Exploring the Relationship Between Technology and Physical Activity

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

Megan Lin

Spring, 2022

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

Signature _____ Date _____
Megan Lin

Approved _____ Date _____
Hannah Rogers, Department of Engineering and Society

Abstract

The primary objective of this thesis is to analyze how technology has created a culture of sedentarism and obesity in the US and explore feasible solutions to reintroduce physical activity into daily life. Sedentarism is the culture of daily routines and habits that require low levels of physical activity. Although there is not a specific list of habits this culture encapsulates, it can be generalized to habits that have feasible alternatives that require moderate to high levels of activity. Examples include using an elevator over stairs, microwaving a frozen dinner over cooking from scratch, and shopping online over in person. Many of these activities vary in the type of alternatives, but many are influenced by modern breakthroughs in technology. Overall, these technologies have developed efficient alternatives to many daily tasks which have, in turn, contributed to our obesity crisis. However, there have been efforts made to reincorporate physical activity into these tasks in a neutral or attractive way to the user, like the standing desk. This paper will elaborate on sociotechnical perspectives including the government's, entertainment companies', and various organizations using the Social Construction of Technology framework (Klein & Kleinman). It was found that although there are some breakthroughs in technologies that incorporate physical activity like the Nintendo Switch and France's soda tax, overall these are rarely implemented as it is difficult to please the major groups involved.

Introduction

Physical activity is essential to one's long-term health & wellness, but Americans especially are not getting nearly enough as proven by our jump from 30.5% to 42.4% adult obesity rate in the last 20 years (*Adult obesity facts*, 2021). While there are a degree of factors

that influence risk of obesity like genetics, medication, and accessibility to nutritional foods– sedentary activities are a key modifiable risk factor (National Heart Lung and Blood Institute; Xiao et al., 2014). The growth in sedentary activities can be seen in the workplace with the transition from the Industrial to the Electronics & Telecommunications Revolution (Woessner et al., 2021). With the transition from the factory floor to desk jobs, we have decreased typical low to medium intensity activity. This transition is especially crucial as the workplace typically takes up ⅓ of our day. Furthermore, there has been a surge in popularity of incorporating electronic technology with leisure. This can be seen through the rise in the intersection of entertainment and technology– especially during COVID-19. Notable sedentary activities that rose in popularity include the video games Among Us & Animal Crossing, binging Netflix Shows like Tiger King, and Zoom calling friends. Because of this surge in popularity, I am interested in researching the culture of sedentarism, its consequences, and how we can effectively battle it.

The key group of technologies we will be evaluating will be named "efficient technologies." These are technologies that replace some aspect of daily activities in a way that requires less physical exertion from the user. These technologies do not necessarily need digital aspects. For example, bicycling is a non-digital technology that replaced walking and burns less calories.

Methodology

The framework utilized in this research paper is Pinch & Bijker's Social Construction of Technology (SCOT) framework. This theory centers around the view that there is a two-way relationship between social structures and the development of technology (Klein & Kleinman, 2002). Each impacts and is influenced by the other. Because we define sedentarism as a culture,

we will be evaluating its relationship with technological innovation. Specifically, we will be looking at the rise of technology in activities of daily living. We will be highlighting the entertainment sector and evaluating the success and creative direction video games and streaming services are going towards. Social groups we will be evaluating include for-profit companies like Nintendo & Netflix, concerned parents & teachers from groups like Fairplay & SHAPE America, and government institutions like the CDC and NRPA.

The main goals of this study are to explore the rise in the culture of sedentarism due to technology and the efforts being made to combat it. As this was a niche area, I scoped out to find scholarly journals and news sources about obesity and physical wellness. I also found company press releases, specifically Nintendo and Netflix's. The purpose of these press releases was to evaluate the commercial success of combining physical activity with technology. Potential bias was taken into account, especially when viewing company press releases as these pieces were intended to paint a good picture of the company for the public and potential stockholders. The research on obesity is more statistically found and less likely to have bias. By incorporating a variety of articles and presentations, I present a research paper that explores how different social groups view "efficient technologies", then compare and contrast these understandings.

