Learning and Developmental Disabilities

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Developmental disabilities (DD) are broadly defined as severe, chronic conditions due to mental, physical or, a combination of mental and physical impairments that develop by the age of 22.[1][2] According to *The Developmental Disability Assistance and Bill of Rights Act of 2000*, the term Developmental disabilities applies only to conditions with functional limitations in at least three of the following areas: self-care, receptive and expressive language, learning, mobility, self-direction, independent living or economic self-sufficiency.[1]

Learning disabilities are conditions which impact an individual's ability to use written or spoken language, perform mathematical calculations, coordinate movements or direct attention. Under legal definition of the *Developmental Disability Assistance and Bill of Rights Act of 2000*, learning disabilities are a subset of Developmental disabilities and will be treated as such for the remainder of this page.[3]

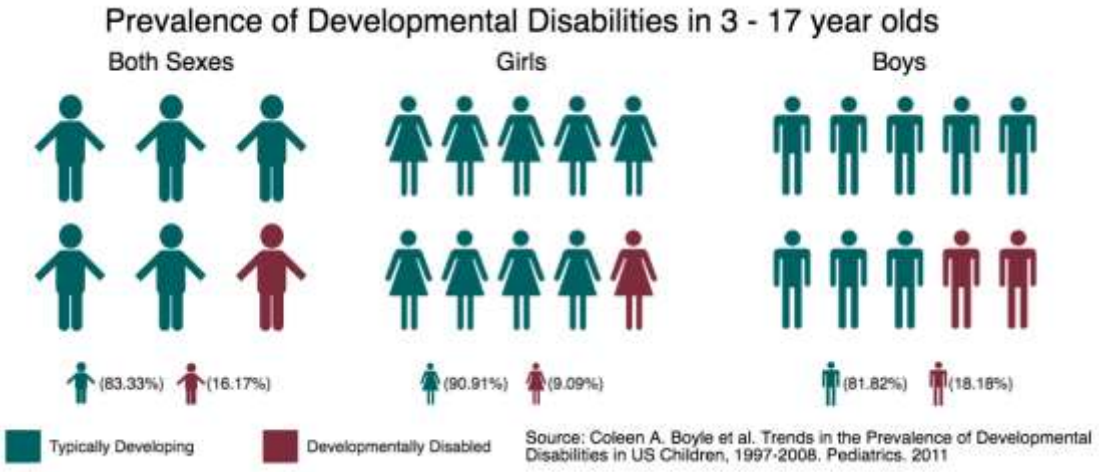
Common developmental disabilities include:

- Attention-Deficit/Hyperactivity Disorder (ADHD)
- Autism Spectrum Disorder
- Cerebral palsy
- Down syndrome
- Epilepsy
- Fetal alcohol syndrome
- Fragile X Syndrome
- Hearing Loss
- Intellectual disability
- Kernicterus
- Learning disability
- Muscular Dystrophy
- Spina Bifida
- Tourette Syndrome
- Vision impairment

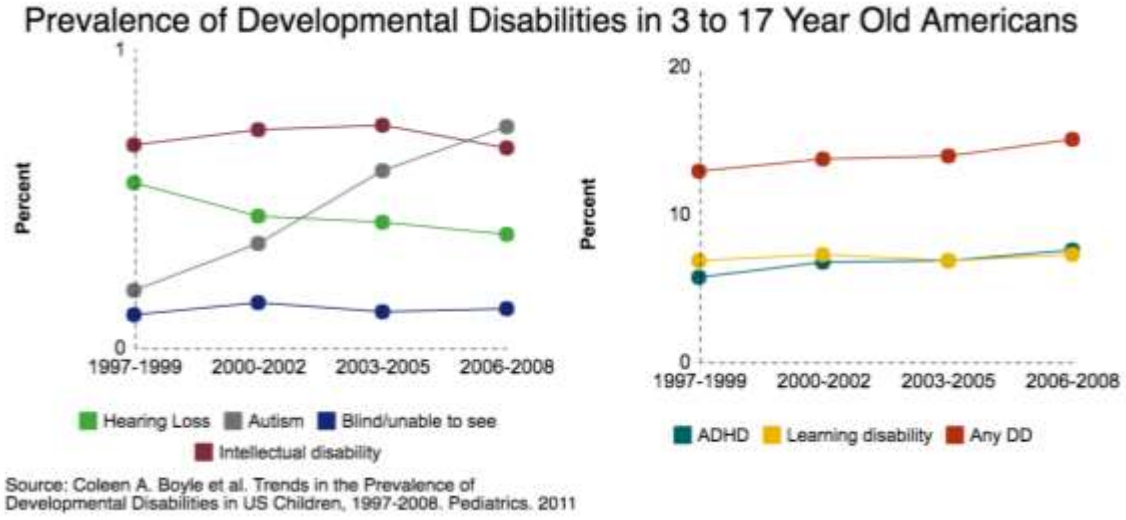
This list was compiled from lists provided by the University of Minnesota's Institute on Community Integration, the 1975 Developmentally Disabled Assistance and Bill of Rights Act, and the CDC's Developmental Disability Fact and Specific Conditions pages.[1][4][5][6]

