

**50<sup>th</sup> Anniversary**  
 PARMA Annual Conference  
 February 20-23, 2024  
 Indian Wells, CA

**50 Years of Ergonomics**

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**parma**  
 PARMA Society for Professional Ergonomics

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**EVENTS**

**Historical Events and Trends that Shaped the Field of Ergonomics**

**TRENDS**

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**What is ERGONOMICS?**

Study of the worker and the work

- Fitting the task to the human
- Efficient use of human energy
- Minimize error / Increase safety
- Do more with less (Efficiency / productivity)

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**Ergonomics goes WAY BACK...**



Bernardino Ramazzini was born in Carpi, Italy, in 1633. While he was still a medical student at **Parma** University, his attention was drawn to diseases suffered by workers.



Bernardino Ramazzini realized that repetitive motions can stress the human body and he wrote about the connection seen among porter and scribes.



The word only became common after World War 2, with a focus on designing tools and procedures that create more productivity and less strain on a workforce.

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**Agriculture Revolution**



An agricultural revolution is when farming techniques drastically improve within a relatively short period of time. This leads to a greater production of food and allows humans to pursue other types of work.

**What are the three agricultural revolutions?**

1. Began around 10,000 B.C. Humans shifted from being hunter-gathers to being subsistence farmers and herders.
2. During the 18th century. Major changes to farming techniques, which included livestock breeding, crop rotation, and mechanical farm equipment.
3. During the 1940s, 50s, and 60s. Innovations in irrigation, fertilizers, pesticides, and plant breeding led to greater crop yields.

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**Agriculture Revolution**



**ERGONOMICS IN AGRICULTURE:  
WORKPLACE PRIORITY SETTING IN THE DAIRY INDUSTRY**

James M Meyers  
Center for Occupational and Environmental Health  
University of California, Berkeley  
Ira Janowitz

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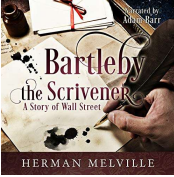
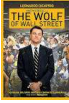
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### 50 Years of Ergonomics

#### Early Wall Street Ergonomics

- Herman Melville's 1853 story "Bartleby, the Scrivener: A Story of Wall Street" describes an office.
- Nipper, a document copier, had constant back pain from long hours writing, and sometimes raised the desktop, says Melville, to an angle like he was using the sharply angled roof of a Dutch house (Melville 1853).



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### EVENTS

#### Mandatory School 1850

#### Back Problems

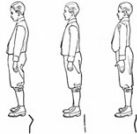


Posture Correction Methods from 1855



Set in 1881

The first compulsory school attendance laws were passed in 1852, in Massachusetts. Critics argued that this would force kids to distort their bodies by sitting at desks for 6 hours every day.



In 1890, a leading pediatric journal found that more than 50% of American kids were suffering from deformed spines. This was alarming and created a national obsession where ramrod-straight postures emerged.

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### 50 Years of Ergonomics

#### The Modern Office

- The modern office emerged in the late 1800s.
  - The elevator
  - The iron frame building
  - Good lighting systems
- The telephone, the manual typewriter and the 3 x 5 file card, carbon paper together created a new information technology.
- More hours in the office also meant more aching backs



Frank Lloyd Wright's Office Chair design in 1904. It was revolutionary because it had a seat height adjustment mechanism.

He made a 3-legged version for secretaries, nicknamed 'the suicide chair' because it was so uncomfortable.

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<https://www.tcm.com/tcmdb/title/70716/cheaper-by-the-dozen/#overview>

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### 50 Years of Ergonomics The Modern Office

- Early office life was brutal.
- 1894 secretaries had to sit in stiff wooden chairs all day.
- No ergonomic support to help hold themselves upright all day.

To make sure they kept sitting ramrod straight, two men were charged with watching over them to 'manage' their work and posture.



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### EVENTS


#### Industrial Revolution

Industrial life replaced an agricultural one as people transitioned to sedentary city living.



#### STAGES OF THE INDUSTRIAL REVOLUTION

1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>
Mechanization Steam engine, hydropower and mechanization	Electricity Mass production, assembly lines and electricity	Computing Automation, information and communication technologies (ICT)	Digitization Internet of things, the cloud, digital coordination, cyber-physical systems and robotics



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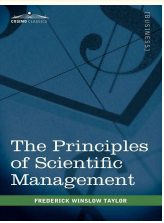
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### TRENDS

#### 50 Years of Ergonomics

##### 1890's - The Start of applying Science to the World of Work

- In the 1890s, the American Frederick W. Taylor pioneered the scientific study of work.
- His team examined the **motions** workers used in performing specific activities, **and the time taken**.
- This resulted in changes that sharply **cut the number of motions**.
- These **"time and motion studies"** resulted in increased productivity, workers got improved working conditions and sometimes better pay.
- Today, ergonomists use RULA, REBA and NIOSH equations.



In 1911, Taylor published "The Principles of Scientific Management" which explains his process of using scientific studies to analyze, optimize and standardize workflow.

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### 50 Years of Ergonomics

#### The Start of applying Science to the World of Work

##### The Brick Laying Study - 1912

- A classic in ergonomics was an analysis carried out by Lillian and Frank Gilbreth. They analyzed bricklaying, and devised a method that reduced the motions of laying a brick from 18 to 5, and increased the number of bricks laid from 120 to 350 per hour.
- Invented motion and fatigue study
- Stoop once for brick, stoop once for mortar
- Pick up 4.5 pound brick
- Designed a non-stooping scaffolding platform
- One-motion brick grasping packet

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[https://youtu.be/dVKTX\\_Sbwzw](https://youtu.be/dVKTX_Sbwzw)

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### 50 Years of Ergonomics

#### The Start of applying Science to the World of Work

- Interesting Fact: The book "Cheaper by the Dozen" was written by Frank and Lillian's children Frank Jr. and Ernestine.
- There were 12 children in the family, and the book (and subsequent movies) highlighted the efficiencies that were introduced into their household as a result of their parents' methods.

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<https://www.tcm.com/tcmdb/title/70716/cheaper-by-the-dozen/#overview>

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TRENDS

### 50 Years of Ergonomics

#### Ergonomics and Henry Ford

The first Ford assembly line at the Highland Park, Michigan, plant was relatively crude. In 1913, workers put V-shaped magnets on Model T flywheels to make one-half of the flywheel magneto. Each worker installed a few parts and simply showed the flywheel down the line to the next worker.

By reducing the money, time and manpower needed to build cars as he refined the assembly line over the years, Ford was able to drop the price of the Model T from \$850 to less than \$300. For the first time in history, quality vehicles were affordable to the masses.

