Periods of Child Development

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The complex transactions between heredity and environment begin to shape the course of development during prenatal period. Prenatal development is divided into three phases:

- the period of the zygote
- the period of the embryo
- the period of the fetus.
Conception

• The development of a single human being begins with conception when a single sperm cell from the male unites with an egg from a female and forms a single cell called a zygote.
• Once conception has occurred, the ovum continues down the fallopian tube. Then, it implants itself in the wall of its uterus.
• This is the first phase of development and it is known as the period of the zygote.

The period of the zygote (Fertilization to 2 weeks)

• This period lasts about 2 weeks.
• The term zygote is used to refer to the organism throughout this period.
• In the early stages, the mass of cell is undifferentiated.
• However, about four days after conception some differentiation begins, at which point the organism is called blastocyst.

The period of the zygote (Fertilization to 2 weeks)

• A blastocyst is a hollow ball of cells that has developed from the fertilized egg.
• During this time, cells begin to differentiate.
• By the end of the period of the zygote, the developing organisms has found food and shelter in the uterus and developed into the embryonic stage.
The embryonic stage (2 to 8 weeks)

- The second major phase of prenatal development (the embryo) begins with completion of implantation.
- It continues for another six weeks until the various support structures are fully formed and all the major organ systems have been laid down in at least rudimentary form.

STAGES OF PRENATAL DEVELOPMENT

The embryonic stage (2 to 8 weeks)

- The embryo is especially vulnerable to interference with healthy development.
- This stage begins at week 3 and ends in the second month (week 8) of conception.

The embryonic stage (2 to 8 weeks)

- The embryo’s circulatory system is connected to the placenta through the umbilical cord.
- The placenta is connected to both the mother’s and the embryo’s (fetus’s) blood system, but the two systems are not directly connected.
- Small molecules pass back and forth through this large filtering system, but large ones cannot.
The embryonic stage (2 to 8 weeks)

- So nutrients such as oxygen, proteins, sugars, and vitamins from the maternal blood pass through to the embryo or fetus, while digestive wastes and carbon dioxide from the infant’s blood pass back through to the mother, whose own body can eliminate them.

- The period from the ninth week of conception until the end of pregnancy is called the fetal stage or the period of the fetus. The embryo is called fetus when the first bone cell appears.

The period of the fetus (8 weeks to birth)

- This is the longest prenatal period.

- The seven months of the fetal stage involve primarily a process of refining all the primitive organ systems already in place.

- At the end of the embryonic period, the main parts exist in some basic form; the next seven month are for the finishing process.

The period of the fetus (8 weeks to birth)

- During this phase, the organisms begins to increase rapidly in size, about 20 times its previous length; organs and body systems become more complex.
Table 2.1 Milestones of Prenatal Development

<table>
<thead>
<tr>
<th>Trimester</th>
<th>Period</th>
<th>Weeks</th>
<th>Length &amp; Weight</th>
<th>Major Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zygote</td>
<td>1-2</td>
<td></td>
<td>• One-celled zygote multiplies and forms a blastocyst. • Structures that feed and protect the developing organism begin to form.</td>
</tr>
<tr>
<td>2</td>
<td>Embryo</td>
<td>3-4</td>
<td>½ inch</td>
<td>• A primitive brain and spinal cord appear. • Heart, viscera, backbone, limbs and digestive tract begin to develop.</td>
</tr>
<tr>
<td>3</td>
<td>Embryo</td>
<td>5-8</td>
<td>1 inch, 1/7 ounce</td>
<td>• Early external body forms and internal organs form. • The sense of touch begins to develop, and the embryo can move.</td>
</tr>
<tr>
<td>4</td>
<td>Fetus</td>
<td>9-12</td>
<td>3 inches, less than 1 ounce</td>
<td>• Rapid increase in size begins. • Nervous system, organs and muscles become organized and connected. • New behavioral capacity such as kicking, thumb sucking, mouth opening and rehearsal of breathing appear. • External genitals are well formed &amp; the fetus’s sex is evident.</td>
</tr>
<tr>
<td>5</td>
<td>Fetus</td>
<td>25-28</td>
<td>13 inches, 1.3 pounds</td>
<td>• First fetal movement is usually felt by the mother at about 16th weeks; bones begin to develop; fairly complete ear is formed. • Weeks 20 - Hair growth begins; child is very human-looking at this age and “thumbsucking” may be seen. • Weeks 24 - Eyes are completely formed (but closed); fingernails, sweat glands, and taste buds are all formed; some fat deposit beneath skin. The infant is capable of breathing, but premature at this stage but survival rate is still low for infants born this early. • Interconnections between individual nerve cell (neurons) develop rapidly; weight is added; general “finishing” of body systems take place.</td>
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Fertilization

• Prenatal development begins when the ovum and sperm unite (i.e., fertilization), creating a new and separate cell called the **Zygote**
Immediately the cell begins to duplicate, taking approximately 30 hours to complete the first cell division.