According to the CDC, approximately one in every six 3 to 17 year old children within the US has one or more Developmental disabilities.[7] Developmental disabilities do not affect all children equally and occur disproportionately more often within males than females, non-Hispanics than Hispanics, and low-income children than middle and high-income children.[8] For more information regarding

vulnerable populations please refer to Boyle et al.'s 2011 examination of the 1997-2008 prevalence of Developmental disabilities within the US.[8]



As shown in the figure below, there has been an increase in the number of children ever diagnosed with DD(s) in recent history. As seen by the orange line in the right graph, between 1997 and 2008 there was an estimated 17% increase in the prevalence of all Developmental disabilities within the United States despite a decrease in the prevalence of moderate to profound hearing loss.[8] This trend is highly dependent on the increase in ADHD and autism prevalence over the past twenty to thirty years.[9][10] However, it is unclear how much of the increase is due to definition changes versus increases in the number of affected children.[11] For more information on this please refer to CHE's ADHD and Autism pages.



As common as Developmental disabilities are within the US, it is prudent to identify and understand what causes these conditions within children. Common causes of Developmental disabilities include but are not limited to genetic or chromosomal abnormalities, substance exposure, preterm birth, low birth weight, and specific

infectious diseases.[2][12][13] Environmental toxicants have the ability to play a role in each of these causal mechanisms.

Major Environmental Causes of Concerns for Developmental Disability

Research has found associations between environmental toxicants and Developmental disabilities through direct and indirect pathways.[14][15][16] The indirect associations progress through pathways including: increased genetic mutation, preterm birth, and intrauterine growth retardation.[15][16][2][17]

CHE Toxicant database breaks down Developmental disabilities into twelve overlapping subcategories: cognitive impairment (including learning impairments, mental retardation, and developmental delay); general congenital malformations (birth defects); cranio-facial malformations; delayed growth; developmental toxicity (not otherwise specified); ADD/ADHD, hyperactivity; fetal alcohol syndrome/fetal solvent syndrome; low birth weight/small for gestational age/intra-uterine growth retardation; neurodevelopmental toxicity; vision impairment; hearing loss; and oral cleft malformations.[18] It is important to note here that not all conditions within these subgroups are Developmental disabilities but that within each subgroup Developmental disabilities exist. For example, many but not all birth defects (congenital malformations) are defined as a DD.[19] Further, due to the fact that adults may loss hearing or vision due to chemical exposures, the database was not utilized as a resource for these impairments.

Table 1 presents a list of prenatal and childhood exposures that are associated with one or more conditions within these DD categories. A "strong" associations implies a known causal link between the exposure and a condition while a "good" association indicates a well-documented association without a well documented human causal link.[18] Additionally, the table describes common exposure pathways as well as the DD category or specific DD associated with the exposure.

Table 1: Chemical Toxicants Associated With One Or More Conditions Within The Development Disability Subcategories

Toxicant	Sources	Developmental Disability or Delay
Strong Evidence[18]		
1,1-Dichloro-2,2-bis(4-chlorophenyl)ethene	Use to make DDT (a pesticide)(20)	Developmental Toxicity, Not Otherwise Specified*
1,1-Dichloroethane	Compound used in the manufacturing of other chemicals and as a solvent for plastics, oils, and fats(21)	Impaired Fetal Growth**

Anesthetic Gases	Workplace exposure for medical staff in hospital and stand-alone operating rooms, recovery rooms, dental offices, and veterinary facilities(22)	Birth defects/Congenital malformations
Carbon Disulfide	Solvent used in the manufacturing of rayon, cellophane, and carbon tetrachloride(23)	Cognitive impairment/Mental retardation/Developmental delay*
Cocaine	A common stimulate, cocaine can be snorted through the nose, rubbed on the gums, dissolved in water and injected, or smoked(24)	Cognitive impairment/Mental retardation/Developmental delay*
Cocaine	A common stimulate, cocaine can be snorted through the nose, rubbed on the gums, dissolved in water and injected, or smoked(24)	Impaired Fetal Growth**
Ethyl alcohol	Drinking alcohol	Fetal alcohol spectrum disorder
Ethyl alcohol	Drinking alcohol	Birth defects/Congenital malformations
Ethyl alcohol	Drinking alcohol	Impaired Fetal Growth**
Ethyl alcohol	Drinking alcohol	Cognitive impairment/Mental retardation/Developmental delay*
Ethyl alcohol	Drinking alcohol	ADD/ADHD, hyperactivity*
Ethyl alcohol	Drinking alcohol	Cranio-facial malformations****
Ethyl alcohol	Drinking alcohol	Motor function
Ethyl alcohol	Drinking alcohol	Postnatal delayed growth
Ionizing Radiation	Energy waves and particles including sun, gamma rays, x rays, visible light, infrared light, microwaves, and radiowaves(25)	Birth defects/Congenital malformations
Lead	Leaded gasoline, industrial facilities, lead-based paints(26)	Cognitive impairment/Mental retardation/Developmental delay*
Lead	Leaded gasoline, industrial facilities, lead-based paints(26)	ADD/ADHD, hyperactivity*
Lead	Leaded gasoline, industrial facilities, lead-based paints(26)	Learning disabilities***(27)(28)
Mercury	Contaminated fish and shellfish and to a lesser extent inhaled in a workplaces such as a dental office or smelting operations(29)	Vision impairment(19)
Mercury	Contaminated fish and shellfish and to a lesser extent inhaled in a workplaces such as a dental office or smelting operations(29)	Hearing loss(19)
Mercury	Contaminated fish and shellfish and to a lesser extent inhaled in a workplaces such as a dental office or smelting operations(29)	Intellectual disabilities***