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**50 Years of Ergonomics**

**Ergonomics and Henry Ford**

His innovation reduced the time it took to build a car from more than 12 hours to one hour and 33 minutes.

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<https://www.youtube.com/watch?v=qF0u24cA9j8>

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**50 Years of Ergonomics**

**Assembly Lines had to match human capabilities**



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[https://www.google.com/url?sa=i&url=https://3AN2P9J2fem0cc.com/Q?view%2Fspeed+is+up+can+you+handle+that+handle+are+you+sure+fast+gl+18189781&imgre=ADWVow1ovv437z7L1k5D\\_6bmIFB&ustc=170664658277008&source=images&ocqy6&ved=0CBIDjveFwoTKDF\\_PfH5-0MDG3A5AAAAA5A5E](https://www.google.com/url?sa=i&url=https://3AN2P9J2fem0cc.com/Q?view%2Fspeed+is+up+can+you+handle+that+handle+are+you+sure+fast+gl+18189781&imgre=ADWVow1ovv437z7L1k5D_6bmIFB&ustc=170664658277008&source=images&ocqy6&ved=0CBIDjveFwoTKDF_PfH5-0MDG3A5AAAAA5A5E)

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**EVENTS**

**50 Years of Ergonomics**

**Ergonomics and WW1 and WWII**  
(human machine interface)

- The world wars were periods of intense use of ergonomics.
- During World War 1, plane cockpits were so ergonomically inefficient, causing many accidents.
- Aircraft were expensive and a cockpit full of dials, indicators and other instrumentation was at the limits of a pilot's ability to control.
- Many planes were lost because they were just too complicated.
- Ergonomic analysis grouped controls in a logical way, assisting pilots and saving a lot of aircraft.

**The Link Analysis**

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### 50 Years of Ergonomics

#### The Evolution of the Office Chair

- Generic office chairs have been using the same design concepts for over 120+ years.
- Most office workers only needed to shuffle papers and push their pencils.
- By the 1970's, padded seats and rocking functions emerged as the pinnacle of luxury.



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### 50 Years of Ergonomics

#### The Evolution of the Office Chair




In the 1960's, a growing automobile craze created a need for better car seats.

1965: RECARO developed FOAM car seats.

Took seating from metal springs and horsehair padding to foam and shock absorption.

1955



1976



2022



The RECARO team went on to develop several ergonomic seating staples. Here are some of their most notable achievements over the years.

- 1965: the RECARO sports seat introduced foam padding and side bolster contours.
- 1968: world's first seat with a headrest + adjustable shoulder support.
- 1973: headrests became standard on all RECARO seats.
- 1977: pneumatic lumbar support introduced.

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### 50 Years of Ergonomics

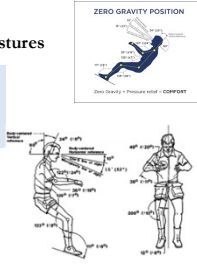
#### 1973 - NASA Discovers Neutral Postures

In 1973, NASA launch SKYLAB. Photos of astronauts were taken as they relaxed in space, in zero gravity.

Neutral postures reduce the body's need to support itself against gravity. This reduces pressures on the body.



These 'neutral postures' shaped the dynamic ergonomics changes to body positions, chair design concepts and adjustments, as well as manufacturing standards.



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### 50 Years of Ergonomics Using NASA's Data:

1990s: Time was ripe to re-invent the desk chair using NASA's neutral posture findings.


- \* Used NASA data to develop healthy desk working / sitting parameters
- \* To support 'neutral postures', chairs needed 3 adjustable features



1. Adjustable Lumbar



2. Adjustable Arms



3. Reclining Backrest

All chairs that qualify as 'ergonomic' come with three core adjustable features.

For a chair to qualify as 'ergonomic', it had to have three core adjustable features.

Having these three features allow for long hours of sedentary office work.

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TRENDS

### 50 Years of Ergonomics Office Chair Design

In 1994, Herman Miller released the Aeron chair. It broke new ground in several ways.

1. First, it came in three sizes to suit 95% of body types.
2. Second, the designers had recently developed a chair mesh that prevented bedsores.
3. It offered adjustable features:
  - Adjustable lumbar support
  - Adjustable back tilt, forward tilt, and seat height
  - 2 D armrests with soft caps
  - Infinite recline (lock in any position between 93-104°)
  - 10-year warranty


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EVENTS

### 1990's

**The Personal Computer**





**Nintendo**











**The Internet**

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**TRENDS**

### 50 Years of Ergonomics

**1990's**

90s-era PC computing and Internet surged sedentary behaviors across many age groups.

Childhood obesity levels also started trending upwards in the 1990s.

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**TRENDS**

**Was it only childhood obesity that rose up as a result of sedentary time from personal computers, video games and surfing the internet?**

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**TRENDS**

### Obesity Trends\* Among U.S. Adults BRFSS, 1985

(\*BMI ≥30, or ~30 lbs. overweight for 5'4" person)

Source: Behavioral Risk Factor Surveillance System, CDC.

