Empowering people to live a healthier day

Innovation using Apple technology to support personal health, research, and care

July 2022

Introduction

Too often health is something we try not to think about. We avoid talking about it. We put it off for another day, a better time. Then, something unexpected happens: an illness, an unfortunate incident, or even, as we've seen these last two and a half years, a pandemic. Suddenly, health becomes everything. Nothing matters more.

Apple is working to change how people think about, talk about, monitor, and focus on their health. We feel drawn to this work not only because of the opportunity to help advance human health but because we are driven by our principles to devote talent, resources, and expertise to where we can do the most good. We believe passionately that technology can play a role in improving health outcomes and encouraging people to live a healthier day.

This report offers a snapshot of our work to advance health. Since the beginning of our journey, the health innovations we've pioneered have aimed to help break down barriers between users and their own everyday health data, between health care providers and patients, and between researchers and study participants.

Our work primarily falls into two categories, described in two corresponding sections of this report: personal health and fitness features on Apple Watch and iPhone, and the work we are doing with the medical community to support research and care. With iOS 16 and watchOS 9

available this fall, Apple Watch and iPhone will offer features that focus on 17 areas of health and fitness, available in nearly 200 countries and territories around the world. Users write to us nearly every day sharing how Apple Watch and iPhone are helping them learn more about their health. We've had the privilege to partner with some of the world's leading medical institutions and researchers to support public health studies, which have already provided insights, while only in their early innings. And we're excited about the ways third-party institutions and organizations are using Apple technology to build new experiences to improve physicians and patients' conversations and offer innovative wellness programs.

Our vision for the future is to continue to create science-based technology that equips people with even more information and acts as an intelligent guardian for their health, so they're no longer passengers on their own health journey. Instead, we want people to be firmly in the driver's seat with meaningful, actionable insights. Our priority has always been the trust of our users, and — in keeping with our belief that privacy is a fundamental human right — every user should have the option to choose who they share their data with and what they share.

We intend to stay on this path, because nothing matters more.

– Jeff Williams
Chief Operating Officer

Eight years into Apple's journey in health, a snapshot of how Apple products are empowering people to be at the center of their health and to live a better day

Apple's work to advance health

Empowering users on their personal health journey

Health data in one place

•

Intelligent guardian for users' health

•

Features to improve everyday health and fitness

•

Fueling innovative third-party health and fitness apps

Supporting the health ecosystem by collaborating with the medical community

Equipping researchers to make new scientific discoveries

•

Strengthening the physician-patient relationship with meaningful data

•

Health organizations promoting healthy lifestyles with Apple Watch

•

Supporting public health and government initiatives

Executive Summary

A growing group of health and fitness features on iPhone and Apple Watch offer actionable, science-based insights that break down barriers between users and their health information — all designed with privacy in mind.

With iOS 16 and watchOS 9 this fall, Apple Watch and iPhone will offer features that focus on **17 areas of health and fitness**, from heart health to sleep, women's health, mobility, and more. These features, available in nearly 200 countries and territories, provide users with high-quality data gathered throughout the day and night and meaningful insights into their health. Apple believes that providing individuals with insights into their health and fitness empowers them to set and stick to personal health goals and, when necessary, seek guidance and care from their medical providers.[i]

The Health app is available on every iPhone, and acts as a central and secure place for users to view all of their health information. Users can now store **over 150 different types of health data** from Apple Watch, iPhone, and connected third-party apps and devices, in addition to available health records data from connected institutions in the US, UK, and Canada. They can also choose to share certain types of this health data with loved ones.

Our APIs are enabling third-party developers to create **new solutions** that promote healthy lifestyles and innovation in health. There are now **tens of thousands** of apps on the App Store that use our HealthKit API, so they can incorporate data users choose to share from the Health app to offer innovative health and fitness experiences, with rigorous privacy and data security protocols. With users' permission, these apps can also contribute data back to the Health app.

When users are equipped with their own everyday health data from Apple Watch and iPhone, they have the ability to share that data with researchers to help advance science.

Apple collaborated with Stanford to build the Apple Heart Study, which was a **first of its kind in the medical community and the largest virtual cardiac clinical study** during its time. It paved the way for Apple's work with some of the world's leading institutions to build **three first-of-their-kind research studies** to advance the science across women's health, hearing health, heart health, and more. Apple features and technologies have made it easier for researchers around the world to develop **cutting-edge medical studies** at unprecedented scale.

The medical and research communities are using our devices, APIs, and frameworks to pioneer new ways of engaging with patients.

Health institutions are using Apple devices, APIs, and frameworks to strengthen the relationship between physicians and patients with **meaningful data**, and enable **care from anywhere**.

Health organizations and insurance companies around the world have collaborated with Apple to integrate Apple Watch in their wellness programs to promote healthier behaviors and **improve individual health at a large scale**, with a focus on privacy.

All of our health and fitness features have been developed with two overarching principles:

They are all subject to rigorous **scientific validation processes**, in collaboration with medical community experts.

Our features put our users' **privacy at the center** and provide users with protections including transparency and control. Data privacy is critical for sensitive health data.

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i.   Some features may not be available in all regions or all languages, or on all devices.

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Empowering users on their personal health journey

Since the release of the Health app in 2014 and Apple Watch in 2015, Apple has introduced a wide array of innovative health and fitness features to help our users take care of their health every day. At Apple we believe health is the combination of health and fitness, and the goal of these features is to provide users easy-to-understand, meaningful insights so they can be empowered to live a healthier life.

Our in-house clinicians are deeply involved in the product development process and work hand-in-hand with our engineers and product designers. This, combined with our collaboration with experts from leading research institutions, ensures that our products and features are grounded in science and user-friendly.

Below are the four categories in which we think about our health and fitness features, with longer descriptions of each to follow.

Health data in one place. The Health app on iPhone was Apple's first health feature. With the Health app, users can see their health and fitness data in one central and secure place, including data from Apple Watch and iPhone, connected third-party apps and devices, and connected Health Records institutions. Health data can be some of the most personal data people have, and in keeping with Apple's belief in privacy, we design all of our products and services so users are in complete control of their data. Health app data is never shared with any third party without the user's explicit permission.

Apple Watch acts as an intelligent guardian for users' health. Apple Watch is equipped with features to notify users of possible underlying health conditions so they have agency to act on this information. We leverage the powerful sensor technology in Apple Watch that millions of users worldwide are wearing on their wrists every day, combined with iPhone, to create breakthrough capabilities in heart health, mobility, hearing health, safety, and preventative health features.

Features to improve everyday health and fitness. Many aspects of people's health are the culmination of small lifestyle choices that they make every day, like regularly exercising to improve cardio fitness, moving throughout the day, reaching their sleep goals, keeping track of their menstrual cycle, or practicing mindfulness with breathing exercises to stay relaxed and focused. Apple Watch is a holistic health and fitness companion that not only tracks daily activities, from activity to sleep, but over time also proactively highlights important changes in health and fitness.

Fueling innovative third-party health and fitness apps. With our HealthKit framework, we've also made it easier for third-party developers to create apps that use Apple Watch and iPhone sensors and certain data types that users choose to share from the Health app, to create new health and fitness experiences. By using our tools to build innovative third-party health and fitness apps, developers expand the opportunities for users to take control of their health and fitness.

An overview of health and fitness features on Apple Watch and iPhone

ACTIVITY
▷ Activity rings
▷ Activity coaching
▷ Workout tracking with validated metrics
▷ Activity sharing
▷ Activity competitions
▷ Fitness+
▷ Fitness app on iPhone

HEART HEALTH
▷ High/low heart rate notifications
▷ Resting, walking, and post-workout heart rate
▷ Heart rate variability
▷ ECG app
▷ Irregular rhythm notifications
▷ Cardio Fitness
▷ Cardio Recovery
▷ AFib History

SLEEP
▷ Wind Down
▷ Sleep tracking
▷ Sleep stages

RESPIRATORY
▷ Respiratory rate during sleep
▷ Blood Oxygen

MOBILITY
▷ Fall detection
▷ Walking Steadiness and notifications
▷ Mobility metrics like double support time, step length, six-minute walk, and more

HEARING HEALTH
▷ Headphone audio levels and notifications
▷ Noise app and notifications

MINDFULNESS
▷ Mindfulness app
▷ Meditation in Fitness+
▷ Focus

EDUCATION
▷ Articles in the Health app
▷ Mobility exercises in the Health app and Fitness+

COVID-19 RELATED
▷ Exposure notifications
▷ Verifiable COVID-19 vaccination and test result records

HANDWASHING
▷ Automatic handwashing detection and reminders

SAFETY
▷ Emergency SOS
▷ Medical ID

WOMEN'S HEALTH
▷ Cycle Tracking
▷ Period prediction and fertile window prediction
▷ Symptom tracking
▷ Cycle factors
▷ Workouts for Pregnancy and Get Back to Fitness After Having a Baby Fitness+ programs

MEDICATIONS
▷ Set up a medications schedule and reminders
▷ Medications education and alerts for potential critical interactions

RESEARCH
▷ Research app, including Apple Women's Health Study, Apple Heart and Movement Study, Apple Hearing Study
▷ ResearchKit
▷ CareKit

HEALTH SHARING
▷ Sharing health data with family, friends, and healthcare providers

DATA VISUALIZATION AND INSIGHTS
▷ Trends
▷ Highlights and favorites

HEALTH RECORDS
▷ Immunizations
▷ Allergies
▷ Conditions
▷ Medications Records
▷ Clinical Vitals
▷ Lab Results
▷ Procedures
▷ Export a PDF of all available health records

ACCESS TO DIVERSE AND INNOVATIVE THIRD-PARTY HEALTH AND FITNESS APPS

and many others…

Health data in one place

The Health app is a secure place to collect and share health data.

The Health app was Apple's first health and fitness feature, creating a central and secure location for all of a user's personal health information on iPhone. With the introduction of Apple Watch, the quantity and quality of health insights available to our users in the Health app significantly increased. Today users can store over 150 different types of health data from Apple Watch, iPhone, and third-party apps and devices in the Health app, in addition to available health records data from connected institutions in the US, UK, and Canada.

Data from the many health and fitness features described in this report is available in one central view in the Health app, and features like Trends allow users to identify important changes over time. With Health Sharing, users can also choose to share certain types of this health data with a trusted partner or caregiver.

Privacy and control over health data

At Apple, we believe that our users' data only belongs to them.

When iPhone is locked with a passcode, Touch ID, or Face ID, all health and fitness data in the Health app — other than Medical ID — is encrypted, and any health data synced to iCloud is encrypted both in transit and on Apple servers. And with a recent version of watchOS and iOS with the default two-factor authentication and a passcode, health and activity data will be stored in a way that Apple can't read it. Health app data is never shared with any third party without the user's explicit permission.
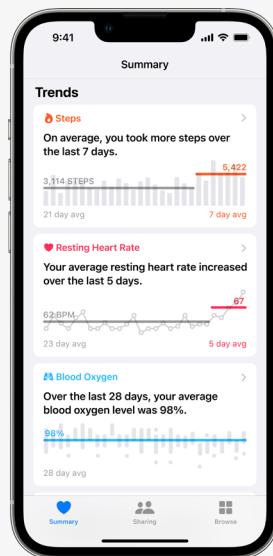
In keeping with Apple's strong stance on privacy, HealthKit lets users control each health data type read from and written to the Health app, and HealthKit-enabled apps are prohibited from using or disclosing that data to third parties for advertising, marketing, or other data mining purposes.

If users decide to share their health data, the Health app provides users with granular control over the types of data they share and who they share it with, and they can review and manage permissions at any time.

To learn more about the privacy of our health features, visit https://www.apple.com/privacy/

Trends in the Health app and Fitness app In the Health app, users can view reports on trends analysis for 20 types of data ranging from resting heart rate to sleep to cardio fitness. Trends can highlight significant changes in types of health data in a way that is easy to understand. In the Fitness app, users can check their fitness progress over time in a variety of metrics like exercise minutes, stand hours, cardio fitness, and more. If a goal is trending down, users receive coaching on how to turn it around.

Health Records In the Health app, users can privately and securely access their health records — including medications records, immunizations, lab results and more — from participating health institutions in the US, UK and Canada. This is available for patients at some of the largest health systems, as well as veterans receiving care through the Veterans Health Administration. With iOS 16, users can also create a PDF of their available health records from connected health institutions, right from the Health app.

Health Sharing In the Health app, users can securely share their data with a loved one or a caregiver, so that trusted partner can follow important alerts and changes over time, have more meaningful conversations and provide support from afar. Users have complete control over which data they share and with whom.

Apple Watch acts as an intelligent guardian for users' health

Apple Watch is equipped with features to notify users of possible underlying health conditions, giving them the agency to act on this information. Because Apple Watch is always on the wrist, features like fall detection and Emergency SOS can also help users call for help in the moment they need it.

Below is more information on our features focused on heart health, mobility, hearing, and safety, which enable Apple Watch to act as an intelligent guardian for users' health.

The prevalence of cardiovascular diseases

Cardiovascular diseases are the leading cause of death in the world. Almost 40% of deaths of people under 70 due to noncommunicable diseases were caused by cardiovascular diseases.[1] In North America, about one in five people above the age of 40 will develop heart failure.[2] In Europe, over half of all deaths are caused by cardiovascular diseases.[3]

Atrial fibrillation (AFib) is a heartbeat irregularity that often goes undiagnosed and is a leading cause of stroke and hospitalization.[4]

Because some AFib episodes can be intermittent and unpredictable, it can be difficult to capture in a clinical environment.[5]

In the US, an ECG can cost hundreds of dollars at an urgent care facility or at a hospital.[6,7]

Heart health

Providing users with a range of features to learn more about their heart health

Apple Watch offers an extensive set of features focused on heart health. Over time, Apple Watch has alerted users around the world of potential signs of atrial fibrillation (AFib), and helped many more establish everyday habits to keep their heart healthy over the long term.

