents a certain dependence on the wearable device (Attig and Franke 2018). The external effect of a health wearable can also be noted, so that it can be perceived as a symbol of a healthy lifestyle (Jarrahi et al. 2016). This suggests that already the wearing of the fitness tracker and also the awareness of the measurement can have an influence on the user's performance. However, Kettunen et al. (2017) state that a self-tracking device alone is not sufficient to make the user physically more active. It rather serves as a supporting factor.

## *Effects of functionalities on humans*

In addition to the derived functionalities, a central component of this research are effects on humans, which can be divided further. Based on the gathered findings, we were able to deduce some significant effects, which can occur through the application of functionalities of self-tracking devices. In total, individuals perceive the functionalities differently, so that they may be either more positive or negative for different users. After studying the literature, the following effects from the functionalities of fitness trackers are significant and mentioned often: increased physical activity, change in sleep behavior, ignorance, resignation, better health literacy, and feelings of happiness. Table 2 shows the correlations between these potential effects on humans and functionalities of self-tracking devices. Taking *feedback* as an example, it can be seen from Table 2 that for some people *feedback* motivates them to exercise, but for some people it can also lead to ignorance or even resignation. The effects are slightly described in the last sections but now need to be investigated in more detail.

| | Increased physical activity | Change in sleep behavior | Ignorance | Resignation | Increased health literacy | Feelings of happiness |
|---|---|---|---|---|---|---|
| Feedback | X | X | X | X | X | X |
| Socializing | X | | X | X | | X |
| Goal Setting | X | X | | X | | X |
| Self-Monitoring | X | X | | X | X | X |
| Gamification | X | | X | X | | X |
| Measurement Itself | X | | | | | |

**Table 2. Potential effects of functionalities on humans**

Especially a changing physical activity in relation to the general usage of a fitness tracker as well as in relation to the individual functionalities can be found in the literature. *Feedback* could be used to promote healthy behavior through increased physical activity (Shin et al. 2018). The effect of sleep is also discussed in some articles. The majority of users wear a self-tracking device to monitor their own sleep behavior, but it is not clear whether self-monitoring affects the quality of sleep (Wieneke et al. 2016). The effect of ignorance aims at the extent to which users of wearables tend to ignore their own physical warning signals for certain reasons. Toner (2018) reports that a jogger ran faster during his running session contrary to his physical condition because his speed was initially below the speed set by the fitness tracker. In respect of *socializing*, social support refers to any support by others (de Laet 2017). Sullivan and Lachman (2017) state that social support can have a high impact on the physical activity particularly of elderly people. Online-based support can occur in various forms, such as comments, emoticons or even collaborative online training (Lyons et al. 2014). Furthermore, social comparison refers to the comparison with other people, often in the form of rankings or direct feedback (Lyons et al. 2014). The possibility of competition with friends may have a motivating effect (Jarrahi et al. 2016). In the example of *goal setting*, it is often said that setting and achieving goals has a motivating effect. Rockmann (2019) notes that a poor performance creates unpleasant pressure situations that can have a demotivating effect. However, it turns out that there is a strong association with other functionalities. In some cases, *goal setting* and *feedback* are seen as playful elements in the context of self-tracking (von Entress-Fürsteneck et al. 2019). Constant *feedback* can lead to higher physical activity, improved health literacy and healthier behavior (Shin et al. 2018). In the context of feelings of happiness, it is necessary to investigate to which functionalities of a fitness tracker these are attributable to (Stiglbauer et al. 2019).

## *Interplay of functionalities*

Effects of the six presented functionalities of health wearables on humans are repeatedly presented and confirmed in previous studies. In some cases, the effect on humans is only possible and demonstrable if the individual functions have been used in interplay with other functions. The lines between the functionalities in Figure 2 represent their potential interplay. In addition, Figure 2 shows that the overall measurement (*measurement itself*) is the basis for enabling all functionalities.

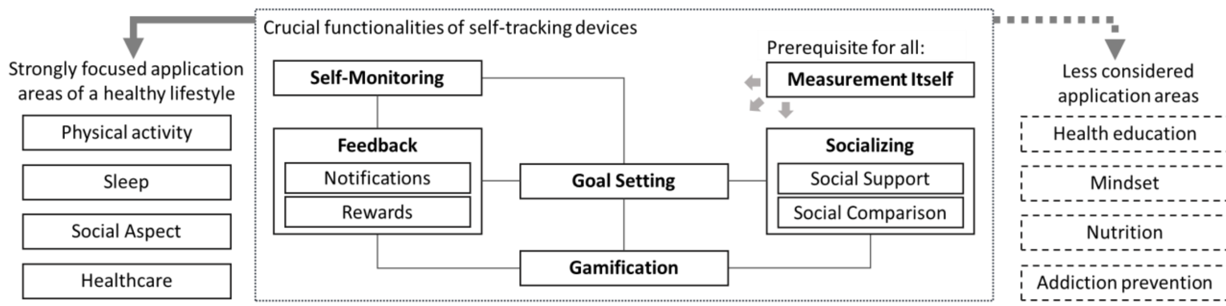


**Figure 2. Common interdependencies between functionalities of self-tracking devices and their integration in lifestyle areas**