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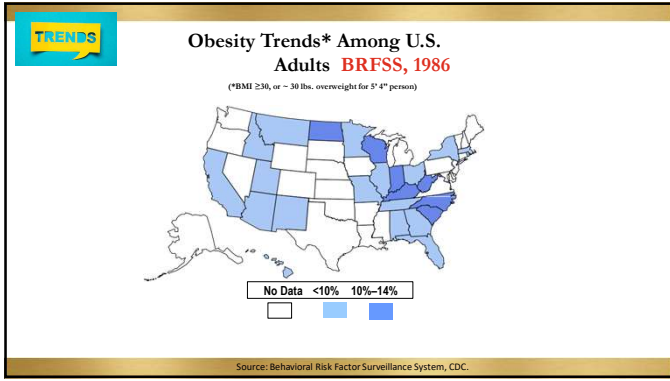
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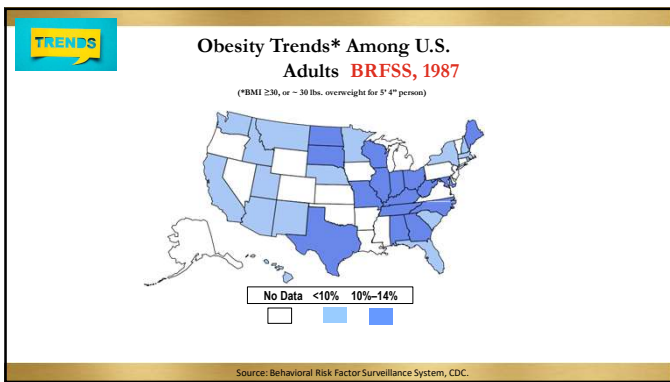
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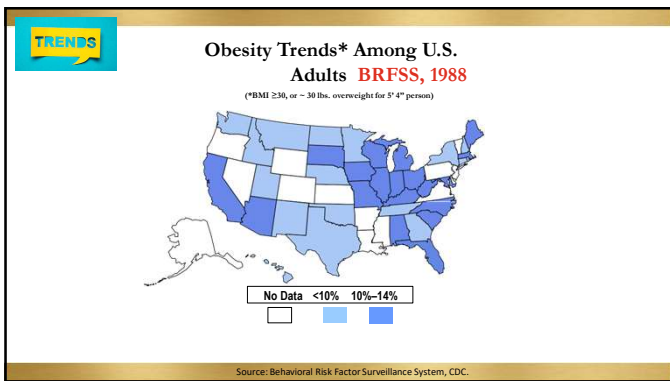
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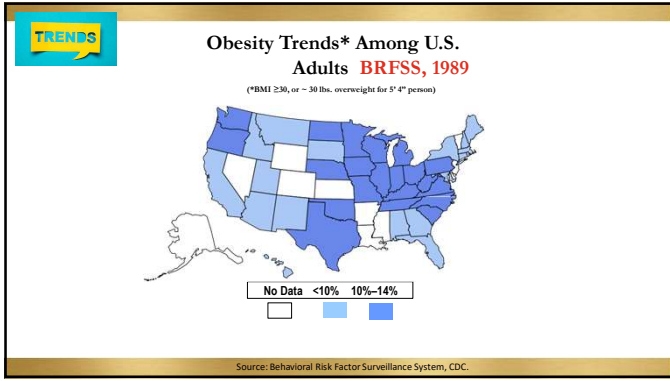
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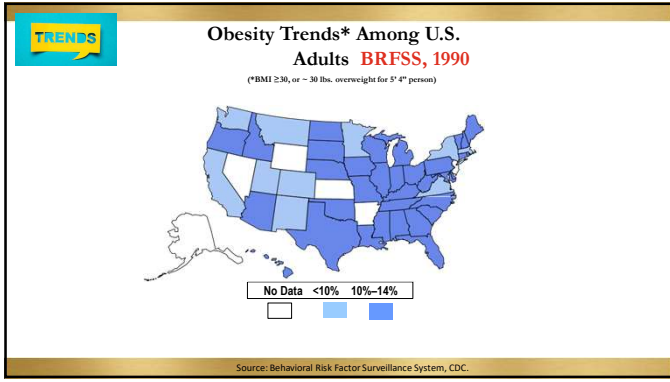
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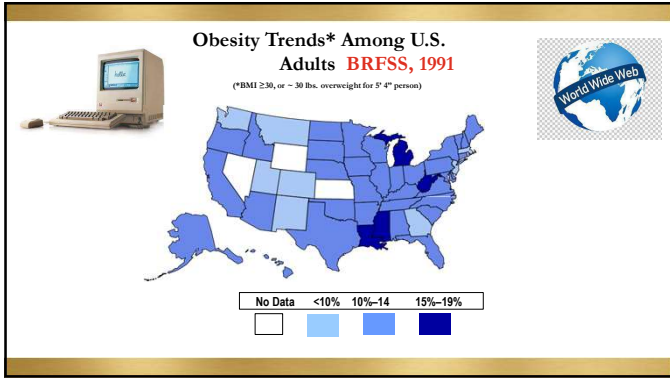
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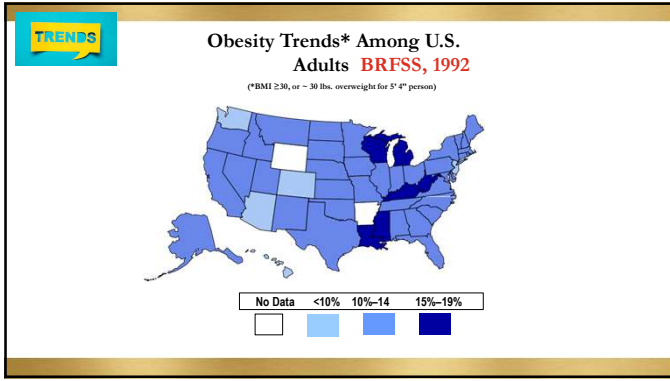
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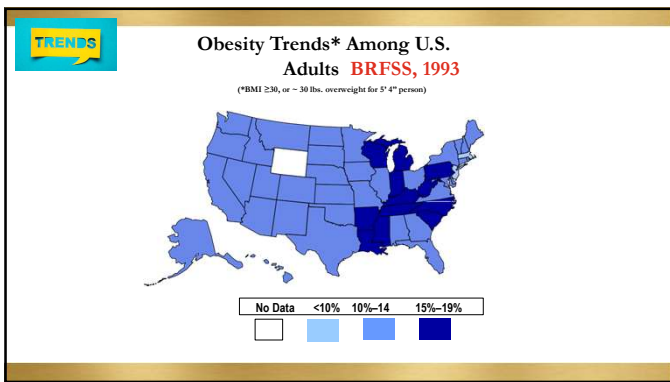
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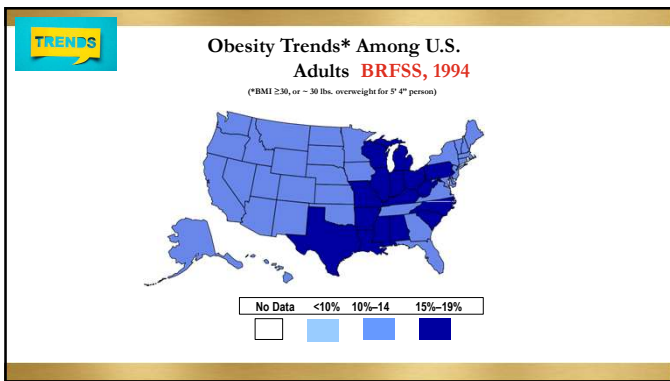
