Investigating Perspectives of and Experiences with Low Cost Commercial Fitness Wearables

WHITNEY-JOCELYN KOUAHO, University of California, Irvine, USA

DANIEL A. EPSTEIN, University of California, Irvine, USA

Consumer fitness wearables account for a growing body of personal mobile devices in the U.S. As a result, there has been increasing interest in Ubicomp in designing sensing devices which incorporate the needs of people of a broad range of backgrounds, especially of lower socioeconomic (SES) status. However, fitness trackers are expensive, and although low cost versions exist, there has not been much research on the viability of these devices for promoting their goals. To further the conversation of device use, we review a corpus of over 1,700 product reviews of 9 low cost consumer trackers, to determine perceptions and expectations of quality and general use. From this, we find that the low cost device is not currently necessarily increasing access, and that people have a wide range of expectations for what tracking will allow and represents at this price point, which colors how they describe their use experiences. We suggest that there is a need for a focused design effort for low cost devices which rectifies such discrepancies, and presents the low cost device as a counterpart to those of a higher consumer price, not an alternative.

CCS Concepts: • **Human-centered computing** → **Empirical studies in ubiquitous and mobile computing**; **Ubiquitous and mobile devices**.

Additional Key Words and Phrases: wearables, low cost, fitness trackers, device reviews, physical activity, personal informatics

1 INTRODUCTION

Fitness wearables are devices which are usually placed onto the body to track some personal data such as physical activity. In 2023 alone, more than 500 million wearable device units, largely fitness trackers and smartwatches, were shipped worldwide, a number that is expected to increase by no less than 25 percent by 2028 [41]. In 2024, around 21 percent or one in five Americans, are projected to regularly use fitness trackers [40], a number that is consistent with previous years data [80] but also expected to continue to rise. As adoption of such technology has moved from early adopters [8, 47] and users of research prototypes [12, 13, 51] to the broader public, we have sought to better understand people's motivations for adopting these devices, their experiences with them, and reasons for abandoning them in service of creating recommendations for tools which can support wellbeing [11, 23, 29, 44, 63, 69]. This conversation has largely focused on designing for, and people's use of, high cost wearables, such as those designed by brands like Fitbit, Apple Watch, Garmin, and others [19]. As of 2024, these devices retail for hundreds of dollars ($399 for the Apple Watch Series 9, $799 for the Apple Watch

Authors' addresses: Whitney-Jocelyn Kouaho, wkouaho@uci.edu, University of California, Irvine, P.O. Box 1212, Irvine, California, USA, 92617; Daniel A. Epstein, University of California, Irvine, Irvine, California, USA, 92617.

Ultra 2) or more ($2,100 or more for the Garmin Marq) [70, 78]. And over 1,200 research studies have used Fitbit wearables alone [25].

More recently, the research community has sought to understand and support the fitness tracking needs of people of lower socioeconomic status, through designing apps and devices [15, 65, 66] and evaluating the efficacy of interventions on increasing physical activity [83]. This work is particularly valuable in light of social determinants of health, which technology can mistakenly reinforce rather than help address [79]. However, the high price tag of fitness tracking devices is often marked as one of the reasons, among others, for their inaccessibility to a large portion of economically under-served populations [31].

Yet, in spite of the high price tags, the underlying cost of sensing which fitness wearables rely on (e.g., accelerometers, electrocardiograms, altimeters) is relatively low. Furthermore, while the Ubicomp community continues to leverage these sensors to improve detection of various everyday activities, detection for many common physical well being measures (e.g., steps, heart rate variability) has been standardized. Therefore, although detection of physical activity was once a core area of research study in Ubicomp [4, 9, 46, 71], it is now achievable at a low cost, with reasonable quality, and has been integrated into countless commercial fitness devices. low cost sensing, as it relates to physical activity wearables, therefore presents a unique use case in that the understanding of the lived in use of wearables seems to center brand name market devices even in the conversation of cost inclusivity. However, there is a distinct lack of focus on how people perceive and experience current commercial devices valued as low cost, and how their experiences relate to the larger goals of fitness wearables.

We therefore sought to investigate the perspectives and expectations of current users of low cost devices, in order to understand how (or whether) these devices effectively meet people's needs. Our work was led by the following research questions:

- RQ1: What intended uses motivate users to purchase the low cost devices?

- RQ2: How do users perceive device *capability* as it corresponds to cost?

- RQ3: How do users perceive device *quality* as it corresponds to cost?

To achieve this, we reviewed over 1,700 product reviews left on Amazon, Best Buy, and Walmart for 9 low cost wearable devices. We use product reviews as our qualitative basis in particular because reviews can help us understand what *some* users value [58, 77] and what motivates them to use the product [22, 56]. For our purposes, we evaluated how online product reviews framed device use both in relation to the price tag and in a general sense, complementing the extensive prior work which has examined people's motivations for purchasing market rate fitness wearables [11, 23, 69, 87] and experiences with them [20, 44].

From this process, we find that:
- There is a preconceived notion that the low cost devices will have some loss in value because of price. This manifests in a form of "scapegoating", where the device's price is laid to blame for any dips in quality.

- The meaning of "low cost" manifests differently for different user types. Specifically, the motivation that draws people towards the device is not necessarily one of access. For some, low cost is a necessity, but for most, it allows for transitional or trial use.

- The "affordability" and "low cost" of these devices are in some way questionable, as many reviewers note issues pertaining to longevity which requires replacing, repurchasing, or discarding of devices.

- There is a glaring need for focused design of low cost wearables in the Ubicomp and HCI space. As of now, the low cost wearable is largely unexplored, and without careful and intentional research with and on these devices, we are potentially pricing people out of the opportunity to use consistent and effective tracking devices.

Finally, we contemplate on these themes and their impact on users who financially rely on the low cost wearable. We provide suggestions for research questions which could help to generate artifact design considerations. We focus on the need to: elaborate on what is or is not feasible within price constraints, clarify the vitality of the low cost tracking device, accommodate for varying restrictions to access such as lack of internet, and generally survey the differences between the higher cost devices and the lowest.

2 BACKGROUND

Our examination of people's perspectives and experiences with low cost wearables is informed by prior work on people's use of wearables for physical activity promotion, how low cost has been conceptualized and considered within Ubicomp, and how socioeconomic class has been considered when designing technologies.

2.1 Everyday Experiences with Wearables for Physical Activity Promotion

The field of ubiquitous computing has a long history of examining people's experiences with wearable devices for encouraging physical activity. Prior to widespread commercialization of digital fitness wearables, prototype research systems like Houston [12], UbiFit [13, 14] and Fish'N'Steps [51] offered early evidence that devices could effectively promote physical activity, especially when paired with self-monitoring capabilities like goal-setting, social comparison and team features, and ambient awareness. In the 2010's, the rise of wearables from companies like Fitbit, Garmin, Jawbone, Samsung, and Misfit coincided with a set of studies understanding people's everyday experiences with these wearables. This work largely followed shift from examining the practices of experienced self-trackers, who often had the expertise needed to develop tools for collecting or analyzing their own data (e.g., *Quantified Selfers*) [8, 47, 48], to examining how the commercialization and widespread adoption of these devices led to use intersecting with aspects of everyday life (e.g., *lived informatics* [63]).

Attempts at understanding people's experiences with commercial wearables have often focused on motivations for adopting the technology, patterns of use, and perceptions of capabilities. While some people adopt fitness trackers with the intent of monitoring and improving well-being, others begin tracking in order to have a record of their activities. Some even track simply because they are curious about the technology [23, 63]. From this work, research studies have made notable contributions such that they show that people regularly abandon use of these fitness wearables, often within days or weeks [11, 20, 44, 69] or that during use, people often lapse or take breaks from tracking [21, 23, 53]. We also know that people have varied expectations around the accuracy of these devices, often informed by their perceptions of the devices before adoption as well as the kinds of activities that they undertake [29, 76, 87].

However, our understanding of people's use of wearables for physical activity has largely centered devices which we would not consider to be low cost, even while some studies explicitly frame these devices as having low cost (e.g., a $160 Fitbit [5]). While we stop short of searching for the retail price of different devices mentioned in studies at the time that the studies were run, we estimate that the devices which participants in studies typically use (e.g., Fitbits, Apple Watches, "GPS Watches" [76]) retailed for $100 and often more. In Clawson et al.'s analysis of Craigslist posts looking to sell wearables, posts are quoted aiming to sell devices for $100 and $120 [11].

In other cases, understanding was built from participant's experiences with commercial devices purchased by the researchers [44, 69] or by a sponsored program (e.g., workplace wellness, public health) [10, 50], mitigating cost passed on to participants. For example, in Lazar et al., participants were given $1,000 which they could use to purchase smart devices pertaining to their wellbeing goals [44].

2.2 Low Cost in Ubicomp

Driving down cost has in some way been an integral part of the ubiquitous technology research space. Sometimes we see that the interest in "low cost" sensing seems to more so be an interest in cost savings for research

procedures. For example, Kawahara et al. developed a low cost technique for *other researchers* to print components for their devices [35]. The cost effective goal of this work was tied to future research rather than making the technique commercially viable, and also included the optimization of commercial printers as part of this strategy. In those examples, it appears that "low cost" sensing is more so used as a mechanism for testing hypothesis at a reduced rate instead of creating high quality sensing apparatus that can be sustainable at commercially affordable rates.

More directly relevant to our focus, in the early stages of advancing monitoring activities like walking, cycling, and climbing stairs, researchers sought to reduce the number of sensors required for reliable detection. Bao & Intille proposed a system involving five accelerometers placed across the body [4] and subsequent research successfully drove down the cost of detection by reducing the number of accelerometers needed to single accelerometer on the wrist or the hip [39, 46, 62]. In defining their "practical" approach to recognizing physical activities, Lester et al. explicitly introduce the requirement that such a system *"should be effective even with a cost-sensitive subset of the sensors and data features"* [46]. Other spaces within Ubicomp have followed similar trajectories of aiming to reduce the number or cost of sensors needed while still detecting a behavior or piece of context reliably, such as indoor localization [90].