Extent of America's Obesity Epidemic

In the United States, the obesity rate is 42 percent and rising. Among adults of all demographics, physical activity is a major cause. Only 45.5 percent of Americans have sufficient activity levels (fig. 1). Internet usage, including compulsive phone or device use, contributes to physical inactivity. SHAPE America and the National Institute for Occupational Safety and Health (NIOSH) promote physical activity, though their success has been modest. Obesity

increases the risk of coronary artery disease by 45 percent, stroke by 60 percent, hypertension by 30 percent, and osteoporosis by 59 percent. Because of its part in mortality from these conditions, obesity may be the leading cause of preventable death in the U.S. (Matusitz & McCormick, 2012).

Characteristic	Overall		Prevalence of Physical Activity Level [b]					
	Sample size (%) [c]		Inactive		Insufficiently Active		Active	
			(N = 19 959)		(N = 10 264)		(N = 20 942)	
			%	(SE)	%	(SE)	%	(SE)
Overall	51 165		34.2	(0.6)	20.2	(0.4)	45.5	(0.5)
Sex								
Male	23 170	(50.2)	32.8	(0.8)	18.5	(0.5)	48.6	(0.6)
Female	27 995	(49.8)	35.6	(0.7)	22.0	(0.5)	42.4	(0.6)
Age (years)								
21–29	6741	(16.2)	27.6	(1.1)	17.5	(1.0)	54.9	(1.3)
30–39	9493	(17.4)	29.3	(0.9)	19.6	(0.6)	51.2	(1.0)
40–49	10 173	(20.2)	32.8	(0.9)	20.5	(0.8)	46.7	(0.9)
50–59	9650	(19.7)	34.2	(1.0)	21.3	(0.7)	44.4	(0.9)
60–69	7119	(13.5)	37.1	(1.3)	22.1	(0.9)	40.7	(1.1)
70–79	4691	(7.8)	42.8	(1.4)	20.8	(1.0)	36.4	(1.3)
≥ 80	3298	(5.2)	56.4	(1.6)	20.3	(1.2)	23.4	(1.3)
Race/ethnicity								
White, non-Hispanic	27 992	(69.0)	30.2	(0.8)	20.7	(0.5)	49.1	(0.6)
Black, non-Hispanic	9749	(11.1)	43.6	(1.1)	19.4	(0.7)	36.9	(0.9)
Hispanic	9638	(13.3)	46.6	(1.1)	18.4	(0.7)	35.0	(1.0)
Other, non-Hispanic	3786	(6.6)	35.2	(1.4)	20.5	(1.3)	44.2	(1.6)

Figure 1. Distribution of prevalence of physical activity level by various sex and ethnicity – US adults, NHIS and MEPS 2006–2011 (Carlson; data from National Health Interview Survey, 2015).

History of Obesity

The boom in worldwide obesity began with the vast advancements in medicine to nearly eliminate infectious diseases, the decline in manual labor after the end of the industrial revolution, and the increasing availability paired with decreasing cost of food.

Obesity itself has some combination of calorie intake, diet content, and amount of physical activity. Therefore, there are multiple factors that can be altered to decrease the risk of obesity.

> In some cultures, lack of physical activity can be a more important determinant of obesity; in other cultures, overeating or food composition may be the more important determinant of obesity. It is also true that within countries, individuals could differ in the causes of obesity. For instance, changes in activity might be more characteristic of women or men resulting in different reasons for obesity by gender. (Vasunilashorn, 2013)

Key Examples of "Efficient Technology"

As previously defined, "efficient technologies" are technologies that replace some aspect of daily activities in a way that requires less physical exertion from the user. These technologies do not necessarily need digital aspects.

Transportation is a key source of physical activity that we have made more efficient in the land, air, and sea. We can see the evolution from the wheel to horseback carriages, bikes, and cars. In the era of COVID, we also see the elimination of physical transportation altogether through working from home using technologies like Zoom, Slack, and Gmail.