At an increasingly faster rate, new cells are added until they form a hollow, fluid-filled ball, called a blastocyst (about 4 or 5 days after conception).

Approximately 60 to 70 cells form the blastocyst.

Those on the inside (called the embryonic disk) will become the new organism whereas those on the outside will provide the protective covering.

Around the seventh or ninth day, the blastocyst implants itself into the uterine lining.

The protective covering quickly develops into the amnion, surrounding the organism in amniotic fluid.

A yolk sac also develops, producing blood cells until the liver, spleen, and bone marrow is mature.
The period of the embryo lasts from about 2 weeks until about the 8th week of pregnancy. During this time, the groundwork for all body structures and organs is laid.

Even before the mother knows she is pregnant:
- the heart has begun to pump blood;
- the muscles, backbone, and ribs have begun to appear;
- and tiny buds have developed into arms, legs, fingers, and toes.

By the 7th week, the liver and spleen begins producing blood cells and the heart has developed separate chambers. At this time, the tiny organism shows sensitivity to touch and freely moves about in the amniotic sac.

However, at less than an inch long and only an ounce in weight, the organism is still too tiny for any movements to be felt by the mother.
By the end of the embryonic period, the internal organs as well as external structures have become more distinct.

Illustration: The development of the eyes.

- The eyes form on stems that have grown from either side of the front of the brain out to the skin on the face.
  - At first, the eyes are mere indentations on the side of the head, but they develop rapidly through seven (top), eight (middle), and 10 (bottom) weeks of pregnancy.
  - By three months, the eyelids form, and then close for a few months over the newly formed eyes. (text by Your Growing Child)

The 3rd month of pregnancy marks the end of the first trimester for the mother, and the end of the first month of the Fetal Period.

During the third month, the organs, muscles, and nervous system become connected and organized.
- The fetus can kick, bend its arms, make a fist, open its mouth, and can even suck its thumb.
- The skin of the fetus is thin and transparent. Thus, the internal organs and features can still easily be seen with an internal camera.

During the 4th month - vernix (a white, cheeselike substance) covers the entire body of the fetus.
- The vernix protects the skin from chapping during the several months that the fetus is in the amniotic fluid.
- A white, downy hair called lanugo also covers the fetus' body, which helps the vernix stick to the skin.
- The fetus has grown large enough that the movements can sometimes be felt by the mother. Often felt like a flutter or a "flip-flop". These first movements that can be felt by the mother is called quickening.
At 22 weeks, the fetus weighs a little over 1 pound, and is about 1 foot in length.

At this time, the movements can clearly be felt by the mother and by others who place their hands over the mother’s abdomen.

The fetus also shows a sensitivity to light and can be stimulated and irritated. However, it still has a long way to go before it is mature enough to survive outside of the womb. Although there are a few cases of infants being born and surviving at this time, the chance of survival (and without later complications), is very slim.

The 6th month marks the beginning of the third trimester for the mother. If born during this trimester, the fetus has a chance survival.

The point in which it can first survive is referred to as the age of viability and occurs sometime between 22 and 26 weeks.

At only 3-4 pounds, the 7 month old fetus has yet another 3-4 pounds to go before reaching the average 7.5 pounds.

During this time, the brain continues to develop at an increasingly fast rate.

By 7 months, the fetus clearly responds to sounds outside of the womb, developing a preference for the tone and rhythm of its mother’s voice.
By the 8th month, the fetus has little room for large movements. During this month, a layer of fat is added that will assist with temperature regulation.

The lungs however, still remain immature. If born at this time, the infant will likely require some help with breathing.

It is not until the 9th month that the lungs are mature enough to regulate breathing without assistance.

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One minute, and again at five minutes after birth, the infant is assessed using the APGAR scale.

On average, the newborn infant weighs 7.5 pounds and is 20 inches long.

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A majority of the newborn's first month is spent sleeping, waking every few hours to be fed.
GROWTH of the DOWN'S SYNDROME FOETUS COMPARED with NORMAL
Prenatal development from 4½ weeks to birth. The upper line represents normal
development. The lower line represents the deceleration of normal development and
differentiation seen in Down's syndrome.

INFLUENCES ON PRENATAL DEVELOPMENT
The pervasive influences of the prenatal environment underlines the important of providing an unborn child with the best possible start life.