Mercury	Contaminated fish and shellfish and to a lesser extent inhaled in a workplaces such as a dental office or smelting operations(29)	Cerebral palsy
Nicotine	Smoked, orally ingested using smokeless tobacco products, or dermally using nicotine patches(30)	Cognitive impairment/Mental retardation/Developmental delay*
Nicotine	Smoked, orally ingested using smokeless tobacco products, or dermally using nicotine patches(30)	Impaired Fetal Growth**
4, 4'-Oxybis (benzenesulfonyl hydrazide)	Industrial processing aid, propellants and blowing agents(31)	Developmental Toxicity, Not Otherwise Specified*
PCB (Polychlorinated biphenyls)	A good insulating material previously used widely as coolants and lubricants in electrical equipment(32)	Intellectual disabilities***
PCB (Polychlorinated biphenyls)	A good insulating material previously used widely as coolants and lubricants in electrical equipment(32)	ADD/ADHD, hyperactivity*
PCB (Polychlorinated biphenyls)	A good insulating material previously used widely as coolants and lubricants in electrical equipment(32)	Impaired short term memory***(32)
Tobacco smoke	Firsthand through: inhaled from cigarettes, pipes, vaporizers, or hookahs / Secondhand inhalation occurs when smoke is in the air(33)	Cognitive impairment/Mental retardation/Developmental delay*
Tobacco smoke	Firsthand through: inhaled from cigarettes, pipes, vaporizers, or hookahs / Secondhand inhalation occurs when smoke is in the air(33)	Impaired Fetal Growth**
Toluene	Solvent used to make aviation gasoline, spray and wall paints, paint thinner, medicine, dyes, explosives, detergents, fingernail polish, spot, removers, lacquers, adhesives, rubber, and antifreeze(34)	Cranio-facial malformations****
Toluene	Solvent used to make aviation gasoline, spray and wall paints, paint thinner, medicine, dyes, explosives, detergents, fingernail polish, spot, removers, lacquers, adhesives, rubber, and antifreeze(34)	Fetal alcohol spectrum disorder
Good Evidence(18)		
1,1-Dichloroethane	Compound used in the manufacturing of other chemicals and as a solvent for plastics, oils, and fats(21)	Cognitive impairment/Mental retardation/Developmental delay*

2-Ethylhexanoic acid	Additive in paints, coatings, adhesives, sealants, automotive care products, lubricants and greases, plastics, and rubbers(35)	Developmental Toxicity, Not Otherwise Specified*
2,2',4,4',5,5'-hexabromodiphenyl ether	None found(36)	Neurodevelopmental toxicity*
3,4-Methylenedioxymethamphetamine (MDMA, Ecstasy)	Commonly used stimulant primary administered orally(37)	Birth defects/Congenital malformations(38)
Agent Orange	Former chemical weapon used heavily during the Vietnam War(39)	Birth defects/Congenital malformations
Air Pollution (fine particulate matter)	Incomplete combustion of fuels (diesel exhaust and biomass)(40)	Impaired Fetal Growth**
Air Pollution (fine particulate matter)	Incomplete combustion of fuels (diesel exhaust and biomass)(40)	Autism spectrum disorders(41)(42)
Amphetamine	Commonly used stimulant and medication for individuals with ADHD(43)	Impaired Fetal Growth**(38)
Arsenic	Consumed through drinking contaminated water using contaminated water to process or wash foods, and smoking tobacco(45)	Birth defects/Congenital malformations
Arsenic	Consumed through drinking contaminated water using contaminated water to process or wash foods, and smoking tobacco(45)	Cognitive impairment/Mental retardation/Developmental delay*(14)
Arsenic	Consumed through drinking contaminated water using contaminated water to process or wash foods, and smoking tobacco(45)	Impaired Fetal Growth**
Carbon monoxide	Vapor produced while burning fuel in cars, trucks, grills, fireplaces, or other fuel burning items(46)	Cognitive impairment/Mental retardation/Developmental delay*
Carbon monoxide	Vapor produced while burning fuel in cars, trucks, grills, fireplaces, or other fuel burning items(46)	Birth defects/Congenital malformations
Carbon monoxide	Vapor produced while burning fuel in cars, trucks, grills, fireplaces, or other fuel burning items(46)	Impaired Fetal Growth**
Chlorination byproducts	Inhalation or injection of disinfectant byproducts (chlorine, bleach, etc.)(47)	Impaired Fetal Growth**
Chloroform	Workplace exposure - used to create other chemicals and can contaminate chlorinated water in small amounts(48)	Developmental Toxicity, Not Otherwise Specified*
Chromium (VI)	Industrial workplace exposure(49)	Developmental Toxicity, Not Otherwise Specified*