In the same vein, communication has evolved drastically over time. While face-to-face remains a key method of communication, letters, emails, texts, phone calls, and video calls have become feasible alternatives to leaving the house to talk to others. This has been especially solidified as a feasible alternative to communication during the pandemic as normal face-to-face communication was highly discouraged for public safety.

A key factor to obesity is also caloric intakes and food sources. Regardless of dietary choices, the method of obtaining food also factors into daily caloric intake. Over time, we have evolved from foraging, hunting, & gathering to grocery shopping & cooking, microwave meals,

and ordering delivery to your door. Not only has food evolved to be more processed and less nutritionally balanced, but the act of obtaining it has become sedentary.

Difficulties to Add Physical Activity to Efficient Technologies

As activities of daily living have declined, sedentary living and exertion-free activities have displaced them. The consequent deficit in physical activity increases the likelihood of obesity (Matusitz & McCormick, 2012). Because exercise for health is nonessential to daily routines and requires planning, many do not engage in it (Hutt, 2017). However, can for-profit companies incorporate physical activity back into their technologies?

The two key factors to product feasibility are typically user buy-in and profitability. An example of a product with high-user adoption that would not ne profitable would be state-of-the-art VR play centers in every neighborhood. On the other hand, a profitable but not user-friendly product could be the Peloton, depending on the user, or a subsidized fresh food delivery infrastructure.

Typically, key metrics of success in technological innovation are speed and effort. It can be generalized that increasing speed and decreasing effort are basis for improvement in product design. Reintroducing physical activity into most sectors of technology directly contradicts these guidelines to product success.

For example, within transportation with the most recent technological developments of the car, boat, and plane, there is not a clear path to how activity can be feasibly reintroduced. At best, boats have been transformed into cruises and cars can be substituted by party buses, but these are expensive and typically reserved for special occasions.

Within communication, there is also not a clear area of opportunity. Most communication has been digitized to computer & phone screens. While there have been some efforts made like Apple Health's steps counted functionality, there are no clear areas social media companies could venture into.

Lastly, in cooking, there is opportunity in the food's dietary value itself, but speed and efficiency are still prioritized in obtaining the food itself. This leaves the same void for potential active technologies.

Overall, we see that incorporating physical activity while satisfying relevant stakeholders is a difficult task that requires creativity, research, and planning.

Opportunities to Engage in Digital Entertainment

An interesting area of growth of digitization is entertainment. While entertainment has varied drastically over time with social trends, we can see the growth from simple games like tag and hopscotch to physical games like marbles and cards. We can most recently see the shift with digitization to video games and TV.

Compared to other sectors, the success metric for entertainment is the amount of enjoyment or the "fun" factor the product brings, not speed or efficiency. This differentiates entertainment and is why we will evaluate further in this paper on the feasibility of incorporating physical activity into entertainment.

While an obvious area of entertainment that incorporates physical activity are sports, this is often high-intensity and requires multiple players. This creates difficulty in adoption due to logistical barriers and personal preference for lower intensity activities. We will be focusing on

digital entertainments like TV and video games as these are a generally accessible, sedentary experience.

Corporate Social Responsibility in User Health

A key player in the digital entertainment space, Netflix is a prime example for a source of sedentary leisure. According to Hastings (2018), Netflix plans to factor its effects on users' health into its evaluations of corporate performance. The success of Netflix's unlimited access business model tends to exacerbate sedentary living among its customers.

The Nintendo Wii, and now Switch, are examples of how a company has induced a more active user experience. Nintendo had been best known for its handheld games, such as the DS, but the Wii made gameplay active. According to Nintendo, it revolutionized gaming to "a place where playing is no longer just about looks, it's about the feel" (Nintendo, 2006). We can see the extent of Nintendo's success in active gaming through the massive success of Wii Fit, Pokemon Go, and Just Dance.

