A SYSTEMATIC REVIEW ON WHAT FEATURES SHOULD BE SUPPORTED BY FITNESS APPS AND WEARABLES TO HELP USERS OVERCOME OBESITY

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Abstract

Obesity is a major global challenge. It increases the risk of developing health problems such as cancer, diabetes and cardiovascular disease. Its prevalence puts pressure on the healthcare systems and on individuals'health and finances as well. The use of fitness technology, mobile apps and wearable devices in supporting health behaviour change is promising. Fitness technology not only expands opportunities for users to access health related information but also facilitate cueing behaviour change and collection of ongoing personal data. The objective of this paper is to identify the features that should be supported by health and fitness apps and fitness wearable devices to encourage obese individuals to be active, change their lifestyle and to keep them motivated to overcome obesity. Firstly, it investigates the effectiveness and the efficiency of prevalent fitness apps and fitness wearable devices design features used to encourage physical activity. It then provides a method to evaluate bothfitness apps and fitness wearable devices as motivational tools. The results regarding mobile apps highlight that goal setting, monitoring/tracking and feedback are the best features for motivation and that Zombie Run is the best fitness app for the Australian market in 2015. The results in regards to wearable devices emphasise reminders, tracking / monitoring/ feedback and goals / rewards are the best features for motivation and that Garmin Vivofitis the best fitness wearable devices for the American market in 2015.These results are useful for the users; fitness apps' and fitness wearable devices' developers because they provide some understanding of the various features needed to motivate individuals.

Keywords: *Mobile Fitness Applications, Fitness Wearable Devices, Obesity, Gamification and Motivation*

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1. INTRODUCTION

Over the last five years use of fitness apps and wearable devices have gained popularity in fitness behavior interventions; especially for obese individuals who want to lose weight and gain better fitness. In 2014 the global fitness technology market was estimated to be worth 19 billion U.S dollars [1].

The use of fitness technology, mobile apps and wearable devices in supporting health behaviour change is promising. Health and fitness apps have grown rapidly over the years and there are more than thirty-one thousand fitness apps available on the Internet [2]. There is a growing interest in how the role of fitness apps and wearable devices can influence the behaviour of obese individuals. Fogg introduced a framework called the 'functional triad' that describes the role of devices in the device-human interaction [3]. He also highlights that devices can motivate humans by being mediums, social actors or tools. For example, fitness apps can act as predisposing factors or tools to diffuse fitness information. They can also collect personal information about the user's behaviour. These apps also connect the user to social networks.

In this paper, we identify what features used in fitness apps and wearables are important for obese individuals to stay motivated and active. We then conduct a systematic literature review to check the effectiveness of fitness apps and wearable devices using those features. Furthermore, we develop a ranking procedure for obese individuals to select the best fitness apps and wearable devices based on their features and functions. We created the systematic reviews of mobile fitness applications and wearable devices adopting the methodologies from Payne et al. [4] and Lewis et al. [5]. We used various keywords to retrieve articles related to fitness mobile apps and wearable devices and their impact on health and fitness of obese individuals.

We queried JMIR, CINAHL, Academic Search Premier, PsycINFO, PubMed, Health Source, Communication and Mass Media Complete, Computers and Applied Sciences Complete, Psychology and Behavioral Sciences Collection, Web of Science and PsychARTICLES. The first app-ready mobile phone hit the market in 2007 so we only considered articles that were published after that year.

This paper is unique because it discusses both the wearable devices and fitness apps. The literature review discusses how individuals can be motivated. Then a systematic review is conducted for fitness mobile apps and wearable technology. Finally, an evaluation procedure is developed for the most popular fitness apps are wearable devices.

2.MOTIVATION FEATURES IN MOBILE FITNESS APPS AND FITNESS WEARABLE DEVICES

2.1 Motivation Features in Mobile Fitness Apps

Mobile apps' biggest advantage is that they are adjustable to the needs of the user; constantly accessible; able to provide feedback; have interactive features and large reach [6]. Ample research has shown that most effective behaviour change related to fitness and health occurs through behaviour interventions [8]. Recently, many researchers have tried to explore the effectiveness of apps as a way of providingbehavior intervention to the user [7-8].

Goal setting is considered as the most vital tool to motivate individuals to pursue their goals and it has been found to have a positive impact on the performance [9-10]. Goal-setting featuresare prevalently used in fitness apps and they can be considered to have a positive impact on individual fitness.