Heart Rate app The first Apple Watch included a heart rate sensor to allow users to take heart rate measurements whenever they wanted, and offer them the most accurate metrics during workouts that we could. When we released that first set of features into the world, we started receiving letters and emails from users writing about how seeing their heart rate measurements in the Heart Rate app helped them realize that something might be wrong. Listening to this feedback from our users, it accelerated our interest to continue to invest in technology that could help them lead healthier lives.

Cardio fitness as an indicator of overall health

The American Heart Association (AHA) considers cardio fitness as a reflection of total body health and reports that it is a strong predictor of mortality similar to other risk factors like cigarette smoking, hypertension, high cholesterol, and type 2 diabetes. It has recognized a growing link between low cardio fitness and a higher risk of developing heart disease, high blood pressure, and obesity later in life.[8]

The AHA reports that an estimated 80% of cardiovascular disease is preventable when detected early and by leading a more heart-healthy lifestyle.[9,10]

Studies reveal that low cardio fitness is a major risk factor for cardiovascular disease. They noted that the best predictor of increased risk of death in their participants was exercise capacity, also known as Cardio Fitness, followed by pack-years of smoking cigarettes.[11,12]

In the Health app, Cardio Fitness Levels are classified as high, above average, below average, or low relative to people in the same age group and same sex, and these levels are derived from the Fitness Registry and Importance of Exercise National Database.[13]

High and Low Heart Rate Notifications Over the years, we have introduced features that could help users identify signs of potentially serious underlying health conditions. With high and low heart rate notifications, Apple Watch can notify users if it detects a high heart rate when a user is at rest, which can be a sign of a serious underlying condition. It can also notify users when their heart rate is notably low for at least ten minutes, known as bradycardia.

ECG app The ECG app, launched with Apple Watch Series 4, uses an electrical heart sensor on Apple Watch to record an electrocardiogram of the user's heart to help users identify signs of AFib. With the ECG app, Apple Watch users can record a single lead electrocardiogram from their wrist in the moment they are experiencing symptoms like a rapid or skipped heartbeat. The ECG app on Apple Watch also allows users to make note of symptoms, and easily share the ECG result with their doctors.

Irregular Rhythm Notifications With the irregular rhythm notification feature, Apple Watch can occasionally check heart rhythm in the background and send a notification if an irregular heart rhythm that appears to be AFib is identified, so users can seek medical evaluation.

The ECG app and irregular rhythm notification feature are now available in 130 countries and territories around the world.

AFib History Research suggests that the amount of time spent in AFib may impact a person's symptoms, overall quality of life, and risk of complications, and according to the American Heart Association, addressing modifiable lifestyle factors may decrease the amount of time spent in AFib.[16] With watchOS 9, users who are diagnosed with AFib can turn on the FDA-cleared AFib History feature and access important information including an estimate of how frequently a user's heart rhythm shows signs of AFib, providing deeper insights into a user's condition. Users will also receive weekly notifications and view a detailed history in the Health app, including lifestyle factors that may influence AFib like sleep, alcohol consumption, and exercise minutes. Users can download a PDF with a detailed history of their AFib and lifestyle factors, which can easily be shared with doctors and care providers for more informed conversations.

"On her birthday, coming back from the beach, my mom was out of breath and not feeling well. Her jaw was clenched. The watch showed that her heart was beating too fast and detected AFib. I did the same test with my own Apple Watch, which showed the same result. … This health issue could have had a dramatic outcome. Somehow, it likely saved my mom's life."[14]

Loïc, speaking about his 77-year-old mother, France

"The 47-year-old … is a yoga therapist, works out every day, and eats healthy, yet her watch said her resting heart rate was 126. '…It turned out I was having heart failure.' She ended up needing open-heart surgery to have her heart valve repaired. 'Thank goodness for the Apple Watch because I felt fine. I wonder if it hadn't been for the Apple Watch, I might not even be here?'"[15]
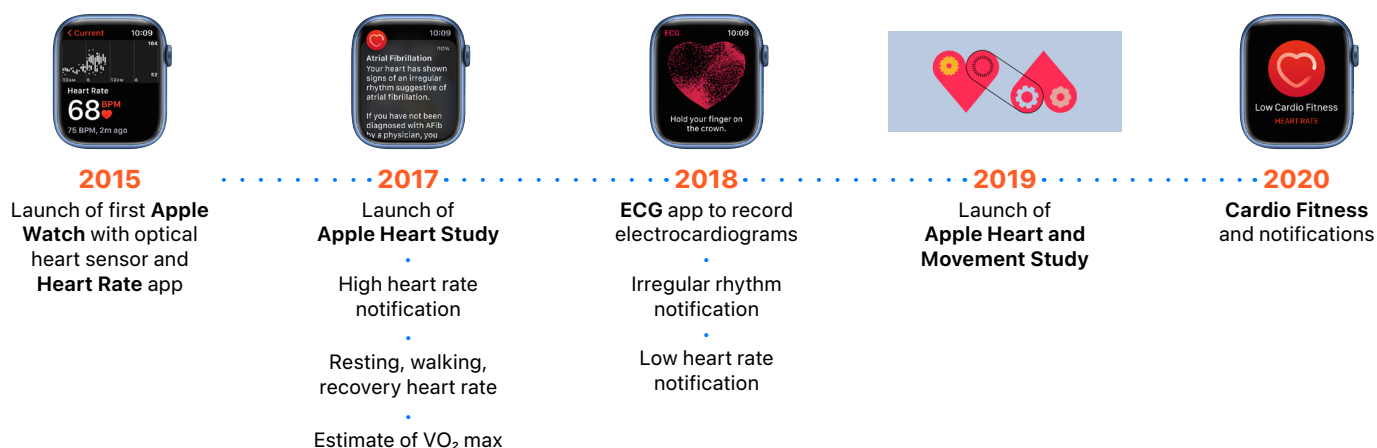
Amy, 47, US, Heart Failure

Cardio Fitness To provide users with more information about their overall health, we introduced Cardio Fitness and notifications. Cardio respiratory fitness, as measured by VO_2 max, is the maximum amount of oxygen the body can use during exercise.

Previously, direct measurement of VO_2 max typically required rigorous testing usually done in a clinical setting. Apple Watch estimates cardio fitness, or VO_2 max, using multiple sensors including the optical heart rate sensor, GPS, accelerometer, gyroscope, and barometer, as well as user inputs like age, gender, and certain medications that affect maximal heart rate. The estimate captures a wide range of cardio fitness levels as users walk throughout the day, whether or not they are tracking a workout.

Users can view their cardio fitness levels in the Health app on iPhone along with information on what cardio fitness means and how to interpret the information. They can also choose to receive a notification if their cardio fitness falls within the low range for their age group and sex, along with guidance on how to improve cardio fitness and have a conversation with their doctor.

"American Heart Association science associates low cardiorespiratory fitness levels with a higher risk of cardiovascular disease and all-cause mortality. The American Heart Association is focused on helping all people equitably achieve longer, healthier lives, and we believe that emerging technology solutions can empower individuals to manage their own health."[17]

Nancy Brown, American Heart Association CEO

To develop our heart health features, we have done extensive clinical validation to evaluate their performance across a variety of conditions and user behaviors. We collaborated with researchers at Stanford University School of Medicine to conduct the Apple Heart Study, which used the irregular rhythm notification feature on Apple Watch to show that a wearable can help with early detection of AFib. For more information on the science and clinical validation behind these heart health features and our collaboration with medical experts, including an overview of the **Apple Heart Study** and our **white papers** that detail our methods and processes, please see **Extensions and Spotlights section 1.**

Timeline of heart health feature releases

2015
Launch of first **Apple Watch** with optical heart sensor and **Heart Rate** app

2017
Launch of **Apple Heart Study**
•
High heart rate notification
•
Resting, walking, recovery heart rate
•
Estimate of VO_2 max

2018
ECG app to record electrocardiograms
•
Irregular rhythm notification
•
Low heart rate notification

2019
Launch of **Apple Heart and Movement Study**

2020
Cardio Fitness and notifications

Mobility

Driving greater understanding and improvement
of a user's mobility data

Our mobility features utilize the sensor technology on iPhone and Apple Watch to help users stay aware of potential mobility issues before they result in a fall, and help them get help if they do take a hard fall.

Mobility is a critical part of overall health that is often overlooked until it affects a person's day-to-day life or causes a serious health issue. Further, falls are a major concern for older segments of the population and can have significant consequences, particularly when people are on their own (see sidebar). This is true among older adults and those impacted by certain conditions such as epilepsy who experience seizures, or anyone living or exercising by themselves.[24]

Fall Detection The advanced accelerometer and gyroscope in Apple Watch Series 4, 5, 6, and 7 allow it to detect hard falls, using the motion sensors and an algorithm to identify if a fall occurs based on wrist trajectory and impact acceleration. These algorithms were initially designed to identify and detect hard falls that can occur in the day-to-day living of older adults.

The fall detection feature is paired with Emergency SOS, a safety feature available on Apple Watch and iPhone (see page 16). If a hard fall is detected and the user is immobile for about a minute, Apple Watch's Emergency SOS feature automatically calls emergency services and notifies the emergency contacts registered in the user's Medical ID with a text message and the user's location. Our fall detection feature is available globally and has helped people of all ages. On a daily basis, it can provide peace of mind to users.

Since its initial release, we have expanded the scope of the fall detection feature so adult users of all ages can have it automatically enabled during workouts. With watchOS 8, our fall detection algorithms were updated and optimized to better recognize the unique motion and impact patterns from different types of workouts, including cycling.

The prevalence and high costs of falls

Falls are a leading cause of injury and death amongst Americans aged 65 and above and 25% of older adults will fall each year.[18]

About 1 in 100 people in the US has had a seizure or has been diagnosed with epilepsy.[19]

Falls contribute to $50 billion in annual medical costs in the US.[20] Half of Germans 80 years and older fall at least once a year, 10% of which result in injuries that require treatment.[21] 10,000 seniors die each year from falls in France.[22]

The risk of falling increases sharply between the ages of 40 and 65, particularly in women, making this time window a critical stage for interventions designed to prevent falls.[23]

"In February 2019, Toralv was staying with friends just outside of Oslo, Norway, where he lives. He wore his Apple Watch Series 4 to bed that night so he could test a sleep app, but then things start to get blurry. He has no memory of his fall later that night and doesn't remember getting back into bed... Sometime around 4 a.m., he had got up to go to the bathroom when he experienced a sudden drop in blood pressure. He fainted and landed face first on the bathroom floor. His collapse triggered the fall detection feature ... 'Nobody heard my fall,' he says. 'My friend and his wife didn't hear anything about it until the police car came to their door.'"[25]

Toralv, 68, Norway,
drop in blood pressure

"One day in early February, Yuewei was riding his bike home from work at 10 p.m. ... He fell down accidentally and hit his head on the road pier. ... [H]e was still conscious but unable to move ... At this time the fall detection of his Apple Watch played a role. After calling 120, ... within 5 minutes, the ambulance arrived, and Mr. Hu was promptly treated. Later, his doctor told him that there was a slight brain injury, and that a little delay could have caused irreversible damage."[26]
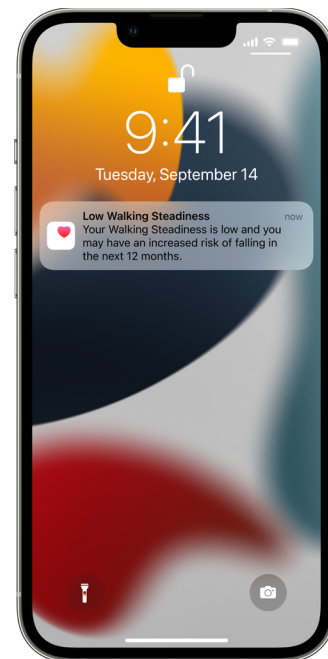
Yuewei, 23, China

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Walking Steadiness Research shows that declines in mobility take place gradually, sometimes years before a serious issue ever arises.[27] In 2021, we introduced Walking Steadiness in the Health app to leverage the powerful sensors in iPhone along with custom algorithms to give users an overall sense of their fall risk in the next twelve months. The walking steadiness feature estimates balance, stability, and coordination. It uses mobility metrics like walking speed, step length, double support time, and walking asymmetry to determine a user's walking steadiness and classification.

While walking may sound simple, it requires the coordination of multiple complex physiological systems, and a single failure in any of them can affect one's walking. For example, a limp, or changes in the length of each step, can indicate an increased risk of injury. Walking Steadiness can observe changes in walking patterns outside of a clinical setting, capturing natural, everyday movements.

Developing this feature was possible because of data shared by more than 100,000 users across all ages participating in the Apple Heart and Movement Study, in addition to findings from more focused studies with elderly populations and post-operative orthopedic patients.[ii] The data set from the Apple Heart and Movement Study allowed us to estimate walking steadiness across all segments of the population.

Users' walking steadiness is classified as OK, Low or Very Low to provide them with simplified insights into their potential fall risk. Users can also choose to receive a notification if their walking steadiness is classified as Low or Very Low.

> "When I hurt my back in the fall, I could tell I was not walking well, [I] could barely walk a quarter of a mile without lots of pain. As I recovered, it was nice to see a numeric metric that showed me how I was improving, and not just my own personal feelings. It's so cool to have technology come alongside and pick up on all the little things that help you see the bigger picture."
>
> Joshua, 34, Florida

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ii.   Walking steadiness studies are typically validated for small samples of individuals above 65, only for data gathered in a clinical setting.