However, active gaming's level of success in adoption amongst users and improving user's health is contested. In one study by BMC Public Health, it was found that:

> Sedentary activities such as watching TV and playing video games, have been found to be associated with negative health outcomes such as overweight and obesity, partly independent of diet and moderate to vigorous physical activity. It has been suggested that reductions in sedentary behavior may be as effective as or even more effective than increasing physical activity directly in decreasing BMI, and percentage overweight. (Simons et al., 2014)

Thus, BMC's research predicts that simply reducing sedentary time without directly increasing physical activity may be more feasible and effective in creating a healthy lifestyle. If

this hypothesis is proven, this opens up entertainment companies to more facets of varying levels of active entertainment.

When tested, BMC found that no significant evidence was found pointing to meaningful changes in lifestyle behaviors between the active and passive gaming test groups. A major reason was that users tasked with active gaming on their Playstation Move were not reaching their weekly quota of 1 hour of play time per week. Thus, this low dose of active game play "might thus have been insufficient to induce differences in the anthropometrics between the intervention and the control group (Simons et al., 2014)."

This research shows that adoptability of active entertainment systems like the Playstation Move or Microsoft Kinect may be a major barrier to the success of their parent companies and towards improving the physical wellbeing of their users. While Nintendo has made breakthroughs with their consoles and games, we haven't seen comparatively successful products amongst similar gaming companies or across the rest of the entertainment industry.

Pushback Against Technologies: Parents & Teachers

Amongst pushbacks against technologies in entertainment, concerned groups of parents are a significant group who are against tech companies' reach onto younger demographics. We will be evaluating the stances from the Campaign for Commercial-Free Childhood (CCFC, recently rebranded as Fairplay), National Environmental Education Foundation (NEEF), and the Society of Health and Physical Educators (SHAPE America).

Fairplay is working to limit certain big tech companies' reach citing increased obesity, body dysmorphia, and unhealthy sleep habits (CCFC 2018 and 2021). They have most recently prevented the launch of FB Messenger Kids (2018) and a kid-targeted Instagram variant (2021).

While the introduction to sedentarism and addiction are often cited concerns from these parental groups, toxic internet culture is more often prioritized as a concern. As cited in Fairplay's letter to Facebook's CEO, Mark Zuckerberg:

> Our 2018 letter presented research linking adolescent social media use with depression, poor sleep habits, and unhealthy body image. We asked why, given this research, Facebook was targeting children as young as five, who are even less equipped to navigate the challenges and harms of social media. (CCFC 2018)

Outside of social media, Fairplay also puts a spotlight on the dangers of video games. As said by Tracy Markle in a Fairplay podcast, video games are rewarding and engaging, but guide players too much so that they aren't engaging their brain (*Is it Video Game Addiction or Not? Navigating Summer with Children during COVID-19*, 2020). Furthermore, as seen through the success of Animal Crossing: New Horizons at the height of the pandemic, there is a risk for escapism and negative feelings when forced to leave these virtual realities for the real world (Nguyen, 2021).

Aside from the similar call for concern in regards to physical wellness and toxic online culture, Fairplay highlights the tension and power struggles that can be introduced between child and parent. These tensions arise because video games are built upon the success metric of hours of playing games which easily creates childhood addictions. Kids are an especially vulnerable group for video games as they lack impulse control and ability to regulate emotions (*Is it Video Game Addiction or Not? Navigating Summer with Children during COVID-19*, 2020). This can cause lashing out and tantrums when kids want to play "just one more" game.

Similar to Fairplay, NEEF is a charitable organization focused on lifelong environmental learning with a subgroup focused on K-12 education (*K-12 education*, n.d.). NEEF posted a list of tips to balance screen & nature time as advised by the World Health Organization (WHO) and

Mayo Clinic. These tips are centered around the WHO's recommendations that physical activity benefits all ages, but specifically "children younger than age five need to spend less time sitting watching screens—and more time dedicated to active play—to grow up healthy." Furthermore, they state that "unstructured playtime is important for a young child's developing brain." These tips include creating tech-free environments, eliminating background TV from daily activities, and prioritizing unstructured playtime (*The right mix of screen time, Nature time*, n.d.).

