Health Technology in the Workplace: Leveraging technology to protect and improve worker health.

An Interdisciplinary Center for Healthy Workplaces Report.

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Introduction

Americans spend most hours of their waking day at work, which is directly affected by their health and well-being. However, the health of these workers is put at risk by unhealthy lifestyles – lifestyle factors like poor diet, sedentary lives, and unhealthy environments are at the heart of the disease burden in our nation. America leads most countries in the rate of obesity. Diabetes, now the number one burden of disease globally for the next decade, affects over 21 million Americans, and 33% of the US population is expected to have the disease by 2050 [1]. Depression, hypertension, diabetes, allergies and other medical conditions account for a significant portion of productivity losses in organizations. Furthermore, presenteeism – where workers are present at work yet have lowered productivity due to illness or other performance barriers – accounts for 75% of productivity losses, amounting to $12,000 per employee per year [2].

We are getting sicker as a nation and are facing staggering health care costs associated with preventable and chronic diseases. Health costs are increasing as Baby Boomers age and live longer and as many Americans continue to eat poorer food and live more stressful lives. Organizations are also facing often hidden, indirect costs in productivity losses. Employers will need to adapt the workplace to protect and promote health among this changing demographic in order to reduce these costs. It appears that the public and corporate America in particular is increasingly interested in becoming healthier, and employers can capitalize on this trend. However, most current approaches to improving worker health and well-being are very specific and narrow in focus such as diet programs, exercise regimens, health care benefits, disease management programs, and other interventions that are external to the work itself. This requires employees to choose between involvement in the optional program and involvement in other activities such as leisure, other jobs, or family responsibilities. It is no surprise that participation rates in these programs are so low, averaging 20%, thus severely limiting their effectiveness [3].

The design and structure of workplaces is likely to have promise in abating some of the stressors and in promoting behaviors to improve worker health and psychological well-being. Looking towards UC Berkeley as an example, recent studies conducted by the Center for Information Technology Research in the Interest of Society (CITRIS) have shown that technology can have a positive impact on employee health and well-being [4] [5]. These technologies do so by acting as a source of personal feedback on current physical and psychological states and as a source of real-time information designed to change employee behavior. CITRIS' work in the area of sensors may provide breakthrough information on how to change employee behaviors that were previously difficult to modify. Several factors have been identified by CITRIS that seem to positively affect knowledge-worker productivity and well-being such as low intensity physical activity, nutrition, air quality, interaction with nature, restorative environments, low noise levels, natural light, ergonomic equipment and furniture, privacy, and personal control over workspaces.

This report will examine ways in which technology can interface with work and organizational design to bring about new ways of improving worker health and psychological well-being. The report is based on research conducted by the Interdisciplinary Center for Healthy Workplaces (HealthyWorkplaces).

Objectives and Methodology

Objectives

The main research objective for this study is to investigate how technology can interface with the structure and operation of workplaces to create a healthier workforce. A secondary objective is to explore how companies are likely to adopt emerging technologies to promote healthier work behaviors by better understanding the factors and criteria companies consider when adopting health-enabling technology.

Methodology

In order to create guidelines for employers, HealthyWorkplaces conducted a series of meetings with experts and stakeholders (i.e., scientists, company executives) and created a technology inventory to address the following questions:

1. What do workers want and need in order to be most productive in their work environment?
2. How can information or feedback facilitate worker productivity and their sense of well-being?
3. What factors in the built environment are directly or indirectly related to workers' job satisfaction, emotional well-being, engagement in the work, interest in collaboration, formation of social relationships, triggers stress and discomfort, and triggers of physical activity?
4. How can emerging technologies be integrated strategically and innovatively to create healthy and productive workplaces?

Our first meetings were with workers in a variety of job types. Members of our research team are job analysts and followed a practice for identifying work performed by workers and the physical context in which tasks are performed. We focused largely on knowledge-workers for this initial study. This population can easily identify barriers to performance and elicit factors that create barriers to their health and well-being. A job analyst and graduate student researcher conducted interviews and observations with knowledge workers from volunteer organizations. Additionally, HealthyWorkplaces met with researchers and scientists from fields associated with health-related technology to learn about cutting-edge developments in each of their fields. We explored ways in which the developing technology may be directly applied to the workplace and to workers specifically in beneficial ways. Finally, we conducted meetings with decision-makers in a selection of companies to explore ways in which they might consider adopting emerging technology for the purpose of promoting employee health and well-being. We identified factors and criteria that significantly impact their adoption of such applications.

The technology inventory HealthyWorkplaces created is a non-exhaustive list of technological features that could be implemented in the workplace in order to improve employees' health and psychological well-being. Technological features cover mobile applications, wearables, devices, websites, data analysis and initiatives.

Interface between technology and the workplace

Much of today's generation of workers connect, share, discover, and work using some aspect of technology. They expect the technology tools they have embraced in completing work tasks and in their

personal lives to play a more integrated role in the workplace. Technology is a factor of the built environment that is directly and indirectly related to worker outcomes. Worker outcomes are largely influenced by a combination of physical and psychological states that determine the overall health and well-being of an individual. Integrating technology into the workplace that aims to improve worker health and well-being will ultimately improve the work experience and outcomes, such as job satisfaction and productivity.

It is necessary to identify the most relevant physical and psychological states that comprise worker health and well-being to know which technologies will have the greatest impact in the workplace. Organizational attributes, or workplace features and functions, shape the workplace environment and will affect these physical and psychological states. We know from experience and descriptive studies that poor physical and psychological states result in poor health and organizational outcomes, but we know very little about the relationship between positive physical and psychological states and positive health and organizational outcomes. Understanding how technology plays a role in the workplace as an organizational attribute will elucidate the link between organizational attributes and physical and psychological states.