The Health app also contains educational resources explaining, for example, what walking steadiness is, why people should monitor it, and sample exercises on how to improve it. In addition, if a user's walking steadiness is low, the Health app offers sample exercises to improve their balance, stability, and coordination, which come with short instructional videos. **Fitness+** also offers a "Workouts for Older Adults" program that incorporates key exercises that may improve walking steadiness.[28]

To develop our mobility features, we have conducted extensive clinical validation to evaluate the performance based on real-world movement patterns and falls. We are collaborating with Brigham and Women's Hospital and the American Heart Association to conduct **the Apple Heart and Movement Study**. Results of this study are expanding the fall detection capabilities of Apple Watch. For more information on the science and clinical validation behind our mobility features and our collaboration with medical experts, including our white papers that detail our methods and process, please **see Extensions and Spotlights section 2.**

Timeline of mobility feature releases

2015
Launch of first **Apple Watch** with accelerometer and gyroscope

2018
Fall Detection with connection to emergency services relying on Emergency SOS

2020
Mobility Metrics, including Walking Speed, Step Length, Double Support Time, and Walking Asymmetry

2021
Walking Steadiness metrics and notifications

Workouts for Older Adults program on Apple Fitness+

Exercises to improve walking steadiness in the **Health** app

Hearing health

Providing users with a range of features to help them protect their hearing health

Apple Watch and iPhone can help users monitor for noise exposure that can damage their hearing over the long term.

Hearing Health

Noise-induced hearing loss affects more than one in ten people in the world to some degree, and could be preventable.[33] Using noise exposure limits derived from World Health Organization (WHO) recommendations, we introduced hearing health features to help make our users aware of the hazards of noise exposure, and help them monitor their environmental noise levels and headphone audio levels.

The importance of limiting noise exposure for hearing health

12% of the global population, including nearly 25% of Americans, 17% of Europeans, and 14.5% of Australians, have at least mild noise-induced hearing loss.[29,30,31,32]

Headphone Audio Levels Introduced in 2019, users can track the volume of their headphone audio levels over time in the Health app. Users can see the volume of their headphone audio measured in A-weighted decibels and whether they are surpassing audio exposure limits derived from WHO recommendations. They can also receive a notification if they reach a seven-day audio exposure limit based on WHO recommendations.

Noise app The Noise app on Apple Watch uses the microphone to measure the ambient sound levels in a user's environment. Noise Notifications alert users if the average sound levels nearby are over a certain noise threshold for three minutes.

Safety

Helping users seek help when they need it

Since iPhone and Apple Watch are with users every day, they offer safety features that can help users call for help in an emergency.

Emergency features

Emergency SOS Emergency SOS is available on every iPhone and Apple Watch, allowing users to easily call for help and alert emergency contacts if they need to.[iii] When a user makes an Emergency SOS call, it allows first responders to access real-time location data from iPhone and Apple Watch so they can quickly locate someone in the moment they need help.

In some regions users can choose the service they need (for example, in mainland China, users can choose if they need police, fire department, or ambulance assistance).

Medical ID When users set up Medical ID in the Health app, first responders can access a user's critical health information — like allergies and medical conditions — from the Lock Screen of iPhone or Apple Watch. They can also see names and contact information of the user's designated emergency contacts.

In the US, users can also choose to share their Medical ID with emergency responders during an Emergency SOS call. By having Emergency SOS and Medical ID easily accessible on iPhone and Apple Watch, users have peace of mind that they can easily call for help when they need it.

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iii.   To use Emergency SOS on an Apple Watch that doesn't have cellular, the connected iPhone needs to be nearby. If the connected iPhone isn't nearby, your Apple Watch needs to be connected to a known Wi-Fi network and Wi-Fi Calling must be set up.

Studies show

Providing an Apple Watch and incentives to participants helped increase their activity by 30-40%.[34]

In various randomized control trials, mindfulness apps like Calm on iPhone and Apple Watch were found to lead to reduced stress and decrease in fatigue, daytime sleepiness, as well as improvements in sleep quality.[35]

EMPOWERING USERS ON THEIR PERSONAL HEALTH JOURNEY:

Features to improve everyday health and fitness

Offering users meaningful insights to encourage healthier behaviors every day

In many ways, health is the compilation of small lifestyle choices people make every day. When people develop positive habits they repeat consistently, their overall health can significantly improve.

With the features built into Apple Watch and iPhone, our users are able to see a more complete picture of their health and are empowered with actionable insights to help them reach their personal health and fitness goals. Articles and descriptions in the Health app provide users with accessible explanations surrounding important health topics.

Activity and fitness on Apple Watch: Activity rings, sharing activity with friends, coaching, competitions, awards, Fitness+

Throughout the years, we have introduced a host of new features to encourage users to stay active and work out. We designed these features on Apple Watch to cater to a range of fitness levels, from the experienced athlete to the newcomer to fitness, and each goal is customizable.

Activity Rings Users can view their daily physical activity as tracked by Apple Watch sensors in an intuitive manner on three dimensions, (1) Move: active calories burned, (2) Exercise: time spent engaging in workouts or brisk activities, and (3) Stand: number of hours in which the user stood and moved for at least a minute. Users can set a different goal that suits their lifestyle and health goals. In iOS 16, the Fitness app is now available to all iPhone users, even if they don't have an Apple Watch, so they can now set up a daily Move goal with iPhone motion sensors tracking steps, distance, flights climbed, and workouts from third-party apps to estimate active calories to contribute to the Move goal.

Workout app The Workout app is one of the most popular apps on Apple Watch, using advance motion sensors to accurately track performance data across a wide range of modalities and to automatically detect popular activities like walking, running, cycling, swimming and more. In watchOS 9, users have access to even more informative metrics like running power, stride length and vertical oscillation, and new powerful training experiences like Heart Rate Zones and Custom Workouts to help users reach their goals.

Activity Sharing Apple Watch users can share workouts, Activity rings, and Activity achievements with friends and receive notifications when a friend has completed a workout, closed their Activity rings, or has achieved a new goal.

Daily Coaching Hourly stand reminders, monthly challenges customized to the user's previous month fitness data, and friendly reminders about whether their daily activity is on track, encourage users to complete daily activity goals and monthly challenges.

The high cost of a sedentary lifestyle

A sedentary lifestyle leads to all kinds of health risks, increasing the likelihood of cardiovascular disease, diabetes, high blood pressure, obesity, osteoporosis, depression, and anxiety, including mortality risk.

Researchers estimate the global yearly cost of sedentary lifestyles at $68 billion in direct healthcare costs, productivity losses, and disability-adjusted life-years.[36] Another study that includes the indirect costs of inactivity-related mood and anxiety disorders estimates the economic costs of inactivity in the EU regions alone at more than €70 billion.[37]

According to the World Obesity Federation, 800 million adults live with obesity. By 2025, the estimated annual cost of treating the negative effects of obesity is projected to be over $1.2 trillion.[38]

The WHO estimates that, in Europe, 25% of adults and 80% of adolescents are insufficiently active. Insufficient activity is estimated to lead to 500,000 deaths per year in Europe.[39]

The importance of taking care of the many aspects of one's health

Researchers estimate the economic burden from insufficient sleep at $680 billion of economic output every year for five large OECD countries.[40]

Mindfulness intervention programs have been shown to have positive effects on mental as well as physical health. Numerous studies have shown meditation can lead to improvements in patients with high blood pressure, inflammatory bowel disease, and rheumatoid arthritis.[41]

"I fell into a deep depression and weighed 250 pounds. I ran my first Spartan Race in December and ran a full marathon in February."[42,43]

Arthur, 34, Mississippi, US, commenting on his use of Apple Watch

Activity Awards Users can earn awards for personal records, streaks, and major milestones using their Apple Watch. Apple Watch serves as an accountability partner and motivates users with opportunities to earn awards for personal records, streaks, and major milestones. Users also win awards for competitions against other users, for monthly challenges that are customized for each user, as well as for limited edition challenges that are offered on special occasions such as major holidays and other important events throughout the year like Earth Day, International Women's Day, and Yoga Day.

Activity Competitions Apple Watch users can compete in a seven-day competition with their friends, where each person earns points by filling their Activity rings. At the end of the competition, the one with the most points wins, and earns an award.

Apple Fitness+ The first fitness and wellness service powered by Apple Watch, designed to be welcoming to all wherever they are in their fitness journey, and to help users live a healthier day. Subscribers have access to the largest library of workout content in 4K Ultra High Definition with studio-style workouts and meditations, all led by a diverse and inclusive team of trainers. Fitness+ helps users train their body and mind with a one-of-a-kind personalized and engaging experience that can be done anytime, anywhere, intelligently incorporates workout metrics from Apple Watch right on the screen, and motivates users from start to finish with music from today's top artists. Users also have access to inspiring audio experiences including Time to Walk, featuring some of the world's most interesting and influential people, and Time to Run, designed to help users become more consistent and better runners. With watchOS 9, Fitness+ reveals four new metrics that will be initiated by the Fitness+ trainers during workouts, including Intensity for HIIT, Cycling, Rowing, and Treadmill; Strokes per Minute (SPM) for Rowing; Revolutions per Minute (RPM) for Cycling; and Incline for walkers and runners in Treadmill.

Women's health

The menstrual cycle is an important marker of health, so much so, that it is often considered a vital sign because it represents the coordination of so much physiology and gives a window into overall health. Since cycles vary from month to month and person to person, the best way to understand what is normal for an individual user is to track their menstrual cycle.

Since menstrual cycles have been under-researched, we also launched the Apple Women's Health Study with Harvard T.H. Chan School of Public Health and the NIH's National Institution of Environmental Health Sciences to help scientists learn more about women's health (for more, see page 28).

Cycle Tracking and Cycle Factors To help give users insight into their menstrual cycle, we built the Cycle Tracking feature. Users can easily track their menstrual cycle using iPhone and Apple Watch, to help them understand their cycle history over time, including cycle length and period length. The feature uses users' logged periods and heart rate data from Apple Watch to offer predictions and notifications alerting them when their next period or fertile window may be approaching. People can also add cycle factors that influence the timing and length of their cycle, such as birth control pills or pregnancy.

Reaching sleep goals: Sleep tracking, Wind Down and setting a sleep schedule

Given that sleep plays an important role in a person's overall health, we have developed features to help our users understand their sleep.

Sleep tracking Apple Watch estimates time spent in bed and time spent asleep by detecting micro-movements from the accelerometer and analyzing changes in activity and movement during the night. Sleep tracking in watchOS 9 provides even more insights with the introduction of sleep stages. Using signals from the accelerometer and heart rate sensor, Apple Watch can detect when users are in Core, REM, or Deep sleep, and users can view sleep comparison charts in the Health app on iPhone. Without Apple Watch, users can also track time in bed using iPhone based on whether or not they pick up and use their iPhone during the night.

Sleep Schedule Users can create personalized sleep schedules that help them meet their sleep goals and improve their overall health.

Wind Down Users can start winding down before bedtime and can create shortcuts that quickly begin a Wind Down activity such as playing music or a podcast, or beginning a meditation, yoga or stretching session.

Mindfulness

We have introduced features and apps to help users be more aware of their state of mind and take action to improve their overall wellbeing. These features are backed by widely recognized physical and mental health benefits of mindfulness intervention programs ranging from cardiovascular improvements to stress relief.

Mindfulness app Users can perform guided deep-breathing exercises assisted by visuals and haptic feedback, as well as take a moment to pause and reflect on a thought or an action, using Apple Watch. Users can have their watch remind them to breathe or reflect throughout the day.

Focus When users want to concentrate on a specific activity, they can turn on a Focus option for work, personal time, sleep, fitness, mindfulness, gaming, reading, or driving. Users can reduce distractions across all of their devices by allowing only notifications from the people and apps they choose.

Fitness+ guided meditations and mindful cooldowns Fitness+ offers Meditation to help users develop a regular meditation routine and improve their overall sense of well-being. Users can choose from several meditation themes alongside the Fitness+ trainers or as an audio-only experience right on their Apple Watch. Fitness+ also offers Mindful Cooldowns to reduce stress and improve flexibility and focus.

Other healthy habits

Features on Apple Watch and iPhone also help users develop other everyday healthy behaviors, like washing their hands for the recommended amount of time, and helping them track and manage the medications they take.
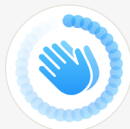
Handwashing Apple Watch can automatically detect when users begin washing their hands and start a 20-second timer. Through Handwashing reminders, Apple Watch can remind users to wash their hands after returning home.

Medications With iOS 16 and watchOS 9, the new Medications experience on Apple Watch and iPhone helps users manage and track medications, vitamins, and supplements they take by allowing them to create a medications list, set up schedules and reminders, and view information on their medications in the Health app. In the US, users can simply point their iPhone camera at a label to add a medication, read about the medications they're taking, and receive an alert if there are potential interactions for their medications.

EMPOWERING USERS ON THEIR PERSONAL HEALTH JOURNEY:

Fueling innovative third-party health and fitness apps

HealthKit empowers developers to create new experiences for users everywhere

Apple makes available a number of tools and core technologies to all developers to help them create innovative apps, including more than 250,000 software development building blocks called APIs. With the HealthKit API, Apple makes it possible for third-party developers to develop health and fitness apps that take advantage of the sophisticated sensors on iPhone and Apple Watch and are compatible with the Health app. HealthKit provides a framework for developers of health and fitness apps to integrate users' health data, with permission, into their apps' features, and for apps to contribute data to the Health app (which users can then see in one place and with permission, other apps can use for their own features). Importantly, we developed HealthKit to provide users access to and granular control of their health data, and we designed HealthKit with privacy and security at its core.

Many HealthKit-enabled apps are popular with users worldwide, providing a host of health and fitness experiences to users. They include running apps like Nike Run Club, fitness apps like MyFitnessPal, sleep apps like Rise: Energy & Sleep Tracker, SnoreLab, and Pillow, meditation and mindfulness apps like Calm, Headspace, and Ten Percent Happier, hearing-related apps like SonicCloud, nutrition apps like WeightWatchers or Lose It!, and medications and symptoms tracking apps like Pt Pal Pro and Medisafe Medication Management.