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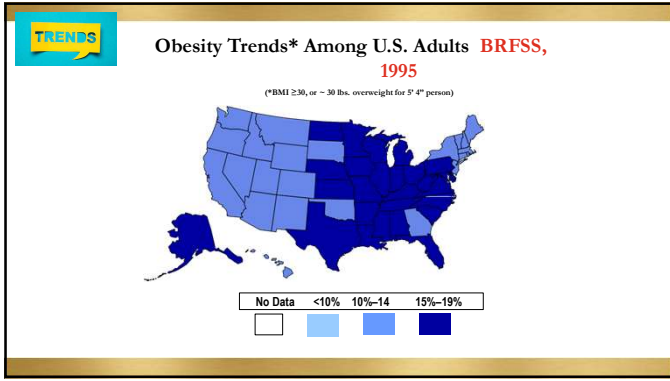
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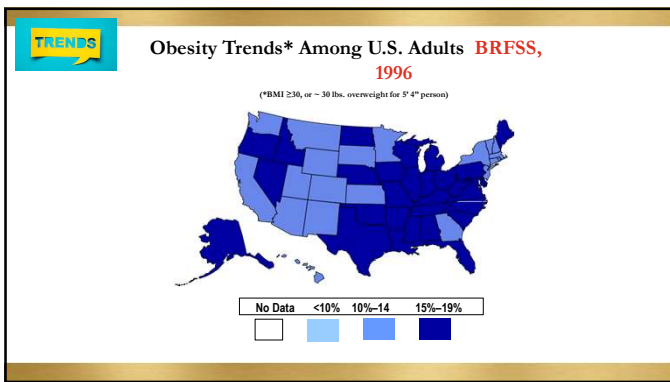
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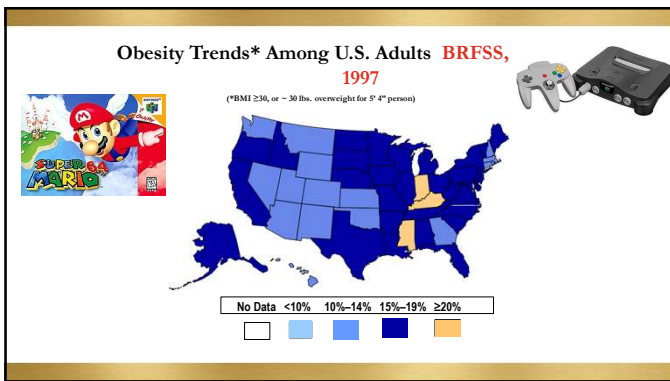
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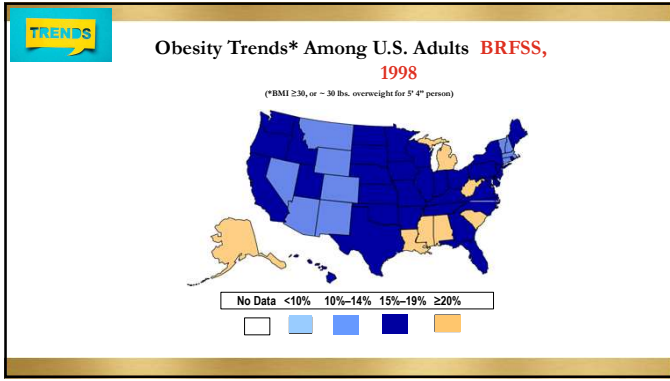
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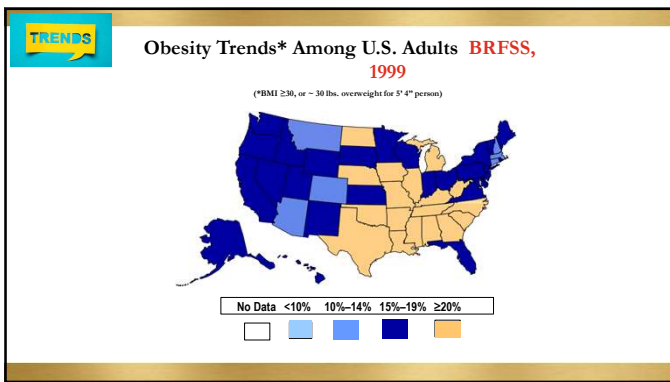
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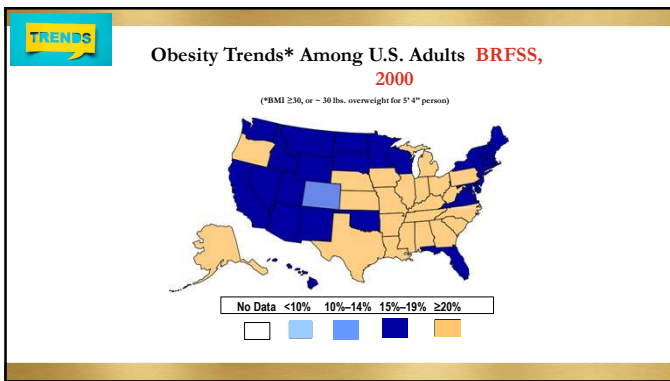
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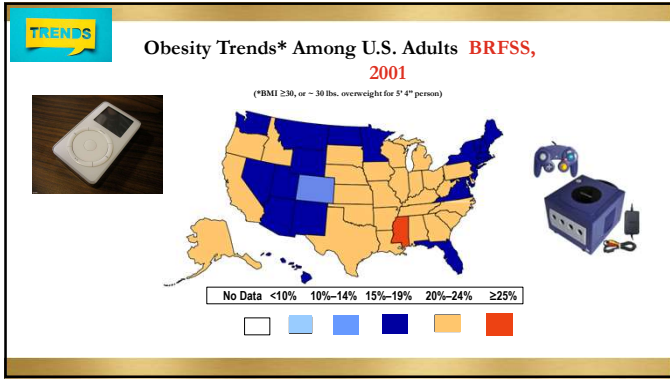
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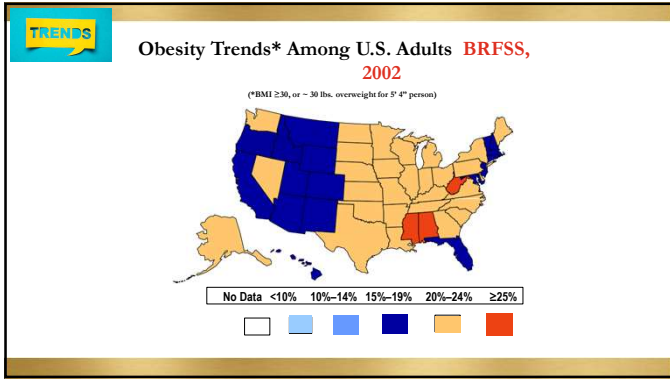