Feedback has a powerful effect on performance and enhances the learning and training of an individual [11-12]. Mobile fitness apps provide interactive feedback through graphs, progress charts and peer comparison charts. This is therefore an effective feedback tool.

Many researchers have discussed reminders' impact on health in various settings and they have been found to be very effective motivational interventions [13-14]. These researchers' findings provide ample evidence that features of mobile apps can enhance the app users' fitness through constant and effective reminders that enhance compliance with physical activity and dietary recommendationsto improve BMI (Body Mass Index).

Rewards have bee heavily discussed in the research as a very useful way of increasing motivation and task performance [15]. Gamification features in the apps can also act as very creative rewards to motivate users [16-17].

2.2 Motivation Features in Fitness Wearable Devices

Much of the research has examined the impact of wearable devices on the user's behaviours and perception in their efforts to promote healthy lifestyle and the results have supported the hypothesis [18-19]. According to Michie et al. [20], the most successful behaviour change techniques employed by wearable devices extracted from recently published meta-analyses are: reminders, tracking/ monitoring and feedback, and goals and rewards.

Reminder features in wearable devices act as a source of extrinsic motivation for the user [21]. Wearable devices can be connected to smartphones. This provides the user with an opportunity to share their fitness achievements within their social circle. The user can crowdsource and compare their motivation with others and be motivated by peer pressure.

Tracking/monitoring and feedback features in wearable devices are appreciated in a lot of recent literature because of their effectiveness as a tool for measuring and motivating physical activity among individuals [22-24].

Usually wearable devices offer some explicit rewards or goals, which are referred to as "system rewards".Research by Fritz et al. [25]discovered through interviews that most users of wearable devices commented upon how rewards affected their fitness goals and physical activity. System rewards offer motivation at the early stage; however, overtime changing rewards are valuable for motivation.

3. SYSTEMATIC REVIEW OF MOBILE FITNESS APPS

A systematic literature review was conductedfor published, peer-reviewed articles that studied some features or health behaviour interventions that mobile apps utilized to increase physical activity among obese individuals.We used the keywords mentioned in the table below (Table 1)to search for the articles related to our research topic.We attemptedto include all the possible keywords that can provideus with articles related to fitness mobile apps and their impact on the healthof obese individuals.

We queried JMIR, CINAHL, Academic Search Premier, PsycINFO, Health Source, Communication and Mass Media Complete, Computers and Applied Sciences Complete, Psychology and Behavioural Sciences Collection, Computer Source, PubMed, Web of Science and PsychARTICLES.

The first app-ready mobile phone hit the market in 2007 so we only considered articles that were published after the year 2007. The systematic review methodology has been adopted from [4] and the flow chart below shows the course of the systematic review.

Table -1: Search terms for systematic review regarding mobile fitness apps

Search Lines	Search terms	Filtered by
Line 1	Mobile Device OR Mobile Phone OR Smart Phone	Title/Abstract
2. AND	Applications OR Apps OR	Title/Abstract
3. AND	Obese OR Obesity OR Fat OR Overweight OR Unfit	Title/Abstract
4. AND	BMI OR Weight Loss OR Fitness OR Health	Title/Abstract
5. AND	Behaviour OR Interventions	Title/Abstract
6. AND	Features OR Design Features	Title/Abstract
7. AND	Goal-Setting OR Feedback OR Monitoring OR Gamification OR Rewards	Title/Abstract