Physical and psychological states

HealthyWorkplaces identified the following eight fundamental physical and psychological states that have the greatest impact on overall health status and organizational outcomes:

1. **Sense of Meaning and Purpose in Life**
   This includes feeling part of something bigger than oneself, contributing and making a positive difference. It includes having clear, longer-term goals, and working in accord with core personal values.
2. **Sense of Belonging and Social Connection**
   This includes enjoyment of positive relations with others, feeling valued, and feeling supported by others.
3. **Sense of Being Challenged and Growing Personally**
   This includes facing challenges that are stretching but not overwhelming and the feeling of growing and developing as a person.
4. **Sense of Autonomy**
   This is a general feeling of being in control of one's life and includes the feeling that meaningful choices are available.
5. **Sense of Accomplishment/Mastery**
   This includes the feeling of having the skills and confidence to do whatever is asked and that one are achieving, or on the way to achieving, important life goals.
6. **High Ratio of Positive to Negative Emotions**
   This involves experiencing on average more positive emotions (joy, serenity, awe, love, humor, hope, gratitude) than negative emotions (anger, fear, anxiety, depression). It includes self-acceptance, positive self-regard, and feeling balanced as a person.
7. **Feeling Safe and Secure**
   This involves feeling free from risk and danger, as well as free from worries and persistent negative thinking.
8. **Physical Health and Well-being**

This includes a balanced diet, sufficient physical activity (1.25 hours aerobic or 2.5 hours mildly aerobic exercise per week), and sufficient sleep and opportunities to rest/recover. Muscles and joints are uninjured, workers have a lack of disruptive pain, and workers are rested and physically comfortable.

Organizational attributes

HealthyWorkplaces aims to understand at a deeper level how workers respond physically and psychologically to a variety of organizational attributes in the workplace, and how adjusting these attributes can change behavior and desire to perform at work. Meetings with Emelieke Huisman, PhD Candidate and researcher at Hogeschool Utrecht, University of Applied Sciences, helped the HealthyWorkplaces Center identify the following organizational attributes that affect physical and psychological states:

- Building/office design, lay-out, location
- Work organization and design
- Health, safety, and environment
- Organizational culture
- Communications
- Compensation and benefits
- Human Resource (HR)policies
- Personal and career development
- Work-life fit
- Employee support
- Perceived justice/fairness
- Positive emotions/morale

Worker experience and outcomes

Effects of organizational attributes on outcomes

Given the list of physical and psychological states and the list of organizational attributes, HealthyWorkplaces seeks to answer these fundamental questions: (1) how do workers respond to these organizational attributes of their workplace and (2) how do we determine what workers want and need in order to be most productive in their work environment? Workers are motivated by different elements in the workplace that vary by demographic and individual experiences, so individual differences will be important factors to consider when creating recommendations for adopting certain technologies.

Integrating technology into the workplace that supports flexible work or that helps workers balance demands of work and personal life may contribute to overall increased productivity in an organization. Workers report that they are more productive and more engaged in their work and overall healthier when they are able to balance the demands of work with other aspects of their lives. Indeed, 86% of Americans consider work-life balance to be either "very important" or "extremely important" in their careers [6]. Research shows that flexible work arrangements may reduce stress because employees working flexibly are more satisfied with their jobs, more satisfied with their lives, and experience better balance with family responsibilities (otherwise known as work-family balance) [7]. In 2002, the Families and Work Institute

conducted a National Study of the Changing Workforce (NSCW) and found that workers in more flexible workplaces exhibited less negative spillover between work and family life [8].

Technologies that monitor and support daily work activities are crucial to ensuring predictability in the workplace. Workers report the need for predictability, which encompasses job security, a predictable environment, steady income with health benefits, as well as a pleasant, safe, harassment-free, non-confrontational workplace [8]. Predictability contributes to increased satisfaction, motivation, and productivity. In addition, financial rewards, such as stock options or profit-sharing, give employees a personal financial stake in company performance, which increases individuals' sense of identity with the company, leading to increased productivity.

Finally, health technologies that promote and support social interaction among workers may predict a more sustainable change in worker behavior. Social interaction and connection is also one of the greatest motivators for behavior change, since employees consider social aspects of the workplace to be valuable and rewarding.

Behavioral motivations for a healthy work life

Regarding employee motivation itself, no single set of factors has been found to adequately account for why people do or do not engage in healthy behavior. Awareness, attitudes, reactions to stress, and motivation for behavior change are certainly important individual determinants of health behavior according to the "State of the art reviews: Changing and adhering to lifestyle changes" [9]. Current views suggest that looking beyond the individual to the social milieu and environment can enhance the chances for motivating individuals to adopt healthier lifestyles. Integrating technology that supports worker health and well-being into the workplace to enhance the work environment can contribute to positive outcomes in workers. The most notable factors include:

- **Past behavior**
  Encompasses long-term behaviors that tend to be deeply embedded in the neurological system and are electrochemically reinforced.
- **Demographics**
  Includes the gender, education, ethnicity, marital status, and age.
- **Personality traits**
  Includes conscientiousness, delayed gratification, and goal direction.
- **Demographics**
  Includes the gender, education, and marital status.
- **Social support**
  Refers to support from others that can boost behavioral changes.
- **Family functioning**
  Refers to dependents who have a stake in one's health.
- **Ongoing contact with health advocates**
  Encompasses all reinforcement from health-minded co-workers and supervisors.
- **Social ecology or networking**
  Refers to strong alignments among wellness, benefits, safety, workers' compensation, and work-life programs.