Low cost has also been associated with the effort to reconfigure existing resources as an exercise in savings. With this approach, mobile phones, printers, household appliances, etc., are leveraged (in part) as cost effective measures for lived in use. For example, in the case of measuring household energy use, price reduction was loosely grounded in the re-purposing of existing household infrastructures and the insights gleaned from that exercise [26, 60].

This re-purposing is also represented in multiple pieces of work where sensors built into mobile phones, such as microphones [42, 43] and cameras [16, 82] can be extended to detect wellbeing characteristics such as lung function, blood screening, and bilirubin levels. This style of research sometimes mentions the transfer-ability of the sensing efforts to health care settings in the Global South, stemming from the presumed availability of "low cost commodity phones" which can be used for the detection. Other novel Ubicomp systems, such as Beacon, seek to replace expensive medical-grade devices by demonstrating similar functionality and detection quality with commercially-available sensors and printable components [34].

In a disparate example, we see that "low cost" is a relative term, with devices which are cheaper comparative to others being designated as affordable. This is evidenced in this paper by Gjoreski et al., where they use (as described)"inexpensive" Microsoft Band 2 devices to detect physiological data connected to cognitive load [28]. They use this specific sensing device as a direct response to their expressed need for affordable devices to accommodate this detection. Although this may have been a lower end device in the context of the time period, what is notable is that the Microsoft Band 2, which has now been removed from shelves, was a device that was at least $175 in 2016 [84].

2.3 Socioeconomic Class as a Consideration for Design

As previously stated, there has not been large movement to incorporate access as it correlates to the design of low cost commercial tracking devices. This is an important gap to focus on, especially as there has been increased dialogue on socioeconomic class as a consideration for design [38, 73].

These explorations, such as Holko et al.'s study done with patients in Federally Qualified Health Centers to solicit interest in fitness tracker use, have presented findings which identify *cost*, among others, as a barrier to adoption [31]. This work is further extended when looking at a study conducted by Western et al., which surveyed past literature to determine the efficacy of physical activity (PA) intervention by socioeconomic class and found that PA tracking is not effective in low socioeconomic groups, although the opposite is true for higher socioeconomic groups [83]. Such findings are consistent with other studies that survey tracking adoption and

lower socioeconomic class [79] and discussing biases in tracking systems [89]. This signifies a need to investigate the viability of budget friendly devices for meeting needs within this socio-cultural context.

By way of direct observation, there is a limited contingent of studies which directly interact with lower socioeconomic communities, and look at designing for safety [15], families [64, 65], and engendering social data reflections [66, 67]. What's interesting is that many of these studies use higher cost devices as the research tools. Saksono et al.'s StoryWell and StoryMap systems are exceptions, as they used a Xaomi Mi Band for collecting the step data presented in their research apps [64, 67]. In all of these cases however, the cost burden on study participants was alleviated as the researchers provided the trackers.

Regardless, from our view, we surmise that there has not been much by way of contention with commercial low cost devices in a lived in sense, even in the spaces which focus on participants of a low socio-economic status.

This decision to focus on high-cost interventions, may be owed to the history Ubicomp has with examining the relative capabilities of different kinds of devices, which finds that it is not uncommon for "cheaper" versions of technological devices like some cell phone models, to be regarded as questionable in function owing to hardware specifications [85, 86]. But as there has not been much research into affordable fitness trackers and their successes and failures to help indicate the status of such devices in this regard, we cannot situate this phenomenon in this context.

3 METHODS

The goal of our research was to review publicly available product reviews of low cost wearables in order to understand user expectations, perceptions, and general experiences with use. We do this through qualitatively analyzing the reviews and developing themes that contextualize the data. User reviews are helpful for giving insight into people's experiences with a product [77], the problems or challenges they encounter [58], their intended motivations for use [22], and can suggest design improvements [37]. Although the method is not enormously common in Ubicomp, it has previously been undertaken to investigate perceptions of energy-saving features of home appliances [91], and comparisons among apps with similar functionality [49]. In the wearables for physical activity tracking space, product reviews have been used to understand overall user experience (of high cost devices) [54] and the utility of trackers geared towards children(which tend to be cheaper, but cater to a different audience) and their families [56].

Furthermore, as reviews are publicly-available, our institution's IRB classified our work as exempt. We note that this study is conducted in the United States, and thus refer to prices from U.S. retailers, and consider the concept of low cost in this context. In the discussion section, we further elaborate on the limitations of this approach and needed directions for future work.

3.1 Search & Inclusion Criteria

To decide which wearables to examine in order to answer our research questions, we needed to establish a definition of *low cost*. We therefore sought to identify what prices are typical for the wearables market, with the understanding that employing one distinct cutoff masks the subjective perspective of what an individual deems affordable or not.

To define a cutoff, we took two approaches: (1) we investigated "top wearables device" lists to examine the prices of popular wearables devices, and (2) examined average prices of fitness trackers available on Best Buy. Best Buy was selected because the inventory was at a usable enough size to allow for meaningful calculation, in a way that Amazon and Walmart were not. A search of Amazon for "fitness tracker" elicits over 10,000 unrefined results, and over 1000 for Walmart, with manual inspection suggesting that a large portion of each were not tracking devices (cases, wristbands, etc.).

We looked at two groups of "top" lists, those which were generally inclusive and those which only included low cost wearables. From these lists, we were able to assess that $100 was the typical point where items began to be listed as "budget" options. For example, in a 2024 updated list of the top wearable devices, the device which is distinguished as the best for users on a "budget" is a Fitbit device retailing at $100 [70]. The next device on the list started at $160 with the most expensive being $1,000. Similarly, another top wearables list [72], where the most expensive device is $800, they classify the wearable which was below $100 as the "basic" and affordable wearable. Lists which were only inclusive of the best "budget" devices, provided further clarity. This one in particular [3], was valuable because it contained a list of highly purchased devices available on the marketplace websites we were targeting. The benchmark here was $50.

In combination with an evaluation of the range of devices listed on Best Buy under "fitness tracker", we confirmed that the **median** price for the devices was above the $100 threshold – of 180 items available, 110 were listed above $100.

Further refinement of our definition of low cost extended to exclude those devices between $75 to $100 because this range included the "budget" devices of well known high-end brands like Fitbit and Samsung. We sought to exclude these devices because although cheaper than the brand's other devices, these devices are still associated to the larger brand name. Some like the Fitbit Inspire 3 (retailed for $99.95), still require users pay a monthly fee ($9.99) for full access to data and features via the Fitbit Premium subscription [1]. Even more so, these budget devices are merely simplified versions aimed at users who are interested in specifically using a *Fitbit* or *Garmin* device and not low cost tracking, which was not the primary target audience for our research questions. We expect that people intentionally seeking out a low cost wearable would therefore look for devices cheaper than these brand names, especially in those cases where the cheaper devices could offer more features. Additionally, we wanted to avoid data which focused on perceptions of the brand itself and not the device.

Furthermore, all reviews for the dataset were pulled from Best Buy, Amazon, and Walmart as these three websites are the most frequented stores for technology purchases [52, 61]. Walmart was also attractive because reviews from in-store purchases were also included. To reduce the list of potential devices and to ensure that we were looking at devices which people found useful (e.g., devices largely working as intended), we excluded any devices which had less than four stars on average. The intent was to avoid data that *overwhelmingly* focused on hardware or software issues. As material and software quality is still included in the data retrieved from the 4 star devices, we were still able to gather insights that would be more typical for lower rated devices. Prior studies of app and device reviews have used similar thresholds [22, 36, 56, 59]. Cross-listed devices were included so long as one site had the device rated at our threshold.

To summarize, our inclusion requirements were that devices must be:

- A physical activity tracker, listed with terms "fitness tracker" or "wearables", with accessories removed from the results.

- Under $75.00.

- Holding an average rating of 4 stars and above on at least one of Best Buy, Amazon, or Walmart's website.

- Not be designed specifically for kids. These devices are often below our threshold for low cost (e.g., the Fitbit Ace 3 retails for $39.95), but largely target a different user market with different goals and use experiences than the frequently-studied high cost wearables.

From this search, we were able to select the top rated devices from the respective websites and cross-reference between companies (if available). There are variations in the number of devices from each website due to respective inventory constraints. For example, at the time of the first data pull, Best Buy had a limited number of devices which met our cost threshold, which explains their smaller presence in the data. Additionally, we note that the most expensive device in our corpus is $60, because all devices between $60 and $75 were excluded by

other criteria like overall device ratings. We acknowledge that for eligibility purposes, we evaluated price at a single point in time (October 2023). It is possible that one or more of the devices may have been on sale at a particular retailer, and therefore below the threshold, but later rose in price.

Following the development of these criteria, we finalized our device list to the following: Amazfit BIP, Amazfit Band 5 & Band 7, Xaomi Mi Band 7, ITouch Sport 3, FITVII, Eurans, Willful, and the DOOSL fitness tracker. Eight of the nine devices had Bluetooth capabilities, which enabled pairing with an accompanying mobile app. The Willful tracker did not require an app, internet, or even a smartphone. Most of the devices had similar sensing capabilities, with all including step tracking and most (six of the nine) including heart rate sensing. Four devices included GPS tracking, and four supported sensing blood oxygen levels.

3.2 Dataset

To avoid violating terms of service, we took a manual approach to collecting the reviews. We began by exporting individual page source files from the respective websites, which contained 10-20 reviews depending on the site. We used a script to then extract the text and scores from each source file. We only downloaded and analyzed reviews made after January 1st, 2021 to ensure a relatively similar point of comparison (e.g., to ensure that these devices were compared to similar high-end wearables) and to try to account for potential price fluctuations (e.g., these devices may have been more expensive previously, and therefore would have been out of our scope).

