Endocrine Disruptors, Chronic Disease, and COVID19?

Linda S. Birnbaum, Ph.D., D.A.B.T., A.T.S.
Scientist Emeritus and Former Director
NIEHS and NTP

Collaborative on Health and the Environment
Webinar – June 18, 2020
Global Health Trend: Non-Communicable Disease “Epidemic”

Examples:
• Type II Diabetes
• Cardiovascular Disease
• Obesity
• Asthma
• Autism
• Cancer

Source: European Environment Agency, 2015
COVID19 Pandemic and Risk Factors

- Age (>65)
- Chronic Lung Conditions
- Heart Disease
- Obesity
- Diabetes
- Immunocompromised
America is an Unhealthy Nation

- >130,000,000 are Obese
- ~34,000,000 have Type 2 Diabetes
- ~23,500,000 have Autoimmune Disorders
- ~25,000,000 have Asthma
- #43/183 countries for Deaths due to Lung Disease
- #2 or #3 for Deaths due to High Blood Pressure and Heart Attacks
Our Environment

**Fact:** 23% of all global deaths are linked to the environment. That’s roughly 12.6 million deaths a year.

**Environmental Impacts on Health**

**What is the Big Picture?**

- Water, air, and soil
- Agricultural chemicals, pesticides, and cleaners
- Microbiome
- Weather extremes
- Stress
- Food and lifestyle
- Synthetic materials
- Infectious agents
- Personal care products
- Prescription drugs
The Endocrine System

- Extremely complex, many controls, interacting parts
- Multiple points of regulation for finely-tuned responses
- Sensitive to perturbations
- Naturally operates at low doses
- Effects can be activational and/or organizational

Involved in multitude of chronic diseases

EDC = An exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub) populations.

EDCs are becoming a "global threat" that needs to be addressed
Exposures to Endocrine Disruptors Are Ubiquitous

Agricultural Chemicals (pesticides/herbicides/fungicides), Food Additives, Packaging (plastics)

Industrial Chemicals and By-Products (Air Pollutants, solvents, PCBs)

Waste Products (Dioxin, PAHs)

Pharmaceutical Products, Phytochemicals

Personal Care Products, Flame Retardants, Coatings (BPA, phthalates, parabens, PFOA/PFOS)

Some bioaccumulate and/or are persistent
WHY DO WE CARE ABOUT PFAS?

- **They are everywhere and won’t go away.**
  PFAAs are stable and persistent in the environment, present in water, air and soil, and distributed globally.

- **They are in our body... even in polar bears!**
  PFOS (C8, ~40 ppb), PFOA (C8, ~5 ppb), PFHxS (C6, ~3 ppb) and PFNA (C9, ~3 ppb) have been detected in humans, while PFOS, PFOA, PFNA (C9) and PFDA (C10) are found in wildlife.

- **They hang around.**
  Estimated half-life in humans for PFOS is 5.4 yrs. PFOA, 3.8 yrs; PFHxS, 8.7 yrs; and PFBS, 2-3 wks.

- **They are bad.**
  Results from animal studies have indicated adverse health effects, and a plethora of associations have been observed in epidemiology studies.
Immune-Related Health Effects of PFAS Exposure

**Animal Studies**
- Experimental studies:
  - **Immunosuppression:** Reduced antibody response, disease resistance, etc.
  - **Hypersensitivity:** Increased airway hypersensitivity
- Wildlife studies

**Human Studies**
- **Immunosuppression:** Reduced antibody response to vaccines
- **Hypersensitivity:** Increased asthma in children
- **Autoimmunity:** Increased incidence of ulcerative colitis

Monograph on Immunotoxicity Associated with Exposure to PFOA and PFOS, National Toxicology Program, 2016

Elevated PFAS exposure associated with reduced diphtheria and tetanus antibody concentrations at ages 5, 7, and 13

Grandjean et al., JAMA, 2012; Grandjean et al., EHP, 2017

Increased lower respiratory infections in children (Impinen et al., Environ Res, 2017)
Why do we care about Phthalates?