In addition, an increasing number of Health-Kit-enabled apps use connected accessories to allow our users to track and monitor even more aspects of their health, including blood pressure (e.g., Qardio heart health), weight (e.g., Withings Health Mate), blood glucose level (e.g., Dexcom, One Drop), and respiratory health metrics (e.g., MIR Smart One).

"Having the 10% Happier app on my iPhone is like having my therapist in my back pocket. It grounds me."[47]

Kristi, 54, US,
Ten Percent Happier user

"[HealthKit] is the enabler of the Rise experience. The motion-activity and steps data that HealthKit collects passively is what enables us to help our users focus on reducing their sleep debt and having more energy every day."

Jeff Kahn, CEO and co-founder of Rise Science

For more information on the APIs available for third-party developers — HealthKit, Research-Kit, CareKit, SensorKit, Movement Disorder, and Fall Detection — please **see the Extensions and Spotlights section 3.**

Supporting the health ecosystem by collaborating with the medical community

A core principle of Apple's work to advance health has always been that the strongest innovation is possible when we work directly with the medical community.

Since the start of our work in this field, the teams building our health products have included in-house clinicians who collaborate with experts from leading research institutions, to ensure all of our health and fitness features are grounded in science. Over time, our close collaboration with institutions has led to our development of features that leverage our ecosystem to help researchers advance science and healthcare providers deliver better and more efficient care. Apple is proud to provide new and innovative features to the medical community so that they can push the frontier of what is possible in health.

Below are the four main categories of our collaboration with the medical community, with longer descriptions of each to follow.

Equipping researchers to make new scientific discoveries. iPhone and Apple Watch give researchers the opportunity to recruit participants from a large user base, and for participants to choose to share health data they collect throughout their lives to help advance science. Through the Research app, Apple has collaborated with Harvard T.H. Chan School of Public Health, Brigham and Women's Hospital, the University of Michigan, and others to offer users across the US the opportunity to participate in the Apple Women's Health Study, the Apple Heart and Movement Study, and the Apple Hearing Study. In addition, Apple is supporting a number of other studies, and ResearchKit makes it easier for researchers around the world to build apps for innovative studies at unprecedented scale.

Strengthening the physician-patient relationship with meaningful data.
Health Records on iPhone in the Health app, along with apps and devices developed by third parties using Apple developer tools, are helping improve physicians and patients' conversations. They are also enabling a more effective use of hospital resources.

Health organizations promoting healthy lifestyles with Apple Watch. Health organizations and insurance companies around the world have collaborated with Apple to integrate Apple Watch in their wellness programs.

Supporting public health and government initiatives. Apple partners with clinicians and local governments on unique ways to support their crucial work to promote public health, and regularly donates to relief efforts and non-profit organizations. We have also built apps and features to support public health during the COVID-19 health crisis.

Partnering with the medical community to move research and care forward

DOCTOR VISITS

Apple Watch, iPhone and third-party apps are allowing patients to gather a more complete picture of their health, so they can have better conversations with their doctor.

ENABLING RESEARCH

Apple's advanced features and technologies are empowering researchers around the world to collect data from study participants who have chosen to share it, more frequently and at a broader scale than ever before.

CLINICIAN MOBILITY AND WORKFLOW

With our products and electronic health records apps, clinicians can read and write patient records on the go, receive urgent lab notifications on Apple Watch, and access on-demand decision support reference materials.
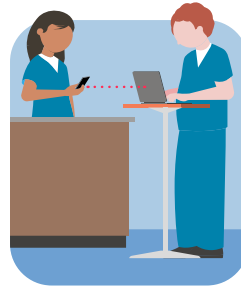
SECURE COMMUNICATION AMONG NURSES AND PHYSICIANS

Apple Watch, iPhone, iPad, and clinical communication apps streamline how nurses communicate with physicians, other care team members, patients, and patients' families while delivering care.

DEVELOPER INNOVATION

Some examples of third-party developer innovation that work with Apple technologies are Stryker's Triton AI — a real time measure of blood loss and hemorrhaging during labor and delivery that is reducing the need for postpartum blood transfusions — and Butterfly iQ+ — a portable ultrasound device that is opening new possibilities for point-of-care ultrasounds.

REMOTE CARE

Hospitals, clinics, physicians, and more are relying on iOS apps built using HealthKit and CareKit to keep patients connected to care teams, resulting in better patient outcomes.

HEALTH RECORDS ON iPHONE

Creates an encrypted connection between participating health institutions and a patient's iPhone so patients can view their allergies, conditions, immunizations, lab results, medications records, procedures, and vitals directly within the Health app.

Apple's Investigator Support Program

Inspired by the innovative ways the research, clinical, and developer communities leverage our products and platforms, we launched the Investigator Support Program that provides researchers with the opportunities to receive Apple Watch to include in their research study. We have witnessed firsthand how researchers and clinicians are able to accomplish even more with the addition of Apple Watch to their research and care programs, and through this program we hope even more people can have the same kind of success. Currently, studies around the globe are integrating Apple Watch into their research across heart, mobility, activity, and other focus areas. For more information, visit www.researchandcare.org/resources/investigator-support-program/

SUPPORTING THE HEALTH ECOSYSTEM BY COLLABORATING
WITH THE MEDICAL COMMUNITY:

Equipping researchers to make new scientific discoveries

Apple's work to advance health is grounded in the belief that all innovation in health should be grounded in science. Today, Apple's advanced features and technologies are empowering researchers around the world to collect data more frequently and at a broader scale than ever before, so they can continue to move science forward. With iPhone and Apple Watch, study participants are collecting their health data every day, throughout the day, and participants can then choose to contribute data to research anywhere and anytime, lowering the barriers to study entry and participation. As a result, researchers can obtain high-quality, varied, and frequent data at greater scale.

The ubiquity of iPhone and Apple Watch gives researchers the opportunity to recruit participants from a large-scale user base, thereby alleviating one of the biggest challenges medical researchers face: recruiting participants. Millions of users have Apple Watch on their wrists and millions more use iPhone every day. We also believe in offering all iPhone and Apple Watch users an opportunity to contribute to science through the Research app, while providing them with transparency and control over their data. Users can easily see how their data will be used in research studies and have the ability to toggle on and off their participation in these studies as they see fit. With these contributions, and leveraging our sensor technology, researchers can study large and varied groups, obtain frequent data, and, ultimately, analyze data from a broader representation of the population.

ResearchKit and the Research app are designed to help researchers advance toward potentially groundbreaking advancements, using our products in areas where they can have the greatest impact.

"We've gone as far as we can with traditional research. Now we have technology in our pockets that lets us go even further."

Dr. Helen Link Egger, Duke University Medical Center

ResearchKit

As an open-source framework for building apps, ResearchKit enables developers to build apps to enroll participants in bigger numbers than ever before, collect data with far more regularity, and give researchers an opportunity to more easily access groups that are harder to enroll in clinical research. ResearchKit also streamlines the process to gather informed consent from participants, allows developers to easily build questionnaires, and provides them with a large variety of active tasks to capture participants' sensor information.

Many research projects, some now completed, ongoing or starting, have been made possible by ResearchKit, including Apple's first-of-its-kind **Apple Heart Study** to detect irregular heart rhythms, **Mom Genes Fight Post-partum Depression** at UNC to explore a genetic cause to post-partum depression, the **Heart Failure Study** at UHN exploring population-level indicators of heart failure, the **Mount Sinai Warrior Watch Study** studying the psychological effects of COVID-19 on healthcare workers, research underway at **UCLA** exploring greater insights into anxiety and depression, the **Autism & Beyond** study by Duke University to better understand and identify risks for development in young children, and **Japan's Keio University** study on heart health.

Apple Heart Study

Apple is committed to the science that underpins all of our health features, and we work closely with clinicians and medical researchers to design and conduct studies that help us develop the next generation of scientifically-based health products to offer our users around the world.

In 2017, Apple scientists collaborated in research led by the Stanford University School of Medicine to conduct the Apple Heart Study on AFib detection. This study evaluated whether irregular pulse data detected via Apple Watch could identify irregular heart rhythms, including AFib and other serious heart conditions.

"This study offers us even greater potential for meaningful breakthroughs that could someday impact countless lives, helping us meet our goal of cutting the burden of depression in half by 2050."
Chancellor Gene D. Block,
University of California,
Los Angeles

"The idea really is how do we provide a continuous-style monitoring of patients in a relatively unobtrusive way that will allow us to detect a change in a patient status before they end up actually coming into hospital. So this is where the opportunity with Apple is tremendous."
Dr. Heather Ross, Head of the Division of Cardiology at the Peter Munk Cardiac Centre, University Health Network, leading the Heart Failure Study

"The goal of my research is to connect healthcare data and medicine in order to help with early detection of some types of disease. Apple Watch collects a huge amount of healthcare data that enables us to analyze the relationship of health outcomes to lifestyle."
Dr. Takehiro Kimura, Assistant Professor, Department of Cardiology, Keio University School of Medicine

> "We are excited about the future of the study as a means to fill the research gap by diving deeper into understanding how periods and menstrual cycles can be a window into overall health. This study with Apple, unprecedented in scope, will greatly advance our understanding of the biological and social determinants of women's health, and lead to better health outcomes."
>
> Dr. Michelle Williams,
> Dean of the faculty,
> Harvard T.H. Chan School

> "It is clear that large scale data on cardiovascular and musculoskeletal physiology offer insights which have simply not been accessible in the past and can empower individuals with information on their personal health and wellness."
>
> Dr. Calum MacRae, PhD,
> Professor of Medicine
> at Harvard Medical School

> "The scale and types of information about noise and hearing ability that we are collecting in this study through iPhone and Apple Watch are yielding insights into exposures and hearing health impacts that have never before been possible."
>
> Rick Neitzel, PhD, MS, CIH, FAIHA, Associate Professor of Environmental Health Sciences at the University of Michigan School of Public Health

The unprecedented study enrolled more than 400,000 Apple Watch users from all 50 states in a span of only eight months.

The study was published in the New England Journal of Medicine in 2019: *Large-Scale Assessment of a Smartwatch to Identify Atrial Fibrillation*. The first-of-its-kind virtual study was able to enroll more than 400,000 participants and helped to demonstrate the feasibility of conducting a real-world study in an everyday setting. The study led Apple to develop and validate the irregular rhythm notification feature on Apple Watch.

Apple Research app

Following the success of the Apple Heart Study, we saw an opportunity to use Apple features to support advancements in science, both in areas that are understudied or have only been researched on smaller scales, and in areas where the incorporation of new technologies can dramatically increase the pace of scientific discovery.

Apple introduced the Research app to broaden the scope of what research could be done digitally by giving researchers the tools to help them uncover new insights, and furthering our ability to create new features grounded in science in the process. Built on the ResearchKit framework, the Research app gives our diverse and large user base an opportunity to participate in landmark studies, all in a way that protects the users' privacy and gives the participants full control over their data.

By downloading the Research app from the App Store, users can easily enroll in health studies from their iPhone, while maintaining control over which data types they choose to share with the study team. Users can also choose to stop contributing to any study at any point in time.

As of July 2022, we are currently collaborating with researchers on three longitudinal, public studies to help advance science in the areas of women's health — gaining insights into the relationship between menstrual cycles and health conditions with the **Apple Women's Health Study** in collaboration with the Harvard T.H. Chan School of Public Health and the NIH's National Institute of Environmental Health Sciences — mobility and heart health — exploring the link with the **Apple Heart and Movement Study** in collaboration with the American Heart Association and Brigham and Women's Hospital — and hearing health — examining how everyday sound levels can affect hearing, stress levels, and heart health with the **Apple Hearing Study** in collaboration with the University of Michigan. See below for more information on each study, and their interim research findings.

All three Research app studies are longitudinal. They have already produced some interim insights and early learnings about the studies, included on the following pages.

Apple Women's Health Study[44,45] Many physicians regard women's menstrual cycles as an important window into their overall health, however, the topic has been under-researched. Medical research on menstruation has often been limited to studies of smaller sizes, which are not representative of the broader population. In fact, prior to 1993, women were not required to be included in clinical trials in the US.[46]

Our Apple Women's Health Study team worked with the Harvard T.H. Chan School of Public Health and the NIH's National Institute of Environmental Health Sciences to launch a long-term study focused on menstrual cycles. Through the Research app, participants answer surveys and can share tracked personal health data and sensor data with the study team. The researchers then have access to large-scale cycle tracking, environmental, behavioral, and social information. This data can be used to learn more about women's health, their menstrual cycles, and their rela-tionship to various health conditions, including polycystic ovary syndrome (PCOS), infertility, osteoporosis, and menopausal transition.

Data from this study can also help develop innovative features. Most recently, data from this study was used to update our Cycle Tacking feature to integrate heart rate for improved cycle tracking predictions.

Interim analysis from the study has already shared new insights around menstrual symptoms, and PCOS, an under-diagnosed condition[47] that can cause symptoms such as long menstrual cycles and heavy periods and that is linked to heart and circulatory health.

The Apple Women's Health Study is a longitudinal study, and we've already shared some interim, early insights. We're looking to share more as the study progresses.