We downloaded the majority of the reviews in October 2023. Amazon limits browse-able reviews to 10 pages (meaning the most recent 100 reviews in total). To obtain greater volume from Amazon, which overall had more reviews of the products than the other platforms, we did two additional exports (one early January 2024, one in early March 2024) to gather newer reviews. For consistency, we also pulled newer reviews (if available) on the other websites.

Once we removed reviews which were outside of our date range, duplicates, or otherwise empty, we ended up with 1,728 reviews. The breakdown of this information by device can be found in Table 1.

3.3 Analysis

After we pulled the initial dataset, we began the process of developing codes for the materials. To do so, the first author randomly selected 100 reviews from the dataset and open coded those for meaning. From this process, we created our code book which included nineteen individual codes, of which eleven had sub codes for positive and negative affiliations. An example of a sub code would be the "battery" code, where a plus signified a review which positively reflected on the battery and a minus would represent the opposite.

The first author used this to code the remainder of the dataset, and as we refined the code book, both authors agreed to add another code for software quality, totaling twenty codes.

In lieu of producing exact numerical percentages or counts of any one particular sentiment, we employ a reflexive thematic analysis (TA) to help organize broader trends observable in the corpus. We generated our reflections in conjunction with our positionalities as researchers interested in how socioeconomic class is situated in device use. This research framing is in line with the TA method, which emphasizes producing a story from close reflection of data, and subsequently analysing it from one's subjective frame of thematic reference [6].

Furthermore, in the following section, we format quoted reviews in the style, *[Device Name]-[Retailer]-[#]*, and the reviews have been paraphrased to help preserve anonymity.

As RQ2 and RQ3 relate to perceptions of the devices, we additionally include the ratings next to quotes in these sections, presented as: (#/5). Since RQ1 relates to user motivations, rather than device characteristics, we opted to exclude review scores for this question.

Table 1. Number of reviews collected for each device and from each website. Overall, 1051 (61%) reviews came from Amazon, 492 (28%) from Walmart, and 185 (11%) from Best Buy. Note that all devices include step tracking, in addition to the listed device capabilities, and that what is listed is not exhaustive.

Device Name	Device Capabilities	Website	Avg. Rating	Retail Price	# of Reviews
Amazfit Band 5	Alexa integration, Blood Oxygen, Bluetooth, Heart	Amazon	4.0	$29.99	185
		Walmart	3.7		105
Amazfit Band 7	Bluetooth, GPS, Heart rate	Best Buy	4.4	$49.99	96
Amazfit Bip Pro	Blood Oxygen, Bluetooth, GPS, Heart rate	Amazon	4.2	$59.99	217
		Walmart	4.2		70
		Best Buy	4.4		89
Xaomi Mi Band	Blood Oxygen, Bluetooth, Heart rate	Amazon	4.2	$42.99	127
		Walmart	5.0	$46.00	3
ITouch	Bluetooth, GPS, Heart rate	Amazon	3.6	$49.99	101
		Walmart	4.2		62
Eurans	Blood Oxygen, Bluetooth, GPS, Heart Rate	Amazon	4.0	$19.99	214
FITVII	Bluetooth	Amazon	4.0	$39.99	207
Willful	Heart rate	Walmart	4.1	$21.99	90
DOOSL	Bluetooth	Walmart	4.6	$19.99	162
Total					**1,728**

4 FINDINGS

We contextualize our findings in light of our primary research questions by investigating intended uses of low cost fitness wearables and the perceived capabilities and quality of these devices.

4.1 RQ1: Why a Low Cost Device?

We observed five distinct motivations for why users elected to purchase low cost fitness wearables over more expensive alternatives. Motivations largely indicated that while the device's low price was a key influence on decision-making, it was only rarely mentioned as a necessity.

4.1.1 Transitioning to A New Device. One significant group of the low cost wearable user profile, which we define as *transitioning* are those users who have previously used trackers. This user group had ranging histories with wearables at different price points. All reviews which mentioned previous device use were included within this theme, thus there were a few separate ways in which previous device use was situated.

Although there are those users who had at one time, or currently still, used other low priced wearables, described in this review:

> *"…this is my third smartwatch. I've used some of the other $30 smartwatches and they were ok for keeping time but that's pretty much it."* [BIP-AMAZ-173]

This was not the predominate finding. More often reviewers noted their relationship to wearables use in conjunction with market price tracking devices. And what became clear in some of these reviews in particular, is one's relationship to the device was not only largely dependent on their perspectives on price, but also their experience with their other devices. For example, some of the motivations for transitioning were more passive in nature, in that the system failures of the higher priced devices enticed them to seek out the budget devices, but

they do not detail any separate reason for purchasing the low cost device before the death of their previous devices. We find that in this review, where there is not an explicit draw to the device for any particular functionality:

> *"My Fitbit stopped working so I bought this Amazfit to replace it. My partner's Fitbit also stopped working, so I bought her an Amazfit Bip3 Pro. We like them a lot, especially because they are much cheaper."* [BIP-WAL-8]

Or here, where the failure of their Fitbit, their sisters, and the anticipation of yet another device failure, was enough motivation to purchase the lower cost device.

> *"My Fitbit died and my sibling told me that she was on her 3rd one in a handful of years, I decided to look elsewhere and go with something cheaper. If its going to stop working after a year or so, might as well forty two dollars."* [XAO-AMAZ-85]

This trend of separating use experiences that are acceptable and those which are not was a central part of the other motivations for reviewers with previous device experience, which we discuss later in the device capability section.

4.1.2 *Augmenting Current Devices.* Another subset of previous wearables users are those who wanted to *supplement* their current devices. Often, these users placed their decision to use the low cost device as impermanent because of the price. These particular reviews were useful because they gave us a profile of users who have experience with the more high cost devices but for some reason, because of a niche need, a desire for more tracking devices, or merely a whim, introduced the lower priced item into their arsenal.

> *"I wanted a inexpensive watch that I could take on my two month trip to Europe because I didn't want to bring my pricy golf watch. I tried a few but had to return them because they didn't fit my needs. As my trip was approaching, I eventually bought a non-golf version of the Garmin...I had to return it...So I made a last ditch effort and got the Amazfit..."* [BIP-AMA-74]

In the above example, the user had a niche and temporary need: to bring a secondary device on their vacation to Europe. And after many other devices did not satisfy their needs, they landed on the Amazfit BIP tracking device, seemingly on a whim.

Similarly, in the following examples, the users also mention a reduced attachment to the device due to the price.

> *"I have a smartwatch collection with a lot of watches more expensive than the Xiaomi Mi Band 7...I purchased it for my job because I wanted an affordable, solid watch that I wouldn't have to worry about damaging."* [XAO-AMA-28]

The low cost device then is an intermediary tool which could satisfy their desire to track their data without significant expense.

Similarly, in the following example, they state that after using other devices they settled on the FITVII tracker because it would be cost friendly to replace. They have the same affect towards the device about the potential impact of clumsiness.

> *"Son broke his Fitbit a few times, this does all the things he uses that the Fitbit did, and costs way less so when he breaks this one it won't be as serious!"* [EUR-AMA-166]

Some also noted that they liked the flexibility of being able to buy multiple low cost devices if problems were to arise.

> *"...I have at least $500 in fitness watches ...I've tried multiple Apple Watches and currently have a Garmin too...the $350 just doesn't support messing with it. At that price I can go thru a whole bunch of these..."* [FTV-AMA-87]

We also noticed a trend where previous fitness tracker users were merely curious about using the device. They did not directly speak on cost, or provide any reasons for purchase other than a desire to survey the landscape. Take this review for example:

> *"I had a Fitbit, the reviews convinced me to buy this but it's not what they say it is. I returned it, you get what you pay for. Name brands it is for me."* [BAND5-WAL-4]

Although this reviewer had previously used a device, they were curious about the low cost device so they trialed it. Unlike the transitioning users above, the specific goal for use is not (as written) tied to anything in particular other than trial for trial sake. Some part of the previously posted reviews, enticed them to look into the device. And ultimately, after trialing it and finding themselves dissatisfied with the tracking experience in this context, they confirmed their preference for market price wearables.

What differentiates this review with the others we will discuss in the trial theme, is that those will rely on the low cost device to indicate what using a higher cost device could be like, and this reviewer is interested in the opposite.

4.1.3 Trialing Tracking. Other reviewers explicitly state that they purchased the device in order to gain firsthand experience with wearable tracking. The goal is to use the experience to determine whether they will invest in another device. This practice of "trialing" has been documented in personal tracking, particularly with mobile phone tracking apps, and users looking to determine their tracking app of choice, and/or to define their use wants and needs [45]. In this context, the user is looking for a lived in experience of tracking without having to first invest in market price wearables. The specific low cost device is not important to the trial necessarily – the cost is. In this following example, the "cheapness" of the device makes it useful for determining if the user would like tracking. The device can also be useful for fleshing out the features you would want in your device.

> *"This is the watch for you if you're unsure whether or not you'd like a fitness watch. Its cheap, and you'll get a good idea of what you might be looking for..."* [Band7-BB-50]

Although the reviewer does not explicitly name what brand of device they are looking to purchase, this next review is specific in that they are trialing to decide if they would like to purchase something more expensive.

> *"I would recommend it if you want to test a smart watch before buying one way more expensive but perhaps more durable and consistent."* [BIP-AMA-128] (5/5 rating)

With this review, we see that the device is useful for sampling tracker use. Generally with this theme, there is an assumed expectation that there is some quality inherent to the low cost device, which makes it similar enough to market price tracking.

4.1.4 Affordability. Where before we observed previous use and how that experience influenced the purchase of these devices, we also observed more direct references to price and those reviews which discuss cost as a necessity. These are the reviews where users explicitly stated that they purchased the device under cost constraints, although this sentiment was not as common.