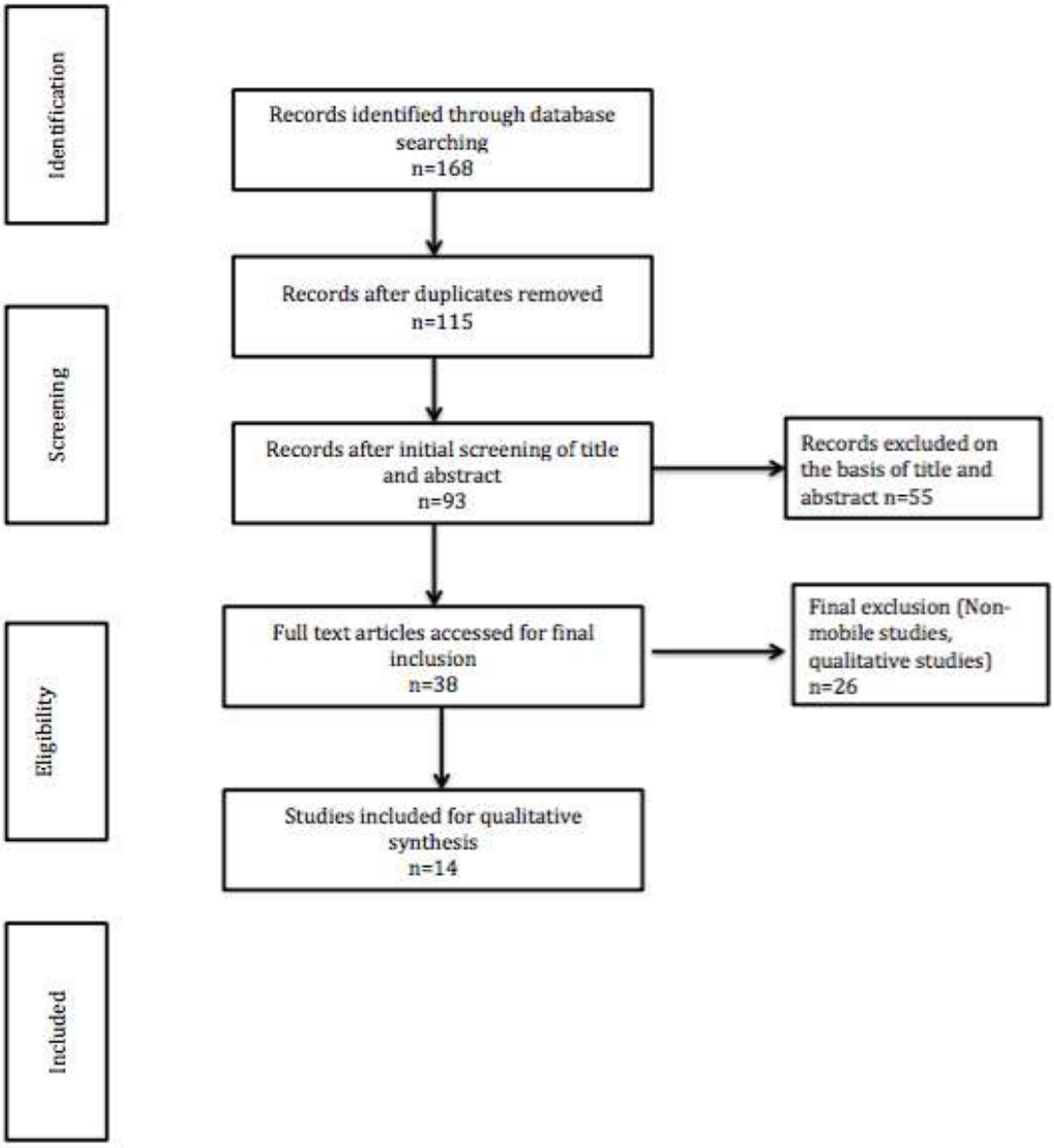

Fig -1: Method used for the systematic review regarding mobile fitness apps

Fourteen studies tested an app that had been developed for intervention and six tested existing apps. Most of the studies test and report just one app.

A study by Hebden et al. [26] tests four apps and this research uses the greatestnumber of apps compared with any other study. At least one health behaviour theory was incorporated in each of these articles and self-monitoring was a common point of discussion (78.6 %) in these articles. Feedback and social support were also very popular (85.7%). The two most common theories discussed were self-determination theory (14.3%) and cognitive theory (14.3 %). Allen et al. (2013) suggests that users were satisfied with behavioural interventions delivered by smartphone to help obese individuals increase their physical activity. Interventions included text messages, videos and goal assessment. There was a strong emphasis on additional feedback and exercise. Bond et al. [27] indicates that a feedback feature and real-time display increased obese users' motivation to participate in physical activity. Brindalet al.'s [28] research indicated that prompting (reminders and alerts) and weight tracking were the two most popular features followed by trophies (rewards). Carter et al. [29] reported that users were more at ease when using mobile apps to track their fitness than when using any other methods. Users were also found to utilize fitness mobile apps in public. King et al. [30] reported that the main acceptable features of the apps are alerts to action and goalsetting. Smith et al. [31]indicated that "push prompt" was the feature that users found most useful. Information sharing with family members and rewards were also rated highly in acceptability.