**Interim research from Apple Women's Health Study:**

- Helping to remove stigma around how common menstrual symptoms really are, researchers found the most frequently tracked symptoms were abdominal cramps, bloating, and tiredness, all of which were experienced by more than 60% of participants who logged symptoms. More than half of the participants who logged symptoms reported acne and headaches. Some less widely recognized symptoms, like diarrhea and sleep changes, were also tracked by 37% of participants logging symptoms.[48]

- Survey data from over 30,000 participants was used to better understand PCOS. Interim results showed that 12% of participants reported a diagnosis of PCOS, with the median age of diagnosis of 22 years old. Those with PCOS were more likely to have unpredictable or irregular cycles, with nearly half (49%) reporting never having regular menstrual cycles or only having regular cycles after using hormones. Participants with PCOS also saw a higher prevalence of conditions that can negatively impact heart health.[49]
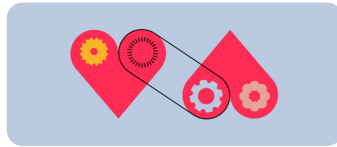
Apple Heart and Movement Study[50,iv] Conducted in collaboration with the American Heart Association and Brigham and Women's Hospital, the Apple Heart and Movement Study explores factors that affect heart health and potentially cause deterioration in mobility or overall well-being, in an effort to promote healthy movement and improved cardiovascular health. By collecting heart health, workout, mobility and activity data from Apple Watch and iPhone users, as well as survey data, this study will provide insights on heart health and potential early warning signs in ways that were not possible before.

Information gathered through the Apple Heart and Movement Study has provided teams at Apple with more information about mobility and falls, which led to the development of our Walking Steadiness feature. Walking Steadiness classifications were developed using the Apple Heart and Movement Study, from data provided by more than 100,000 participants of all ages — the largest data set ever used to study fall risk. Researchers studied people of all age groups who reported more than 12,000 falls, demonstrating that these falls occur during many different activities, regardless of age. This feature is an example of the research and science coming together with actionable recommendations that empower the user with timely information. Additionally, insights from the study have helped power the recent health Trends feature which provides new ways to intelligently and proactively highlight important changes for users, presenting the information in a way that's easy to understand. For many key fitness metrics, cohorts within the study are now 10 times larger than any prior studies.

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iv.   For more information on Apple Heart and Movement Study, visit www.heart.org/en/get- involved/ apple-heart-and-movement-study.
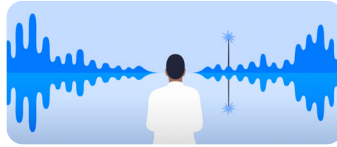
Apple Hearing Study[v] Apple is collaborating with the University of Michigan to examine factors that impact hearing health. The impact of sound exposure on hearing health and stress levels over time is not well understood. The Apple Hearing Study collects headphone usage and environmental sound exposure data through iPhone and the Noise app on Apple Watch, along with several types of hearing tests measured through iPhone, in order to explore how both can impact hearing over time. The study is also investigating how long-term sound exposure can impact stress levels and cardiovascular health.

As part of the study, users have also consented to share their data with the World Health Organization as a contribution toward its Make Listening Safe initiative. The information collected can also help guide public health policy and prevention programs designed to protect and promote hearing health.

Interim indications from Apple Hearing Study:

- 25% of participants experience a daily average environmental sound exposure (which can include traffic, machinery, public transport, among other things) that is higher than the World Health Organization's recommended limit.

- 20% of study participants have hearing loss according to World Health Organization standards, and 10% have hearing loss that is consistent with noise exposure.

- Younger participants (18-24 years old) are exposed to both higher environmental and headphone sound levels than other age groups.

For more information on the Principal Investigators of the Apple Women's Health Study, Apple Heart and Movement Study, and Apple Hearing Study, please **see the Extensions and Spotlights section 4.**

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v.   For more information on Apple Hearing Study, visit https://sph.umich.edu/applehearingstudy/index.html.

Other studies Apple has supported

In addition to the studies in the Research app, Apple has supported a number of other research efforts focused on heart health, mental health, and more. See below for several examples.

Heart Failure Study (University Health Network, Canada) This study, in collaboration with Dr. Heather Ross at the University of Toronto in Canada, is exploring how data collected using Apple Watch can provide early indicators of worsening heart failure. While ongoing, the goal of the study is to understand how remote monitoring through Apple Watch could drive better clinical outcomes for heart failure patients.[51]

Digital Mental Health Study (UCLA, US) Using devices including iPhone and Apple Watch, UCLA experts in behavioral health are collaborating with Apple to obtain objective measures of factors such as sleep, physical activity, heart rate and daily routines to illuminate the relationship between these factors and symptoms of depression and anxiety. Making the connection between quantifiable data and symptoms of anxiety and depression could enable health care providers to note warning signs, prevent the onset of depressive episodes and track the effectiveness of treatment. In addition, these objective measures will help medical science to better understand depression and anxiety, leading to more effective treatments in the future.[52]

For more information on studies that have been made possible by ResearchKit, please **see the Extensions and Spotlights section 5.**

Strengthening the physician-patient relationship with meaningful data

Supporting more informed conversations by offering comprehensive data insights

Most physician-patient relationships are built through interactions that occur in a clinical setting — at the doctor's office or at the hospital. On average, individuals see their doctors at most a few times per year, and during visits, physicians have limited insight into patients' everyday activities, which can be highly relevant to their overall health and care. Historically, most of the data needed to effectively assess behaviors and risks outside of the clinical setting has been difficult to obtain and interpret. Apple Watch, iPhone, and third-party apps are allowing patients to give their doctors a more complete picture of their health.

Our advances in tracking, storing, analyzing, and visualizing health data on Apple Watch and iPhone allow patients to gain insights into their health in between doctors' visits and to be alerted when there is something they should discuss with their doctor, leading to more informed and meaningful conversations between patients and their healthcare providers.

Stronger physician-patient relationships are linked with improved patient health outcomes.[55] When healthcare providers have more insight into how patients are doing outside of their office, it helps them understand the unique challenges their patients face in everyday life. Apple Watch and iPhone data allow patients to engage in conversations with doctors with access to data in the Health app that can provide a better picture of how they are doing on a daily basis — not just on the day of their visit.

The typical physician-patient relationship in numbers

According to 2017 OECD data, Americans consult a doctor 4 times per year, while the OECD average is about 7 visits a year.[53]

The average doctor's appointment is 18 minutes.[54]

Some conditions may be difficult to assess while at the doctor's office, making continuous and/or on-demand health data tracking very valuable.

"Looking at data from wearables such as Apple Watch, and partnering to understand the patient experience, coupled with the information from sensor technology, is a way for us to develop the knowledge that will allow us to take better care of patients. This is the future."

Dr. Heather Ross, Head of the Division of Cardiology at the Peter Munk Cardiac Centre, University Health Networks, leading the Heart Failure Study

"I'm inspired by the life-saving potential of technology and applaud Apple's innovation and commitment to health. Capturing meaningful data about a person's heart in real time is changing the way we practice medicine."

Dr. Ivor J. Benjamin, FAHA, Past President of the American Heart Association

Access to health records

Our features and technologies also contribute to paving the way for users to control their own health records.

Within the Health app on iPhone, users in the US, Canada, and the UK can download their medical records from multiple participating institutions and see them next to all of their other health information in the Health app. Health records on iPhone is now available to patients at over 800 institutions, across over 12,000 locations.

In a recent survey of users who had access to their health records on their smartphones, 90% responded that this improved their understanding of their own health, facilitated conversations with their clinicians, or improved sharing of personal health information with friends and family.[56]

In addition to having conversations in person around data from the Health app, patients can also easily export a PDF of their ECG app results on Apple Watch to share with their doctor.[vi] And at participating institutions in the US, patients can use the Health Sharing feature in the Health app to share categories of Health app data with their physician. When patients choose to share this data, their healthcare team can view the shared data in a web-based view in their own EHR system and review trends and changes over time. This feature builds on Health Records on iPhone, which creates a direct, encrypted connection between participating health institutions and a patient's iPhone so patients can see a central view of their allergies, conditions, immunizations, lab results, medications, procedures, and vitals directly within the Health app (See sidebar).

Apps and devices developed by third parties, built using developer tools such as HealthKit and CareKit, have provided additional ways to strengthen patient-physician relationships through at-home monitoring programs. This data can be shared with physicians and care-givers who can easily and securely remotely monitor different aspects of their patients' health and share personalized care plans that include instructions and reminders, which can be adjusted as the patient's condition evolves.[vii] As discussed in the section below, at-home monitoring programs based on Apple Watch, iPhone, and iPad have shown promising results.

"We're excited to partner [with Apple] in that space and we appreciate the ongoing relationship. FHIR is the new standard that would allow [health records] interfaces to be developed without prior programming which is a big deal from a health care standpoint. Smartphones are ubiquitous and it took us four hours to set the whole thing up with Health Records and FHIR integration."

Dr. Christopher Longhurst, Chief Medical Officer and Chief Digital Officer, UC San Diego Health

"Improving our services to patients while protecting their privacy and security is of paramount importance to us. This exciting development provides a more convenient option for patients to access their health records. Patients retain control over their own health information at all times."

Professor Sir Jonathan Montgomery, chair of Oxford University Hospitals NHS Foundation Trust and professor of healthcare law at University College London

For more information on the studies and data that are showing how technology is being used to support care from anywhere, please **see Extensions and Spotlights section 6.**

vi. To read more about the experience of 27-year-old Simone Deriu, whose ECG readings from Apple Watch were instrumental to his diagnosis of AFib, consult this La Repubblica article. https://www.repubblica.it/ tecnologia/2021/10/24/news/il_lato_bello_della_tecnologia_cosi_l_apple_watch_mi_ha_salvato_la_ vita_-323204108/

vii. For example, HealthSteps provides a digital personalized care plan: https://apps.apple.com/us/app/ healthsteps-your-care-plan/id1175003973.

Technology to support care from anywhere

Patient care does not stop once the patient leaves the doctor's office or the hospital, it continues into the home. Home care is particularly important for diseases and conditions that are chronic, such as diabetes or high blood pressure, or require rehabilitation, such as strokes. Hospitals, clinics, physicians, and more are relying on iOS apps built using HealthKit and CareKit to keep patients connected to care teams. Using iPhone or iPad, patients can follow personalized treatment plans, practice healthy behaviors from home, and record and securely share their own vitals.

By having up-to-date accurate information, the care team can monitor progress remotely and, if needed, engage with their patients.

Multiple health institutions use third-party apps that leverage Apple's technology across a variety of settings. Research has shown that connecting patients with their care teams remotely is resulting in **better outcomes** with the Corrie Health app, UVA Health care at home programs, and the US Department of Veterans Affairs loaning Apple devices to Veterans to connect them with their VA health care services. Care teams are better able to help **patients with chronic conditions** at Ochsner Health System and NHS Sunderland, and remote monitoring is **reducing the cost and length of stays in the NICU** at Odense University Hospital and the University of Virginia Children's Hospital, where premature babies can come home to be with the parents, but still connected to the care teams remotely.

"We can now deliver the same high-level quality of care that we're used to delivering in the inpatient setting to patients at home. That is something we've never really been able to do."

Dr. Jeff Vergales, University of Virginia Children's Hospital

"We've created a new program of monitoring a patient's blood pressure in their home using iPhone and the Health app, and we've been able to dramatically improve how many people got it under control in a short period of time."

Dr. Richard Milani, Chief Clinical Transformation Officer Ochsner Health

Third-party developer innovation

By offering access to sophisticated sensors on iPhone and Apple Watch, technical tools such as our health SDKs and APIs and artificial intelligence and machine learning algorithms, we strive to offer developers the tools to innovate in the medical filed and improve affordability and accessibility in health.

The following are some examples of innovative medical technologies developed by third parties using Apple products and technologies that have helped lead to better patient outcomes, increased cost savings, and improved efficiency in hospitals, clinicals, and other healthcare institutions.

The importance of portable ultrasounds

Pneumonia is a leading cause of death of children in poor countries and is frequently misdiagnosed.

Portable ultrasounds such as the Butterfly iQ+ are used to screen children in more than 13 low-income countries.

To learn more about the portable ultrasound uses in Uganda, consult the New York Times article here.

Increasing accessibility to ultrasounds with Butterfly iQ+[57]

Butterfly iQ+ is a handheld, portable ultrasound device that works in tandem with iPhone and iPad. It has expanded accessibility of ultrasound imaging in low-resource, emergency, and remote settings and is opening new possibilities for point-of-care ultrasound at much lower price point. Butterfly iQ+ is built using Apple developer tools such as Metal, Core ML and SceneKit, and leverages the power of iPhone and iPad to process images on-device which enhances privacy and security.

Reducing post-partum transfusions using Stryker's Triton AI[58]

Triton AI uses iPhone's infrared cameras and Core ML (an Apple machine learning framework) to estimate surgical blood loss in real time and is currently being used in labor and delivery protocols. The use of Triton AI has been associated with early recognition of hemorrhage, decreased postpartum transfusions, and cost savings in labor and delivery.

Helping Military Personnel and Veterans with PTSD to reduce nightmares with NightWare[59]

The NightWare system uses Apple Watch's heart monitor sensor and other biometric sensors and creates a personalized algorithm using artificial intelligence to help patients with PTSD and trauma who suffer from severe nightmares improve sleep quality.[6]

Improving remote post-operative care with Zimmer Biomet's mymobility®[60]

mymobility allows patients scheduled for an orthopedic procedure to better connect with their surgical teams, delivering continuous data and patient-reported feedback to facilitate care and recovery.

Monitoring Parkinson's Disease with the StrivePD app on Apple Watch[61]

Rune Labs offers an FDA-cleared Apple Watch app called StrivePD, which uses Apple's Movement Disorder API to provide a power-efficient approach to measuring and recording tremors and dyskinetic symptoms common in patients with Parkinson's Disease. The app enables a data-driven approach to care management and clinical trial design.

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Augmenting patient experience in hospitals and using hospital resources more efficiently

We support nurses, physicians, and healthcare professionals on their mission to deliver the best care to their patients. Our technologies, devices, and clinical apps help enable hospitals, clinics, and other providers to deliver better care for their patients by helping communication and workflow within the care team and by enhancing the patient experience from registration all the way through discharge.