An example of this theme can be found in this review, where the user states that they had a specific need for a tracking device but were financially constrained.

> *"My money was very limited so I wanted a cheap tracker for my blood pressure..."* [DSL-WAL-28]

Or here,

> *"I've always wanted an Apple Watch, but was hesitant to pay the price for one. This does all I need it to and it didn't break the bank..."* [EUR-182-AMA]

What marks these reviews in contrast to other user motivations, is that low cost is a necessity and not necessarily in exercise in frugality.

4.1.5 Frugality. On the other hand, we observe that low cost also served as a secondary purchase motivation. Specifically, this is differentiated where price is regarded as a *benefit.* In this use case, affordability is not a primary motivation as the user does not state they purchased the device because this was their only financial recourse. Rather they note that they purchased the device to serve some goal and the price was an added advantage. In these scenarios, the lower price is attractive, but the higher cost is not necessarily regarded as financially limiting as with those in the previous theme, where the user states they did not have much of an alternative in terms of watch purchase. For example, in the following review, the cost is described as a support to the device, it does not drive the need, rather it further enhances the positives of using the tracking device.

> *"I love my watch, and it looks great. And at this price, it's especially lovely!..."* [DSL-WAL-153]

Similarly, in this example, the user needed a device for a trip but lost the watch. Interestingly, they did not have any qualms because they state that they had already fulfilled their primary goals for use. And the secondary benefit, price, maintained their perception of the worth of the purchase.

> *"This watch was way beyond what I expected! I went on a week long backpacking trip and used this...I ended up losing the watch while traveling...But for a watch that's about 50 dollars this was totally worth it."* [B7-BB-61]

To clarify, this does not mean that they did not purchase these devices because they were cheap. This means that they do not *report* any actual financial necessity for a lower cost, or any financial barriers to purchasing a higher cost device. Purchasing the device was more so a frugal choice.

4.2 RQ2: Perceptions of Device Capabilities

We also contextualize user expectations for device capabilities because of the low price. We note that reviewers tended to expel beliefs onto the price, which on a granular level, then meant that reviewers were able to attach meaning onto what the device was capable of doing. The affect towards the device's success or failure was then marred by these cost inspired assumptions.

4.2.1 Low Expectations. In some cases, reviewers, although expressing a low expectation of device capability, reported a positive experience with the device *because of* said lowered expectations. We call attention to these which reflect positively on the reduced quality. This often included giving devices a high- or mid-range star rating in spite of concerns around the device's capabilities.

> *"Data definitely isn't accurate, but that's the same as with other inexpensive Fitbits. I don't really care, because its still motivating me to stay active..."* [XAO-AMA-5] (3/5)

Here, the writer expresses satisfaction with the low cost wearables generally, even if, a fundamental feature, tracking, is inaccurate. We are not able to make assumptions about all of their device expectations, however, we can surmise that one of their expectations is to stay active. Therefore, although the device does not produce highly reliable data, it is sufficient in assisting with staying active, and the tracking inaccuracy is acceptable because of the price of the device. This is also conveyed below.

> *"I question the sleep tracking. There are some issues with syncing and have to re sync at least daily but at this price...its amazing!"* [EUR-AMA-18] (5/5)

Here is another similar example of this sentiment:

> *"Overall it's good for the price. Step count is not very accurate and there are connection issues with my phone and getting texts. The battery life is nice though..."* [TOUCH-AMA-16] (5/5)

In both of the above five star rated reviews, the users show a positive affect towards the device, particularly because of its price and although it may be inaccurate with tracking and troublesome in connection, the device's other components still make it attractive.

This is also echoed here, where the user has experienced a mix of device successes and failures, but is not dissuaded from use as the device is affordable.

> *"I usually use this for tracking steps at work. The blood pressure has never been accurate ... the battery life is awesome!...For $45 the cons are very ok. Sound doesn't work and you can't do phone calls, but its a $45 fitness tracker...I recommend it."* [FTV-AMA-17] (4/5)

4.2.2 Simple Functionality. Some users associate the low cost devices with reduced functionality or simplicity. This may mean that they have specific needs, and the device is attractive because it can accommodate that need inclusive of other functions, or, that they desire a device which will only perform basic functions. For the former, a low-entry price is what gives more opportunity for users to exercise their desire for a single function without the financial and technological burden of a device whose complete functionality they may not use. For the latter, a low-entry price may be what entices them to assume that the device has limited functionalities. The star ratings of these reviews further suggest that people who desire simplicity judge the overall quality of the device based on whether it achieved their intent and not the success of the devices functions.

> *"I wanted a simple device to count my steps but it isn't that, it may be great but not for me."* [BAND7-BB-20] (1/5)

Here, the reviewer is predominantly interested in the pedometer, and a device which is limited to that, and express that the competing interest between what they desired and what the watch offered, differed too much for continued use. This same sentiment, regarding a single use can can be found in the following reviews, but the expectations for the device to be limited to that do not necessarily exist.

> *"Wanted a basic watch that could for the most part count my sleep and steps. This is way cheaper than Fitbit and does that mostly good."* [BAND7-BB-75] (4/5)

On the other hand, the previous review is more interested in what they describe as a "basic" use case, defined as tracking steps and sleep count. They offer Fitbit as an example of a device which could be in contention, but ultimately due to one reason or another (which is not provided), they chose this device. Thus, "basic" refers to the portions of the watch they use, and not necessarily the design of the watch itself.

The same can be found below,

> *"I bought this as a Christmas gift. My son didn't want an Apple Watch because he said he didn't need a bunch of extra features. He loves this one. It's of good quality. Just simple."* [EUR-AMA-34] (5/5)

We can presume that the reviewer has found the lower cost device cost device is more conducive to achieving this goal of lesser features in a way that the Apple Watch cannot.

> *"This isn't the watch to buy if you're planning on climbing Mount Kilimanjaro, but it's a nice value for someone who's into light fitness."* [BAND7-BB-23] (5/5)

Simplicity then refers to physical exertion and that reduced functionality corresponds to *how strenuous* the user's activity will or will not be. The onus of what is simple, is the assumed idea that the level of activity dictates the different tracking mechanisms required, and that the device is sufficient in its capacity to serve that.

We also see a general desire for standalone use of the watch which does not require mobile device integration with cellphones and WiFi such as in this review:

> *"It's great that I don't need a phone, app, or Bluetooth..."* [WIL-WAL-39] (5/5)

This was reported often by self-identified elder users. An example of self-identification is:

> *"I am a senior, so not running a marathon. I got it to encourage me to stay active..."* [B5-AMA-62] (4/5)

4.3 RQ3: Perceptions of Device Quality

Particular attention was given to references of material and software quality and how reviewers reported these factors in relation to the use experience. When we note material quality, we refer to the watch band, the materials for the display, the battery, the sensors, and all other physical components of the device. When speaking of software we refer to the UX and UI experiences of the device. This can include data organization, glitches, visual layouts, software applications, and much more.

4.3.1 Hardware & Software Quality. Notably, a large portion of reviewers detail physical problems with their device which required that they either (and) buy new products for broken parts, replace the watches entirely, or discard the watch without replacement.

For example, in this review, the user recounts several use disruptions that occurred because the device stopped working. Within a few months they had gone through two defective devices with similar mechanical issues.

> *"Got the first watch in July. It worked until like mid-August and then had a critical malfunction and stopped coming on. There is a warranty so I sent it back and I only had the new watch for a little over a month (had to pay for shipping). I got a replacement and then the screen broke..."* [ITOUCH-AMA-99] (1/5)

Other reviews mentioned issues with watch bands, such as in the following, where two devices were purchased separately but the same issue presented itself.

> *"I REALLY liked it! Until it kept coming loose and I found out that it was broken on one side. Unfortunately, my friend had the same issue the week before. I bought replacement bands for us."* [EUR-AMA-87] (2/5)

There's another tension that arises where the device may work, but the failure of the watch *band*, if not replaced (like in the previous quote), renders the watch essentially useless. This contention is outlined here:

> *"The watch seems to be fine, it holds a charge for a few days. But the bands already broken so its useless unless I spend more money of course."* [FTV-AMA-22] (5/5)

What is particularly intriguing about this review is the user's 5 star rating for an item that they themselves have deemed unusable. Seemingly, the experience of a broken watch band did not deter them from a positive rating.

Some even noted that the watch caused them physical harm such as burns, rashes, bumps, and bruises:

> *"All of this was messy!!! The watch burned me so I gave it back..."* [BIP-WAL-64] (1/5)

Issues such as glitches and the like also put *software* quality into question. We refer to those software issues where reviewers were either temporarily barred, or permanently disengaged, from use.

> *"I got this watch like a a week before the software update. It worked before but after the update it stopped working right. I got a replacement because I thought it was that watch but it still didn't work. I finally returned it for a full refund."* [BIP-WAL-43] (1/5)

In this example, the reviewer could no longer use the watch because of a software update, however, replacing the watch still did not resolve the issue.

Although these phenomenon are not necessarily unique to these devices, there is an interaction that occurs between "access" and the act of having to replace or discard. This becomes even more important as we observe that some reviewers have notions that the quality of the devices is inhibited by low cost. Some claim that such material and software issues could be bypassed through the purchase of the "real devices", or namely, other higher priced devices. Take the following:

> *"Here's an update, the watch sucks ... it already broke! I should have got the real thing! It stopped charging even with a new charger that I bought it still doesn't work! Save the time and money and go ahead and*

buy the real smart watches! ... I'll likely sell this and buy an Apple Watch because at least I know the quality is better" [ITOUCH-AMA-89] (2/5)

Or here, where this user encountered not only an issue with the band, but separate issues with the display, and the application.