Our research findings show that ten studies focused on physical activity as the primary measure and eight of them reported increase in physical activity because of the use of fitness apps. Questionnaires or self-reporting on the apps have been used to measure physical activity [14; 32; 33-36]. All but Turner-McGriecy and Tate [14] stated an increase in physical activity, while Allen et al. [32] reported only a smallincrease.Some used the apps to provide an objective measure of physical activity [26-27; 31; 37]. The apps had different objectives such as modifying behaviours through intervention, monitoring dietary intake; measuring physical activity or monitoring weight. All of them except Smith et al. [31] found a substantial increase in activity level. Eleven studies focused on weight loss or BMI for overweight or obese individuals. Eight of the studies have noted lower BMI or weight loss because of mobile fitness apps [26; 28-29; 32;35; 37-38]. A study by Turner-McGrievyand Tate [14] did not find any effect on BMI but Turner-McGrievy et al. [36] did find a loss in weight. Smith et al. [31] found no decrease in body fat or BMI as a result of the use of fitness apps.

3.1 Case Study on Four PopularMobile Fitness Apps

We used a ranking procedure for apps based on the four most prevalent features discussed in the literature review. We will use two criteria for evaluating fitness apps: Their 'Better Behavior Functionalities' and their cost. Payne et al. [4] discussed fitness apps based on theirbehavior functionality as well as how thosewith motivational featuresthat have features, which motivate users better have better functionalitycould perform more efficiently.

The cost is also important to the user because apps that are free or less expensive cost less are better.

Once the apps were selected, we investigated how successfully they it employs the four main features discussed in the literature review. We considered the reviews of obese users and assessed how many appreciated a particular feature having an impact on their physical activity or behaviour. Table 2 below shows an example of a feature evaluation table for fitness app.

Table -2: Model of a table used for reviewaggregation for each mobile fitness app

Features	Number of Reviews
Goal-Setting	10
Monitoring/Tracking and Feedback	20
Prompts/Reminders or Alerts	30
Rewards or Gamification	10
Total	70

To determine if an app is high cost or low cost we will verify it is available for free from the Apple Store. The cheapest smartphone on the Apple Store is A$679. If one was to pay up to $20 for an app then it could be considered low-cost because they are paying less than 3% of the smart phone'sprice. We then reviewed the four most common apps available on Australian App Store: Nike+Running, Zombie Run, Runkeeper and Get Running. We chosethese because most of the previous work had compared only two or three. The criteria for selection were that apps should have at least afour-star rating and should have attained a high number of reviews.We excluded any app that had a five-star rating but very few users. We thenevaluated the fifty reviews posted by obese individuals of each app to figure out which features are most admired by the users.All the positive reviews for each app will be aggregated to determine the best one.These reviews were retrieved between October and November 2015. We used recent reviews because they are usually based on the latest version of the app and they also depict the current popularity of the app among users. Reviews were accessed from the Australian App Store and we manually read the recent fifty reviews posted by obese users.

Table -3: Number of positive reviews received for each fitness mobile apps feature

	Goal Setting	MonitoringTracking	PromptsReminders	Rewards Gamification
Nike+Running	29	37	13	10
Zombie Run	33	8	22	28
Runkeeper	21	20	10	0
GetRunning	14	9	3	0

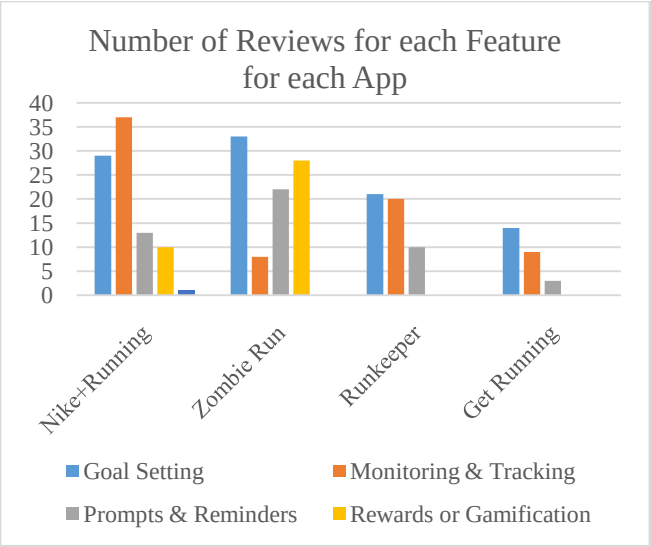

Chart -1: Summary of features evaluation for each app

Table -4: Total reviews and rank of each app

App	Total Reviews	Rank
Zombie Run	91	1
Nike+Running	89	2
Runkeeper	51	3
Get Running	26	4

The results showed that Zombie Run is the highest popular apps because ithaspositive reviews of 91.On the other hand, Get Running has the lowest rank and number of total positive reviews of only26.

