

Wearable fitness trackers and their effectiveness

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ABSTRACT: BI Intelligence, Business Insider's premium research service, expects the wearables market to grow to 162.9 million units by the end of 2020. The healthcare sector will be one of the top catalysts to push the wearables markets to these heights, as consumer and professional healthcare trends will spur interest in wearable devices. Fitness trackers, in particular, are the leading consumer products because most consumers use wearable devices to record their exercise and health statistics and progress. Hospitals, med-tech companies, pharmaceutical companies, and insurance companies have started utilizing these devices. This paper studies the advantages and disadvantages of wearable fitness trackers and their effectiveness as experienced by consumers.

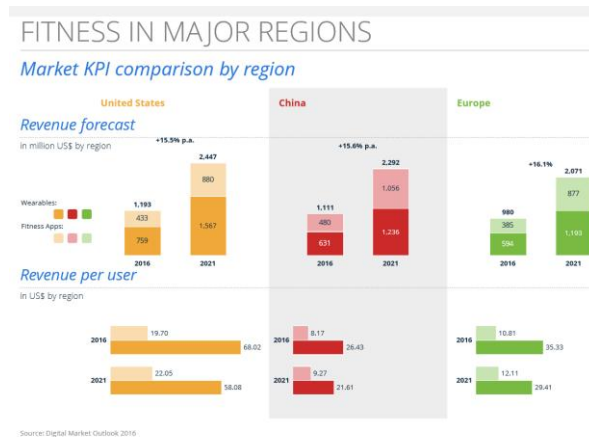
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Introduction

A fitness tracker as the name goes, is a device that tracks the user's activity and records his/her heart rate and breathing. Many fitness tracking devices monitor the user's sleep as well. Many versions monitor the number of steps done walking or running. They also determine the amount of calories one has consumed. These cleverly made devices come in different forms. Some can be worn like a wristwatch. Others can be attached to the user's shoe. They are programmable with options to sync data to one's smartphone or laptop. The user can check the input data from time to time and make a daily comparison on his/her fitness activity.

The fitness trackers market

The Fitness market is divided into two areas: Fitness Wearables and Fitness Apps. As Fitness Wearables can be synchronized with smartphones to give a complex analysis of vital data, smartphone penetration has a major impact on the sale of such wearables. The global revenue in the Fitness segment amounted to US\$4.5bn in 2016. The majority of the revenue is generated by Fitness Wearables with about 60% share. From a global comparison perspective, the most revenue was generated in the United States (US\$1.19bn in 2016). United States is followed by China which had a revenue of US\$1.11bn in 2016. Revenues were the lowest in Europe in this comparison with US\$0.98bn in 2016.



When it comes to top players in the Fitness market, Adidas (Europe) is the leading provider, followed by Fitbit (USA), Garmin (Europe), iHealth (USA) and Jawbone (USA).

KEY PLAYERS IN THE FITNESS MARKET

Selected key players and KPIs in the Fitness market

Company	Products	Headquarter	Revenue (in bnUS\$ 2015)	Revenue (in bnUS\$ 2014)
Adidas	MiCoach FIT SMART, Heart Rate Monitor, Rustrastic	Europe	19.28	15.24
Fitbit	Fitbit Zip, Fitbit One, Fitbit Flex, Fitbit Charge, Fitbit Alta, Fitbit Charge HR	United States	1.86	0.75
Garmin	Garmin Vivofit 3, Garmin Vivoactive, Garmin Vivosmart, Garmin Forerunner	Europe	2.82	2.8
iHealth	iHealth Edge	United States	-	-
Jawbone	Jawbone UP2, Jawbone UP3, Jawbone UP4, Jawbone UP Move	United States	-	-
Misfit Wearables (acquired by Fossil Group)	Misfit Ray, Misfit Shine 2, Misfit Flash, Misfit Speedo Shine	United States	3.51	3.44
Moov	Moov, Moov Now	United States	-	-
Nike	Nike+ FuelBand, Nike+ FuelBand SE, Nike+ Running App	United States	30.6	27.78

Fitness trackers: How they work

Fitness trackers measure motion. Most of today's wearables come with a 3-axis accelerometer to track movement in every direction, and some come with a gyroscope too to measure orientation and



rotation. The data collected is then converted into steps and activity and into calories and sleep quality, though there is some guesswork involved along the way.