"...The display randomly stops working...I have not established a pattern for why. I had to buy a replacement band a few days after getting the watch. The app is barely passable, sometimes the settings don't work...Save up and buy something else." [XAO-AMA-69] (3/5)

From their perspective, purchasing a higher priced item through "saving up", could potentially be a safeguarding against such issues. Here it seems that there is some financial barrier to *immediately* purchasing (or replacing) a higher priced device.

4.3.2 Longevity. Lastly, we also consider *longevity* as a facet of device quality. Longevity refers to the capacity of a device to be used for a sustained period of time. Longevity is tied to material and software quality, but the concern is more on the lifespan of a functioning tracker.

In this review in particular, they both discuss glitches with the device, and in the same breath, contend that if longevity is of interest, the market devices should be considered.

"...Finally glitching a few months in but at this price to me it was totally worth it. I'd go with name brand for longevity and accuracy if you care about that..." [BAND5-AMA-141] (4/5)

And in some instances, reviews alluded that the circumstances of the device failure represented some underlying retribution for buying a cheaper device.

"...it is what it is, a basic tracker that reported I took steps in my sleep. You get what you pay for." [BAND5-WAL-51] (1/5)

5 DISCUSSION

While our approach does not enable making definitive judgements on the overall success or failure of these devices on a functional level, we offer some suggestions on what these reported experiences mean in the context of socioeconomic class. And moreover, we consider how some of these reported experiences impact the larger context under which wearables are designed, developed, and sold. We highlight conflicting needs of different user groups, reflect on how the field could approach designing for low cost sensing, and discuss the limits of our study and opportunities for future work.

5.1 Conflicting User Groups and Expectations

In the space of any one devices' review dataset, we found that the cost of the device impacted how users perceived and assumed device capabilities and quality. Some reviews perceived a low cost device as providing only basic functionality, while others expected its functionality to mirror those of market price wearables. Although people all seek out these devices with some desire to track their fitness, we also noticed sometimes polarizing differences for the motivations behind the use of "low cost" devices in particular.

5.1.1 Transitioning and Trial Users. From the reviews, we observed a large set of transitioning and trial users for whom the low cost affords a luxury that is not available with the higher priced devices. For this group, the low price tag affords the opportunity to be relieved – relieved of carefulness, of worry, or extreme care, because the devices' future is inconsequential. Low cost is made sexy by these groups. It's like decorating a house for Halloween – excitedly placing budget cobwebs and homemade crypt keepers on the front lawn for a month, but as soon as the season has passed, discarding them for the next holiday's thrills. The lower price tag allows users to test out devices at their leisure because the commitment to the device's success is fairly minimal.

This maneuvering of low cost resembles what is often discussed as "budget culture", a middle and upper-class hobby of "couponing" and "saving", which inspires consumers to practice frugality as an attempt to consolidate wealth. However, couponing in this context is not a representation of need, it is tied to the "consumption of bargains" [68] which in our case, settles the decision to purchase the devices as a protection of assets. And particularly, places the low cost wearable within an "opportunity cost" [24] mindset.

The cost-benefit in this case, is a loss of precision in accuracy or reduced software functionality with a compromise around price. Generally, participants justified a lowered capability as a necessary downside to purchasing the device. And if the device does not work as well, they lose less than with the alternative of market price wearables. From the perspective of design, this positions the low cost wearable as a space where we designers are less interested in creating sustainable devices of quality, but more so on creating devices that work just enough. In the same vein, the trial users, those who purchase these devices in order to "test" their potential desire to invest in market price devices, are in a liminal space where the device is merely a means to an end.

The needs of these users are not particularly outlandish or shocking, but there is a danger to designing low cost devices that mostly support their goals. This is of particular importance because the needs of this group are often in tension with other groups who either do not view the market price wearable as an option, or cannot excuse low quality functionality.

5.1.2 When Low Price is a Necessity. Another use group surfaced in our analysis are those for whom the low cost of a device is a necessity. Take the first time user who bought the device primarily for its low price tag, and who unlike the transitioning user, cannot try out multiple devices. The low cost device may be the only option for them to introduce tracking into their tech or wellness ecosystem, likely because of socio-economic differences.

We suspect that a significant portion of the transitioning and supplementing reviewers may be of a higher socioeconomic status, owing to statistics which characterize demographics of American wearables users. This data tells us that those on the middle to higher ends of the spectrum are most likely to simultaneously own multiple device types [27, 81]. Of the percentage of Americans who use wearable devices, those who are at the lower ends of yearly salary, and educational attainment, are the least likely to have adopted wearables [80]. And although a majority of families making less than $30,000 a year own smartphones, the use percentages drop dramatically when considering laptop, tablet, broadband, and other technology usage [27, 81]. As a large part of the reviews discuss previous market price device use, it is not a far stretch to assume what their socioeconomic status' could be.

The drawbacks of a device and the presumed expectations of device quality, will weigh differently for lower SES users compared to users who have used, or still use, market price sensing devices. The same can be said about the material quality of the device. If a device has a finicky watch band, a fragile screen, or no longer works, the burden of replacing or discarding the device will materialize in a different way for lower SES users. This is not surprising, as there are even differences in perceptions of necessary activities by socioeconomic groups. For example, the burden of cost of grocery shopping is shown to produce anxieties for women of a low socioeconomic status, while the shopping experience is seen as an exercise in "joy" and "leisure" for women of a higher socioeconomic status [33].

For our purposes, this could mean that replacing the device will prove more burdensome for someone without disposable income for technology. Furthermore, free time is needed to to call and replicate issues with the device manufacturer, which will be more difficult for lower SES users [31]. A similar sentiment is expressed by low income mobile phone users in a study conducted with rural Kenyan and Zambian farmers [86], who state that it is limiting when their inexpensive handheld devices break and require replacement because it essentially defeats the purpose for purchasing a cheaper device. This sentiment on surprise expenses from broken or lost devices is also alluded to in Holko et al.'s study with patients at a federally qualified health care center [31].

This question of the digital divide is not new. But low cost wearables devices presumably *should* tackle one of the barriers of use, cost. It is notable that who is using these devices are likely not low-SES, and that they seem more willing than others to accept more glaring device downsides.

5.1.3 Longevity, Material and Software Quality. Similarly, we also question the level to which low cost wearables are in service to the goal of affordability as it relates to device longevity. These questions stem from considering the potential implications of reported device quality failures. In the tracking space, long term use of wearable devices is often a central component of the conversation around tracking. It has been discussed in relation to adherence [74, 75], behavior change [14, 55], and more. In these contexts, long term use is associated with the users motivation to form habits towards continued use. But for our purposes, we approach longevity to mean the working lifespan of the wearable device itself, which is often a precursor to achieving these goals.

Across all of the devices, we observed reports of hardware (and software) collapses occurring as early as within a few days of device use. In keeping with the tradition of long term use, we then begin to question whether these goals change with price. It could be the case that it is an intentional choice for low cost devices to support *entry* into tracking. This means that because the device is relatively affordable but has a short life span, you can purchase another device. If this is a part of the design intent (e.g., planned obsolescence [7]), it seems that this is a success.

However, this short life span phenomenon then brings about the troubling reality that the devices are not *perceived* as dependable. Moreover, these devices may not actually be cost effective because of the need to purchase multiple as they break or become ineffective. Finally, concerns around material and software quality introduce concerns that low cost wearables cannot support long term use or behavior change, because the opportunity to support these areas get cut short.

5.1.4 What Does this Mean? All in all, there seems to be uncertainty about the low cost devices and what they represent and allow. We see that at this price point, cost becomes a scapegoat for the user experience at all stages and that ideas of what low cost represents colors the interactions that users have with the devices.

When thinking on tracking accuracy for example, we can see both in the reviews, and in many other papers, that these discussions of inaccuracy are also being had on the level of market brand devices [20, 29, 44, 87]. The same is also true for the complaint of skin burns and allergic reactions [17, 30]. However, from the reviews there is a perception that the low cost wearable, in its function as a budget item, is uniquely poor in this regard.

This is not to suggest that the claims that the devices are inaccurate (or other concerns on quality) are unfounded. On the contrary, one clinical study (presumably one of few conducted with low cost physical activity tracking devices), interested in the viability of a budget Xaomi tracker for clinical monitoring, found the band to be in some part inaccurate, and wholly insufficient for their goals [57]. Instead, what we do suggest is that there is a need to mend these contradictions and expectations.

5.2 Designing in the Low Cost Sensing Space

Without deeply thinking about the low cost wearable, the Ubicomp space and the personal informatics HCI community at large is potentially pricing people out of the opportunity to use consistently efficient devices. This shows up in the low cost commercial wearable device's design itself, which from the reviews, seem to work towards the spectrum of needs of those users who have previously used higher priced devices.

To enable the low cost wearables space to support the needs of people for whom low price is a necessity, we suggest that Ubicomp examine how to maximize design and efficacy within a price point. This line of inquiry can help to remediate low cost devices that are inconsistent yet reminiscent of the higher price devices. To be clear, this is not to say that the value of a low cost device should exclude populations from the "privileges" of the higher

cost devices. We merely suggest an intentional exploration of low cost artifact design focused on removing the distinction between a higher priced device and a lower price device as *high quality* versus *low quality*.

5.2.1 Setting an Agenda for Low Cost Device Design at Ubicomp. Inspired by our findings, we present the following questions as suggestions for further design investigation:

- What features or capabilities can be most easily removed from high cost wearables to bring down the price point without compromising on core utility?

- What new features or capabilities need to be added to low cost wearables to serve the needs of the populations who rely on them?

- Are health interventions which leverage low cost wearables as effective as high cost ones? And if not, what's lost in translation?

- What quality issues can actually be attributed to the low cost of devices, and what issues are typical of activity trackers generally?

- What are the comparative differences in accuracy between low cost devices and those of a higher cost? If there is a significant difference, is cost truly the driving factor?

- How can low cost devices be designed to support long term use? Or does their need to be a unique framing of adherence in the low cost context?