Cocaine	A common stimulate, cocaine can be snorted through the nose, rubbed on the gums, dissolved in water and injected, or smoked(24)	Learning disabilities(50)(51)(52)
Cocaine	A common stimulate, cocaine can be snorted through the nose, rubbed on the gums, dissolved in water and injected, or smoked(24)	Birth defects/Congenital malformations(19)
Di-isodecyl phthalate		Developmental Toxicity, Not Otherwise Specified*
DES	Synthetic female hormone used during form 1940-1971 (53)	Impaired Fetal Growth**
Ethyl alcohol	Drinking alcohol	Language issues(54)
Ethyl alcohol	Drinking alcohol	Learning disabilities(54)(55)
Ethyl alcohol	Drinking alcohol	Oral cleft (cleft lip and palate)
Ethylene glycol ethers	Solvent in resins, lacquers, paints, varnishes, gum, perfume, dyes, inks and component of paints, pastes, cleaning compounds, liquid soaps, cosmetics, and hydraulic fluids(56)	Birth defects/Congenital malformations
Ethylene glycol ethers	Solvent in resins, lacquers, paints, varnishes, gum, perfume, dyes, inks and component of paints, pastes, cleaning compounds, liquid soaps, cosmetics, and hydraulic fluids(56)	Cranio-facial malformations****
Flame retardant	Chemicals applied to furniture, electronics, children's clothing, foam, and insulation(57)	Postnatal delayed growth(58)
Flame retardant	Chemicals applied to furniture, electronics, children's clothing, foam, and insulation(57)	Neurodevelopmental toxicity*
Flame retardant	Chemicals applied to furniture, electronics, children's clothing, foam, and insulation(57)	Cognitive impairment/Mental retardation/Developmental delay* (58)
Fluoride	Treated drinking water(59)	Cognitive impairment/Mental retardation/Developmental delay*(60)
Hexafluoroacetone	Industrial workplace exposure - industrial intermediate(61)	Developmental Toxicity, Not Otherwise Specified*
Ionizing Radiation	Energy waves and particles including sun, gamma rays, x rays, visible light, infrared light, microwaves, and radiowaves(25)	Cranio-facial malformations****
Lead	Leaded gasoline, industrial facilities, lead-based paints(26)	Postnatal delayed growth
Lead	Leaded gasoline, industrial facilities, lead-based paints(26)	Impaired Fetal Growth**
Lindane	Medication used to treat lice and scabies(62)	Impaired Fetal Growth**

Marijuana	Smoked or orally ingested	Learning disabilities(52)
Manganese	Food consumption - higher levels in whole grains, nuts, leafy vegetables, and teas(63)	ADD/ADHD, hyperactivity*
Manganese	Food consumption - higher levels in whole grains, nuts, leafy vegetables, and teas(63)	Cognitive impairment/Mental retardation/Developmental delay*(14)
Mercury	Contaminated fish and shellfish and to a lesser extent inhaled in a workplaces such as a dental office or smelting operations(29)	Cerebral Palsy(19)
Mercury	Contaminated fish and shellfish and to a lesser extent inhaled in a workplaces such as a dental office or smelting operations(29)	Birth defects/Congenital malformations
Mercury	Contaminated fish and shellfish and to a lesser extent inhaled in a workplaces such as a dental office or smelting operations(29)	Cranio-facial malformations****
Mercury	Contaminated fish and shellfish and to a lesser extent inhaled in a workplaces such as a dental office or smelting operations(29)	Postnatal delayed growth
Mercury	Contaminated fish and shellfish and to a lesser extent inhaled in a workplaces such as a dental office or smelting operations(29)	Impaired Fetal Growth**
Methamphetamine (Meth)	Commonly use stimulant primary taken orally, smoked, snorted, or dissolved in water and injected(64)	Cognitive impairment/Mental retardation/Developmental delay* (38)
Methamphetamine (Meth)	Commonly use stimulant primary taken orally, smoked, snorted, or dissolved in water and injected(64)	Language issues(38)
Methyl chloride	Industrial product used to produce silicones, agricultural chemicals, methyl cellulose, quaternary amines, and butyl rubber(65)	Developmental Toxicity, Not Otherwise Specified*
Metolachlor	Compound used in the manufacturing of pesticides including atrazine, cyanazine, and fluometuron(66)	Impaired Fetal Growth**
Nitrates/Nitrites	Common component of fertilizers, can also be used in food preservation, pharmaceuticals, and munition and explosive production(67)	Cognitive impairment/Mental retardation/Developmental delay*
Nitrous oxide	Weak anesthetic agent used in surgery; processed food propellant; industrial intermediate, oxidizing, and blowing agent(68)	Neurodevelopmental toxicity*
PCB (Polychlorinated biphenyls)	A good insulating material previously used widely as coolants and lubricants in electrical equipment(32)	Motor function(32)