Technology and organizations

Roughly 75 million individuals used mobile phones for health in 2014 in the United States, up from 14 million the previous year [10]. In fact, there are more than 100,000 health and wellness apps on the market today (April 2015). At the same time, just one in 10 American adults owns a fitness tracker [11]. However, these devices will become more widespread over the next decade from an explosion of personal monitoring devices that can collect data on everything from steps taken to breathing to heart rate, and apps and websites that sense the start of chronic illnesses or stress. The growth of technology for both personal and professional use makes integrating technology into the workplace a well-positioned approach to affecting the health and well-being of workers.

Technology needs of an organization

Employers and HR managers are continually seeking to make workplaces more dynamic and productive. These improvements include:

- Enhanced collaboration and innovation through global and virtual work teams; putting the best minds together to address a problem or opportunity, regardless of their physical location.
- Greater flexibility and responsiveness to address internal and external client needs.
- Increased cost-effectiveness by leveraging technology (less need for travel and corporate office infrastructure as more employees work virtually).
- Increased engagement and work-life balance for employees with flexible working arrangements.
- Decreased healthcare costs.

Such a shift to a more dynamic and productive workplace can be achieved by making employees feel better and healthier using technological features.

However, challenges to using technology invariably arise, such as:

- Less effective communication and collaboration if not used appropriately.
- Unintended negative consequences to organizational culture with dispersed virtual and on site employees (if not managed intentionally).
- Employee burnout due to the feeling of being constantly “plugged in” to email, voicemail, phone, etc. (regardless of their physical work location).
- Difficulties building effective working relationships among dispersed teams/work groups, especially if the team has never worked face-to-face or doesn’t have a previous history from which to build the team relationship.
- Remote employees in particular may struggle with feeling isolated and disconnected without the right mechanisms in place.

Left unattended, these can impact engagement and ultimately performance; effectively engaging, managing, and developing employees who are surrounded by technology is critical to getting the most out of both the technology and the worker.

Management and Motivational Theories

In order to understand how organizations can achieve employee needs, it is useful to re-examine management and motivational theories.

Psychological theories of motivation to increase motivation and well-being

Getting workers motivated to actually use and interact with health technology in the workplace could be difficult. For decades, social scientists have been trying to determine what motivates people's behavior, how they become motivated, and why. There are five widely accepted theories that stand out as addressing motivation to use technology in the workplace.

Hertzberg's Two-Factor Theory

The Two-Factor Theory of motivation (otherwise known as dual-factor theory or motivation-hygiene theory) was developed by psychologist Frederick Herzberg in the 1950s and identifies two factors that influence employee motivation and satisfaction:

- Motivator factors: if present, they can lead to satisfaction and motivate employees to work harder.
- Hygiene factors: if absent, they can lead to dissatisfaction and a lack of motivation.

This theory implies that for the happiest and most productive workforce, employers need to focus on improving both motivator and hygiene factors, which includes making sure employees feel appreciated and supported, giving feedback, and making sure employees understand how they can grow and progress through the company.

Maslow's Hierarchy of Needs

The Hierarchy of Needs theory, developed by psychologist Abraham Maslow, states that individuals' most basic needs must be met before they become motivated to achieve higher level needs. The five-level hierarchy consists of:

- Physiological - survival needs, such as food, water, and shelter.
- Safety - includes personal and financial security as well as health and wellbeing.
- Love/belonging - the need for friendships, relationships, and family.
- Esteem - the need to feel confident and be respected by others.
- Self-actualization - the desire to achieve everything you possibly can and become the most that you can be.

Elements of the workplace can contribute to each of these needs, meaning each workplace element has a potential to motivate workers. Technology can help employers support these needs for their employees, such as providing safety, improving professional relationships and social networks, reinforcing respect in the workplace, and supporting employees in achieving their goals. Also, employers can support employees in other aspects of their lives outside work. Once these basic needs are met, employers can hope to see an increased motivation among employees to be productive and engaged at work.

Hawthorne Effect

The Hawthorne Effect was first described by Henry A. Landsberger in 1950 who noticed a tendency for some people to work harder and perform better when they were being observed by researchers. The

researchers concluded that employees became motivated to work harder as a response to the attention being paid to them, rather than the actual changes in the workplace themselves. The Hawthorne Effect studies suggest that employees will work harder if they know interest is being shown is them, which could be applied in the case of technology by providing regular feedback and encouraging employees to give feedback and suggestions about their workspace and work experience.

Expectancy Theory

Expectancy Theory proposes that people will choose how to behave depending on the outcomes they expect as a result of their behavior. In this instance, workers may be more likely to work harder if they had been promised a pay raise (and thus perceived that outcome as very likely) than if they had only assumed they might get one (and perceived the outcome as possible but not likely). Employers should set achievable goals for employees and provide desirable rewards to motivate employees. Many technologies that incorporate goals and rewards to achieve better health or well-being outcomes will have better success in changing employee behavior.

Three-Dimensional Theory of Attribution

Attribution Theory explains how we attach meaning to our own behavior and others' behavior. Employers should give employees specific feedback emphasizing employer confidence in the employee's ability to improve and specifying steps for improvement. This, in theory, will help prevent employees from attributing their failures to an innate lack of skill and instead will show that success is attainable from harder work or use of different strategies.

Meetings with experts

We conducted a set of meetings with decision-makers from different organizations in order to explore ways in which emerging technology might be used for the purpose of promoting worker health and well-being. The meetings helped us focus on specific technological devices as well as defining an action plan to integrate technology into the workplace.

Center for Information Technology Research in the Interest of Society (CITRIS)

HealthyWorkplaces first met with David Lindeman, Director of Health Care at CITRIS, to get an overview of what companies are asking for in terms of health technology in the workplace. The CITRIS Health Initiative is built upon a robust history of addressing critical health and health care challenges facing society. The initiative is focusing on developing transformative, scalable and sustainable information technology solutions to improve health and psychological well-being. These technology-enabled solutions will improve the quality of care and health outcomes, while reducing health care costs and improving productivity.