- How can designing for simplicity, or use without internet, be accomplished within a tracking context? This could mean exploring wearables which house only data related to tracking, without complex UX/UI.

For some of these items, it may be that users can assess them on their own, say when step count data is inaccurate. However, as the subject matter experts, researchers in this space are able to provide design-related answers as to why defects are occurring and to what level these inaccuracies differ at certain price levels. This can only be part of the investigation however, because we should also gather insights from intimate qualitative work with potential users.

5.3 Ethical Implications, Limitations and Future Work

It is necessary to highlight the ethical implications of the work. Most notably, the reviewers, although their reviews were made public, were not notified that their claims would be used in a research study. While we paraphrase their thoughts in an attempt to rectify potential harm that could be caused by disseminating such information here, stemming from actors finding the reviews/reviewers, we acknowledge the lack of consent and the potential risks.

Moreover, there are also limitations to this study. Although the analysis of public reviews allowed us to get a broad range of perspectives which would be limited by more granular methods like interviews, there are limitations to this method. For example, even though it was not irregular for reviews to be updated which allowed for clarification of insights, there is still need for further clarity, as use experiences can be more expansive than what is written. This is especially true when we consider both systemic website specifications like word count limits, and the restrictions to what people are willing to say on public platforms.

It's also important to note that sentiments which motivate people to leave online reviews often skew towards extremes [32]. For example, it is most likely that for reviews left on Amazon products or Yelp businesses, the numerical rating will be a 5 or 1 (on a 5 point scale). This means that users are most likely to leave a review if they have had particularly great or negative experiences [32, 88]. We attempt to rectify some of these challenges by looking towards the content of the reviews and not merely the ratings, as the content allows us additional context. However, this still presents a limitation to the data, as our analysis likely over represents perspectives of people who had strong positive or negative reactions to the devices.

Likewise, there are also limitations to the devices we selected. Notwithstanding the fact that we strove for variety in devices, it is the case that every device offers different features and thus hardware/software quality. Therefore, it's worth taking into account that some aspects of our results may not generalize to other low cost fitness devices, and that perspectives may be limited owing to differences in the number of reviews we looked at per device.

Additionally, very limited data may suggest a link between high socio-economic status and likelihood to leave online reviews, specifically on Yelp [88]. However, this data still highlights that middle and lower SES groups do participate in reviewing online. By qualitatively analyzing review commentary, we were able to pull these perspectives when explicitly stated by participants, but further work is needed that directly targets lower SES users. However, it is important to note that we have limited understanding on how online reviewing practices relate to socio-economics, and whether that extends to different kinds of online reviews (e.g., products as well as businesses). More research remains to be done to confirm the extent to which this finding is wide ranging.

Lastly, because we conducted this study in the U.S. and therefore contextualize our understandings from this framework, it is important to note that further evaluation is necessary to address these concerns through country and cultural lines such as in communities in the global south [2, 18], or rural areas of the U.S. While we think many of the main principles likely apply (for the Western context), there are some crucial insights that are worth further study.

6 CONCLUSION

As a research community, we should continue to frame the physical activity tracking device by expanding our framework to be more inclusive of devices that will be low cost *in the consumer market.* To do so, it is imperative to make the decision for whether low cost devices are designed to entice the tastes of transitioning and trial users who want sufficient devices that are deficient but not a fault, or for those users who may be interested in tracking health data, but cannot afford higher cost devices. We do not attempt to suggest that there should be a universal definition of what a low cost device should be, or that our vision should expand outside of Western contexts, or even American contexts. We merely suggest a reality where low cost is not associated with any specific quality, and what that looks like will be dependent on the circumstance, but we can open up spaces for different forms of interventions (those which are minimal or simple, those of lower but practical accuracy) based on those expressed needs.

ACKNOWLEDGMENTS

REFERENCES

[1] [n. d.]. https://www.fitbit.com/global/us/products/trackers/inspire3

[2] Muhammad Sadi Adamu. 2023. No more "solutionism" or "saviourism" in futuring African HCI: A manyfesto. *ACM Transactions on Computer-Human Interaction* 30, 2 (Apr 2023), 1–42. https://doi.org/10.1145/3571811

[3] Jennifer Anyabuine. 2022. 8 best fitness trackers under $50. https://www.semichealth.com/articles/best-fitness-trackers-under-50

[4] Ling Bao and Stephen S. Intille. 2004. Activity recognition from user-annotated acceleration data. In *International conference on pervasive computing*. Springer, 1–17. https://doi.org/10.1007/978-3-540-24646-6_1

[5] Judy Bowen, Annika Hinze, Sally Jo Cunningham, and Richard Parker. 2015. Evaluating low-cost activity trackers for use in large-scale data gathering of forestry workers. In *Proceedings of the Annual Meeting of the Australian Special Interest Group for Computer Human Interaction*. 474–482. https://doi.org/10.1145/2838739.2838741

[6] Virginia Braun and Victoria Clarke. 2019. Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health* 11, 4 (2019), 589–597. https://doi.org/10.1080/2159676X.2019.1628806

[7] Jeremy Bulow. 1986. An economic theory of planned obsolescence. *The Quarterly Journal of Economics* 101, 4 (1986), 729–749. https://doi.org/10.2307/1884176

[8] Eun Kyoung Choe, Nicole B. Lee, Bongshin Lee, Wanda Pratt, and Julie A. Kientz. 2014. Understanding quantified-selfers' practices in collecting and exploring personal data. In *Proceedings of the SIGCHI conference on human factors in computing systems*. 1143–1152. https://doi.org/10.1145/2556288.2557372

[9] Tanzeem Choudhury, Gaetano Borriello, Sunny Consolvo, Dirk Haehnel, Beverly Harrison, Bruce Hemingway, Jeffrey Hightower, Pedja Klasnja, Karl Koscher, Anthony LaMarca, et al. 2008. The mobile sensing platform: An embedded system for capturing and recognizing human activities. *IEEE Pervasive Computing* 7, 2 (2008), 32–41. https://doi.org/10.1109/MPRV.2008.39

[10] Chia-Fang Chung, Nanna Gorm, Irina A. Shklovski, and Sean Munson. 2017. Finding the right fit: understanding health tracking in workplace wellness programs. In *Proceedings of the 2017 CHI conference on human factors in computing systems*. 4875–4886. https://doi.org/10.1145/3025453.3025510

[11] James Clawson, Jessica A. Pater, Andrew D. Miller, Elizabeth D. Mynatt, and Lena Mamykina. 2015. No longer wearing: Investigating the abandonment of personal health-tracking technologies on Craigslist. In *Proceedings of the 2015 ACM international joint conference on pervasive and ubiquitous computing*. 647–658. https://doi.org/10.1145/2750858.2807554

[12] Sunny Consolvo, Katherine Everitt, Ian Smith, and James A. Landay. 2006. Design requirements for technologies that encourage physical activity. In *Proceedings of the SIGCHI conference on Human Factors in computing systems*. 457–466. https://doi.org/10.1145/1124772.1124840

[13] Sunny Consolvo, Predrag Klasnja, David W. McDonald, Daniel Avrahami, Jon Froehlich, Louis LeGrand, Ryan Libby, Keith Mosher, and James A. Landay. 2008. Flowers or a robot army? Encouraging awareness & activity with personal, mobile displays. In *Proceedings of the 10th international conference on Ubiquitous computing*. 54–63. https://doi.org/10.1145/1409635.1409644

[14] Sunny Consolvo, David W. McDonald, Tammy Toscos, Mike Y. Chen, Jon Froehlich, Beverly Harrison, Predrag Klasnja, Anthony LaMarca, Louis LeGrand, Ryan Libby, et al. 2008. Activity sensing in the wild: a field trial of ubifit garden. In *Proceedings of the SIGCHI conference on human factors in computing systems*. 1797–1806. https://doi.org/10.1145/1357054.1357335

[15] Stefany Cruz, Alexander Redding, Connie W. Chau, Claire Lu, Julia Persche, Josiah Hester, and Maia Jacobs. 2023. Equityware: Co-designing wearables with and for low income communities in the U.S. *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (2023). https://doi.org/10.1145/3544548.3580980

[16] Lilian de Greef, Mayank Goel, Min Joon Seo, Eric C. Larson, James W. Stout, James A. Taylor, and Shwetak N. Patel. 2014. Bilicam: using mobile phones to monitor newborn jaundice. *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (Sep 2014). https://doi.org/10.1145/2632048.2632076

[17] DH94. [n. d.]. https://discussions.apple.com/thread/254255279?sortBy=best

[18] Paul Dourish and Scott D. Mainwaring. 2012. Ubicomp's colonial impulse. *Proceedings of the 2012 ACM Conference on Ubiquitous Computing* (Sep 2012). https://doi.org/10.1145/2370216.2370238

[19] Daniel A. Epstein, Clara Caldeira, Mayara Costa Figueiredo, Xi Lu, Lucas M. Silva, Lucretia Williams, Jong Ho Lee, Qingyang Li, Simran Ahuja, Qiuer Chen, and et al. 2020. Mapping and taking stock of the personal informatics literature. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 4, 4 (Dec 2020), 1–38. https://doi.org/10.1145/3432231

[20] Daniel A. Epstein, Monica Caraway, Chuck Johnston, An Ping, James Fogarty, and Sean A. Munson. 2016. Beyond abandonment to next steps: Understanding and designing for life after personal informatics tool use. In *Proceedings of the 2016 CHI conference on human factors in computing systems*. 1109–1113. https://doi.org/10.1145/2858036.2858045

[21] Daniel A. Epstein, Jennifer H. Kang, Laura R. Pina, James Fogarty, and Sean A. Munson. 2016. Reconsidering the device in the drawer: lapses as a design opportunity in personal informatics. In *Proceedings of the 2016 ACM international joint conference on pervasive and ubiquitous computing*. 829–840. https://doi.org/10.1145/2971648.2971656