From NEEF's resources, we can see that they prioritize children's mental development in conjunction with physical activity.

SHAPE America (2013) is a society for professionals in health, physical education, recreation, and dance that also advocates for children's health. SHAPE America seeks more and better physical and health education programs in schools. While groups like SHAPE America have created helpful resources for children like the National Health Education Standards, there are significantly less resources aimed towards adults in the US. In adulthood, exercise requires initiative and planning while in childhood it is mandated by schools or parents. This creates a high barrier towards upholding physical health and wellness due to low resource availability and creativity.

Overall, adults are at higher risk than children to be obese in the US. In 2017-2018, 19.3% of children were obese while 42.4% of adults were obese (*Childhood obesity facts*, 2021 and *Adult obesity facts*, 2021). It is clear these childhood resources and structures do not carry into adulthood based on these statistics.

Furthermore, most health-related technologies aimed toward adults are aimed towards already active adults. For example, the Nike Run Club App is mainly targeted towards adults that

already run. While children are an highly impressionable group that needs guidance, it is clear that adults also need creative and technical resources to get their physical wellness back on track.

Pushback Against Technologies: Government

The US government has put practices in place to promote healthy living in public– especially the workplace and in leisure. In the workplace, Total Worker Health promotes exercise through activities of daily living. This program was developed by the National Institute for Occupational Safety and Health (NIOSH) to encourage healthful substitutions, such as stairs over elevators, walking meetings, and treadmill desks (CDC, 2015).

While there have long been existing technologies including accessories to the typical office space like under-desk pedal bikes, pull-up bars, and stability cushions, they haven't been overly popular. This is because they are accessories users must actively choose to use at their desk. Oftentimes, these tools get shoved aside when the user gets busy and frustrated with work to focus.

However, companies like Herman-Miller, Ikea, and Vivo have ventured into transforming more essential furniture into "work exercise" equipment. For example, we can note the recent rise in popularity of motorized standing desks and accompanying balance boards. When searching the popularity of standing desks on Google Trends, we can see a significant jump from February 2020 to the peak in August 2020. These pieces of furniture require less effort for users to choose to use on a daily basis and are more difficult to "shove aside" compared to the preceding examples.