The altimeter measures altitude, handy for working out the height of the mountains a person has climbed or the number of flights of stairs one managed to get up and down during the day. All of this information is collected and crunched to create an overall reading, and the more sensors one's tracker has, the more accurate its data.

These sensors measure the acceleration, frequency, duration, intensity and patterns of your movement—taken together and it can help a tracker work out if a person is walking down the road or just waving at someone the person knows. One can look into the specs list of a particular tracker to see what sensors are included to collect data about the individual.

Other wearables, such as the Fitbit Charge 2, use optical sensors to shine a light on a person's skin and measure a person's pulse through it: the light illuminates capillaries and thereafter a sensor measures the rate at which the blood is being pumped (and thus the heart rate). These optical sensors are less effective than bio impedance as a gauge of overall health but can be more useful to check the heart rate while exercising or working out.

It's a similar story with sleep tracking. Using a process called actigraphy, the tracker translates wrist movements into sleep patterns as best as it can. It's a useful guide, but it's not as accurate as polysomnography - this is what the experts use to measure sleep in a lab, and it monitors brain activity rather than how much a person is tossing and turning.

Architecture of a fitness tracker

A fitness tracker consists of five main layers as follows:



- Sensing layer: This layer has sensors embedded in the device; these sensors collect data like number of footsteps, heart rate, body temperature, etc. The data collected by sensors are sent to servers using Wide Area Network such as GSM, GPRS, and LTE.

- MAC Layer: This layer is responsible for device monitoring and control, quality-of-service management, and power management.

- Network layer: This layer takes care of transmission, routing, and addressing using IPV6. With IPV6, address allocation and management can be done more efficiently, hence it is chosen over other Internet protocols.

- Processing and storage layer: In this layer, the data received from the sensing layer is analyzed and stored in databases. This layer is also responsible for security control.

- Service layer: This layer provides the analyzed and processed data to other services like mobile application on Android or iOS.

Advantages and disadvantages of using fitness trackers

There are both advantages and disadvantages of using fitness trackers.

Advantages of fitness trackers

Fitness trackers increase the user's fitness awareness because the user wears it. When the user wears a fitness tracker, it reminds him/her constantly about getting and staying fit.

There are different groups of customers that benefit from Fitness Wearables/ trackers and Fitness Apps. Fitness Wearables measure and analyze physical activity or body functions. Wearables are mostly combined with an app to gain valuable insights into the individuals' fitness. These insights can help users to understand their body better and can support them in reaching specific fitness goals, for example losing weight by tracking calories in an app or calculating burned calories with a tracker.

Users can adjust their workout volume and intensity. Fitness and activity trackers tell the user how much effort he/she has exerted. This is useful for runners and even for those running on a treadmill. They tell users exactly how long they have run and measure their heart rate, allowing the user to determine how much he/she worked themselves out at that moment.

One can track one's activity level and make daily or weekly comparisons. Consistency is important in fitness routines. The tracker will tell the user if he/she is slacking off.

Some fitness trackers monitor sleep. Sleep duration and quality affects a person's workout recovery and fitness. Some people report sleeping for 8 hours but still wake up groggy. The problem may have to do with the quality of your sleep, and devices that monitor a person's sleep can give the user hints as to whether he/she is sleeping well.

Disadvantages of fitness trackers

Many fitness trackers are faulty. For instance, some of these devices mistake insignificant activities and mannerisms for an activity. Sometimes the device says that the person has worked out a lot, but the user may have spent much of his/her time just shaking legs underneath the office desk.

Another disadvantage of a fitness tracker is that it is difficult to get two fitness trackers to agree on how much activity a person has got through in a day or what his/her heart rate actually is. That's because the sensors inside each device aren't perfect at measuring what the person is doing - they all use slightly different algorithms to translate the raw data into actual statistics.

For example, the tracker might dismiss a small movement of the wrist and not include it as a step. Different devices will have different thresholds and thus bring back different readings.

A third disadvantage is that fitness trackers can be expensive. For some people, buying one is just impractical when they can track their own fitness activity using conventional methods.