All the apps fall in thelow-cost category due to the fact that Nike+Running, Zombie Run and Runkeeper are free whilstGet Running onlycosts AU$ 3.79.

4. SYSTEMATIC REVIEW OF FITNESS WEARABLE DEVICES

A systematic literature review was conducted for published, peer-reviewed articles that studied interventions or behavior change techniques employed by wearable devices to help obese individuals to lose weight. We used keywords mentioned in the table below (Table 5) to search for the articles related to our research topic.We then attempted to include all possible keywords that could give us articles related to wearable fitness devices and their impact on health and fitness.

We queried JMIR, CINAHL, Academic Search Premier, PsycINFO, Health Source, Communication and Mass Media Complete, Computers and Applied Sciences Complete, Psychology and Behavioural Sciences Collection, Computer Source, PubMed, Web of Science and PsychARTICLES. The systematic review methodology has been adopted from Lewis et al. [5] and the flow chart below shows the methodology of the systematic review.

Table -5: Search terms for the systematic review on fitness wearable devices

Search Lines	Search terms	Filtered by
Line 1	Wearable Devices OR FitnessWearable Devices	Title/Abstract
2. AND	Electronic Activity Monitor System	Title/Abstract
3. AND	Obese OR Obesity OR Fat OR Overweight OR Unfit	Title/Abstract
4. AND	BMI OR Weight Loss OR Fitness OR Health	Title/Abstract
5. AND	Behaviour OR Interventions	Title/Abstract
6. AND	Features OR Design Features OR Design	Title/Abstract
7. AND	Goal-Setting OR Feedback OR Monitoring OR Gamification OR Rewards	Title/Abstract