Apple Watch, iPhone, iPad, and clinical communication apps enhance nurses' workflow and streamline how nurses communicate with physicians, other care team members, patients and the patients' family while delivering care and performing a multitude of other tasks. Beyond communication, they also help improve nursing care, productivity, and patient safety as nurses have access the patients' protected health information, can receive, triage, and escalate alerts, can administer medication, record clinical observations, and receive ongoing training.

Apple technology has also empowered clinicians to be more mobile, leading to times savings and more time spent taking care of patients. With our products and electronic health records (EHR) apps, clinicians can read and write patient records on the go, receive urgent lab notifications on Apple Watch, access on-demand decision support reference materials, and use third-party innovative devices like Butterfly IQ+ for imaging patients by the bedside.

Our products, such as iPhone, iPad, and Apple TV, streamline the patient journey in hospitals and clinics starting with the check-in process and continuing through to providing test results and progress updates. An improved patient experience contributes to more engagement with their health, facilitates better planning for home care once they are discharged, and helps lead to improved treatment adherence.

We take a comprehensive approach to security, meaning we think about security every step of the way when it comes to supporting the healthcare industry with our devices. From the systems itself, through the data on the device and the network, through to the apps created and installed, iOS, iPadOS, and macOS devices are secure by design with integrated hardware, software, and services.

Technology can empower clinicians

Nurses in over 90% of the US top 20 hospitals use iPhone for clinical communication (as of April 2022).

About 90% of US physicians stated they would derive value from technologies that streamline patients' health record-related tasks (e.g., vitals reading, visit notes, patient intake and triage).[62]

In 2020, 83% of US physicians expected that patient-generated data integrated with care delivery will be standard practice in the next 5-10 years.[63]

For more information on the studies and data that are showing how hospitals are augmenting the patient experience and using hospital resources more efficiently, please **see the Extensions and Spotlights section 7.**

"Because of push notifications, we get patients in the ER home quicker, move them to rooms quicker, to the next level of treatment in the OR quicker. By being able to just glance at my Apple Watch, it has been a total game changer in the ER."

Dr. Paul Testa, MD, Chief Medical Information Officer, NYU Langone

There are many examples around the world that highlight the use of Apple devices and technology in the medical community to improve patient care. This includes better communication and care coordination among nurses with iPhone at Parkview Medical Center and Rush University Medical Center, generating efficiencies and streamlining workflows at NYU Langone Health's Emergency Department, Stanford Children's Health, and NHS Ambulance Services, personalizing the patient experience with iPad at NHS Greater Glasgow and Clyde, UCSD, and Ann and Robert H. Lurie Children's Hospital of Chicago, and leveraging technology during COVID-19 at Mass General Brigham Hospital, the UCHealth, and with the University Health Network in Toronto.

Spotlight: Leveraging Apple's health platform to care for patients in the hospital and at home — How Ochsner Health has incorporated digital technologies to take care of patients.

Ochsner Health in Louisiana, USA has implemented several programs that rely on Apple technology to improve care for remote patients.

- **Digital chronic disease programs:** Chief Transformation Officer Dr. Milani and his team provide remote digital medicine programs for patients with hypertension and diabetes. Participants can track their conditions from the comfort of their homes using blood pressure cuffs and glucose monitors. And Ochsner's "O Bar" - staffed by full-time technology specialists - help patients set up devices. Data from the devices is collected via the Epic MyChart app on iPhone (built using HealthKit), and automatically populates for the physician to see in their patient's chart in the EMR. Care teams receive alerts when key thresholds are crossed and adjustments are made to the patients' care plan. Studies have shown that these digital medicine programs led to **79% of patients better controlling their blood pressure within 180 days**.[64] Patients in the Digital Diabetes program saw a reduction of **57% for hyperglycemia** and **74% reduction in hypoglycemic episodes**,[65] usual care patients over the same period had no change in either hyperglycemia or hypoglycemia indexes.

- **Connected MOM program:** Expectant mothers at Ochsner Health can use the Connected MOM program to stay connected to their care teams throughout pregnancy. Patients can use a connected blood pressure cuff, connected weight scale, and urine test strips to keep track of their health remotely, and share their results with their care team. This program led to a **reduction of three OB visits on average (out of 14)** and allowed care teams to identify pre-eclampsia weeks earlier.

- **Detecting early warning signs in hospitalized patients:** Health care providers in Ochsner Health's Rapid Response Team ("RRT") rely on the Epic Haiku app and Apple Watch notifications, with artificial intelligence to get early warning alerts of possible deterioration of hospitalized patients. When an RRT member gets a notification, they can quickly assess the patient and take immediate action, such as transferring them to the ICU. Based on a 90-day pilot study, this program successfully **reduced adverse events outside of the ICU by 44%**.[66] It is now being used in 15 hospitals across Ochsner's health system.

SUPPORTING THE HEALTH ECOSYSTEM BY COLLABORATING WITH THE MEDICAL COMMUNITY:

Health organizations promoting healthy lifestyles with Apple Watch

Scaling the opportunity for health insights to drive healthy choices

Health organizations and insurance companies around the world have collaborated with Apple to integrate Apple Watch in their wellness programs to promote healthier behaviors and improve individual health at a large scale, all while keeping privacy in mind. There are currently 55 programs running in 17 countries with over a million users taking part in an incentive program leveraging Apple Watch. These programs and platforms include **Paceline** in the US, **Vitality Active Rewards** in the US, UK, South Africa, and Australia, and **LumiHealth** in Singapore.

These health engagement programs have been successful in increasing participants physical activity levels and uptake of health behaviors, such as aiming for more regular sleep patterns, focusing on mindfulness, and swapping in healthier food options.

In addition, many of these programs offer participants ways to earn part of or all of the cost of Apple Watch through their progress, creating the opportunity for even more people to benefit from Apple Watch's health, fitness, and wellness features and become healthier in the long term. Programs can also offer other rewards like gift cards as participants track healthy habits.

We have also worked with global fitness clubs to support members' health journeys by integrating Apple Watch and iPhone into fitness experiences, from easier member check-in to the ability to earn rewards by closing Activity rings. For example, Life Time has integrated Apple Watch into its check-in experience, allowing members to seamlessly connect Apple Watch to GymKit-enabled cardio equipment, and was the first health and fitness brand to include Apple Fitness+ as part of its memberships.

"As a working parent, I juggle multiple projects at a time so LumiHealth provides me with helpful reminders to keep my health in check. These include breathing exercises using the Breathe app to help my mental health, curbing sugar intake to keep my diet in check, and switching up my workouts so I don't keep doing the same thing. When you have many things going on, an app that helps you keep your wellbeing in check is very much welcomed."[67]

Faz Gaffa, writer and marketing professional, Singapore

For more information on how health organizations are promoting healthy lifestyles with Apple Watch through various programs, please **see the Extensions and Spotlights section 8.**

SUPPORTING THE HEALTH ECOSYSTEM BY COLLABORATING
WITH THE MEDICAL COMMUNITY:

Supporting public health and government initiatives

The use of Exposure Notifications System

As of July 2022, 76 regions have launched exposure notifications, across 44 countries worldwide.

In the UK, 56% of the eligible population has downloaded the National Health Service (NHS) Covid-19 app that has been downloaded more than 21 million times as of February 2022.[68]

Koronavilkku, the Finnish national contact-tracing app, has been downloaded 2.5 million times as of October 2020.[69]

In Switzerland, the SwissCovid has been downloaded more than 3.8 million times.[70]

A study published in Nature estimated in May 2021 that for every percentage point increase in uptake of the NHS Covid-19 app in England and Wales, the number of cases could be reduced by up to 2.3%. Analysis suggests approximately 600,000 cases were prevented by the app between September 2020 and February 2021.[71]

In research looking at just 15% participation based on three Washington state counties in the US, exposure notifications could reduce infections and deaths by about 8% and 6%, according to an npj Digital Medicine article from March 2021.[72]

Especially during times of need, we strive to play a role in helping communities emerge stronger. We are indebted to heroic first responders, medical professionals, and public health authorities (PHAs) who work to prevent disease transmission and promote improved health. As we partner with clinicians and local governments, we look for unique ways to support their work through manufacturing and donating protective equipment, creating helpful apps and features, and working to disseminate reliable information to our users, all of which are crucial to contain and better manage public health crises.

Contributions and voluntary relief efforts during health crises

Apple regularly donates to relief efforts following natural disasters such as hurricanes and floods, and contributes to organizations such as UNICEF, World Central Kitchen, Feeding America, and other local, national, and international non-profits that support public health.

In 2020, Apple was one of the first companies to shift resources to the Global Fund's COVID-19 Response. By redirecting donations to the Global Fund's COVID-19 Response at the onset of the pandemic, Apple customers were able to help fund programs that mitigated the impact of COVID-19 on existing HIV/AIDS programs.

Apple's company-wide response to the COVID-19 pandemic involved teams across the businesses, including product design, engineering, operations, packaging teams, suppliers, and more. At the beginning of the COVID-19 pandemic, when personal protective equipment was in short supply, we sourced through our supply chain and donated more than 30 million masks for healthcare workers worldwide. And in a company-wide effort, we brought together product designers, engineering, operations and packaging teams, and suppliers in the US and China to produce and ship over 10 million face shields.[73,74] These face shields were delivered to sites around the world from NewYork-Presbyterian Hospital in the US to the Ministry of Health in Zambia.[75]

Additionally, Apple donated tens of millions of dollars toward the global COVID-19 response, and matched employee donations two-to-one to support COVID-19 response efforts worldwide. We awarded $10 million from our Advanced Manufacturing Fund to COPAN diagnostics, a market leader in sample collection kits, that rapidly accelerated their ability to supply sample collection kits to hospitals in the US for COVID-19 testing.

Building apps and features to support public health authorities and disseminating reliable health information during the COVID-19 health crises

We are proud to have been able to support public health authorities in their efforts to respond to health crises such as COVID-19 by adapting our technology and empowering users with resources to keep themselves healthy. Apple has partnered with governments, PHAs, and major technology companies to create innovative technologies that leverage our products, and our efforts have had a noteworthy impact worldwide.

Our partnerships to deliver innovative technologies have covered a wide array of features and programs, including Exposure Notification APIs, the Exposure Notification System, a COVID-19 Screening Tool, Mobility Trends Reports, University of Nebraska Medical Center's 1-Check COVID App, verifiable health records and vaccination cards in Apple Wallet, and Apple Maps Airport Guidance.

In addition, we believe our users should have access to health information so they can be better equipped to protect themselves and others during a public health emergency. To do this, during the COVID-19 pandemic we tailored our services — Apple Podcasts, Apple News, the App Store, Apple Maps (with vaccine and testing locations), and Siri — to promote easy access to reliable information on the outbreak, vaccination locations, and testing sites.

For more information on the apps and features that we have developed or services that were tailored in response to the COVID-19 health crisis, please **see the Extensions and Spotlights section 9.**

Extensions and Spotlights

1. The science and clinical validation behind our heart health features and our collaboration with medical experts

Apple collaborated with researchers at Stanford University School of Medicine to conduct the **Apple Heart Study** on AFib detection to validate the irregular rhythm notification on Apple Watch.[76,77]

Apple sponsored clinical trials to rigorously test the ability of the ECG app on Apple Watch to detect AFib and compare it with the results from ECGs conducted with FDA-cleared clinical devices. For more information about the development of the ECG feature — Apple's first regulated feature — see Apple's White Paper: "Using Apple Watch for Arrhythmia Detection."

The VO_2 Max and Cardio Fitness features available on Apple Watch were rigorously tested in a study with over 700 participants. Data collected during this study was used to design the algorithm that calculates the VO_2 max measurement. For more information about the development of the Cardio Fitness feature, see Apple's White Paper" "Using Apple Watch to Estimate Cardio Fitness with VO_2 max."

Independent research from Duke University has validated Apple Watch's technology for measuring heart rate against ECG readings and found that the heart rate readings from Apple Watch Series 4 were accurate relative to an ECG, both when measured at rest or during activity.[78]

> **Spotlight: Apple Heart Study**
>
> - The unprecedented study enrolled more than 400,000 Apple Watch users from all 50 states in a span of only eight months.
>
> - As part of the study, if an irregular heart rhythm was identified, participants received a notification on their Apple Watch and iPhone, a telehealth consultation with a doctor and an electrocardiogram (ECG) patch for additional monitoring.
>
> - Results published in the New England Journal of Medicine by Stanford Medicine found that the probability of receiving an irregular pulse notification was low: 2161 participants (0.52%) received notifications of irregular pulse. Among participants who received notification of an irregular rhythm, 34% had atrial fibrillation on subsequent ECG patch readings. This resulted in a positive predictive value for the irregular rhythm notification of 0.84 (95% CI, 0.76 to 0.92) among participants who had received an irregular rhythm notification.

2. The science and clinical validation behind our mobility features and our collaboration with medical experts

Fall detection was initially designed to detect the types of falls that adults over 55 are more likely to experience as they age – slips, trips, or falls.

To develop this feature, we worked with assisted living facilities and movement disorder clinics to observe real-word movement patterns and falls, following 2,500+ people over a total of 250,000 days.[79] We expanded the fall detection capabilities using the results of the **Apple Heart and Movement Study** – a study in collaboration with Brigham and Women's Hospital – for a wide range of activities and user demographics.

To design and validate the Mobility metrics features – including measuring walking steadiness – we gathered data through several in-lab studies. For more information on the development of this feature, see Apple's White Paper: "Measuring Walking Quality Through iPhone Mobility Metrics."

Apple Watch also expands on the ability to measure changes in mobility patterns by estimating the distance users are able to walk in six minutes, a measurement of overall mobility that was previously only available in clinical settings. For more information on the development of this feature, see Apple's White Paper: "Using Apple Watch to Estimate Six-Minute Walk Distance."