- Large group of chemicals used to make plastics soft and flexible
- Present in food packaging, cosmetics, toys
- Diet and Dust are major sources of exposure
Phthalate Health Effects: 
**BLOOD LEVELS CORRELATED WITH HUMAN EFFECTS**

- Endocrine outcomes
- Reproductive outcomes
- Fetal development
- Obesity
- Neurodevelopment
- Cancer
- Diabetes and insulin resistance
- Immune system and allergic disease
- High blood Pressure
- Insulin resistance, a precursor of diabetes

---

**ADHD increases with prenatal DEHP exposure**
Modified from: Engel et al., EHP, 2018

**Monobenzyl phthalate linked to decreased sperm motility**
Thurston et al., Andrology, 2016

---

Benjamin et al., J Haz Materials, 2017; Trasande & Attina, Hypertension, 2015
Attina & Trasande, J of Clin Endocrinol and Met: 2015
Why do we care about BPA (and alternatives)?

- Endocrine Disruptor
- Obesity
- Diabetes
- Neurological Disorders
- Cancer
- Reproductive Abnormalities
- Heart Disease
OBESITY

Figure 4. Measured overweight (including obesity) among children aged 5-17, 2010 or nearest year

Source: International Association for the Study of Obesity, 2013; Bös et al. (2004), Universität Karlsruhe and Ministères de l’Éducation nationale et de la Santé for Luxembourg; and KNHANES 2011 for Korea.
BPA Impacts Many Pathways Related to Obesity

**BPA Exposure**

- Liver: ↑ Glucose, ↓ Glucagon, ↓ Insulin receptors and signaling
- Pancreas: ↑ Insulin production and release, ↓ Glucose utilization, ↓ Insulin sensitivity
- Muscle: ↓ Leptin, ↓ Adiponectin, ↓ Glucose utilization, ↓ Fatty acids accumulation
- Adipose Tissue: ↑ Leptin, ↑ Adiponectin, ↓ Glucose utilization, ↓ Fatty acids accumulation
- Hypothalamus: ↓ POMC, ↑ NPY/AgRP

Menale et al. Open Biotech Journal 2017
Why do we care about Air Pollution?

- Coughing/Wheezing
- Bronchitis, COPD
- ↓ Lung Development
- Asthma
- ↑ Blood Pressure
- Arteriosclerosis
- Heart Attack
- Ischemic Heart Disease
- Stroke

- Autism, IQ
- Cancer
  - Lung
  - Nasopharyngeal
  - Laryngeal
- Liver, Kidney Damage
- ↓ Birthweight, ↑ Birth Defects
- Neurodegenerative Disorders
  - ALS, Alzheimer’s Disease
Susceptible populations include people with obesity and metabolic dysfunctions.
Ambient Air Pollution and Asthma

• Living closer to major roads (<200m) associated with increased incidence and persistence of asthma (Bowatte et al., 2018, Environ Int)

• Higher lifetime exposure to traffic-related pollution during childhood, not just early life exposure, increases risk of asthma (Brunst et al., 2015, Am J Respir Crit Care Med)

• Among girls, but not boys, lifetime exposures to black carbon and PM2.5 were each associated with greater odds of asthma (Rice et al., 2018, J Allergy Clin Immunol)
Wildfire health effects

- Acute respiratory problems
- Headaches
- Worsen asthma
- Irritation of eyes and throat
- Worsen chronic respiratory and heart problems

CDC, 2017
Risks for COVID-19 and Pre-Existing Conditions

- Adults 65 and Over
- Chronic Lung Disease
- Immunocompromised People
- Heart Disease
- Diabetes
- Liver Disease
- Chronic Kidney Disease
- Obesity
- Neurological Disorders

THANK YOU!