[22] Daniel A. Epstein, Nicole B. Lee, Jennifer H. Kang, Elena Agapie, Jessica Schroeder, Laura R. Pina, James Fogarty, Julie A. Kientz, and Sean Munson. 2017. Examining menstrual tracking to inform the design of personal informatics tools. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. 6876–6888. https://doi.org/10.1145/3025453.3025635

[23] Daniel A. Epstein, An Ping, James Fogarty, and Sean A. Munson. 2015. A lived informatics model of personal informatics. In *Proceedings of the 2015 ACM international joint conference on pervasive and ubiquitous computing*. 731–742. https://doi.org/10.1145/2750858.2804250

[24] Jason Fernando. 2024. Opportunity cost: Definition, formula, and examples. https://www.investopedia.com/terms/o/opportunitycost.asp

[25] Fitabase. 2024. Fitabase Research Library. https://www.fitabase.com/research-library/

[26] James Fogarty, Carolyn Au, and Scott E. Hudson. 2006. Sensing from the basement: a feasibility study of unobtrusive and low-cost home activity recognition. In *Proceedings of the 19th annual ACM symposium on User interface software and technology*. 91–100. https://doi.org/10.1145/1166253.1166269

[27] Risa Gelles-Watnick. 2024. Americans' use of mobile technology and home broadband. https://www.pewresearch.org/internet/2024/01/31/americans-use-of-mobile-technology-and-home-broadband/

[28] Martin Gjoreski, Mitja Luštrek, and Veljko Pejović. 2018. My watch says I'm busy. *Proceedings of the 2018 ACM International Joint Conference and 2018 International Symposium on Pervasive and Ubiquitous Computing and Wearable Computers* (Oct 2018). https://doi.org/10.1145/3267305.3274113

[29] Daniel Harrison, Paul Marshall, Nadia Bianchi-Berthouze, and Jon Bird. 2015. Activity tracking: barriers, workarounds and customisation. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. 617–621. https://doi.org/10.1145/2750858.2805832

[30] Walaa Hassan. 2023. https://eu.community.samsung.com/t5/wearables/samsung-watch-4-classic-burning-my-wrist/td-p/7362343

[31] Michelle Holko, Tamara R. Litwin, Fatima Munoz, Katrina I. Theisz, Linda Salgin, Nancy Piper Jenks, Beverly W. Holmes, Pamelia Watson-McGee, Eboni Winford, and Yashoda Sharma. 2022. Wearable fitness tracker use in federally qualified health center patients: Strategies to improve the health of all of US using digital health devices. *npj Digital Medicine* 5, 1 (2022). https://doi.org/10.1038/s41746-022-00593-x

[32] Nan Hu, Jie Zhang, and Paul A. Pavlou. 2009. Overcoming the J-shaped distribution of product reviews. *Commun. ACM* 52, 10 (2009), 144–147. https://doi.org/10.1145/1562764.1562800

[33] Josée Johnston and Kate Cairns. 2014. Food shopping: a chore or a pleasure? *Contexts* 13, 3 (2014), 6–6. http://www.jstor.org/stable/24710540

[34] Ravi Karkar, Rafal Kocielnik, Xiaoyi Zhang, Jasmine Zia, George N. Ioannou, Sean A. Munson, and James Fogarty. 2018. Beacon: Designing a portable device for self-administering a measure of critical flicker frequency. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 2, 3 (2018), 1–27. https://doi.org/10.1145/3264927

[35] Yoshihiro Kawahara, Steve Hodges, Benjamin S. Cook, Cheng Zhang, and Gregory D. Abowd. 2013. Instant inkjet circuits. *Proceedings of the 2013 ACM international joint conference on Pervasive and ubiquitous computing* (Sep 2013). https://doi.org/10.1145/2493432.2493486

[36] Emily Knight, Melanie I. Stuckey, Harry Prapavessis, and Robert J. Petrella. 2015. Public health guidelines for physical activity: Is there an app for that? A review of Android and Apple app Stores. *JMIR mHealth and uHealth* 3, 2 (May 2015). https://doi.org/10.2196/mhealth.4003

[37] Nikolaos Korfiatis, Elena García-Bariocanal, and Salvador Sánchez-Alonso. 2012. Evaluating content quality and helpfulness of online product reviews: The interplay of review helpfulness vs. review content. *Electronic Commerce Research and Applications* 11, 3 (2012), 205–217. https://doi.org/10.1016/j.elerap.2011.10.003

[38] Whitney-Jocelyn Kouaho and Daniel A. Epstein. 2024. Socioeconomic class in physical activity wearables research and design. *Proceedings of the CHI Conference on Human Factors in Computing Systems* (May 2024). https://doi.org/10.1145/3613904.3642789

[39] Jennifer R. Kwapisz, Gary M. Weiss, and Samuel A. Moore. 2011. Activity recognition using cell phone accelerometers. *ACM SigKDD Explorations Newsletter* 12, 2 (2011), 74–82. https://doi.org/10.1145/1964897.1964918

[40] Federica Laricchia. 2024. U.S.: Fitness tracker users by segment 2028. https://www.statista.com/forecasts/1425172/fitness-tracker-users-by-segment-us

[41] Federica Laricchia. 2024. Wearables shipments worldwide 2028. https://www.statista.com/statistics/437871/wearables-worldwide-shipments/

[42] Eric C. Larson, Mayank Goel, Gaetano Boriello, Sonya Heltshe, Margaret Rosenfeld, and Shwetak N. Patel. 2012. SpiroSmart: using a microphone to measure lung function on a mobile phone. *Proceedings of the 2012 ACM Conference on Ubiquitous Computing* (Sep 2012). https://doi.org/10.1145/2370216.2370261

[43] Eric C. Larson, TienJui Lee, Sean Liu, Margaret Rosenfeld, and Shwetak N. Patel. 2011. Accurate and privacy preserving cough sensing using a low-cost microphone. *Proceedings of the 13th international conference on Ubiquitous computing* (Sep 2011). https://doi.org/10.1145/2030112.2030163

[44] Amanda Lazar, Christian Koehler, Theresa Jean Tanenbaum, and David H. Nguyen. 2015. Why we use and abandon smart devices. In *Proceedings of the 2015 ACM international joint conference on pervasive and ubiquitous computing*. 635–646. https://doi.org/10.1145/2750858.2804288

[45] Jong Ho Lee, Jessica Schroeder, and Daniel A. Epstein. 2021. Understanding and supporting self-tracking app selection. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 5, 4 (Dec 2021), 1–25. https://doi.org/10.1145/3494980

[46] Jonathan Lester, Tanzeem Choudhury, and Gaetano Borriello. 2006. A practical approach to recognizing physical activities. In *International conference on pervasive computing*. Springer, 1–16. https://doi.org/10.1007/11748625_1

[47] Ian Li, Anind Dey, and Jodi Forlizzi. 2010. A stage-based model of personal informatics systems. In *Proceedings of the SIGCHI conference on human factors in computing systems*. 557–566. https://doi.org/10.1145/1753326.1753409

[48] Ian Li, Anind K. Dey, and Jodi Forlizzi. 2011. Understanding my data, myself: Supporting self-reflection with ubicomp technologies. In *Proceedings of the 13th international conference on Ubiquitous computing*. 405–414. https://doi.org/10.1145/2030112.2030166

[49] Yuanchun Li, Baoxiong Jia, Yao Guo, and Xiangqun Chen. 2017. Mining user reviews for mobile app comparisons. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 1, 3 (Sep 2017), 1–15. https://doi.org/10.1145/3130935

[50] Brian Y. Lim, Judy Kay, and Weilong Liu. 2019. How does a nation walk? Interpreting large-scale step count activity with weekly streak patterns. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 3, 2 (2019), 1–46. https://doi.org/10.1145/3328928

[51] James J. Lin, Lena Mamykina, Silvia Lindtner, Gregory Delajoux, and Henry B. Strub. 2006. Fish'n'Steps: encouraging physical activity with an interactive computer game. In *UbiComp 2006: Ubiquitous Computing: 8th International Conference, UbiComp 2006 Orange County, CA, USA, September 17-21, 2006 Proceedings 8*. Springer, 261–278. https://doi.org/10.1007/11853565_16

[52] David Marcotte. 2024. A look at the 2024 top 50 global retailers. https://nrf.com/blog/look-2024-top-50-global-retailers

[53] Jochen Meyer, Merlin Wasmann, Wilko Heuten, Abdallah El Ali, and Susanne C.J. Boll. 2017. Identification and classification of usage patterns in long-term activity tracking. In *Proceedings of the 2017 CHI conference on human factors in computing systems*. 667–678. https://doi.org/10.1145/3025453.3025690

[54] Vivian Genaro Motti and Kelly Caine. 2016. Smart wearables or dumb wearables? Understanding how context impacts the UX in wrist worn interaction. *Proceedings of the 34th ACM International Conference on the Design of Communication* (Sep 2016). https://doi.org/10.1145/2987592.2987606

[55] Elizabeth L. Murnane, Yekaterina S. Glazko, Jean Costa, Raymond Yao, Grace Zhao, Paula ML Moya, and James A. Landay. 2023. Narrative-based visual feedback to encourage sustained physical activity: A field trial of the WhoIsZuki mobile health platform. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 7, 1 (2023), 1–36. https://doi.org/10.1145/3580786

[56] Işıl Oygür, Daniel A. Epstein, and Yunan Chen. 2020. Raising the responsible child: Collaborative work in the use of activity trackers for children. *Proceedings of the ACM on Human-Computer Interaction* 4, CSCW2 (Oct 2020), 1–23. https://doi.org/10.1145/3415228