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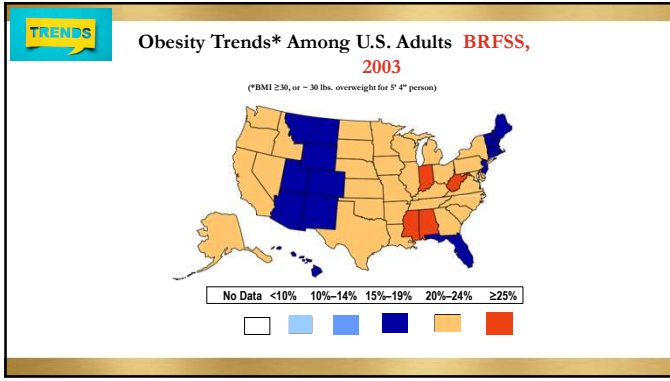
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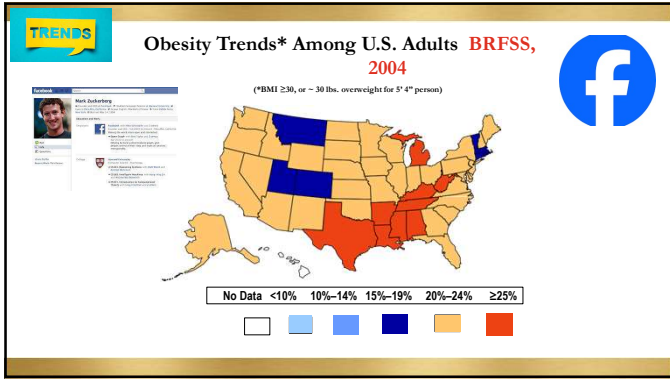
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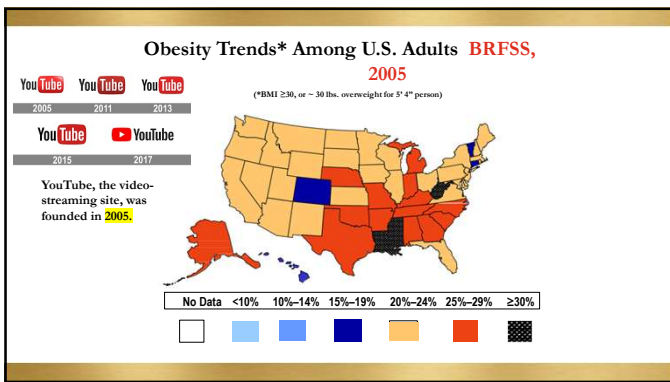
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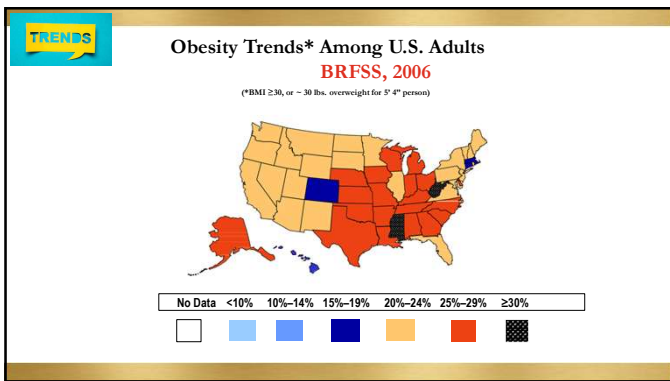
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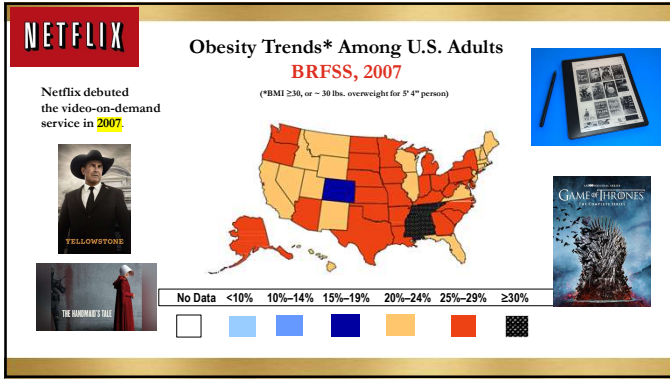
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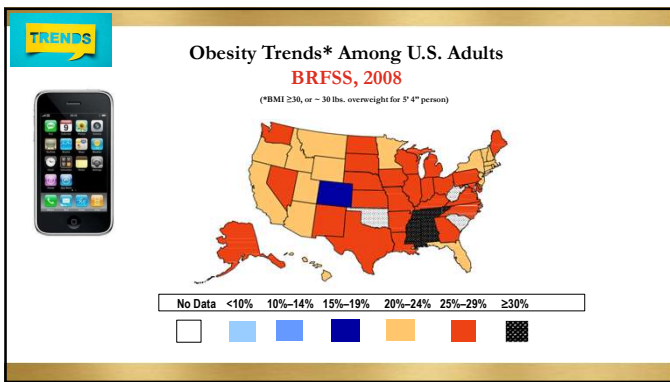
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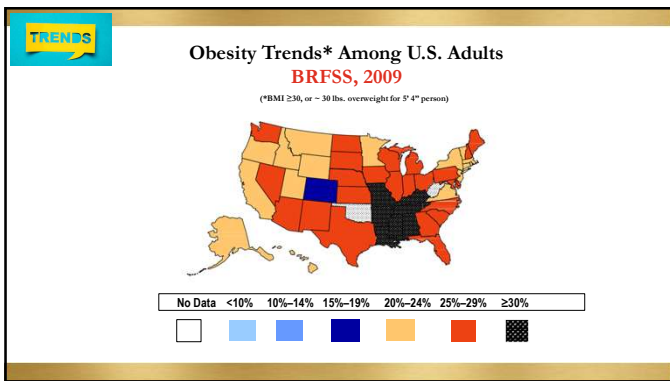
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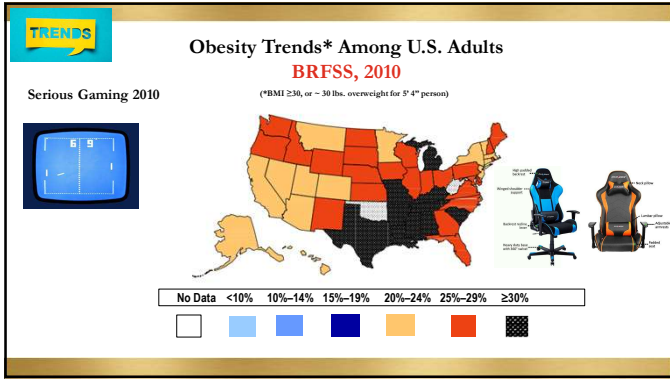
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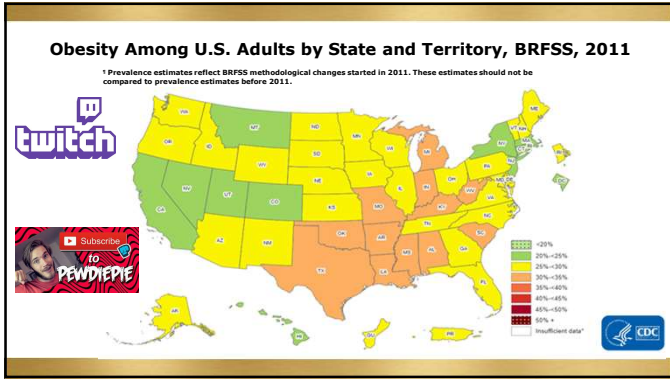