PCB (Polychlorinated biphenyls)	A good insulating material previously used widely as coolants and lubricants in electrical equipment(32)	Cranio-facial malformations****
PCB (Polychlorinated biphenyls)	A good insulating material previously used widely as coolants and lubricants in electrical equipment(32)	Postnatal delayed growth
PCB (Polychlorinated biphenyls)	A good insulating material previously used widely as coolants and lubricants in electrical equipment(32)	Impaired Fetal Growth**
Pentachlorophenol(PCP)	Pesticide and wood preservative(69)	Cognitive impairment/Mental retardation/Developmental delay*
Pentachlorophenol(PCP)	Pesticide and wood preservative(69)	Impaired Fetal Growth**
Pesticides	Chemicals used to control weeds, insects, and other unwanted organisms(70)	Cognitive impairment/Mental retardation/Developmental delay*
Pesticides	Chemicals used to control weeds, insects, and other unwanted organisms(70)	Impaired Fetal Growth**
Pesticides	Chemicals used to control weeds, insects, and other unwanted organisms(70)	Learning Disabilities(38)
Pesticides	Chemicals used to control weeds, insects, and other unwanted organisms(70)	ADHD*****(71) (72)
Pesticides	Chemicals used to control weeds, insects, and other unwanted organisms(70)	Motor function(64)
Phthalates	Additive in plastics, cosmetics, and other consumer products(73)	Developmental Toxicity, Not Otherwise Specified*
Phthalates	Additive in plastics, cosmetics, and other consumer products(73)	Impaired social interactions(73)
Solvents	Workplace exposure - used to dissolve or thin grease, oil, paint, pigment, glue, pesticides, and epoxy resins(74)	Fetal alcohol spectrum disorder
Solvents	Workplace exposure - used to dissolve or thin grease, oil, paint, pigment, glue, pesticides, and epoxy resins(74)	Cognitive impairment/Mental retardation/Developmental delay*
Solvents	Workplace exposure - used to dissolve or thin grease, oil, paint, pigment, glue, pesticides, and epoxy resins(74)	Impaired Fetal Growth**
Solvents	Workplace exposure - used to dissolve or thin grease, oil, paint, pigment, glue, pesticides, and epoxy resins(74)	Birth defects/Congenital malformations

Solvents	Workplace exposure - used to dissolve or thin grease, oil, paint, pigment, glue, pesticides, and epoxy resins(74)	Cranio-facial malformations****
Solvents	Workplace exposure - used to dissolve or thin grease, oil, paint, pigment, glue, pesticides, and epoxy resins(74)	ADHD*****
Styrene	Compound used in the manufacturing of plastics, rubber and resins(75)	Cognitive impairment/Mental retardation/Developmental delay*
tert-Amyl methyl ether (TAME)	Fuel additive(76)	Developmental Toxicity, Not Otherwise Specified*
Tetrachloroethylene (PCE)	Used for metal degreasing operations and dry-cleaning fabrics(77)	Cognitive impairment/Mental retardation/Developmental delay*
Tobacco smoke	First-hand and Second-hand	ADHD*****
Tobacco smoke	First-hand and Second-hand	Birth defects/Congenital malformations
Tobacco smoke	First-hand and Second-hand	Cognitive impairment/Mental retardation/Developmental delay*
Tobacco smoke	First-hand and Second-hand	Oral Cleft (cleft lip and palate)
Toluene	Solvent used to make aviation gasoline, spray and wall paints, paint thinner, medicine, dyes, explosives, detergents, fingernail polish, spot, removers, lacquers, adhesives, rubber, and antifreeze(34)	Cognitive impairment/Mental retardation/Developmental delay*
Toluene	Solvent used to make aviation gasoline, spray and wall paints, paint thinner, medicine, dyes, explosives, detergents, fingernail polish, spot, removers, lacquers, adhesives, rubber, and antifreeze(34)	Postnatal delayed growth
Toluene	Solvent used to make aviation gasoline, spray and wall paints, paint thinner, medicine, dyes, explosives, detergents, fingernail polish, spot, removers, lacquers, adhesives, rubber, and antifreeze(34)	Impaired Fetal Growth**
Trichloroethylene		Cognitive impairment/Mental retardation/Developmental delay*
Trihalomethanes	Contaminated drinking water(78)	Impaired Fetal Growth**
Xylene	Highly produced solvent used in the printing, rubber, and leather industries; also used as a cleaner, paint thinner, and additive in paints and varnishes(79)	Cognitive impairment/Mental retardation/Developmental delay*

* Disability wording according to the CHE's Toxicant and Disease Database
** Impaired fetal growth includes: Low birth weight/intra-uterine growth retardation

*** Learning disabilities, impaired short term memory and intellectual disabilities are subsets of cognitive impairment/mental retardation/developmental delay
**** Cranio-facial malformations and oral cleft malformation are subsets of Cranio-facial malformations
***** ADHD is a subset of ADD/ADHD, hyperactivity

This list of environmental toxicants was taken from Collaborative on Health and the Environment's Toxicant and Disease Database and supplemented with recent toxicant literature.[18] Pesticides and flame retardants are not presented individually within the table but are presented as binned toxicant types. This table should not be considered exhaustive and does not include non-chemical environmental exposures such as noise or electronic media exposure.

Research surrounding the effect of environmental toxicants on Developmental disabilities is limited. Over 200 industrial chemicals have been found to be neurotoxins in adults and 1,000 chemicals have been reported as neurotoxins during laboratory animal studies.[81] However, fewer than 15 compounds were identified as causing any type of Developmental disabilities according to Toxicant Datable and only five industrial compounds are recognized to cause neurodevelopmental disorders.[18][81] Based on the large discrepancy in the number of toxins, it is evident that more research is needed.