- Only recently have scientists become aware of some of the myriad environmental influences that can negatively affect the developing organism.
- Although the mother’s role has been recognized far longer, researchers are still discovering environmental hazard that can affect her fetus.

Some of these findings have led to ethical debate over a woman’s responsibility for avoiding activities that may harm her unborn child.

- Since the prenatal environment is the mother’s baby, virtually everything that impinges on her well-being, from her diet to her moods, may alter her unborn child’s environment and affect its growth. Not all environmental hazard are equally risky for all fetuses.
- Some factor that are teratogenic (birth defect-producing) in some cases have little or no effect in others. The timing of exposure to a teratogen, its intensity, and its interaction with other factors may be important. Vulnerability may depend on a gene in the fetus or in the mother.

Normal prenatal development requires an adequate environment, but “adequate” seems to be fairly broad range.

- Most fetuses are quite normal.
- The list of things that can go wrong is long (and getting longer as our knowledge expands). But many of this possibilities are quite rare.
- More important, a very great number of them are partially or wholly preventable, and many of the remaining problems need not have permanent consequences for the child.
Teratogens

- Teratogen is an agent that increases the likelihood of deviations or produces malformations in a developing fetus. Teratogens can include factors such as maternal diet, drugs or blood disorders. Factors like maternal age, size, parity and stress can also influence the developing fetus.

Teratogens influence prenatal development according to the general principles such as the followings:

- Variation of teratogen effect in relation to the developmental stage of the unborn child.
- Teratogens have their strongest impact on newly differentiating and unformed organ systems.
- The critical period of sensitivity to teratogens begins the second week after conception and continues the eight weeks and beyond.
- Organ systems start and stop their development at differing times. Therefore, their sensitivity to teratogens also varies in time.
- Figure 2.2 shows the teratogens and the critical periods in development.
Teratogens

- Teratogens influence prenatal development according to the general principles such as the followings:
  - Individual teratogens produce specific developmental deviations.
  - The genetics characteristics of both mother and the unborn child influence the impact of teratogens.
  - The physiological status of the pregnant mother.

Nutrition

- Women need to eat more than usual when pregnant: typically 300 to 500 more calories a day, including extra protein. Pregnant women who gain 26 pounds or more are less likely to bear babies whose weight at birth is dangerously low. However, desirable weight gain depends on individual factors, such as height and weight before pregnancy.

- Malnutrition during fetal growth may have long-range effect. Findings of the study on Dutch military recruits whose mother had been exposed to wartime famine during pregnancy suggest that severe prenatal nutritional deficiencies in the first or second trimesters affect the developing brain, increasing the risk of antisocial personality disorder (Neugeauer, Hoek & Suser, 1999).
Physical Activity

- Moderate exercise does not seem to endanger the fetuses of healthy women. Regular exercise prevents constipation and improves respiration, circulation, muscle tone, and skin elasticity, all of which contribute to a more comfortable pregnancy and an easier, safer delivery and may result in a bigger baby. Pregnant women should avoid activities that could cause abdominal trauma.

- Strenuous working conditions, occupational fatigue, and long working hours may be associated with greater risk premature birth.

- The American College of Obstetrics and Gynecology (1994) recommends that women in low risk pregnancies be guided by their own abilities and stamina. The safest course seems to be for pregnant women to exercise moderately, not pushing themselves and not raising their heart rate above 150, and, as with any exercise, no taper off at the end of each session rather than stop abruptly.

Drug Intake

- Practically everything an expectant mother takes in makes its way to the uterus. Vulnerability is greatest in the first few months of gestation, when development is most rapid. What are the effects of the use of specific drugs during pregnancy? The effects of taking a drug during pregnancy do not always show up immediately.
Nicotine - Tobacco use during pregnancy may contribute to miscarriage, low birth weights, babies who need intensive care, sudden infant death and long term cognitive and behavioral problems. Past studies also show that:

- Newborn whose mothers had smoked during pregnancy were shorter and lighter and had poorer respiratory functioning than babies of nonsmoking mothers.
- Mother’s smoking during pregnancy may increase her child’s risk of cancer.

Drug Intake

- Smoking during pregnancy seems to have some of the same effects on children when they reach school age as drinking during pregnancy:
  - Poor attention span
  - Hyperactivity
  - Anxiety
  - Learning and behavior problems
  - Perceptual-motor and linguistics problems
  - Poor IQ scores
  - Low grade placement
  - Neurological problems.