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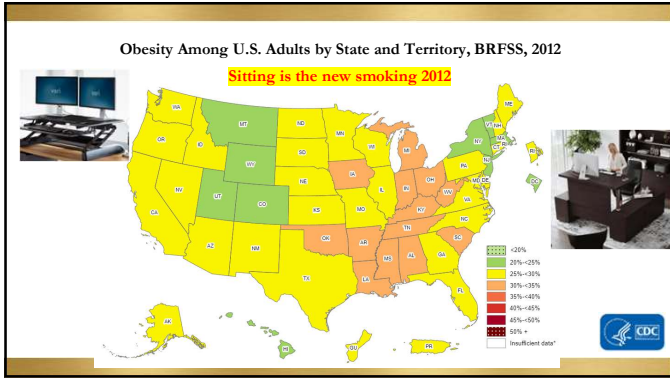
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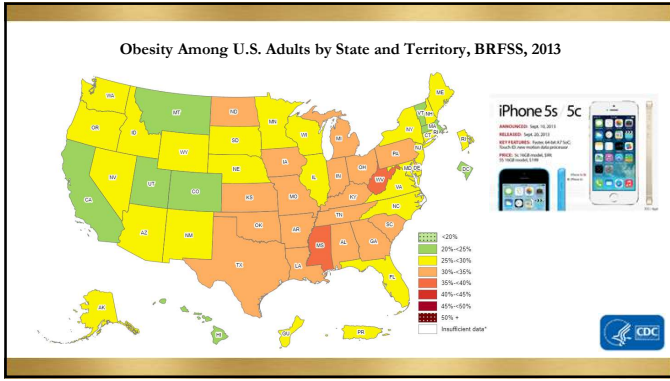
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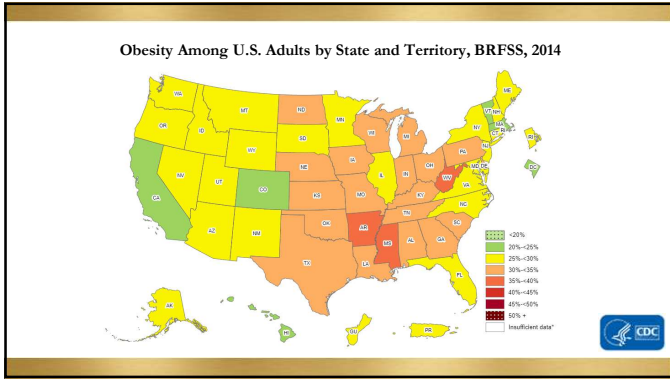
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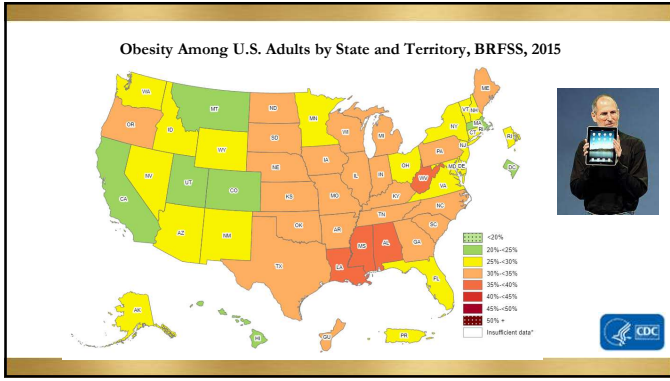
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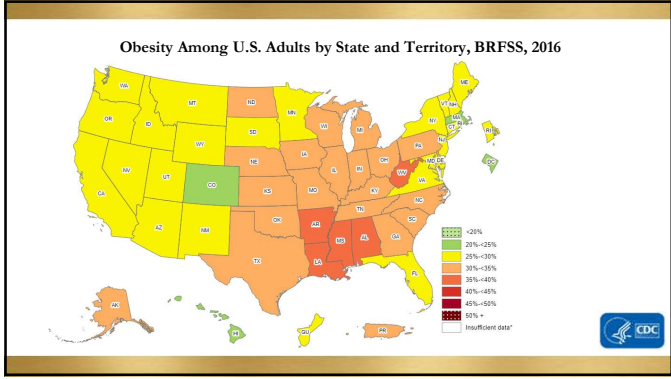
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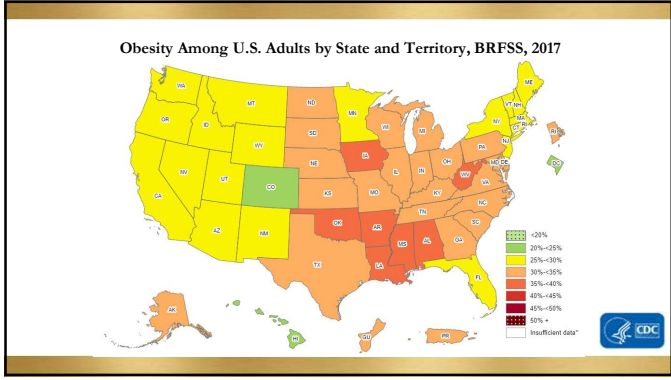
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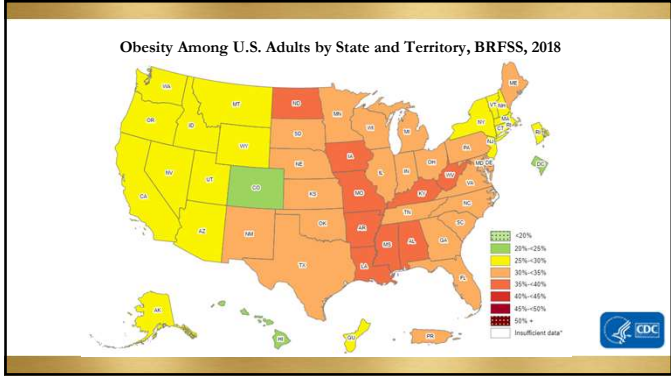
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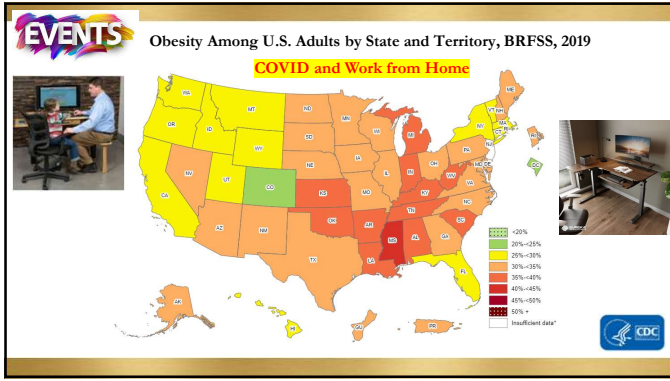
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**TRENDS**