HealthyWorkplaces also met with Brandie Nonnecke, Research & Development Manager of the Data and Democracy Initiative at CITRIS. Her research focuses on how information and communication technologies (ICTs) can be used as tools to support civic participation, improve governance and accountability, and foster economic and social development in order to help understand the limitations in data collection and privacy. The Federal Health Insurance Portability and Accountability Act of 1996 (HIPAA) seeks to strengthen privacy requirements and protect health information that has to remain private and secure. There is currently a big gap in the legal requirements between health data collected for a consumer's

personal use which is not subject to HIPAA and the use of this stored data by a third party which, as soon as that information is potentially exchanged with a third party, the data on the device fall under HIPAA regulations. Thus, when building software for a wearable technology or just a mobile application which plans to share the data with a third party such as an employer, it is essential for developers and health tech providers to understand HIPAA laws to ensure compliance before bringing a product to market.

These meetings at CITRIS helped us define the scope of the technological devices we will focus on as well as understanding the boundaries of it, namely, the privacy regarding the use of personal data by a third party which will be the case when employers will implement technology into the workplace. The concerns raised by privacy are the main obstacles to using health technology in the workplace, and that is why there should be further study on them.

The Young Men's Christian Association (YMCA)

HealthyWorkplaces met with Erik Halaas, the Director of Health Initiatives of the YMCA of San Francisco. Erik's goal is to make children from 5 to 14 years old in the Bay Area the healthiest children in America by the year 2020. To reach this goal, the YMCA must first have the healthiest employees, which is already being facilitated since employees are given free access to the YMCA's sport infrastructures. Erik wants to use technology and free employee access to facilities to reach the 2020 health goals faster and more efficiently. The goal would be to motivate employees to use the existing health-promoting infrastructures with the help of new technologies to enhance their work experience.

Even though the YMCA does not yet have any views on how they are going to get healthier employees, this meeting showed that the YMCA is one of many companies interested in implementing technology into the workplace. In this particular instance, they first aim to take advantage of existing resources – sport facilities in the case of the YMCA -- before fitting additional technology into the worker health promotion template.

Johnson & Johnson

Johnson & Johnson is working on a Digital Health project that would encourage positive behavior change that promotes health by providing tailored solutions on workplace improvements to big companies. Large companies that are interested in adopting health technologies are mainly looking for decreased healthcare costs and increased productivity. Some of these technologies include wearables such as Fitbit and Apple Watch. David Johnson, involved in the leadership program of this project, reported that the project was mainly employee-centered in order to offer a healthier life and larger discounts on health insurance. For instance, Johnson & Johnson is working on an alert that would help employees remember to take medication through a system that monitors if a pillbox is opened. They are also working on information tools that would help track the employee's health patterns and would allow doctors to give remote consultations via smartphones or computers. Overall, the project is developing into an innovative health app that will allow an individual to be aware of their health and be motivated to make changes.

The meeting with David Johnson highlighted the fact that insurance companies see the technological breakthroughs as a way to decrease healthcare costs – up to 30% according to David Johnson - which would also directly increase their own profits. This is why insurance companies have a great incentive to reckon their client companies into implementing technology within the workplace.

Center for Technology and Aging (CTA)

The CTA is a national leader in the use of patient-centered technologies for older adults by working with health care providers, aging service organizations, philanthropies, and technology companies to accelerate the diffusion of effective technologies. Valerie Steinmetz, CTA Program Director, says:

> *"Early technologies such as remote patient monitoring have proven successful in supporting care coordination and management for older adults with complex conditions and needs, leading to improved health and well-being and reduced health care utilization. Existing technologies are now moving off of purpose-built devices and on to off-the-shelf cell phones, smart phones, tablets, and personal computers. Meanwhile, a wide range of new consumer- oriented technologies is coming into use. These include activity trackers paired with mobile apps for virtual health coaching, web sites that help older adults and caregivers get access to critical resources such as non-medical home care, and provider platforms that can support increasingly mobile professional homecare workers, to name just a few."*

It is clear that decision makers in the healthcare, aging-services, and policy communities seek to create a new concept of "connected aging" that builds upon the concept of "connected health." Indeed, "connected health focuses on the use of telecommunications and Internet-based technologies to broaden the provision of care to non-clinical settings, such as the home and the broader community," stated Steinmetz. Therefore, some features of these technologies can be used to monitor individuals with chronic conditions to detect and prevent complications that can lead to acute, negative health episodes. In order to maintain employee health and well-being, "it is just as important to provide individuals with automated health coaching, based on monitoring vital signs, activity, and behavior" since connected health is about both providing the basis for timely, preventive treatment and for precluding the need for treatment through empowerment and self-management.

The meeting with the CTA showed that employers would benefit from having a specific focus on older employees in order to prevent chronic diseases, and also would benefit from postponing retirement if older employees prove to be as healthy and still as productive. We should recall that, by 2030, according to the U.S. Census Bureau projections, 18% of the U.S. population will be 50 and older and 25% of the population will be 60 years of age and older.

Summary

Our meetings with several leaders in health technology confirm that there is a great interest in implementing technology within the workplace in order to improve employee health and well-being. Although technology is continually evolving, much has already been done with existing technology.

Inventory

In order to know what is currently available to employees and employers, HealthyWorkplaces created a technological inventory which includes mainly wearables and mobile apps which could be used to improve worker health and well-being. These technologies might already exist in the personal market but are not yet implemented into the workplace. In addition, we examined and included innovative devices, websites, and technological health initiatives.