3. APIs available for third-party developers

Apple has made a number of APIs available to third-party developers so they can build innovative health apps.

HealthKit HealthKit is an open-source API designed to share health and fitness data while maintaining the users' privacy and control. The framework constrains the types of data and units to a predefined list — developers cannot create custom data types or units — ensuring that all apps understand what the data means and how it can be used.

ResearchKit ResearchKit is an open-source framework that was released to help researchers create powerful apps for medical research. Since launch, researchers have been able to initiate groundbreaking new studies through apps that reach participants at scale and produce breakthrough insights.

CareKit CareKit is an open-source framework for developing apps that support care for patients with medical conditions. Care teams can continue to remotely monitor patients with apps that can deliver personalized treatment, track daily progress, and generate trends over time.

SensorKit For researchers who are looking for more nuanced data types for study purposes, the SensorKit framework makes additional data types available with consent from users with iPhone and Apple Watch. Access to these data types is limited to research uses and requires an app to have a private entitlement, which is reviewed separately for each study.

Movement Disorder Doctors and researchers can monitor the symptoms of movement disorders continuously using Apple Watch. The Movement Disorder API provides a power-efficient approach to measuring and recording tremors and dyskinetic symptoms for Parkinson's disease. It is Apple's first API with scientifically validated digital biomarkers. In a study published in Science Translational Medicine, the tremor and dyskinesia symptoms measured on Apple Watch matched clinician expectation in 94% of cases.[80]

Fall Detection Apple Watch Series 4 and later can detect when a user falls, and contact emergency services if necessary. The Fall Detection API is particularly useful for apps that need to respond to falls in a timely manner so that the app can provide help to the person who fell. With a user's authorization, an app can set up a delegate to receive notifications about these fall detection events.

4. Information on Research app Principal Investigators

Apple Heart and Movement Study

Dr. Calum A. MacRae is Vice Chair for Scientific Innovation in the Department of Medicine at Brigham and Women's Hospital, a Principal Faculty Member at the Harvard Stem Cell Institute, an Associate Member of the Broad Institute of Harvard and MIT, and a Professor of Medicine at Harvard Medical School, He received his medical degree from University of Edinburgh Medical School and his PhD from the University of London. He is a cardiologist and a geneticist whose interests include investigating new ways to measure health and disease, developing new ways to treat or prevent disease and accelerating the translation of research findings into broad public use. He holds numerous patents for his work, and has authored over 300 peer reviewed publications on a range of medical and scientific topics. He is particularly focused on the role of the individual in understanding and managing their own health and wellness.

Apple Women's Health Study

Michelle A. Williams, SM '88, ScD '91, is Dean of the Faculty, Harvard T.H. Chan School of Public Health, and Angelopoulos Professor in Public Health and International Development, a joint faculty appointment at the Harvard Chan School and Harvard Kennedy School. She is an internationally renowned epidemiologist and public health scientist, an award-winning educator, and a widely recognized academic leader. Prior to becoming Dean, she was Professor and Chair of the Department of Epidemiology at the Harvard Chan School and Program Leader of the Population Health and Health Disparities Research Programs at Harvard's Clinical and Translational Sciences Center. Dean Williams previously had a distinguished career at the University of Washington School of Public Health. Her scientific work places special emphasis in the areas of reproductive, perinatal, pediatric, and molecular epidemiology. Dean Williams has published more than 500 scientific articles and was elected to the National Academy of Medicine in 2016. In 2020, she was awarded the Ellis Island Medal of Honor and recognized by PR Week as one of the top 50 health influencers of the year. The Dean has an undergraduate degree in biology and genetics from Princeton University, a master's in civil engineering from Tufts University, and master's and doctoral degrees in epidemiology from the Harvard Chan School.

Shruthi Mahalingaiah, MD, MS, FACOG, is an assistant professor of environmental, reproductive, and women's health in the Department of Environmental Health at the Harvard T.H. Chan School of Public Health. She serves clinically as a physician specializing in ovulation disorders, reproductive endocrinology and infertility at the Massachusetts General Hospital in the Department of Obstetrics and Gynecology. Shruthi has a BA from Middlebury College, where she dual majored in chemistry/Spanish and dual minored in physics/dance. Supported by a Thomas J. Watson III Fellowship, she lived with indigenous shamans in the Ecuadorian Amazon Basin, Andes mountains, and Bali studying the role of ritual in the healing process before matriculating to medical school. She attended Harvard Medical School

and an OB/GYN residency and fellowship in reproductive endocrinology and infertility at Mass General Brigham. She joined the faculty at Boston University School of Medicine/ Boston Medical Center in 2011 with K level funding from the Building Interdisciplinary Research Careers in Women's Health (BIRCWH 2011–2014) and the Reproductive Scientist Development Program (RSDP 2014–2017) to study environmental exposures and incidence of benign gynecologic conditions. She received a Master of Science in epidemiology at Boston University School of Public Health in 2015. She was awarded the 2016 Endocrine Society Early Investigator award, an Ellison Family Foundation award, and an RSDP seed grant in 2017–2018 to create a pilot online study of ovulation and menstruation health.

Russ Hauser MD, MPH, ScD, is chair of the Department of Environmental Health, Frederick Lee Hisaw Professor of Reproductive Physiology, and professor of environmental and occupational epidemiology at the Harvard T.H. Chan School of Public Health. He also holds an appointment at Harvard Medical School, where he is professor of obstetrics, gynecology, and reproductive biology. Dr. Hauser's research focuses on the effects of environmental chemicals on reproductive health, perinatal outcomes, and children's health. He has served on several NRC and IOM committees, including the Committee to Review EPA's State of the Science Paper on Non-Monotonic Dose Response, the Committee on the Health Risks of Phthalates, and the Committee on Endocrine-Related Low Dose Toxicity. Dr. Hauser was a member of two U.S. EPA Science Advisory Boards and served on the U.S. Consumer Product Safety Commission's Chronic Hazard Advisory Panel examining the effects of phthalates on children's health. He received his MD from the Albert Einstein College of Medicine and his MPH and ScD from the Harvard Chan School, where he also completed a residency in occupational medicine. He is board certified in occupational medicine.

Brent Coull, PhD, is professor of Biostatistics in the Departments of Biostatistics and Environmental Health and associate chair of the Department of Biostatistics at the

Apple Women's Health Study (continued)

Harvard T.H. Chan School of Public Health. He received his PhD in statistics from the University of Florida and has over 25 years of experience in a wide range of biostatistical applications to environmental health and health disparities research. His primary research interests focus on the development and application of integrative modeling of exposure and health data collected at multiple spatial and temporal scales, measurement error issues associated with the use of outputs from such models in risk assessments, and methods for analyzing the health effects of high-dimensional environmental mixtures in complex epidemiological study designs. Professor Coull directs a NIH T32 training program in environmental statistics, is Associate Director of the Air, Climate and Energy (ACE) Research Center at Harvard University, and is principal investigator of the Environmental Statistics and Bioinformatics Core of the Harvard NIEHS Center. Professor Coull has served as an external advisor for multiple U.S. EPA and NIH research centers and as an associate editor for the Journal of the American Statistical Association and Biometrics.

Apple Hearing Study

Rick Neitzel, PhD, CIH, FAIHA, is a Professor of Environmental Health Sciences and Global Public Health at the University of Michigan (UM) School of Public Health. His work, and the work of his team in the UM Exposure Research Lab, focuses primarily on noise exposures, noise-related health outcomes, and injury risks, and takes place in workplace and community settings both domestically and abroad. He is particularly interested in incorporating new methodologies and exposure sensing technologies into research, and also has a strong interest in translating his research findings into occupational and public health practice. Dr. Neitzel is Chair of the ACGIH® Threshold Limit Values for Physical Agents (TLV®-PA) Committee. He is also a Fellow of the American Industrial Hygiene Association and has been a Certified Industrial Hygienist since 2003. He directs the UM Global Public Health Certificate program, and is also Director of the UM Center for Occupational Health and Safety Engineering.

5. Other studies that have been made possible by ResearchKit

Exploring a genetic cause to PPD with Mom Genes Fight Postpartum Depression (UNC, US)

Our ResearchKit framework has been fundamental in UNC School of Medicine's research on postpartum depression aiming at determining whether there is a genetic cause to PPD. The app "Mom Genes Fight PPD," which relies on ResearchKit, allowed the researchers to recruit, screen, and enable collection of genetic samples from 4,000 women. Given the large scale of the study, UNC researchers can better understand the relationships between genes and environment, thus potentially preventing risks of PPD. Researchers also conducted a pilot study, tracking daily symptoms of PPD in participants using Apple Watch, and found that this data can be used to enhance clinical care access.[81]

Studying the psychological effects of COVID-19 on healthcare workers with the Mount Sinai Warrior Watch Study[82] (Mount Sinai, New York, US)

In the Warrior Watch Study, researchers from the Mount Sinai Health System are studying the psychological effects of COVID-19 on healthcare workers and the ability to predict COVID-19 infection before symptoms appear. So far, the study has found that self-reported metrics, health records, and Apple Watch data could help predict a positive COVID-19 diagnosis up to a week before PCR-based tests.

6. Technology to support care from anywhere

Connecting patients with their care teams remotely for better recovery outcomes

Helping heart attack patients navigate recovery and reduce readmissions with Corrie Health (MD, US)

This app is based on the collaboration between Johns Hopkins physicians and staff, nurses, engineers, and patients. After a heart attack, patients are provided with the Corrie iPhone and Apple Watch app and blood pressure monitor in the hospital and for an additional 30 days at home. The app uses CareKit frameworks to offer evidence-based education modules and a daily care plan, track progress and provide reminders to patients to complete daily tasks. The app is integrated into clinical workflow and the patient receives support from their care team to optimize their recovery. In the US, the all-cause 30-day readmission rate following an acute myocardial infraction is nearly 20%; a clinical study showed that patients using the Corrie Health platform had less than a 7% chance of readmission.[83]

Interactive Home Monitoring at UVA Health (VA, US)

UVA Health serves a large cross-section of patients with acute and chronic illnesses including a number of patients from underserved groups and rural communities. Using a data plan-enabled iPad with the Locus Health app and devices to monitor vital signs such as blood pressure, weight, heart rate, temperature, blood sugar levels, and oxygen levels, patients can attend telehealth visits with UVA care providers and share key health information from home.[viii] The home monitoring program supports a variety of patients, including transplant patients, premature infants, pregnant mothers at high risk for delivery early, and patients with chronic conditions such as heart failure. During the COVID-19 pandemic, UVA Health has leveraged the program to serve patients recovering from the virus. The program has improved patient outcomes, including lowering the Emergency Department visits and hospital readmissions as well as lowering blood-sugar levels for patients with diabetes.[84]

Leveraging iPad Pro and iPhone for mobile primary care with Heal

Heal delivers value-based primary care to patient homes to achieve better outcomes and lower the cost of healthcare. Apple SDKs are used to build applications for patients, doctors, and care coordinators. Doctors use iPad Pro to conduct patient visits and enter clinical notes. Patients use the Heal app to make appointments, have telehealth calls, and utilize remote monitoring technology to send their vitals readings directly to their doctor while in the comfort of their own home.

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viii   For more information on Interactive Home Monitoring at UVA Health, visit https://appletoolbox.com/how-uva-leverage-apple-healthcare/.

Helping veterans more easily connect with their care teams with iPad

As part of their efforts to address the digital divide, the U.S. Department of Veterans Affairs (VA) worked with Apple before and during the pandemic to facilitate more equitable access to care for Veterans without the technology or internet services they needed to connect to VA virtual care, using iPads. This VA loaned iPad program provides qualifying veterans with cellular-enabled iPads and currently helps more than 100,000 veterans across the country connect to VA health care services virtually. In a recent JAMA study of more than 470,000 veterans living in rural areas, VA researchers found that this program increased the participation in mental health care visits via video; increased psychotherapy visit participation via video, phone or in-person; and saw a 20% reduction in the likelihood of emergency Department (ED) visits, a 36% reduction in the likelihood of suicide-related ED visits; and a 22% reduction in the likelihood of suicidal behavior.[85] In addition, veterans across the nation and surrounding territories who receive their care through the Veterans Health Administration can also use the Health Records feature within the iPhone Health app to see a fuller, more comprehensive picture of their health care, including information from multiple health care providers.[86]

Reducing cost and the length of NICU stays through remote monitoring

Odense University Hospital (Denmark)

The neonatal intensive care unit (NICU) of Odense University Hospital relied on Apple technology and products to shorten NICU stays and keep babies with their families. By sending families home with an iPad and an infant scale, NICU nurses trained parents of premature babies to enter daily weight and other metrics in the Odense My Hospital App. The data was directly recorded into the patients' medical records allowing nurses to remotely monitor the babies and engage with the families via video call. The program reduced the length of stay in the NICU allowing babies to go home sooner, with an average of 23 days of monitoring the babies from home. The program was also more cost effective than regular hospital care (15% less costly for infants born under or at 32 weeks, and 5% less costly for infants born after 32 weeks).[87,88]

University of Virginia Children's Hospital (VA, US)

The hospital's remote monitoring program Building HOPE uses iPad configured for individual patients to collect data that is automatically transferred to their electronic health records and facilitate remote consultations. The program has enabled early discharge for babies in the neonatal intensive care unit who can be safely monitored at home, leading to a reduction in the length of stay by 8 days.[89]

Helping patients with chronic conditions

Improving health outcomes for patients with hypertension and diabetes with Ochsner Digital Medicine (New Orleans, US)

The medical team at Ochsner uses Apple's technology, Epic's MyChart app that is integrated with HealthKit, along with third-party medical devices, such as blood pressure cuffs and glucose monitors, to provide remote digital medicine programs for patients with hypertension and diabetes. Patients can monitor their blood pressure and blood sugar levels from the comfort of their homes and based on their results, their care teams of physicians, pharmacists, and health coaches can make real-time adjustments to their care plan with data coming directly to the patient's Electronic Medical Record flowsheet. These programs have led to patients showing significant improvements: after 90 days, 79% of high-blood pressure patients had controlled their blood pressure under the program compared to only 31% of patients not participating in the program[90]; after 1 year, patients with type 2 diabetes enrolled in Ochsner's digital diabetes program saw a 57% reduction in hyperglycemic events and a 74% reduction in hypoglycemic episodes; patients not enrolled in these programs had no significant changes in either hyperglycemia or hypoglycemia.[91]

NHS Sunderland helps seniors with chronic conditions live independently (Sunderland, UK)

This hospital provides iPad to senior patients and their nurses, which enables them to share health data with the Luscii app and stay connected with the care team, allowing them to live independently at home. Patients can record their vitals from their own homes and share this data with their care team. They can connect with their care team through video conferences and nurses can visit them at home. This program has reduced accident and emergency visits by 70%, re-admissions by 26%, and hospital costs by 51%.[92,93] The qualitative feedback for patients participating in the COPD program was universally positive, with 100% of patients seeing benefits using Luscii app on iPad.