Effectiveness of fitness trackers

Extensive research has been done in the field of fitness trackers. Researchers have found that wearable trackers may not increase activity levels enough to significantly benefit health. It has also been found that Pedometers are not a solution for rising rates of chronic diseases.

In a particular study, that was published in *The Lancet Diabetes and Endocrinology*, an international team of researchers tracked 800 people from Singapore aged 21 to 65 to see whether using such devices improved their health. The study was conducted weeks after research published in the *Journal of the American Medical Association (JAMA)* found that wearable gadgets that track users' physical activity may not help people lose weight. The participants were assigned

to one of four groups – a control group which had no tracker, a group which wore a Fitbit Zip device and the two remaining groups were given trackers and offered financial rewards- either cash incentives for themselves or donations to charity for the first six months of the trial. The researchers also measured participants' levels of moderate-to-vigorous physical activity (MVPA) per week as well as their weight, blood pressure and cardio-respiratory fitness at the start of the study and six and 12 months later.

The researchers found that during the first six months of the study, only participants in the cash incentive group recorded increases in physical activity. The mean daily step count among wearers was 11,010 steps in the cash group, 9,280 in the charity group, and 8,550 in the Fitbit group. After a year, those in the cash incentive group had returned to the same levels of physical activity that they recorded at the start of the trial.

But by contrast, those in the Fitbit group showed improved levels of physical activity, recording an average of an additional 16 minutes of MVPA per week than they did at the start of the trial. However, the authors said that this increase was probably not enough to generate noticeable improvements in any health outcomes.

They also found that Fitbit and charity participants showed similar step counts to when they were measured at six months.

The researchers concluded that wearable activity trackers were unlikely to be a panacea for rising rates of chronic disease. The trackers seemed to have been effective at stemming a reduction in physical activity seen in participants in the control group at 12 months, but there was no evidence of improved health outcomes."

Lead author Prof Eric Finkelstein from Duke-NUS Medical School in Singapore said after a year-long study that volunteers who wore the activity trackers recorded no change in their step count but moderately increased their amount of aerobic activity by an average of 16 minutes per week. No evidence was found that the device promoted weight loss or improved blood pressure or cardiorespiratory fitness, either with or without financial incentives.

A study conducted by the University of Pittsburgh measured whether fitness devices aided weight loss and found that people shifted more flab when they were not wearing trackers. Around 470 overweight adults enrolled on the Pittsburgh trial. All were told to diet and exercise more, which is standard advice.



After six months, half the participants were randomly assigned to an enhanced intervention: they got a fitness tracker, could monitor their progress and receive feedback through a website. The results, collated two years after the experiment started, confounded expectations: the unmonitored slimmers lost an average of 5.9kg, whereas their digitally tracked peers shed 3.5kg. The authors concluded in the Journal of the American Medical Association that “devices that monitor and provide feedback on physical activity may not offer an advantage over standard behavioural weight loss approaches”.

And yet the evidence on their effectiveness has struggled to keep pace with consumer enthusiasm. One issue is the algorithms used to count steps and estimate the number of calories expended. These vary between devices, as shown by guinea pigs who have worn several trackers simultaneously.

One tester found that, over a week, her tally of calories burnt, as measured by Jawbone and Fitbit devices, differed by more than 2,600. That’s roughly a day’s worth of eating. If you have a tracker that systematically over-counts the calories used up, and you dine accordingly, you are unlikely to lose weight.

Conclusions

The main global driver of the Fitness market is smartphone penetration, as fitness trackers can be

synchronized with a smartphone to give a complex analysis of vital data. Furthermore the self optimization trend drives demand. As a very general rule of thumb, the more sensors a tracker contain such as accelerometers for detecting motion, and altimeters and gyroscopes for orientation, the more accurate it should be about the nature, frequency, intensity and duration of your activity. Device makers, perhaps aware that comparison tests undermine the scientific validity of their products, point out that it is the trend in activity that wearers should focus on, rather than precise data. In that respect, fitness devices might prompt people to become more active. Although no evidence is found that fitness devices promoted weight loss or fitness, they can chide us silently to get off the bus a little earlier or take the stairs instead of the lift.

Companies are producing mass quantities of wearable technology, but the market is not oversaturated. There is scope for new companies to tap into the market potential offered by the wearable fitness industry.

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