Technology landscape: different types of technology

All technologies provide some sort of information or feedback service. Typical outputs fall under four different categories:

- **First-layer feedback**, which includes biological and productivity feedback that help to reach personal and other goals.
- **Educational information**, which involves information about health and well-being.
- **Advice and counseling**, which includes all tips, advice, and counseling provided by mobile applications to help the user improve his health and well-being.
- **Interconnection**, which encompasses social and professional connection within the workplace by gathering employees and employers around competitions or activities.

These technologies also fall under three structural categories: Wearables, mobile applications, and hardware and other devices.

Wearables

The emerging landscape of wearable technology promises to change the way people perform fitness, monitor emotions, and communicate. With hundreds of wearable devices (smartwatches, health monitors, pedometers, activity trackers, virtual reality headsets) on the market, users can track almost any aspect of their health by providing real-time feedback in an un-invasive way from steps to calories and blood pressure, without even having to think about it -- which makes them specifically adapted to a workplace setting. They could even be used in a friendly competition among employees, which increases engagement and incentive to perform, since employees could even be able to bring their own devices which would only lead the company to provide feedback and organize interaction between the employees.

Mobile applications

Research shows that almost two-thirds (65%) of American adults have a smartphone [12]. About half of these smartphone users have downloaded at least one application (app) that is intended to support healthy living, and 19% of all adults have downloaded and also routinely used at least one such app. This means that almost one of every five people are regularly using mobile technology to support healthy living. Among full-time employees, this percentage climbs to 23%.

These mobile health and fitness apps comprise a significant segment of the app universe. While there are many different types of health and fitness apps, we can include many of these apps in the global category of wellness apps which includes those that support diet and exercise programs, pregnancy trackers, behavioral and mental health coaches, symptom checkers that can link users to local health services, sleep and relaxation aids, and personal disease or chronic condition managers.

These apps vary widely in how they interact with users: some are interactive while others are simply informational. Consumers use some to participate in a program, and others to look up information about diseases or medications, nutritional values of restaurant food, to highlight just a few examples. A number of apps are also simply mobile magazine subscriptions for health and lifestyle publications.

Hardware and other devices

We can gather the remaining technology types, other than wearables and mobile applications, into devices and hardware, such as smart chairs that measure worker posture and how long he has been sitting, or smart work surfaces that know when the worker is present, and movement sensors to record physical activity. In addition, wireless sensor technology enables sophisticated monitoring and logging of temperature, humidity and lighting.

Going further than technology itself, we are seeing more and more organizations implementing technology initiatives, such as GameBreaks@Work, PopCap Games and Goji Play. Contemporary theories, derived from early 20th century scientific management (Taylorism), identify cultural norms that may affect worker health. Some preliminary evidence suggests that flexible working arrangements such as flextime and telecommuting, which give workers more choice or control, are likely to have positive effects on health and well-being. In addition, transforming portions of a work site's physical environment also can influence employee health behavior. For example, based on research on the recovery process, Leonard Reinecke identified several aspects that support the suggestion that computer and physical games may fulfill the function of recreation and recovery from stress and strain in the workplace. Specifically, casual games, downloadable computer games with small file sizes, or online games are played by many office workers to unwind and to escape stress. Recent experimental data suggest that playing games after a demanding task might help to improve cognitive performance and concentration [13],[14]. Consequently, playing games during working hours might provide an effective means of light fitness and recuperation.

To explore one health technology initiative further, HealthyWorkplaces met with Panpan Wang, Director of Sales & Partnerships at Jiff to discuss their unique health service. Jiff is a health tech service provider which provides organizations with a health benefits platform that delivers personalized incentives and real-time data analytics in order to target individual employee cost drivers and increases utilization of services that have been shown to save money. The company monitors its own platform and application that is connected to employees' wearable devices. Jiff engages employees in their own health and well-being where employers can decide the extent of the platform – to have company or individualized goals, provide incentives, connect to wearables, etc. Jiff is currently working on connecting employees to their company's benefits/medical records as a future platform feature. The company collects employee data and sends it securely to Jiff where it is analyzed to understand how employees are using the platform and see if the platform is helping the organization and individuals reach their health goals. Platforms such as this aim to increase participation by offering incentives and personalization.

Technology landscape: currently on the market

In this section, we categorize the technological features currently being studied and implemented in workplaces under three separate headings: the individual, the workplace, and communication. Technologies that fall under the category of "the individual" primarily support the health and wellness of employees by monitoring physiological and mental health status (Table 1). Technologies that fall under "the workplace" are generally based on technology that is currently used to monitor the home (Table 2). While a connected home environment is still evolving, "smart home" technologies could already be implemented in the workplace. Technological devices can also enable employees to maintain and

strengthen their social ties to other individuals in the workplace and facilitate more efficient communication, thus falling under "social" (Table 3).

Table 1: The Individual: Technology to monitor employees' physiological and mental health status

Category	Description	Example products
Vital sign monitors	Technologies that measure vital signs such as weight, blood pressure, blood glucose, heart rate, temperature, and hydration. Some products are designed to measure multiple vital signs in one package. This could prevent employees' illness.	• AliveCor Heart Monitor • Basis Watch • Blood pressure monitor and scale • Fitbit Aria scale • Fitbit Flex • Jawbone UP • Nike+ Fuel Band • Samsung Gear • Scanadu Scout • Azoi • Ginger.io
Activity monitors	Set of activity tracking products that measure steps taken, speed, activity level, calories spent, and amount of sedentary time. Most activity monitors are wrist-worn devices, while others can be carried in the pocket or attached to clothing. Smart phones and Smart Watches contain internal accelerometers that enable them to track movements.	• Fitbit Flex • FitLin Pebble • Jawbone UP • Misfit Wearable's Shine • Withings Pulse • Fooducate
Sleep monitors	Individuals and clinicians use these products to monitor sleep in order to adjust behavior (caffeine intake and other elements of sleep hygiene) or to provide indications of other issues that might require a professional intervention, such as sleep apnea. This could prevent fatigue at work which decreases employees' productivity.	• BAM Labs • Smart Bed Fitbit One Lark Pro sleep monitor • Withings Aura • Dreem