7. Augmenting patient experience in hospitals and using hospital resources more efficiently

Better communication and care coordination among nurses with iPhone

Improved clinical communications and improved patient care at Parkview Medical Center (CO, US)

Parkview has provided each of its nurses with an iPhone so that they can rely on certain features and iOS-based apps to help deliver better care to patients and to help the staff stay coordinated and in sync. As a result, Parkview saved 60 minutes per nurse, per shift, on documentation and coordination tasks, allowing them more time to spend with patients.[94,95]

Barcode scanning to limit errors and patient disruption at Rush University Medical Center (IL, US)

Rush has deployed iPhone with the Epic Rover app to all its nurses to streamline nursing care and improve clinical communications. Nurses use iPhone to send and receive text messages from care teams, document vitals with dictation, and scan patients' wristbands, medication, and blood products using soft-scan that uses the native iPhone camera with Rover, ensuring that each patient gets the proper medication and reducing likelihood of transfusion errors.[96] The scanning feature also limits patient disruption by removing the need for a workstation on wheels. Physicians, transport, radiology technicians and many other groups of employees use iPhones to help improve coordination among patient care teams.

Generating efficiencies and streamlining workflows by using Apple technology

Reduced length of stay and wait times in the NYU Langone Health's Emergency Department (NY, US)

A study involving the emergency department (ED) found that the use of push notifications on iPhone and Apple Watch alerting physicians about the availability of test results reduced the lag between result availability and physician decision-making. Such efficiency gains decrease the length of stay and wait times in the ED. The reduction in crowding in the ED is associated with lower stress level among physicians and higher quality of care.[97]

Virtual Onboarding and Training for Nurses (Stanford, US)

Apple collaborated with clinicians and nurses at Stanford Children's Health on a project to explore whether the use of mobile technology, modules and software on iPad and iPhone, could be translated to education within the health care setting. The project results were published in the journal Nurse Leader in 2019. Stanford's virtual program saw a cost savings of $1.3 million over 18 months by reducing training costs compared to its traditional "in-classroom" training programs. In addition, the new programs allow nurses to use QR codes strategically placed on medical equipment for just-in-time training which has led to reducing hospital-acquired infections and pressure injuries with improved clinical outcomes and increasing nurses' competency.[98]

NHS Ambulance Services empowers first responders with iPad devices

More than 30,000 iPads have been issued to ambulance crews across England so that patients get the right care faster.[99] The solution allows on-site paramedics to document patient vitals as they assess patients' injuries and decide whether they should be taken to hospital or treated at the scene. Detailed patient information can also be sent directly to the emergency department for patients that are critically injured, this speeds up patient handover and frees the ambulance to attend to the next call.

Providing iPad to personalize the patient experience at hospitals

Helping patients connect with their families during COVID-19 at NHS Greater Glasgow and Clyde (Scotland)

During the COVID-19 pandemic, in-person visits at NHS Greater Glasgow and Clyde were suspended for most patients. The hospital created "person centered virtual visiting" and used iPad to help reunite patients with their families.[100]

Integrating iPad for bedside connection UCSD (CA, US)

UCSD has allowed patients to take control of their hospital experience by adding iPad to every hospital rooms. Patients can stay connected with their loved ones, engage with their care team, and control their room settings. iPad apps such as Epic's MyChart Bedside let patients view their schedule, track progress and lab results, which empower them to participate in their own care.[101,102]

Using iPad reduce children's anxiety before surgeries among children at Ann and Robert H. Lurie Children's Hospital of Chicago (IL, US)

To reduce anxiety before surgeries Lurie Children's Hospital uses iPad to distract, entertain, and calm children, many of whom are facing long stays and difficult treatments. A study published by the Pediatric Anesthesiology Department at Lurie Children's Hospital comparing the use of iPad mini with the sedative midazolam for pediatric patients undergoing ambulatory surgery showed that using iPad reduces anxiety before surgery (perioperative anxiety) and delirium after surgery (emergence delirium), as well as increases parental satisfaction. The study also showed a 24-minute reduction in median time-to-discharge from the PACU (post-anesthesia care unit) from using iPad mini.[103,104]

Leveraging technology during COVID-19

Reducing exposure to COVID-19 at Mass General Brigham Hospital (MA, US)

During the COVID-19 pandemic, the health system deployed iPad and iPhone to protect staff, preserve protective equipment, and help patients in isolation wards connect with loved ones. Doctors and nurses used Apple devices in rounds to provide virtual care to patients. Through an app developed by the health system, nurses could check on and communicate with patients and doctors. This enabled the hospital to reduce its use of personal protective equipment by 50%, helping the hospital cope with the nationwide shortage of PPE, and reduced virus exposure by the staff.[105]

Large scale vaccination in Toronto (University Health Network, Canada)

10,000 iPad devices were deployed across Ontario to support vaccination efforts during the COVID-19 pandemic. In a joint effort between the City of Toronto, Maple Leaf Sports & Entertainment (MLSE), Scotiabank, Michael Garron Hospital, and the University Health Network, 385 iPad devices helped enable large scale mass vaccination sites in Toronto by transforming Scotiabank Arena without the need for a single cable, keyboard, barcode scanner, or monitor. Vaccinations at Scotiabank Arena led to a record setting, 26,771 people vaccinated in one day.[108]

Deploying Apple devices during COVID-19 at University of Colorado Health (UCHealth, CO, US)

UCHealth deployed over 3,000 Apple devices – iPad, iPhone, and Apple TV – in nursing stations, labs, translation service, rehabilitation, remote doctor-patient communication in high-risk environments, accessing patient medical records, to connect families to their loved ones, as well as patient entertainment.[106] They also partnered with Epic to use iPhone in outdoor mass vaccination sites, where paper documentation can be a major hassle, to check in patients, document responses and obtain patient consent. The move from paper documentation to the use of iPhone with 5G connections reduced vaccination time from 3 minutes to 30 seconds per patient.[107]

Scaling video visits during COVID-19 and NYU Langone (NY, US)

As with other hospitals during the COVID-19 pandemic, NYU Langone had to quickly change their patient-physician dynamic to being by video rather than in person. The ease of use of iPad and iPhone allowed them to keep their patients connected during the worst of the pandemic.

8. Health organizations promoting healthy lifestyles with Apple Watch

Promoting healthy behaviors with Apple Watch through the LumiHealth program (Singapore)

LumiHealth is part of Singapore's Smart Nation initiative, a national effort to leverage technology to deliver benefits to its citizens and businesses. Created in collaboration with physicians and public health experts, LumiHealth encourages users to achieve better health over time using Apple Watch and iPhone.[109] The program rewards users for being more active, eating healthy, improving sleep and mindfulness habits, and going for health screenings and immunizations. Since launch, the app has been downloaded over 300,000 times, with more than 19 million health and wellness challenges served. The app has helped users increase their daily exercise minutes, for example, users who are a part of the 'low activity' group grew their weekly exercise minutes by 88% compared to the month before they start using the program.[110]

Seamlessly integrating Apple Watch into the Life Time member experience (US and Canada)

With 160 athletic clubs across the US and Canada, Life Time offers its members the ability to use Apple Watch for frictionless check-in, seamless connectivity to GymKit-enabled cardio equipment for optimal fitness tracking, and pay with Apple Pay on Apple Watch or iPhone at its in-club LifeCafe and LifeSpa locations. In 2020, Life Time was the first health and fitness brand to include Apple Fitness+ as part of its memberships.

Rewarding activity with Apple Watch and other rewards with Paceline (US)

With a program built in collaboration with Apple, Paceline's first-of-its-kind credit card allows cardmembers to earn back the purchase of Apple Watch by consistently achieving a 150-minute exercise "streak" each week. Paceline members connect their Paceline app with Apple Watch to track activity. When members hit their weekly workout streak, they can also earn up to 5% cash back on gym memberships, groceries, fitness classes, and more, and up to 3% cash back on everything else.

Encouraging active lifestyle and positive behavior changes with Vitality Active Rewards programs around the world

Health and life insurance companies around the world have adopted Vitality Active Rewards – a behavioral program that encourages physical activity. Through a global collaboration with Apple, participants can earn their Apple Watch or other rewards by consistently meeting a weekly activity or other goals over a period of time.

• An independent study by RAND Corporation[111] of the Vitality Active Rewards program in the US, UK, and South Africa showed that the uptake of Apple Watch was associated with a 34% average increase of tracked activity days per month. This increase in activity persisted after the end of the program.

• AIA Vitality Active Benefits program (Australia): The addition of Apple Watch Benefit to the program led to a 35% increase in physical activity year on year among members who opted into the program.[112]

9. Apps and features developed or services that were tailored in response to the COVID-19 health crises

Exposure Notification APIs
Early in the pandemic, public health officials identified contact tracing as a valuable tool to help contain the spread of COVID-19.[113] And as governments and health authorities worked together to find solutions that could protect people and support their communities, we partnered with Google to launch the Exposure Notification APIs in May 2020 for apps developed by public health officials and institutions throughout the world.[114] This was an important first step in developing this technology with user privacy and security central to the design.

COVID-19 Screening Tool[115]
To help people stay informed and take proper steps to protect their health during the pandemic, in March 2020, we released a screening tool, that walks users through a series of questions and provides recommendations on next steps, and a set of resources that were created in partnership with the Centers for Disease Control and Prevention (CDC), the White House Coronavirus Task Force and FEMA. A COVID-19 website and COVID-19 app were made for people in the US to get trusted information and guidance during early stages of the pandemic.

Exposure Notifications System In September 2020, we made it easier and faster for PHAs to use the Exposure Notifications System without the need to build and maintain an app. We built a fully operational Exposure Notifications System, built directly into iOS, available when a PHA supports it. Additionally, iOS users in many countries accessing Exposure Notifications Express can simply turn on the feature in their settings without downloading an app.

Mobility Trends Reports[116] To support impactful work and research around the world to mitigate the spread of COVID-19, we publicly released a mobility data trends tool that presented daily aggregated data collected from Apple Maps for over 4,600 regions, counties and cities. By showing the change in volume of people driving, walking, or taking public transit in their communities against a baseline of January 13, 2020, all while protecting user privacy, we strived to help local governments, health authorities, and research institutions assess mobility within their communities to help contain the spread of COVID-19.

University of Nebraska Medical Center's 1-Check COVID App Early in the pandemic, we worked on concern with UNMC as they created a groundbreaking mobile app using ResearchKit and CareKit frameworks to screen large groups of individuals who are concerned that they may have COVID-19 and to help first responders and other health care providers determine a person's likelihood of carrying the disease.[117]

Verifiable health records and vaccination cards in Apple Wallet Users around the word can easily add and store COVID-19 vaccinations or test results from vaccine providers, health organizations, or national health system that support the SMART Health Cards or EU Digital COVID Certificate specifications in the Health app. They can also store and quickly access COVID-19 vaccination information as cards in Apple Wallet.

Apple Podcasts In March 2020, Apple Podcasts launched "COVID-19 Essential Listening," a worldwide collection of shows dedicated to coverage of the coronavirus pandemic that included informative, fact-based reporting from reputable providers such as ABC News, the BBC, and CNN. This collection expanded over the following weeks to include programming about mental and emotional health during this uncertain time. With each variant, Apple Podcasts updated the collection to feature additional shows from providers — such as Bloomberg, Johns Hopkins School of Public Health, and the World Health Organization — and has featured the collection and its content through the Browse tab in over 170 countries and regions.

Apple Maps Airport Guidance In collaboration with Airports Council International, Apple Maps place cards provide information on the latest COVID-19 requirements for over 300 airports worldwide along with a link to the airport's COVID-19 information page.

Vaccine and testing locations We enabled search for more than 130,000 COVID-19 testing and vaccine locations in 33 countries and regions including Australia, Brazil, Canada, France, Germany, Japan, Mexico, Thailand, and the US.

Apple News We launched a new COVID-19 section where users can be sure they can find the latest verified reporting from trusted outlets. A map describes the spread of infection, and a vaccine section supports users looking for information and how to find an appointment in their state.

Siri We introduced a tool providing guidance from the Centers for Disease Control to users concerned they may have COVID-19 based on their answers to questions about symptoms and exposure. Siri also provides statistics on COVID-19 cases on a country and state level as well as provides support for daily trend changes to learn of the number of new cases in a region.

App Store A telehealth collection provided a sample of some of the many apps available to provide additional health information and support, and App Store collections have highlighted apps that allow people to stay connected, entertain themselves, and take care of their mental health during the pandemic.

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