Learning Disabilities and Intellectual Disabilities

Learning Disability (LD) is a broad term applied to individuals with disorders that impact their ability to utilize language, perform calculations, coordinate movements, or direct attention.[3] The NIH states that the most common LDs are:

- Dyslexia (language-based disability)
- Dysgraphia (writing-based disability)
- Dyscalculia (mathematics disability)
- Apraxia of speech (motor speech disorder)
- Central auditory processing disorder
- Nonverbal learning disorder
- Visual perceptual/visual motor deficit
- Aphasia (communication disorder)
- Dyspraxia (motor and cognitive disability)

While ADHD is a DD that can impact an individual's ability to learn, it is not a LD.[82] Further, impairments in one's ability to learn due to intellectual disabilities, vision or hearing loss, or emotional disturbances are not considered learning disabilities.[83]

More narrowly defined, intellectual disabilities (IDs) are any conditions marked by an intelligence quotient (IQ) of 70 or less.[84] Up until 2010 and the passage of the Rosa's Law (Intellectual Disability Terminology Changes), ID was termed mental retardation.[84][85] IDs are sub-categorized by severity in the following way:[86]

- Mild: IQ 50-70
- Moderate: IQ 35-49
- Severe: IQ 20-34

- Profound: IQ less than 20

It is estimated that between 1 to 3% of American children have at least one ID and 5 to 10% have a LD.[7][87] While the causes of learning and intellectual disabilities are commonly unknown within an individual, IDs have known physical (such as autism or cerebral palsy) and non-physical causes (such as a lack of stimulation).[88][87] Environmental toxins can play a role in the following ID causal pathways: chromosomal abnormalities (such as Down syndrome)[89], adverse pregnancy outcomes (such as preterm birth and inter-uterine retardation)[90][16], drug exposure (such as fetal alcohol syndrome)[91], and other select Developmental disabilities (such as cerebral palsy and autism)[19][92][41].[87]

Little is known about what causes learning disabilities but current causal hypotheses include hereditary, toxicant exposure (such as alcohol or lead), adverse pregnancy outcomes (such as premature birth or meningitis of mother or offspring), and non-chemical environmental factors (such as malnutrition and poor prenatal health care).[93][94] For more information about the current theories about what causes learning disabilities, see the National Institute of Child Health and Human Development's "What causes learning disabilities?"

Environmental Contributors: The Collaborative on Health and the Environment's Toxicant and Disease Database identified eight toxicants as known causal risk factors for learning and intellectual disabilities.[18] Additionally, 21 toxicants are identified as having a known association with learning and intellectual disabilities. Of these 21 toxicants, four (DDT, methyl bromide, organochlorine pesticides, and organophosphates) are pesticides and have been treated as a single toxicant type within this document. To see which toxicants are associated with learning and intellectual disabilities please see Table 1.

Multiple environmental exposures including Aluminum, Cadmium, Dioxins, and Sulfuyl fluoride have also been linked to learning and intellectual disabilities but research remains limited and inconclusive.[18] Non-toxicant, environmental exposures associated with learning and intellectual disabilities include infectious disease (such as Hib), nutrition (such as malnutrition), and trauma.[95]

Adverse Pregnancy Outcomes and Learning and Intellectual Disabilities

Preterm birth and intrauterine birth retardation are positively associated with the occurrence of IDs.[15][16][5] Additionally, Public Broadcasting Station (PBS) experts state that adverse pregnancy outcomes are associated with learning disabilities.[96] For more information regarding the adverse pregnancy outcomes and developmental disabilities see the Adverse Pregnancy section further down this page. For more information regarding environmental risk factors for adverse pregnancy outcomes see the Impaired Fetal Growth/Preterm Birth section of the Reproductive Health Page.

Intrauterine Drug Exposure and Learning and Intellectual Disabilities

Intrauterine exposure to alcohol and solvents are known causes of ID.[87][18] Associations between prenatal exposures to IDs and Methylenedioxymethamphetamine (MDMA), cocaine, and marijuana have been identified but the research remains limited and/or inconsistent.[38][97] The effects of alcohol and solvents on a developing fetus are discussed in the Alcohol Syndrome/Fetal Solvent Syndrome section further down this page.

Learning disabilities (motor skills, language and reading impairments, and attention issues) have been associated with prenatal and early life exposure to the following toxicants:

- Cocaine[50][51][52]
- Ethyl alcohol [54][55]
- Lead[27]
- Marijuana[52]
- Organochlorine pesticides[64]
- Methamphetamines[38]

Additional research has found a link between manganese and motor skill development but results remain inconclusive.[98][99]

Genetic Mutations, Chromosomal Abnormalities, and Learning Disabilities

Conditions due to genetic mutations or chromosomal abnormalities commonly cause IDs. Such conditions include Fragile X Syndrome, Retts Syndrome and Down Syndrome.[87][100] Testing for such conditions has increased within the US and as of 2009, 49 States screened newborns for 21 or more congenital conditions.[88] Extensive research has been performed studying risk factors of such conditions including studies examining environmental contributors.