### How Did Ergonomics Respond?

Work from Home Equipment

Webinars on Setting up a Home Office

www.kathyespinoza.com Kathy@kathyespinoza.com

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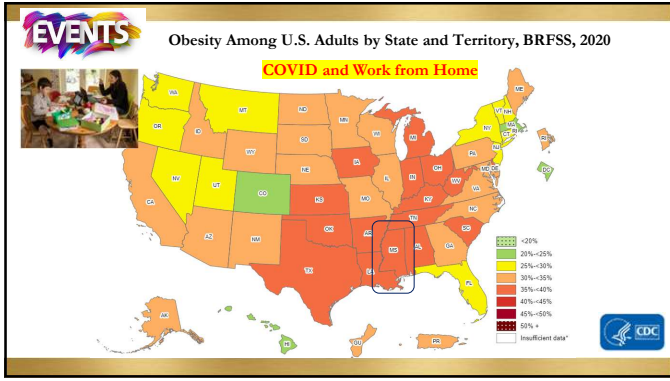
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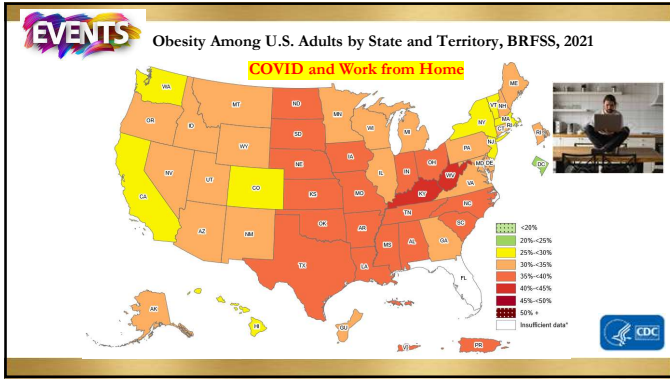
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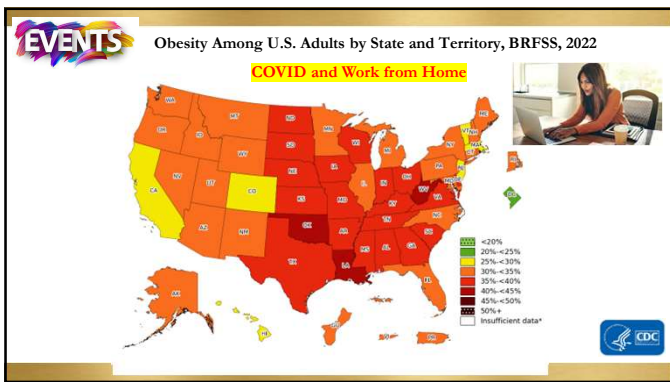
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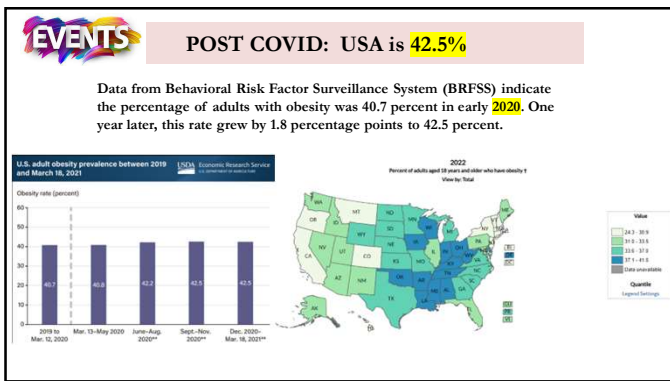
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**TRENDS**

### How Did Ergonomics Respond?

Equipment and Accommodations for a Larger Workforce

www.kathyespinoza.com      Kathy@kathyespinoza.com

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**TRENDS**

### What does the Future of Ergonomics Look Like?

www.kathyespinoza.com      Kathy@kathyespinoza.com

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### Future of Ergonomics

Multi-device Ergonomic Guidelines

The **4th Industrial Revolution** aims to plug the masses into a near-virtual reality powered by an Internet of Things (IoT).

**STAGES OF THE INDUSTRIAL REVOLUTION**

1st	2nd	3rd	4th
<b>Mechanization</b> Steam engine, hydropower and mechanization	<b>Electricity</b> Mass production, assembly line and electricity	<b>Computing</b> Automation, information and communication technologies (ICT)	<b>Digitization</b> Internet of things, the cloud, digital coordination, cyber-physical systems and robotics

economipedia

www.kathyespinoza.com      Kathy@kathyespinoza.com

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**Virtual Reality:  
Good for Simulation Training**

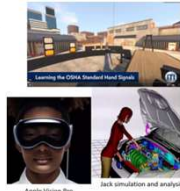
**Virtual Reality**

- Mostly used for training
- Safe environment for errors
- Consistent Instruction


**Issues with headsets**

- Cybersickness
- Eye Strain
- Discomfort
- Dizziness
- Nausea

**VR Apple Vision Pro**



Apple Vision Pro



Jack simulation and analysis

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**Augmented Reality:  
Good for Training and Troubleshooting**




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**Augmented Reality:  
Good for Training and Troubleshooting**





<iframe width="388" height="500" src="https://www.youtube.com/embed/d3YT8j0yY10" title="Introducing Dynamics 365 Remote Assist for HoloLens 2 and mobile devices" frameborder="0" allow="accelerometer; autoplay; clipboard-write; encrypted-media; gyroscope; picture-in-picture; web-share" allowfullscreen></iframe>

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### AI in Ergonomics

- AI can predict potential ergonomic issues before they cause discomfort or injury.
- By analyzing historical data on an individual's movements and work habits, AI can identify patterns that might lead to problems and suggest proactive measures to avoid them.