Category	Description	Example products
Mood/depression monitors	Mood/depression monitors provide objective sensing of a person's mood, though their efficacy is not clinically substantiated, which could still help create a better positive work environment.	• M3 (Android and iOS app) • Mood Scanner (Android app) • Neumitra
Emotion monitors	Some products enable objective, long-term monitoring of emotions. For instance, one product is a wearable, wireless biosensor that can detect a body's "harmonic frequency." With a deep analysis tool it can learn the dynamic shift in a user's autonomic nervous system capture anxiety levels.	• ACogito's Social • Phyode W/Me wristband • Signal Platform (SSP) and Cogito Companion
Medication adherence systems	Medication adherence devices provide medication reminder alerts via interactive voice response, text messaging, or e-mail. Products are available as multi-day container trays or as lids on pill containers. If an individual does not open a compartment of a pillbox (or the lid of a pill container) after receiving an alert, the device can notify the individual as well as a remote caregiver via text or e-mail, which will make sure employees stay medicated and thus, fully involved in their work.	• ActualMeds • MedMinder May and Jon • Pilljogger App and MedWheel cartridge for smartphone • RxAdvance Pillstation Vitality GlowCap • MediSafe • HealthTap
Medication dispensers	Medication dispensers provide the right dosage of medication to a person when his/her medication is due, avoiding harm that can be caused by an overdose.	• InRange System's Emma • Phillips Lifeline pill dispenser and service

Table 2: The Workplace: Technology from smart homes to monitor activities of daily work

Category	Description	Example products
Fall detection	These technologies can detect falls and automatically call for help when an employee cannot get up on his/her own and thus increase work safety.	• MobileHelp • Phillips Lifeline with AutoAlert System • SafetyCare EMTWatch FallDetect
Environment sensors/ passive monitoring sensors	Many different sensors are used in passive sensing to improve the home environment and can equally be applied to the workplace. Sensor products can monitor a number of items: motion patterns, carbon dioxide or carbon monoxide levels, presence of smoke, air quality, humidity, and fire. Motion sensor products employ algorithms to automatically detect movement aberrations. Those sensors also increase work safety and the indoor quality.	• Care Innovations • Lively • Lowe's Iris system • Quietcare CarePredict • Tempo • WellAware Systems • Silentium • IntelligentM
Video monitoring	Video cameras can monitor an employee's activities of daily work or provide caregivers who are at work with direct video feed on a smart phone, tablet app, or on the web.	• Guardian Medical Monitoring's • Lorex LIVE • Netgear VueZone • Virtually There Care • ProtectYourVision

Table 3: Social: Technology to monitor employees' social life

Category	Description	Example products
Physical and cognitive gaming and training	Technologies include online or mobile app-based cognitive games as well as physical interactive games which helps increase productivity at work	• GameBreaks@Work • Games.AARP.org • Happy-Neuron.com • Jiff • lumosity.com • PositScience.co • Respondesign • Wii Fit

Category	Description	Example products
Social contribution	Technologies that support personal activities and societal contributions include websites that enable employees to pursue their hobbies, make charitable donations for philanthropic projects, and volunteer.	• Causes.com • Charity Miles • Razoo.com • SeniorCorps.org • TapRootFoundation.org • RallyFit • Pact

Using technology to improve worker outcomes

Is technology a right fit for employees?

Many industries are considering making wearable tech, mobile applications, hardware, and technological devices permanent fixtures in the workplace. From the medical field to office work to engineering field, technology has much to offer. It is necessary to understand early on how employees will be affected by companies that introduce such technology. These features have the potential to impact health insurance benefits, efficiency, or performance, among other outcomes. Technology can accomplish many things, but employee input should be a major factor in deciding whether they should be a part of the work experience since these inputs will significantly change the individual's work environment. It is therefore important to consider if certain technologies are a right fit for the individual employee and how his work experience might be improved by it.

Current implementation of technology

Wearables

Wearable technology is big in the consumer market and holds even bigger promise for boosting workplace productivity and employee health, according to employees. Nearly two-thirds of employees would be willing to use wearable technology if it helped them do their job better. By the word 'willing', we can underline the fact that employees wouldn't necessarily choose to use it on their own, but wouldn't resist. The devices may look in-style on their wrists, yet only 17% of employees who aren't already wearables users think it would help them boost productivity. Only 12% of employees currently use wearables for work-related tasks, but of those who use them, 71% say they make them more efficient and more productive at work, which is promising for the future of wearables in the workplace [15].

A study by Goldsmiths University found that using wearable technology devices boosts productivity by 8.5% and increase job satisfaction by 3.5% [16]. The study looked at 80 workers, who were given one of three wearable devices for three weeks. The three devices were Lumo Back, which monitors and prompts the wearer to improve their posture, NeuroSky, a headset that uses sensors to translate brain activity into action and GeneActiv, a wristband that gathers motion data. Half of those using GeneActiv and 46% of those wearing NeuroSky reported an improved performance at work, compared to just 36% of those using Lumo Back saying that the device improved their performance. However, the researchers said that this

could be down to users finding the posture monitor disruptive due to the prompts to sit up straight. Those results are an example of the Hawthorne effect.