Strong associations have been found between maternal socioeconomic status (SES) and maternal age and chromosome 21-nondisjunction, the cause of 95% of Down Syndrome cases.[101][102][103] However, results surrounding environmental toxicants such as smoking, alcohol, maternal irradiation, fertility drugs, oral contraceptives, and spermicides remain inconsistent.[89]

Select Developmental Disorders and Their Causal Association with Intellectual Disabilities

A number of neurological disorders affect intellectual development and can cause IDs.[19][41] This includes Autism Spectrum Disorders and Cerebral Palsy. For more information on Autism Spectrum Disorders see the Autism Page.

Cerebral Palsy

Cerebral Palsy (CP) is a neurological disorder that primarily affects mobility but in severe cases can cause IDs.[104] Other common symptoms that occur include but are not limited to seizures, hearing loss, and impaired vision, bladder and bowel control.[92]

Caused by malformation of the brain or brain injury,[19] CP is the most common motor disability within children. The CDC reports that one in every 323 children born in the US have CP.[105]

The onset of CP symptoms ranges from infancy to early childhood and dictates the type of CP an individual has: spastic, dyskinetic, ataxic, or mixed. Spastic, or muscular stiffness causing awkward movements, is the most prevalent form making up 77% of all CP cases.[105] For more information regarding the types of CP please visit the National Institute of Child Health and Human Development's Cerebral Palsy Page.

Environmental exposures: In instances of high exposure, methylmercury can cause CP. For more information on mercury please see the Mercury page.[19] Other environmental risk factors include preterm birth and maternal SES.[15][16][106]

Congenital Malformations (Birth Defects)

The CDC defines birth defects as structural changes in one or more body parts that are present at birth.[107] Birth defects include the DD subcategories: cranio-facial malformation and oral cleft malformations. Depending on the type and severity, a birth defect such as Spina Bifida can cause Developmental disabilities.[6] For more information regarding birth defects, see the Birth Defects Page.

Fetal Alcohol Spectrum Disorders

Defined by the CDC as conditions which occur in individuals whose mothers drank alcohol during pregnancy, fetal alcohol spectrum disorders are marked by physical, behavioral, and learning problems. The physical issues caused by prenatal alcohol exposure are low birth weight; kidney, heart and other organ problems; and brain damage.[108] These issues lead to the common symptoms of FASD:

- Learning disabilities and low IQ
- Hyperactivity
- Difficulty with attention
- Poor ability to communicate in social situations
- Poor reasoning and judgement skill
- Poor understanding and following of directions
- Poor ability to perform daily life skills, such as feeding and bathing

These intellectual and behavioral problems are incurable and cause lifelong issues within affected individuals. The lifelong issues include problems with mental health, substance use, getting and keeping a job, and the law.[108]

Unlike the other disabilities discussed on this page, FASDs are completely preventable.[108] The only cause of FASD is prenatal alcohol exposure. However, alcohol consumed at any stage of pregnancy can cause FASD; this includes the period prior to knowledge of the pregnancy.[109] Thus there is no pregnancy period

in which it is safe to drink alcohol. Despite this, three out of every four women who want to get pregnant as soon as possible report drinking. This puts over 3 million women at risk of exposing their developing baby to alcohol.[108]

Within the 2011-2013 pregnant population, Behavioral Risk Factor Surveillance System (BRFSS) estimates that 1 in 10 women consume alcohol. The impact of this consumption is not insignificant.[110] The CDC estimates that up to 1 out of every 20 school age children within the US may have FASD. And in 2010, alcohol consumption during pregnancy cost the US $5.5 billion dollars.[111]

While alcohol is the only causal factor of FASDs, not all alcohol consumption is the same. The quantity, frequency, and timing of consumption all impact the effect of alcohol on a developing baby.[112] Additionally factors that impact the effect of prenatal alcohol exposure include nutrition, parity (having multiple pregnancies), smoking, genetic makeup, and maternal stress and age.[95][112]

FASDs are subdivided into three forms based on the types of symptoms present within an individual. The three forms are: Fetal Alcohol Syndrome (FAS), Alcohol Related, Neurodevelopmental Disorder (ARND), and Alcohol-Related Birth Defects (ARBD).[108] For more information on ARND and ARBD refer to the CDC's Fetal Alcohol Spectrum Disorders Facts about FASD's page or the National Institute of Alcohol Abuse and Alcoholism's Fetal Alcohol Exposure page.

Fetal Alcohol Syndrome

FAS is the most severe form of FASD and is estimated to affect 0.2 to 9 out of every 1000 births within the US.[91] It is characterized by prenatal alcohol exposure, facial and brain structure or function abnormalities, and growth deficits prenatally, after birth, or a combination of both.[108] Individuals with FAS struggle in school and getting and retaining employment.