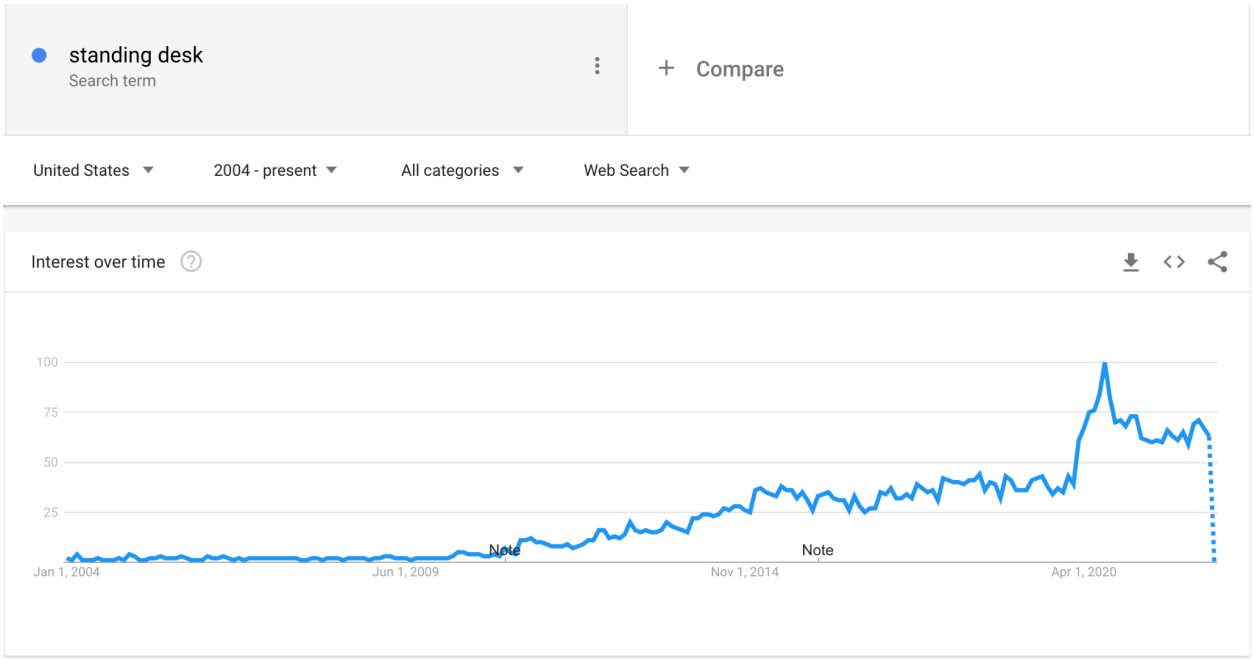

Figure 2. A Google Trends report from 2004- May 3, 2022 on the term "standing desk" within the US. Note that from 1/1/2011 and 1/1/2016 an improvement to geographical assignment and data collection were applied respectively. This data was measured relative to itself with a value of 100 indicating a peak popularity score.

Outside of the workplace and home, American adults often spend their free time doing leisure. This can include parks and recreational facilities, but accessibility is variable based on location.

In the public sector, the National Recreation and Park Association (NRPA) promotes park, recreation, fitness, and sports (PRFS) activities. Almost all areas of PRFS involves some degree of physical activity to the user whether that be through arts & crafts or open basketball games. An added benefit to recreational centers and parks are the financial accessibility and degree of socialization they provide. These are integral as they are key factors people use when deciding if this will become a daily/habitual activity.

The NRPA provides 173,000 parks and recreational facilities at little or no cost to participants (Mowen & Baker, 2009). It contends that "by centering health equity," it "can ensure

that all people — regardless of race, class, ability or identity — have a fair and just opportunity to achieve positive health and well-being outcomes" (NRPA, n.d.).

However, there are four main factors that influence park usage and physical activity levels: accessibility, distribution, facilities, and conditions (NRPA, n.d.). To address each of these factors, ideally the NRPA should be ensuring the following for all citizens:

1. Parks/recreational centers within walking distance
2. Equitable rationing of park acreage regardless of surrounding income levels/race
3. Quality facilities that encourage higher levels of physical activity
4. Facilities that are consistently maintained for hygiene, aesthetics, and safety

International Methods to Tackling Obesity

Obesity is a formula involving caloric intake, diet content, and physical activity– thus by changing any one of these factors will directly affect one's risk for obesity. While we have focused on fostering physical activity in this paper, there are other methods that could be utilized that shifts the onus of responsibility from for-profit companies to the individual, government, or other companies/organizations.

Within Europe, it has become increasingly popular to focus on caloric intake and diet content using the government's power to tax foods that have a higher risk of causing obesity. For example, Hungary has instilled a tax on some foods due to high sugar, salt, or caffeine. Finland has a tax on certain confectionary products due to high sugar and fat content (Public Broadcasting Service, 2013).

However, the success of these types of methods is questionable. For example, France introduced a "soda tax" in 2012 to all sweetened beverages, including diet versions. In one study,

it was found that this tax contributed to a 10ml reduction in weekly purchases of soft drinks which equates to a 3% reduction relative to 2011 average levels. However, when compared to the 5% increase in price with the soda tax, this translated into a low own-price elasticity of -0.60 (Capacci, 2019).

Although the impact of these food taxes may not have as strong of an impact as governments were hoping, governments can use this extra tax revenue towards health initiatives like health education campaigns or subsidizing lower risk foods. Countries including France and Hungary have already used this approach, but this is a politically controversial move for the food industry and on an individual level (Public Broadcasting Service, 2013).