Since wearables contain private information about employees' work style and lifestyle, companies must get employee buy-in to access that information. More than three in four employees would wear devices that track job performance and productivity and give their employers access to that information [17]. Productivity aside, many companies introduce wearable devices for health and wellness benefits alone. Four out of five employees would use company-provided wearable that tracks health and wellness and provide that data to their employer [5]. Additional perks or compensation - such as a 5% end-of-the-year bonus, reduced health insurance premiums, exercise program discounts, extra vacation days, flexible schedule, and less work hours would encourage sign-ups.

Not long from now, wearables will be commonplace, since 72% of employees believe that wearable technology in the workplace will eventually be the norm, even if it may take a little while for the trend to catch on [18].

Mobile Applications

Ninety-five percent of employees report bringing their own devices at work -- mostly a smartphone -- and a third of them are already using health and well-being related mobile applications to self-monitor and motivate them to have positive, healthy behavior [19]. Mobile apps are existing resources that workers currently use on their own, and have potential to be used on a larger, more involved scale by employers at organizations.

Hardware and other devices

Game breaks flourish in today's workplaces, such as Blue Goji's "GameBreaks@Work," financed by Coleman Fung. This interactive fitness technology provides controllers that can be attached to most exercise equipment (stationary bikes, elliptical machines, treadmills, stair-steppers) in order to play a variety of games, while tracking the employee's fitness.

Employers making a positive impact with technology

Many employers believe that connected workers could create an entirely new way of working using new technologies among a new generation of mobile individuals, with implications that can be felt in the office as well as in the home office. Indeed, there is a strong belief that wearable technology will take off in the workplace before the home because devices such as smart watches, intelligent ID badges, and fitness and health monitors can provide organizations with opportunities to greatly improve safety, productivity, collaboration, and overall workplace effectiveness. This new workplace definition is the result of industry trends in technology and work habits, and poses important challenges for the organization supporting the workplace.

Above all, employers can make a substantial difference in employee well-being by encouraging workers to use health-related mobile technology, apps, and wearables. Specifically, employers can take the following actions in order to make a positive impact:

- **Lead by example**. Employers should make time at company events to show employees a health-related app on their smartphone and explain why they like it. This would likely inspire action among workers, and it can especially be strengthened when this behavior is reinforced regularly.
- **Highlight a "Feature of the Month."** Managers should create a standing agenda item at employee meetings to share one new technological feature that is meant to improve health or well-being. They can also encourage employees to share their experiences with favorite features.
- **Test the usefulness of wearables, apps, or hardware within the workplace.** Employers should not assume that having a wearable or downloading an app or hardware will guarantee it will be used -- or that its use will improve well-being. In order to promote both actions, employers should create a log on the company intranet site that tracks download and use, ask employees to rate their usability and value, and then share the results at company events.
- **Set up team competitions to promote the use of well-being apps.** Three key requirements for making the most of health-promotion apps are knowing what to download, understanding how best to use that app, and being motivated to keep using it routinely. Team competitions -- such as counting weekly steps -- will inspire team members to complete all three requirements.
- **Assign technology champions at every department.** Employers should establish a go-to person in each department or within IT who can help new users download well-being apps and understand how to use them.
- **Make technology use easy without forcing it.** Indeed, not all employees are motivated by the same activities. Even technology-savvy workers may not be interested in or motivated by using well-being apps on their smartphones. Thus, managers can be key advocates in helping employees find the right activities and actions that will give their well-being a boost.

Concerns: Costs, ROI, Privacy and Ethics

Even though the pros can seem to outweigh the cons of using technology to make workers healthier, potential limitations and concerns still exist from the employer's point of view. For starters, despite the "cool factor" gadgets can bring to the workplace, organizations shouldn't expect a majority of their employees to participate in using technological devices, except if strong incentives are given. The cost of wearable devices is also another potential obstacle. Indeed, prices will need to drop considerably before they become the norm in the workplace since there is currently a lack of evidence for ROI for HR and wellness departments to invest in technology.

Another concern regards privacy, since some employees may hesitate or refuse to share personal activity data due to privacy concerns. Currently, many fitness trackers' privacy policies are vague and changing, even though privacy risks are relatively low for employees. Primary data being collected, such as activity, steps, and calories, are nondescript. For instance, Fitbit offers employer wellness programs with privacy agreements meant to prevent employers from accessing information employees haven't agreed to share. Instead of seeing specific results from individual employees, company wellness plan administrators receive reports from Fitbit in aggregate form.

These privacy issues overlap the ethical issues raised by a GPS tracker or wearable that travels with an employee outside of work which could help paint a detailed picture of that person's private life. Devices could record enough data to make detailed profiles of individual employees: their lifestyle, exercise, and sleep habits. In the future, bosses could rely on such profiles of their employees to make daily decisions depending on who's had a good night's sleep, for example. Conversely, people could use their tracker data

to put together "biometric CVs" that prove they're particularly well suited to jobs that take place at unconventional hours or under stressful conditions.

From an alternative perspective, companies may need to restrict or ban certain type of wearables to protect their own privacy where employees have access to valuable intellectual property, since employees could use them to record and collect proprietary information. Also, devices that are plugged into a corporate laptop or desktop through a USB port could pose security threats – by introducing viruses or malware into the company's system. Private corporate information could be downloaded onto the device, resulting in the exposure of customer or vendor information such as social security or credit card numbers, which may result in financial and reputational damage for the employer.

Discussion

Implications

Employers and employees are seeking much of the same goal, which is health and well-being, but not always for the same purpose: employees are looking for health in itself to feel better, live longer, and live happier, whereas employers are looking for improved collaboration and engagement to in turn increase the overall productivity of a company and decrease healthcare-related costs.