[https://assets-global.website-files.com/63db9c75396a16272747b95/63e691fd65832069659e3ddf\\_NicePng\\_iphone-frame.png\\_8035468-p-500.png](https://assets-global.website-files.com/63db9c75396a16272747b95/63e691fd65832069659e3ddf_NicePng_iphone-frame.png_8035468-p-500.png)

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### Wearable Technology

Wearable technology is NOT new

- Clothing
- Eyeglasses (1200 AD)
- Watches (1500 AD)
- Abacus Ring (1600 AD)
- Pocket Radio (1925)
- Pacemaker (1958)

**What is new is occupational research on it.**

Year	Publications
2000	0
2001	0
2002	0
2003	0
2004	5
2005	10
2006	15
2007	20
2008	25
2009	30
2010	35
2011	40
2012	45
2013	50
2014	55
2015	60
2016	65
2017	70
2018	75
2019	80
2020	85
2021	90
2022	95
2023	100

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### Types of Wearable Technology

IMU: Inertial Measurement Unit Sensors

<b>Movement and posture:</b> Lifting, manual handling 	<b>Physiology:</b> Vitals, hydration, fatigue, depression 
<b>Online instruction &amp; training:</b> AR/VR 	<b>External hazard alerts:</b> chemical, noise, proximity 

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### What do employees think about wearables?

Employee acceptance of wearable technology in the workplace  
James V. Janda<sup>1</sup>, Lawrence J. Heringer<sup>2</sup>, Young-Hoang Haung<sup>3</sup>, Susan Jeffler<sup>4</sup>,  
 Mary F. Leach<sup>5</sup>, Lucinda A. Simmons<sup>6</sup>, Sunah K. Yoon<sup>7</sup>, Joana L. Willett<sup>8</sup>

2019, Did a survey on wearable technology in workplace:

- Does it work? Do YOU think it will work?
- Workers are attracted to technology with safety in mind.
- They hate monitoring technology, tracking.
- Focus on workplace safety. Involve and inform EEs on wearables.




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### Hepatic Devices for Better Lifting

• Seen at Ergo Conf

• Premise: To get people to lift correctly.

• Problem: What IS the correct way to lift?

• There is no correct value to bent knee/squat. No validation in research




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### Fall Detection Wearables

After the fact. Gets help sooner.

Aging workforce is prone to same level slip and falls

Good for:

- Elderly living alone
- Lone workers
- False positives (slamming hand on counter)
- False negatives (me)




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### Loss of Balance Wearable

**LOSS OF BALANCE Indicator –**  
Identify dirt, objects, hazards

- Uses an IMU Sensor and GPS to zero in on same-level fall risks
- Camera on hard hat
- Risk identified where multiple workers had loss of balance in same area
- 90% of exposures correctly identified



... Each dot is a location where four workers had LOB.

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### Exoskeletons:




Edge of Tomorrow 2014




- A wearable external mechanical structure that
  - Enhances strength
  - Enables mobility
  - Provides protection
- A wearable device that augments, enables, assists or enhances physical activity through mechanical interaction with the body (Draft ASTM F48)

Off load musculoskeletal stress but often times, it is placed elsewhere.



Aliens 1986



Elysium 2013

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**CAUTION**  
**BUYER BEWARE!**


- It's a hot topic in research
- Sellers want to sell
  - Manufacturers claims are not substantiated
  - Persuasive marketing is not always truthful
  - Ask: Who paid for the research?
  - Look/Evaluate their scientific evidence
- More questions than answers
- High price point (starting \$5,000)
- Soft, active, smart exoskeletons show promise
  - Discomfort is an issue
  - Technology keeps changing/improving

### Exoskeletons



herowearexo.com





**GOOD  
ADVICE**

- Skeptical Optimism
- Don't fall for 'shiny object'
- Evaluate vendors
- Involve employees early in process
- Ensure it is used for **SAFETY at WORK** and not a tracking device for all activity

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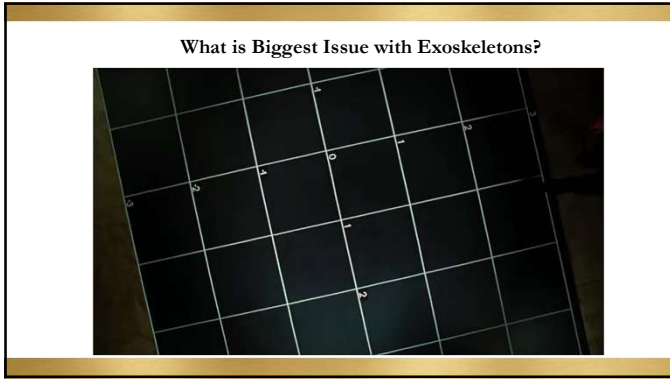
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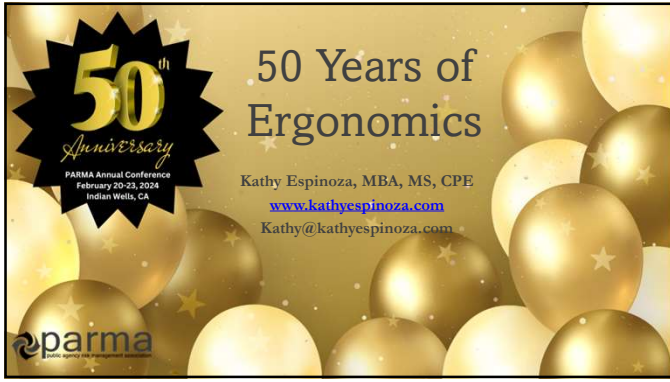
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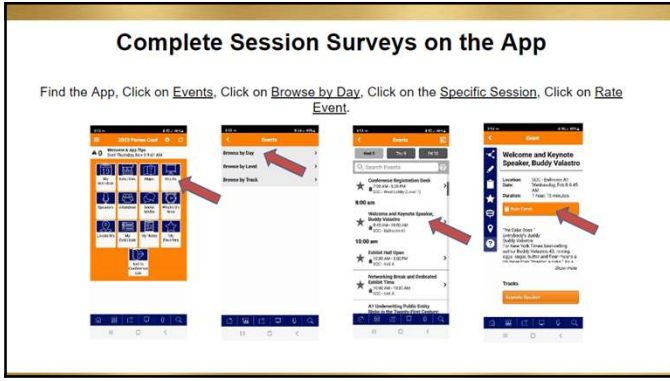
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