Other areas that these taxes could go towards include subsidizing wearable health decides like FitBits, funding healthy food delivery services like Hello Fresh, or funding GMO technology to increase the nutritional value of foods.

Where Private Companies Can Go

Key companies that have feasible areas of opportunities to incorporate physical activity into their products include Netflix and Apple. Each has their own unique set of products, creative direction, and potential for growth.

First, while Netflix has made moves to further engage their users through the recent launch of interactive "choose your own adventure" episodes, they have not quite gotten their users off the couch yet (Engelbrecht, 2017). This creates a prime area of opportunity for streaming services to venture into by incorporating physical interaction. This would further engage the user by incorporating more senses, thus creating a win-win scenario if companies can successfully incorporate these active components into their product.

For Netflix specifically, their strength is their large catalog of cult-favorite TV shows like *New Girl*, *Squid Game*, and *Floor is Lava*. Netflix could create a post-credits screen detailing to viewers how to play the games in these shows and encourage them to share these instructions with their friends. While the watching experience would still be sedentary, it would encourage users to try the challenges they just saw on the screen in real life like Squid Game's dalgona challenge or red light green light.

Apple is a great example of a company that has begun to encourage physical activity into their products, but there is still room for improvement. Although the Apple Watch is an accessory to the groundbreaking iPhone, Apple has taken fitness trackers to the next level. Although fitness trackers date back to the 1960s in Japan with the manpo-kei, FitBit was actually the first in the US to jump onto the craze with their first launch in 2009 (Rubin, 2018).

While the Apple Watch was originally developed to complement the iPhone and make its experience less invasive during the quiet moments of life, it has gone beyond a sneaky way to check your notifications at the dinner table. Through the implementation of Healthcare, the Apple Watch now keeps track of health data in the background and gives users notifications about mobility metrics including: Cardio Fitness, Six-Minute Walk Distance, and various metrics used to measure walking quality (*Healthcare - Apple Watch*, n.d.). Furthermore, Apple has used gamification to make daily movement fun through their 3 ring system. Each day, users can set moves, exercise, and stand goals for themselves that will be displayed proportionally through a ring in the "Activity" app. This creates a level of fun for the user, forces the user to set physical wellness goals for themselves, and gives a visual aid as to where they are in their progress throughout the day.

To continue this trend of physical activity, Apple could integrate video games into their Watch. Similar to how Wiis work, the paired iPhone could be used as a larger monitor displaying a game, while the Apple Watch acts as a controller. Users could punch, dodge, or dance their way to victory.

Conclusion

Efficient technologies have taken away the natural physical exertion from daily activities. This has contributed to America's obesity epidemic. We explored the stances for-profit companies, parents & teachers, and the government have on efficient technologies and the efforts they are making towards a healthier America. Entertainment in technology was chosen as the most feasible sector that physical activity could be incorporated into because of its dependency on the "fun" factor over speed. While there have been some successful moves made by tech giants like Nintendo to incorporate physical activity, many companies are still remaining conservative in order to maintain profitability and user buy-in. Although difficult, some companies are in a position where they can incorporate physical activity with their existing technology like Netflix and Apple. Ultimately, existing efforts made by various social groups are insufficient in combatting America's obesity epidemic. Thus, for-profit companies must acknowledge their role in it and focus their efforts towards health-promoting technological advancements.

References

Apple watch - close your rings. Apple. (n.d.).

Campaign for Commercial-Free Childhood. (2018, January 30). Facebook Messenger Kids. Fairplay for Kids.

Campaign for Commercial-Free Childhood. (2021, April 15). Fairplay for Kids.

Capacci, S., Allais, O., Bonnet, C., & Mazzocchi, M. (2019, October 11). The impact of the French soda tax on prices and purchases. an ex post evaluation. PloS one.

Carlson, S.A., Fulton, J.E., Pratt, M., Yang, Z., & Adams, E.K. (2015). Inadequate Physical Activity and Health Care Expenditures in the United States. *Progress in Cardiovascular Diseases 57*(4): 315-23.