The functionality *feedback* can be considered by itself, but also in connection with other functionalities. For example, de Laet (2017) states that a greater positive effect such as increased physical activity can be achieved when *feedback* is combined with *goal setting*. Accordingly, it also contributes to the achievement of objectives. Also, *feedback* is presented as part of the functionality *gamification* (Vooris et al. 2019; von Entress-Fürsteneck et al. 2019). *Socializing* can be integrated into some functions of *gamification*. For example, in their longitudinal study, Tu et al. (2019) found that respondents who use an app that integrates playful elements with a social focus perform better in terms of physical activity. The possibility of sharing data conveys a positive feeling. However, critique should also be considered so that it might yield the possibility for a demotivating effect. If the results are poor, there might be a fear of being judged negatively by others. This creates uncomfortable pressure, which tempts people not to use social components at all (Rockmann 2019). Altogether, negative feedback is only occasionally observed in literature. *Goal setting* can also overlap with other functionalities. In an experiment, Sullivan and Lachman (2017) recognize that participants, who wore fitness trackers for three months and previously set goals, achieved a significant increase in steps per day and were able to reduce their body fat percentage. The control group did not achieve these numbers. Interpreting these results, they find that not only the functionality *goal setting* is responsible, but also *self-monitoring* and *socializing*. *Self-monitoring* associated with fitness trackers is predominantly positively perceived in literature, since it can lead to better performance (Sullivan and Lachman 2017). However, *self-monitoring* must be linked to other functionalities in order to have an actual effect on users. Especially the combination with *goal setting* results in a significant increase in the daily number of steps (Sullivan and Lachman 2017). A benefitting connection to the functionalities *gamification* and *feedback* in the form of rewards has also been confirmed (Asimakopoulos et al. 2017). In other articles, the benefits of *gamification* tend to be considered more cautiously. For example, it is argued that basically there should be playful elements and *feedback*, but in a moderate way (Kari and Rinne 2018; Shin et al. 2018). In some cases, the functionality *gamification* is also considered irrelevant but there is a lack of a research model that reliably proves the benefits of *gamification* (Burbach et al. 2019).

### *Application of functionalities in healthy lifestyle areas*

The use of health wearables is generally aims at promoting a healthy (or healthier) lifestyle by managing your own health (Lupton 2020). Technologies, including self-tracking wearables, can be used in the following eight healthy lifestyle areas: physical activity, nutrition, mindset, social aspect, addiction prevention, sleep, healthcare, and health education (Behne and Teuteberg 2020). In the investigated literature, the areas of physical activity, sleep and the social aspect repeatedly emerge. In addition, in the long run, wearables could represent a serious alternative for medical examinations in the field of diagnostics and treatment. Currently, some self-tracking technologies are used in healthcare, such as the use of Apple Watches to detect atrial fibrillation (Tison et al. 2018). This self-gathered health information can now be stored in platforms that collect and process data from various health sensors (Meier et al. 2019) or in electronic health records (Beinke et al. 2019; Fitte et al. 2019). In this way, the user could exchange his health data with doctors, who is able to gain a better understanding of the symptoms in interaction with the vital parameters of the wearables before or during a doctor's consultation. This can result in time savings and patient benefit of a more precise individual diagnosis or treatment (Meier et al 2019). In total, there are four application areas that are strongly addressed in the use of wearables. Within the other four areas proposed by Behne and Teuteberg (2020), there is (even more) potential to utilize the functions of health wearables in a worthwhile or better way. In Figure 2, the left outside of the box shows the areas in which functionalities are already strongly affected and the right outside shows areas where greater potential for use has been identified.

## Discussion

In the following, practical implications (PI) and scientific implications (SI) are presented, which can be derived from previous sections. With regard to the effects caused by functionalities of self-tracking health wearables, the findings reveal positive and negative effects. The latter are crucial for the high abandonment rate in usage of wearable self-tracking devices, which ranges from one third according to Chen et al. (2017) to 50% according to de Laet (2017) within the first six months of use. The findings of this article, the effects of functionalities (Table 2) and a powerful interplay between those (Figure 2) can provide indications to health wearable manufacturers. Table 2 shows that functionalities may have a positive but also a negative effect on humans. Feelings of happiness can be evoked by *goal setting*. Nevertheless, in case of a non-achievement of this goal, negative effects such as ignorance or even resignation can follow if goals are too ambitious. Therefore, standardized goals, which are set in the beginning, should be appropriate for the user and not too ambitious for the current lifestyle. Preferred goals could be queried in advance or regularly or added to users' profile in order to exclude negative effects. S*ocializing* should be handled with caution, since besides the potential motivation a strong social pressure can arise. With regard to the functionalities *feedback* and *gamification*, it should be ensured that users have a choice to set their preferred frequency of notifications, e.g. when setting up the device for the first time. However, since opinions towards *gamification* differ widely, further research would be interesting to see how and whether *gamification* should be used in fitness trackers. *Feedback* is generally criticized in the shape of the occurrence of too many numbers and figures. Therefore, it is recommended that *feedback* should only be given with clearly understandable information (Kari and Rinne 2018). In total, this article offers manufacturers of health wearables the opportunity to reposition the functionalities in their self-tracking systems correctly, especially in terms of *goal setting*, *socializing*, *feedback* and *gamification* **(PI)**. With regard to the potential relations between functionalities and possible positive or negative effects on humans, we created a basis for further quantitative evaluation of these connections with a research model, if the use of the identified functionalities is perceived positive (e.g. motivation) or negative (e.g. resignation) depends on control variables or one's own preferences **(SI)**. Another approach could be to investigate, whether functions that are initially perceived positively are perceived negatively from a certain level or frequency on the functionalities. Therefore, a model has to be developed to determine the perception and the correlation of effects of functions on humans **(SI)**.