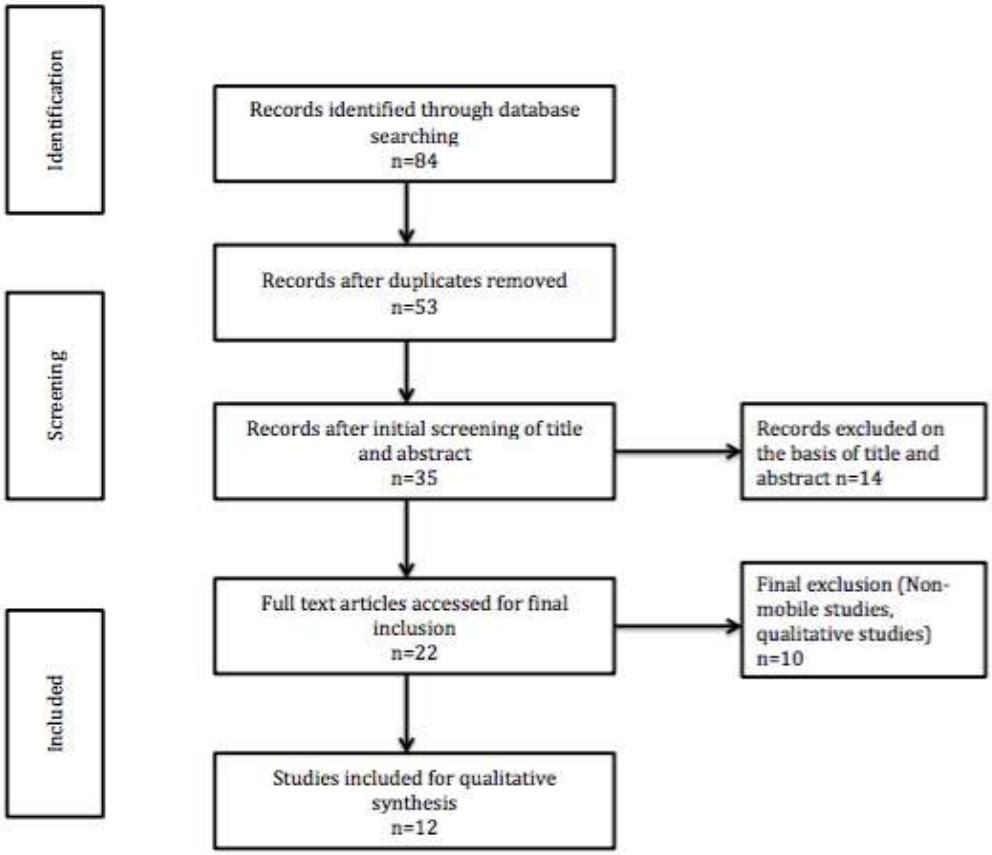

Fig -2: Method used for the systematic review regarding fitness wearable devices

In the twelve studies selected, each one was based on a different wearable device: Fitbit [30-41], Gruve [42] Bluetooth Actiwatch [43], activPAL [44], PAM [45-46] Sense Wear armband [47-49] and MTx-W sensor [50].

Three of these wearable devices, Fitbit, PAM and Gruve are available commercially while other devices can be bought through distributors. These wearable devices are worn on different body parts in these studies as per monitor instructions. Studies using Fitbit [39], MTx-W [50] Gruve [42] and PAM [46] required the devices to be worn along the iliac crest. Fitzsimons et al.'s [44] study, which used activePAL as a monitoring device required it to be worn along the upper thigh. Studies using Sense Wear armband required it to be worn along the upper arm [44; 47; 49]. All of these wearable devices allowed for individualfeedback and self-monitoring. In some of the research, investigators manipulated accelerometers to provide automated self-monitoring to the wearer [44; 47-49].

The feedback from these wearable devices was delivered via email an online monitoring system [42; 45-49] or via text message [40]. Out of the twelve studies, nine focused on measuring changes in physical activity [39; 42-48; 50].

Five studies reported that intervention by the wearable devices served as a motivational tool and brought about a significant increase in the physical activity level of the individuals [42-44; 47-48]. Five studies discussedchange in the body weight of obese individuals [39; 45; 47-49].

Four studies reported a significant decrease in weight overtime [39; 47-49]. Two studies found a significant difference between the intervention and comparator group [48-49]. These two studies included physical activity alongside dietary intervention.

4.1 Case Study on Three PopularFitness Wearable Devices

In the literature review, we discussed the main purposes of wearable devices as being monitoring and feedback. Other features they provideare reminders and alerts, usually through smartphone synchronization. Some devices themselves have alerts to encourage the user to become more involved in physical activity. Goal setting and rewards are also features of some wearable devices that usually rely upon a website or mobile app that synchronizes with the device. A final feature is cost which affects the accessibility of the device. Unlike fitness apps, which are usually free or cheap, wearable devices have a cost component and their availability on online stores and other stores is important.

Overall, we will evaluate fitness wearable devices based on these four criteria to show the effectiveness and efficacy of the device. The effectiveness and efficacy criteria were selected so that we can compare how well the device can motivate the user and whether it is affordable compared to other devices. We will evaluate how successfully the wearable device employs each feature. For the first three

features we will use customer reviews retrieved between October and November 2015 to see how much each feature is appreciated by the user. In terms of accessibility we will look at the price of the three wearable devices and rank them as shown in the table 6 and 7. Table 8then calculates the total number of reviews for each wearable.

Table -6: Model of a table used for review aggregation for each fitness wearable device

Features	Number of Reviews
Monitoring/Tracking and Feedback	10
Reminders and alerts	20
Goal setting and rewards	30
Total	60

We will review fifty recent customer reviews in order to assess how many users appreciate each of the first three features. In regards to accessibility, we will look at the price of the three wearable devices and rank them as shown in the table above. The feature that has the highest reviews for one wearable device as compared to all three devices will achieve a ranking of one.

In terms of accessibility, we will look at affordability because all three wearable devices we have selected for evaluation and comparison are available on Amazon.