Whether it is wearables, mobile apps, or hardware devices, it seems that health- and well-being-related technology is expected to have a huge impact on employee welfare; in fact, by implementing technology into workplace programs, an organization will be able to use incentives to reward behavioral changes in its employees while tracking their health over time. Sustained behavior change will be more likely if an employee is aware that the organization is actively tracking their performance on the health scale; however being monitored may not be enough incentive to get every worker out of their seats. Adequate communication in an active healthy culture is one factor that needs to be taken into account in order for employees to understand the benefits of health technology in the workplace. To improve communication, organizations should discuss the health and well-being data that is gathered and ensure employees are aware of its relevance and what it means in order to promote a healthy lifestyle. In addition, employees also need to discuss how they perceive their work environment and what they might need to improve their health in the workplace and beyond their work.

Competitions have potential to be a main feature of employee engagement. Also, aids to help manage mental illness within the workplace, such as depression or emotional states such as feeling stressed, could be introduced. Various devices such as Google Glass, HealthKit from Apple, FitBit, and Pulse bands are some of the most likely candidates to be adopted by corporations in a bid to get their employees up, healthier, and more productive. By tracking for example heart rate, food consumption, activity, and exercise, employees will become more aware of their overall health and take action against sedentary lifestyles, which would consequently improve their well-being and overall performance at work as well as decreasing healthcare related costs.

A promising future

An intrinsic property of technology is that it quickly evolves, making it more difficult to understand the increasing variety and versions of product offerings, capabilities, and functionalities that will be available in the upcoming years. Research tends to support that, for instance, Apple's entrance into the market will not only lead to a spike in adoption, but the increased competition and new development platforms will drive innovation. This tells us that we are only beginning to scratch the surface of the health technologies that are being developed. The current trends show that the workplace is going to witness more and more changes in the world of health and well-being. Indeed, more competition will drive down the cost and increase the democratization of the studied technological devices, hopefully making such technologies more accessible to and cost-effective for employers. Innovation itself will allow more accurate tracking of one's health through different features and better self-monitoring.

Regarding the privacy concern, HIPAA is being updated on a regular basis in order to strengthen privacy requirements and protect health information which must remain private and secure. Also, as wearables and health and well-being apps becomes more popular, the United States Department of Health and Human Services (DHHS) will likely begin issuing more guidance around the collection and sharing of wearable-collected data to ensure it conforms to the privacy and protection standards outlined in the HIPAA rules. The upcoming laws will therefore ensure a better future with respect to employees' privacy.

Challenges

Since the implementation of technology in the workplace is still in its early stage, there are too-few current data that can show the effect of technology on employees' health and well-being, leaving the issue open to question future of technology in the workplace. We can take, for instance, the specific case of gamification at work. The study of Leonard Reinecke shows that negative effects of the use of games at work do exist as computer and physical games demand high concentration from the player. After long gaming sessions, the resources consumed to play the game might exceed the recovery effect of the gaming experience. Hence, instead of facilitating recovery, prolonged gameplay may have the opposite effect and may even increase exhaustion. However, the data do not exist for these scenarios. Frequent and prolonged playing could also cause conflicts with colleagues and supervisors. These potentially harmful effects of playing games at work still have to be investigated in future studies.

In addition, the use of technology that gathers data raises many concerns, even though it can be a benefit to both employer and employee. Where the line should be drawn on what data to collect is still blurred. Some employers may allow employees to decide if their data is used to analyze productivity, but other employers won't. It is not difficult to imagine a future where wearables are compulsory and failure to meet health and wellbeing objectives is penalized. Another interesting challenge regarding wearables and apps in the workplace is deciding who will take control of this data first -- the employer or the employee. Will an employee be able to speak to their employer about what their data means and how it correlates to their productivity? Or will the employer file away the information and not relate it to the individual? We could imagine a manager knowing that an employee only had a few hours of sleep the night before and using that information to pre-determine poor levels of productivity. How would the employee react to this use of their lifestyle (and some might say personal) data?

Going beyond technology

Although many people may love new technology, it is unclear if it can make a lasting and sustained impact on wellness programs. Wellness fads tend to come and go, and surveys [6] show a big participation drop in health technology usage after a couple months. Ultimately, regarding technology adoption and interaction, this involves behavior change on a large scale. It is very difficult to motivate workers to change their behaviors. Novelty alone won't motivate workers to exercise more or eat healthier, for instance. Technology is a good start, but employers and employees need more evidence before considering integrating apps or devices into companies' wellness programs. There is no one-size-fits-all solution to workplace wellness, of which technology should in some way be a component. Wearable devices, apps, and other technology may not be a good choice for all even though some employers have success with them. Technology is not a magic wand, though at first it may help to make a significant positive impact in the workplace. Employers and employees must go beyond technology to incorporate health and well-being into the workplace culture in the long run.

Summary

Employers' growing desire to support employee health and wellbeing, desire to increase worker efficiency, productivity, and safety, and need to decrease associated healthcare cost is driving the adoption of technological devices in the workplace, which is expected to continue in the near future. The current biggest attraction of technology for employers is its ability to generate real-time data in an un-invasive way, which can elucidate drivers of poor health in the workplace and, ultimately, reduce worker health risks.

Nonetheless, concerns still exist about data protection, worker privacy, information security, and return on investment could hinder the growth of the integrated workplace technology market, as well raise fears that some employers may opt to use data to monitor workforce activity rather than use it for workforce health benefits. It appears that the current, efficient ways to integrate technology into the workplace is using technology as part of a workplace program that uses incentives as reward for behavioral changes. Introducing competitions and other engagement tactics alongside technology can encourage individuals to make positive changes to their lifestyle. Technology aids for health are gaining traction, with a number of apps and devices being developed to ameliorate issues such as stress and depression and support healthy lifestyles.

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