Drug Intake

- 6-23 year old offspring of women who reported having smoked heavily during pregnancy found a four fold increase in risk of conduct disorder in boys, beginning before puberty, and a five fold increased risk of drug dependence in girls, beginning in adolescence, in comparison to those whose mothers do not smoked.
Drug Intake

- **Caffeine** – Caffeine is not a teratogen for human babies. However, four or more cups of coffee a day during pregnancy may increase the risk of sudden death in infancy.

- **Marijuana, opiate and cocaine** – Some evidence suggest that heavy use of marijuana, opiate and cocaine can lead to birth defects. A study on blood samples from the umbilical cords of 34 newborns found a greater prevalence of cancer-causing mutations in the infants of mothers who smoked marijuana.

- **Other studies show that:**
  - Women addicted to morphine are likely to bear premature, addicted babies who will be addicted to the same drugs and will suffer the effects until at least age 6 years old.
  - Prenatal exposed newborns are restless and irritable and often have tremors, fever, vomiting and breathing difficulties.
  - At 1 year, infants tend to show somewhat slower psychomotor development.
  - These children tend not to do well in school, unusually anxious in social situations and tend to have trouble making friends.

Sexually Transmitted Diseases

- Infants born to HIV-infected mothers tend to have small heads and slowed neurological development. Syphilis can cause problems in fetal development, while gonorrhea and genital herpes can have harmful effects on the baby at the time of delivery.
Outside Environmental Hazards

- Hazards of modern life, chemicals, radiations as well as extreme heat and humidity can affect prenatal development. Some of the findings of past studies are:
  - Women who work with chemicals have about twice the rate of miscarriage as other female workers.
  - Infants who were exposed to high levels of lead during prenatal period, score lower cognitive abilities and higher rates of childhood illness.
  - Radiation can cause genetic mutations.

MATERNAL AGE

- Delayed childbearing may increase risks to mothers and babies due to diabetes, high blood pressure or severe bleeding.
- After the age of 35, there is more chance of miscarriage or stillbirth, more likelihood of premature delivery, retarded fetal growth, other birth-related complications and or birth defects such as down syndrome.
- Women age 40 and above are at risk of needing cesarean. Risks of all birth complications are increased.
- Adolescent mothers also tend to have premature or underweight babies.

GENETICS & PRENATAL DEVELOPMENT
Every human cell carries a genetically programmed blueprint for development.

The blueprint is coded by the genes.

The genes reside on the structures called chromosomes.

In normal humans, each cell contains 46 chromosomes.

Chromosomes work together in pairs (23 pairs) – one inherited from the mother, one from the father.

The first 22 pairs of chromosomes (autosomes) account for most aspects of development.

The 23rd pair is sex chromosomes, which accounts for a person’s sex.

A person’s genotype (genetic code) influences his/her phenotype (outward expression of the genotype). However, not all the information in one’s genotype is expressed in one’s phenotype.

Why? Genes work in pairs. Thus, certain type of genes are more likely to be expressed than others.

Both parents contribute identical copies of a gene to their child – the child is homozygous for the trait.

Each parent contributes a different copy of the gene to their child – the child is heterozygous for the trait.

A gene whose code is expressed is called a dominant gene.

A gene that is not expressed in the presence of dominant gene is called recessive gene.

For a recessive gene to be expressed, both genes in the pair must be recessive.
**Dominant transmission** – most serious genetic diseases are not transmitted through a dominant gene. Why?
- But some genetic diseases (e.g., a degenerative neurological disease) are maintained in the population because they often do not strike until middle-age.
- Dominant transmission poses serious problems for those who carry the dominant gene for the disease.
- Recessive transmission – recessive characteristics & diseases can remain hidden for generations because they are not expressed unless both parents contribute the gene to their child.
- People who are heterozygous for a recessive disease or characteristic do not have the recessive disease or characteristic but are carriers.

**How Do Genes & Environment Work Together?**
- The environment plays an important role in how and when genes are expressed.
- The particular genes that are expressed vary depending on the developmental stage of the organism.
- Though single gene can be the cause of certain diseases or characteristics, most physical features, disorders & behaviors are likely influenced by multiple genes & by genes in interaction with in interaction with environmental agents.

**What Are Common Chromosomal Abnormalities?**
- 3-5% of the newborns may have chromosomal abnormality – born with missing or extra chromosomes.
  - Down syndrome:
    - Occurs in about 1 in 900 live births.
    - 90% have 47 chromosomes with an extra number 21 chromosomes (trisomy 21) – due to failure to separate during meiosis.
    - Identifiable by their facial features (large tongue, wide-spaced eyes, round face, folds in the corner of the eyes), short stature, & unusual creases on the palms of their hands.
  - Sex chromosomes abnormalities:
    - Having extra X & Y chromosomes and lacking an X chromosome.