Table -7: Evaluation of accessibility of the wearable device based on price

Wearable Device	Price	Rank
Garmin Vivofit	$71.99 (Lowest Price)	1
Fitbit Flex	$89.99 (Medium Price)	2
UP3 Jawbone	$152.53 (Highest Price)	3

Table -8: Number of positive reviews received for each wearable device feature

	Monitoring Feedback	Reminders and Alerts	Goal-Settings and Rewards
Garmin Vivofit	41	27	12
Fitbit Flex	30	22	17
UP3 Jawbone	32	17	13

We will then compare the total number of positive reviews of the three devices and rank them accordingly. This method of ranking a wearable device can be very useful for users looking to choose from amongst various wearable devices. Table 8 shows that Garmin Vivofit is ranked overall as the most effective wearable device in terms of user motivation because it has the highest number of 80 positive reviews. On the other hand, UP3 Jawbone has the lowest number of positive reviews at 62. These numbers show how effective these wearable devices are considered by users based on reviews of the four features we have used to rank and judge the effectiveness of each wearable device.

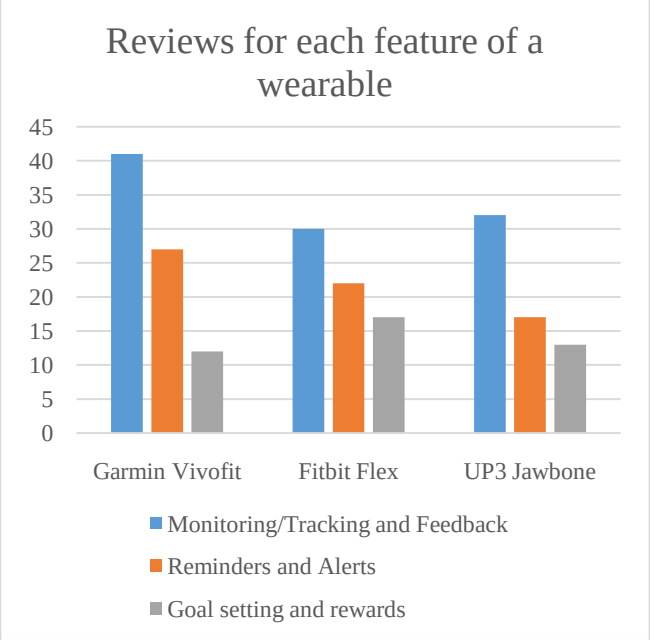

Chart -2: Positive reviews for each feature in each wearable device

Table -9: Total reviews and rank of each wearable device

Wearable devices	Total Reviews	Rank
Garmin Vivofit	80	1
Fitbit Flex	69	2
UP3 Jawbone	62	3

5. LIMITATION AND FUTURE TRENDS

Most of the studies that arereferred to in the literature review discuss the impact of fitness technology on health, so we assume their motivational features to have similar impacts on fitness. This is the reason why we did not try to look at the original intention of the author in the study but rather aimed at finding the impact of fitness technology on motivation. Most of the studies we included in the literature review were feasibility or pilot studies and had small sample sizes. With the fitness technology industry becoming a billion dollar industry, it is concerning that more effort and money are not being invested into investigating the efficacy of fitness apps and wearable technology on a much larger scale. However, there are some possible future directions to enhance this research. One could be developing an app that specifically targets obese individuals. Another option could be for experts for example, developers and academicsto partner with manufacturers in order to help them improve the efficacy of their fitness technology. Another direction could be related to developing a set of online rating criteria that is comprehensive and captures the overall success of the app or wearable. Another interesting area of future research could focus on the study of the benefits of introducing fitness technology into the public health sector in order to combat obesity.

6. CONCLUSION

Obesity is a major issue for health departments all over the world. Despite a great effort, the obesity rate is higher than ever before. The literature review highlighted that obese individuals can be motivated to increase their physical activity through behavioural interventions. It identified that features such as goal-setting, monitoring, reminders and rewards can impact upon the fitness of users by encouraging them to become more involved in physical activity. This systematic literature review makes it evident that fitness technology has the potential to play a greaterrole in the health and fitness of the individual because of these features. In the ranking procedure of the fitness apps and wearable devices, Zombie Run had the best reviews regarding motivational features and therefore it achieved the highest ranking. Amongst wearable devices, Garmin Vivofit was ranked first one based on the same features. Whilst simple, the ranking systemcan be useful when the user is selecting a fitness technology. Moreover, this is a step towards developing a comprehensive ranking system, which uses more features. Such a ranking system may not only be useful for the user but also for fitness app developers. They could use such a system to evaluate their prototypes as well as their launched products.

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