In general, fitness trackers and wearables have the potential to be used more extensively in the area of health than just in the currently focused areas (fitness and sleep). Initial approaches have also been explored and have already been used to integrate self-measured vital parameters into the healthcare sector. For this purpose, the sensor data of various health devices must be gathered in a collected and processed manner (Meier et al. 2019). Sharing this data with the physician in order to remotely monitor patients' well-being, can save time and can lead to a patient benefit in the shape of a more precise, individual diagnosis or treatment. Consequential, physicians should regularly inform themselves and be open-minded for implementations and to communicate and discuss digital values with their patients as a complement of their medical tasks **(PI)**. Furthermore, in the context of healthcare, the feedback function can be used to indicate when thresholds are about to exceed, so that users do not have to constantly check their data themselves. As the example given in the section on self-monitoring shows, one solution would be to warn the user of potentially dangerous situations. Manufacturers are therefore encouraged to set individual thresholds and warn users in case of irregularities but just in case of a high data quality in order to avoid false-positives **(PI)**. Figure 2 shows four areas where fitness trackers have so far little or no application. Especially in the area of health education, functions such as *gamification* or *feedback* could be used to increase health literacy even further and thus give a greater understanding of health and healthy living. Currently, the analysis only displays what has happened and been tracked but not the conclusion: what follows from that information? For example, fitness trackers could provide users with *feedback* to give them an individual context for their activities. An example is to provide information why it is useful to run at a certain heart rate (Behne and Teuteberg 2020). Another example is the implementation of advice about what food would be appropriate after a completed training session based on the individual training of the user. Another possibility is to show information on what effects an irregular sleep rhythm can have on the organism to a user with actual different sleep rhythms (Tanaka and Tamura 2016). This information can be also transmitted by *gamification*. Further not focused areas are mindset, nutrition and addiction prevention. With regard to the mindset area, the functionalities could be integrated to promote mental recovery. An example could be a reminder during working hours by means of *feedback* in order to take the look away from the computer regularly for eye relaxation (Agarwal et al. 2013). Furthermore, in addition to step goals, the *goal setting* functionality could be used to set goals for relaxation phases e.g. a specific number of meditations a week. Thus, our research gives impulses for the extension of a fitness tracker to further application areas such as health literacy and mindset, for which existing functions could be used, so that self-tracking health wearables cover the topic health in a more holistic way **(SI)**.

## Conclusion

In this work, we investigated crucial functionalities of self-tracking devices, their effects on humans and their application areas. With regard to RQ1, we identified six crucial functionalities by deriving these from literature-based influencing variables. These functionalities of wearables are feedback, socializing, goal setting, self-monitoring, gamification and measurement itself. We describe these in detail and in relation to their effects on humans. It shows that positive as well as negative effects can follow. The most mentioned effects are increased physical activity, change in sleep behavior, ignorance, resignation, increased health literacy, and feelings of happiness. Furthermore, we identified the interplay between the functionalities, which can increase the potential effects on human. With respect to RQ2, we recognized that the functionalities of health wearables are not used in each possible healthy lifestyle area. Currently, the utilization is common in the application areas, physical activity, sleep, social aspect, and healthcare. Further investigations are interesting for the usage of health wearables especially in the areas health education and mindset. Overall, Table 2 and the model in Figure 2 reveals our main findings the crucial functionalities, their most mentioned potential effects on humans, the interplay among functionalities as well as current and further application areas.

Scientific and practical implications were derived from the results, which are presumed as advice for future actions. From the manufacturer perspective, implications were given which concern the orientation and focus of functions, the implementation of *feedback*, i.e. producers could provide more health-related recommendations for the user. Regarding health actors, they should be open-minded to integrate wearable devices in their daily business in order to support diagnostics and treatments.

As a limitation of this contribution, it has to be mentioned that the literature research could be further extended by including wearables in the search term. Furthermore, the possible effects on humans are not complete but were mentioned with the highest frequency in literature. Despite the limitations, this contribution provides three recommendations for actions for wearable manufacturers and three scientific implications. The scientific implications provide basis for further investigation be carried out in respect to dependencies between the effects caused by functionalities or between effects and the degree or frequency of using functionality.

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