CDC. (2021, April 5). *Childhood obesity facts*. Centers for Disease Control and Prevention. Retrieved May 3, 2022, from https://www.cdc.gov/obesity/data/childhood.html

CDC (2015, Nov. 6). U.S. Centers for Disease Control and Prevention. Prevalence of Sedentary Behavior.

CDC (2021, September 30). Adult obesity facts. Centers for Disease Control and Prevention. Retrieved April 18, 2022, from https://www.cdc.gov/obesity/data/adult.html

Engelbrecht, C. (2017, June 20). *Interactive storytelling on Netflix: Choose what happens next*. Netflix.

Google Trends Report for the term "Standing Desk" as of May 3 2022. (2022). Google Trends.

Hastings, R. (n.d.). How Netflix Changed Entertainment – and Where It's Headed. YouTube.

Healthcare - Apple Watch. Apple. (n.d.).

Hutt, G. (2017, July 11). *How technology is CRIPPLING physical activity without US REALIZING*. YouTube.

Is it Video Game Addiction or Not? Navigating Summer with Children during Covid-19. (2020). *Fairplay*.

K-12 education. NEEF. (n.d.).

Klein, H. K., & Kleinman, D. L. (2002). The social construction of Technology: Structural Considerations. *Science, Technology, & Human Values*, *27*(1), 28–52. https://doi.org/10.1177/016224390202700102

Long-Term View. Netflix. (n.d.).

Matusitz, J., & McCormick, J. (2012). Sedentarism: the effects of Internet use on human obesity in the United States. *Social Work in Public Health 27*(3): 250-69.

Mowen, A. J., & Baker, B. L. (2009). *Park, Recreation, Fitness, and Sport Sector Recommendations for a More Physically Active America: A White Paper for the United States National Physical Activity Plan*.

National Heart Lung and Blood Institute. (n.d.). *Overweight and obesity - what are overweight and obesity?* National Heart Lung and Blood Institute.

Nguyen, V. (2021). *The Success of Nintendo and Animal Crossing: New Horizons During the Covid-19 Pandemic* (thesis).

Nintendo (2006). Nintendo E3 2006 Press Conference. YouTube (2012).

NRPA (n.d.). National Recreation and Park Association. Health and Wellness.

NRPA. (n.d.). *Parks & Recreation in underserved areas*.

Public Broadcasting Service. (2013, April 11). How U.S. obesity compares with other countries. PBS.

Rubin, P. (2018, September 15). *How Fitbit Started the Wearables Craze and Got Us All Moving*. Wired.

SHAPE America (n.d.). Society of Health and Physical Educators. About SHAPE America.

Shape America (2013). Society of Health and Physical Educators. Teaching with Technology in Physical Education.

Simons, M., Chinapaw, M. J. M., van de Bovenkamp, M., de Boer, M. R., Seidell, J. C., Brug, J., & de Vet, E. (2014). Active video games as a tool to prevent excessive weight gain in adolescents: Rationale, design and methods of a randomized controlled trial. BMC Public Health, 14(1). https://doi.org/10.1186/1471-2458-14-275

The right mix of screen time, Nature time. NEEF. (n.d.).

Vasunilashorn, S., Kim, J. K., & Crimmins, E. M. (2013). International differences in the links between obesity and physiological dysregulation: The United States, England, and Taiwan. Journal of obesity.

Woessner, M. N., Tacey, A., Levinger-Limor, A., Parker, A. G., Levinger, P., & Levinger, I. (2021, May 28). *The evolution of technology and physical inactivity: The good, the bad, and the way forward*. Frontiers.

Xiao, Q., Keadle, S. K., Hollenbeck, A. R., & Matthews, C. E. (2014). Sleep duration and total and cause-specific mortality in a large US cohort: Interrelationships with physical

activity, sedentary behavior, and body mass index. American Journal of Epidemiology, 180(10), 997–1006. https://doi.org/10.1093/aje/kwu222