Preterm Birth and Impaired Fetal Growth

Table 2: Developmental Delays Disabilities Associations with Preterm Birth and Impaired Fetal Growth*

Preterm birth[15][102]	**Impaired Fetal Growth**
Cerebral Palsy	Cerebral Palsy[113]
Mental Retardation/Lower IQ[114]	Autism[115]
Vision Impairment	Lower IQ[116]
Hearing Impairment	
ADHD[117]	

* All associations are good according to the CHE Toxicant database

Multiple adverse pregnancy events and birth outcomes are associated with an increased risk of many Developmental disabilities.[5] Of these, both preterm birth and impaired fetal growth (low birth weight and intrauterine growth retardation) can be caused by prenatal chemical exposure. Table 2 presents common

Developmental disabilities associated with preterm birth and impaired fetal growth. For more information regarding the toxicant causes of preterm birth and impaired fetal growth please refer to the Reproductive Health page's Impaired Fetal Growth/Preterm Birth section.

Vision and Hearing Impairment

Vision impairment is defined by the Metropolitan Atlanta Developmental Disabilities Surveillance Program (MADEVELOPMENTAL DISABILITIESP) as visual acuity of 20/70 or worse in the better eye in the presence of corrective technologies (such as glasses). Impairment severity is defined in the US as low vision (20/70 to better than 20/200) and legal blindness (20/200 or worse).[84] The MADEVELOPMENTAL DISABILITIESP defines hearing loss as an inability to hear 500, 1000, and 2000 hertz averaging 40 decibels (dB) unaided, measured, bilateral, pure-tone in the better ear. Within the US the hearing loss severity groups are moderate, severe, and profound with hearing losses of 40-69 dB, 70-89 dB, and 90dB, respectively.[84]

According to the CDC, blindness affects an estimated 0.13% of American children while moderate to profound hearing loss affects between 0.1 and 0.5%.[8][118] A 2011 study using the Family Core and Sample Child Component of the NHIS 1997 to 2008 data found that the prevalence of hearing loss decreased by 30.9% and the prevalence of blindness increased by 18.1% during the study period.[8]

Environmental exposures: Both preterm birth and mercury exposure have been linked with vision and hearing impairment within children.[19][15][16]

Ethical, historical, and social issues surrounding developmental disabilities

The United States has a rich history surrounding the definition, stigmas, and laws of developmental disabilities.

Legal History

The mental retardation laws of the 1960s supplied the groundwork for the developmental disability laws we see today. The original laws, the Maternal and Child Health and Mental Retardation Planning Amendments and the Mental Retardation Facilities and Community Mental Health Centers Construction Act of 1963, were restricted to individuals with mental retardation status. It wasn't until 1970 that the term developmental disability was introduced and neurological conditions, such as cerebral palsy and epilepsy, were included under the laws protections. Since then, amendments and new regulations have expanded the legal definition of Developmental Disabilities with the current definition defined by the Developmental Disabilities Assistance and Bill of Rights Act of 2000. The goal of these laws is to insure that individuals with developmental disabilities have access

to the resources need to "promote self-determination, independence, productivity, and integration and inclusion in all facets of community life…"[119]

Additional protection for individuals with disabilities is found under the Americans with Disabilities Act of 1990.[120] This Act prohibits the discrimination on the basis of disability and extends to employment, State and local government, public accommodations, commercial facilities, transportation, and telecommunications. While specific impairments are not identified within the ADA, the laws extend to individuals with physical and mental impairments that impacts one or more major life activities.[120]

Educational services for individuals with developmental disabilities are regulated by the Individuals with Disabilities Education Act .[121] First signed in 1975, IDEA ensures children with disabilities are provided with the "least restrictive environment appropriate to their individual needs."[122] The Act distinguished the types of government and public agency intervention by child age into two parts, Parts B and C. IDEA's Part B applies to school age children (3-21 years old) and outlines Individualized Educational Programs (IEPs). Regulating the services available to infants and toddlers, IDEA's Part C describes early intervention service requirements.[123][122] More than 6.5 million children are eligible for services under IDEA nationwide. For more information regarding IDEA please refer to Disability.gov's Individuals with Disabilities Education Act (IDEA).[123]

Social Issues and Stigma: Neurodiversity Paradigm and Movement

Coined by Judy Singer in 1988, Neurodiversity is "the diversity of human brains and minds – the infinite variation in neurocognitive functioning with our species."[124] However, it wasn't popularized until Harvey Blume's 1998 article in an issue of *The Atlantic*. In the article, Blume states "Neurodiversity may be every bit as crucial for the human race as biodiversity is for life in general. Who can say what form of wiring will prove best at any given moment? Cybernetics and computer culture, for example may favor a somewhat autistic cast of mind."[125]

A specific perspective has developed around neurodiversity called the neurodiversity paradigm. The fundamental principles of neurodiversity paradigm is that neurodiversity is naturally occurring and a valuable form of human diversity; there is no "right" or "normal" type of brain in the same way that there is no one "right" or "normal" sex or race; and that the social dynamics around neurodiversity mirror those around other forms of human diversity.[124] This is the philosophy behind the Neurodiversity Movement.

As a powerful movement in the neurodivergent community, the Neurodiversity Movement has accomplished a lot over the past decade. While starting along with the Autism Rights movements, the neurodiversity movement strives to be inclusive of all neurominorities.[124] However, the overlap between this movement and the Autism Rights movement is large and achievements are credited to both groups.[126] For more information regarding recent achievements in the field of the

neurodiversity and Autism rights movements please see the Disability Rights and Neurodiversity page run by Autistic Self Advocacy Network.

This document is student work. CHE makes no claim that all the information has been verified.

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