[57] Thomas A. O'Mara, Miguel Armengol Hoz, Oren J. Mechanic, and Alon Dagan. 2021. Can a low-cost exercise monitor provide useful heart rate monitoring for use in low-resource emergency departments? *Clinical and Experimental Emergency Medicine* 8, 3 (Sep 2021), 201–206. https://doi.org/10.15441/ceem.20.128

[58] Dennis Pagano and Walid Maalej. 2013. User feedback in the appstore: An empirical study. In *2013 21st IEEE international requirements engineering conference (RE)*. IEEE, 125–134. https://doi.org/10.1109/RE.2013.6636712

[59] Sherry Pagoto, Kristin Schneider, Mirjana Jojic, Michele DeBiasse, and Devin Mann. 2013. Evidence-based strategies in weight-loss mobile apps. *American Journal of Preventive Medicine* 45, 5 (Nov 2013), 576–582. https://doi.org/10.1016/j.amepre.2013.04.025

[60] Shwetak N. Patel, Thomas Robertson, Julie A. Kientz, Matthew S. Reynolds, and Gregory D. Abowd. 2007. At the flick of a switch: Detecting and classifying unique electrical events on the residential power line. In *UbiComp 2007: Ubiquitous Computing: 9th International Conference, UbiComp 2007, Innsbruck, Austria, September 16-19, 2007. Proceedings 9*. Springer, 271–288. https://doi.org/10.1007/978-3-540-74853-3_16

[61] Pricespider. 2023. https://www.pricespider.com/blog/top-10-online-stores-for-consumer-electronics-brands-2023/

[62] Nishkam Ravi, Nikhil Dandekar, Preetham Mysore, and Michael L Littman. 2005. Activity recognition from accelerometer data. In *Aaai*, Vol. 5. Pittsburgh, PA, 1541–1546. https://doi.org/10.5555/1620092.1620107

[63] John Rooksby, Mattias Rost, Alistair Morrison, and Matthew Chalmers. 2014. Personal tracking as lived informatics. In *Proceedings of the SIGCHI conference on human factors in computing systems*. 1163–1172. https://doi.org/10.1145/2556288.2557039

[64] Herman Saksono, Carmen Castaneda-Sceppa, Jessica Hoffman, Vivien Morris, Magy Seif El-Nasr, and Andrea G. Parker. 2020. Storywell: designing for family fitness app motivation by using social rewards and reflection. In *Proceedings of the 2020 CHI conference on human factors in computing systems*. 1–13. https://doi.org/10.1145/3313831.3376686

[65] Herman Saksono, Carmen Castaneda-Sceppa, Jessica Hoffman, Magy Seif El-Nasr, Vivien Morris, and Andrea G. Parker. 2018. Family health promotion in low-SES neighborhoods: A two-month study of wearable activity tracking. In *Proceedings of the 2018 chi conference on human factors in computing systems*. 1–13. https://doi.org/10.1145/3173574.3173883

[66] Herman Saksono, Carmen Castaneda-Sceppa, Jessica Hoffman, Magy Seif El-Nasr, Vivien Morris, and Andrea G. Parker. 2019. Social reflections on fitness tracking data: A study with families in low-SES neighborhoods. In *Proceedings of the 2019 chi conference on human factors in computing systems*. 1–14. https://doi.org/10.1145/3290605.3300543

[67] Herman Saksono, Carmen Castaneda-Sceppa, Jessica A Hoffman, Magy Seif El-Nasr, and Andrea Parker. 2021. StoryMap: using social modeling and self-modeling to support physical activity among families of low-SES backgrounds. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–14. https://doi.org/10.1145/3411764.3445087

[68] Jennifer A. Sandlin, Jennifer L. Milam, and Corrine M. Wickens. 2007. "Spend smart, live rich": Popular pedagogy and the construction of the "good consumer" in the popular lifestyle magazinebudget living. *Journal of Curriculum and Pedagogy* 4, 1 (Jun 2007), 113–135. https://doi.org/10.1080/15505170.2007.10411630

[69] Patrick C. Shih, Kyungsik Han, Erika Shehan Poole, Mary Beth Rosson, and John M. Carroll. 2015. Use and adoption challenges of wearable activity trackers. *IConference 2015 proceedings* (2015).

[70] Adrienne So. 2024. The best fitness trackers and watches for everyone. https://www.wired.com/gallery/best-fitness-tracker/

[71] Timothy Sohn, Alex Varshavsky, Anthony LaMarca, Mike Y Chen, Tanzeem Choudhury, Ian Smith, Sunny Consolvo, Jeffrey Hightower, William G. Griswold, and Eyal De Lara. 2006. Mobility detection using everyday gsm traces. In *International Conference on Ubiquitous Computing*. Springer, 212–224. https://doi.org/10.1007/11853565_13

[72] Victoria Song. 2022. The best fitness trackers to buy right now. https://www.theverge.com/22985108/best-fitness-tracker

[73] Elizabeth Stowell, Mercedes C. Lyson, Herman Saksono, Reneé C. Wurth, Holly Jimison, Misha Pavel, and Andrea G. Parker. 2018. Designing and evaluating mHealth interventions for vulnerable populations: A systematic review. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–17. https://doi.org/10.1145/3173574.3173589

[74] Lie Ming Tang and Judy Kay. 2017. Harnessing long term physical activity data—How long-term trackers use data and how an adherence-based interface supports new insights. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 1, 2 (Jun 2017), 1–28. https://doi.org/10.1145/3090091

[75] Lie Ming Tang, Jochen Meyer, Daniel A. Epstein, Kevin Bragg, Lina Engelen, Adrian Bauman, and Judy Kay. 2018. Defining adherence: making sense of physical activity tracker data. *Proceedings of the ACM on interactive, mobile, wearable and ubiquitous technologies* 2, 1 (2018), 1–22. https://doi.org/10.1145/3191769

[76] Jakob Tholander and Stina Nylander. 2015. Snot, sweat, pain, mud, and snow: Performance and experience in the use of sports watches. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. 2913–2922. https://doi.org/10.1145/2702123.2702482

[77] Rajesh Vasa, Leonard Hoon, Kon Mouzakis, and Akihiro Noguchi. 2012. A preliminary analysis of mobile app user reviews. In *Proceedings of the 24th Australian computer-human interaction conference*. 241–244. https://doi.org/10.1145/2414536.2414577

[78] G. S. Vasan. 2024. Top 10 most expensive smartwatches in the world in 2024. https://www.91mobiles.com/hub/most-expensive-smartwatches-in-the-world/

[79] Tiffany C. Veinot, Hannah Mitchell, and Jessica S. Ancker. 2018. Good intentions are not enough: How informatics interventions can worsen inequality. *Journal of the American Medical Informatics Association* 25, 8 (2018), 1080–1088. https://doi.org/10.1093/jamia/ocy052

[80] Emily A. Vogels. 2020. About one-in-five Americans use a smart watch or fitness tracker. https://www.pewresearch.org/short-reads/2020/01/09/about-one-in-five-americans-use-a-smart-watch-or-fitness-tracker/

[81] Emily A. Vogels. 2021. Digital divide persists even as Americans with lower incomes make gains in tech adoption. https://www.pewresearch.org/short-reads/2021/06/22/digital-divide-persists-even-as-americans-with-lower-incomes-make-gains-in-tech-adoption/

[82] Edward Jay Wang, William Li, Doug Hawkins, Terry Gernsheimer, Colette Norby-Slycord, and Shwetak N. Patel. 2016. HemaApp: noninvasive blood Screening of hemoglobin using smartphone cameras. *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (Sep 2016). https://doi.org/10.1145/2971648.2971653

[83] Max J. Western, Miranda E. Armstrong, Ishrat Islam, Kelly Morgan, Una F. Jones, and Mark J. Kelson. 2021. The effectiveness of digital interventions for increasing physical activity in individuals of low socioeconomic status: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity* 18, 1 (Nov 2021). https://doi.org/10.1186/s12966-021-01218-4

[84] Jeff Williams. 2020. Microsoft drops the price on their band 2 to a comfortable $175. https://www.tweaktown.com/news/50750/microsoft-drops-price-band-2-comfortable-175/index.html

[85] Susan Wyche, Tawanna Dillahunt, Nightingale Simiyu, and Sharon Alaka. 2015. "If God gives me the chance I will design my own phone". *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (Sep 2015). https://doi.org/10.1145/2750858.2804249

[86] Susan P. Wyche, Melissa Densmore, and Brian Samuel Geyer. 2015. SHARE ON Real mobiles: Kenyan and Zambian smallholder farmers' current attitudes towards mobile phones. *Proceedings of the Seventh International Conference on Information and Communication Technologies and Development* (May 2015). https://doi.org/10.1145/2737856.2738013

[87] Rayoung Yang, Eunice Shin, Mark W. Newman, and Mark S. Ackerman. 2015. When fitness trackers don't 'fit' end-user difficulties in the assessment of personal tracking device accuracy. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. 623–634. https://doi.org/10.1145/2750858.2804269

[88] Yelp. [n. d.]. Yelp fast facts. https://www.yelp-press.com/company/fast-facts/default.aspx

[89] Sofia Yfantidou, Pavlos Sermpezis, Athena Vakali, and Ricardo Baeza-Yates. 2023. Uncovering bias in personal informatics. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 7, 3 (2023), 1–30. https://doi.org/10.1145/3610914

[90] Faheem Zafari, Athanasios Gkelias, and Kin K. Leung. 2019. A survey of indoor localization systems and technologies. *IEEE Communications Surveys & Tutorials* 21, 3 (2019), 2568–2599. https://doi.org/10.1109/COMST.2019.2911558

[91] Albin Zeqiri, Pascal Jansen, Jan Ole Rixen, Michael Rietzler, and Enrico Rukzio. 2024. "Eco is just marketing": unraveling everyday barriers to the adoption of energy-saving features in major home appliances. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 8, 1 (Mar 2024), 1–27. https://doi.org/10.1145/3643558