SEX AND SEX STRUCTURE

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Contents

Summary

In this chapter we argue that sex structure is one of the most important and relevant features of human societies. Regarding demographic study, the interaction of sex structure with the three demographic processes is of paramount importance. But the importance of sex structure extends far beyond demography. A society's sex structure has important implications for socioeconomic and demographic development, as well as for labor force participation and gender relations.

Accordingly, we first examine the importance of sex and sex structure for demography. We next consider the definition and classification of sex. Then we discuss the major demographic measures of sex structure. This is followed by a discussion of the population pyramid. We conclude the chapter with two detailed substantive demographic analyses of unbalanced sex structure, namely sex structure and the labor force and the sex ratio at birth.

1. Introduction

Sex structure is without doubt one of the most important and relevant features of population composition. The interaction of sex structure with the three demographic processes of fertility, mortality and migration is of paramount importance for demographers, but the importance of sex structure extends far beyond demography. The division of labor in traditional societies is heavily differentiated on the basis of sex. For that matter, sex differentiation of one form or another is found in all known human societies (Davis, 1949; Murdock, 1949). A society's sex structure has important implications for socioeconomic and demographic development (Keyfitz, 1965), as well as for labor force participation and gender relations (South and Trent, 1988). Indeed "almost any measurement that can be taken of human beings, or of groups of human beings, will show substantial variation by sex and age" (Bogue, 1969: 147).

In this chapter we focus first on the importance of sex and sex structure for demography. Next we consider the definition and classification of sex; in addition to reviewing the various biological definitions of sex, we also discuss the phenomena of intersex and transsexualism. Then we examine the primary demographic measures of sex structure, and a demographic measure involving simultaneously both sex structure and age structure, namely, the population pyramid. We conclude the chapter with two detailed substantive demographic analyses of unbalanced sex structure, viz., sex structure and the labor force, and the sex ratio at birth.

2. The Importance of Sex and Sex Structure for Demography

Populations are not homogeneous units; they differ by sex, age, race/ethnicity, marital status, and a host of other characteristics. Sex and age are by far the most important for demography. They are absolutely essential for analyzing the demographic processes of fertility, mortality and migration (Hawley, 1959; Namboodiri, 1991). The demographic processes are all affected directly by sex and by age, and these influences occur via biological, psychological, cultural, and social variables (Palmore, 1978; Halli and Rao, 1992).

With respect to fertility, more males are born than females, usually around 105 males for every 100 females. The fecundity, and hence the childbearing years, of females also differs from that of males. Most births occur to females when they are between the ages of 15-49, whereas males are fecund usually between the ages of 15-79. This increased male fecundity, however, usually occurs only "in polygamous populations (where) a man's fertility can remain high well into his fifties and sixties; ... in controlled fertility societies, it peaks ... with a mode in the mid-twenties" (Coleman, 2000: 41). This is due in part to low fertility norms in Western societies, as well as to a small average age difference of about two to three years between men and women in first marriages.

Regarding mortality, females have lower death rates than males at every age of life. Death rates are high in the first year of life, and then drop to very low levels, and do not begin to increase until several decades later in the life cycle. But this so-called age curve of mortality is higher for males at every age than it is for females. Also, cause-specific mortality is frequently sex-related. For example, in many societies, causes of death such

as infanticide, parricide, suicide, and deaths due to violence and accidents are heavily differentiated by sex.

Migration also differs by sex. Traditionally, males and females have not migrated to the same places in equal numbers. Long-distance migration has tended to favor males, and short-distance migration, females. This has been especially the case in developing countries. However, migration rates of females are starting to approximate those of males. Finally, the sex and age structure of human populations sets important limits with respect to sustenance organization. The two characteristics of sex and age together define a biological entity to which the population's sustenance organization is or must be adapted. Hawley has noted that the demographic structure of sex and age contains the possibilities, and sets the limits, of organized group life (1950: 78). The sex and age structure of a population at "any given time constitutes a limiting factor on the kinds of collective activities (it) may engage in. … In effect, the organization of relationships in a population is an adaptation to its demographic (i.e., sex and age) structure. And to the extent that the (sustenance organization) is differentiated, the adaptation to its demographic features must be precise" (Hawley, 1950: 144). The degree to which a population's sex and age structure limits the kinds and varieties of sustenance activities in which the collectivity may be engaged is an important analytical issue, but one not well explored or understood (Poston and Frisbie, 2005). We turn next to a consideration of the conceptualization, definition and classification of sex.

3. The Conceptualization, Definition and Classification of Sex

In this section of the chapter, we first consider sex as an ascribed characteristic. We next review the major biological definitions of sex. We then turn to how demographers classify and designate sex. Then we discuss the issue and conceptual distinction of sex versus gender.

Sex is defined much more straightforwardly than most demographic variables. Sex is an ascribed characteristic, and for the most part unchangeable. With but a few exceptions, it is fixed at birth. When a baby is born its sex is determined on the basis of its genital tubercle. On average, boys are born with penises ranging in length from 2.9 to 4.5 centimeters (Flatau et al., 1975). For girls, clitoral length at birth ranges from 0.2 to 0.9 centimeters (Fausto-Sterling, 2000: 60; Sane and Pescovitz, 1992). When the length of the tubercle is between these two average ranges, sex determination is open for discussion and decision-making by the parents and medical workers. But even in such extreme situations (1 per 4,500 live births), sex assignment is usually made soon after birth, and most often is permanent (Lehrman, 2007: 41; Money, 1988).

Approximately five sex-assignment surgeries are performed every day in the United States to correct genital ambiguity in infants (Lehrman, 2007). Even when the anatomy or gender identity of individuals fails to match their assigned social gender, they are aware of their given classification. Because of this awareness, the census definition of sex is usually not problematic and is easily ascertainable through self-identification.
However, there are several important biological and social considerations regarding the determination of sex that require our discussion and attention. When demographers identify or enumerate the sex of an individual or the sex distribution in a population,

they almost always rely on the social definition of self-identification. That is, when a question about a person's sex is listed on a census instrument or survey or certificate, its designation is not based on biological considerations such as the person's chromosomes or the person's external genitals, but, rather, on the person's self-identification of his/her sex. However, sex is also determined biologically. We now address these issues in some detail.

3.1. Biological Definitions of Sex

The first biological definition of sex is based on chromosomes which are structures containing genetic material. Males have an X chromosome and a Y chromosome, while females have two X chromosomes. The X chromosome is larger than the Y chromosome and carries more genetic material (Tavris and Wade, 1984: 135). One's chromosome distribution is determined by the parents. The ovum of the female and the sperm of the male each contain 23 chromosomes. When the sperm and the ovum come together in one of the woman's fallopian tubes, they produce a fertilized egg, known as an embryo. It consists of 46 chromosomes aligned in 23 pairs. One of these constitutes the sex of the embryo. An X chromosome is contributed by the mother and either an X or a Y chromosome is contributed by the father. The father thus determines the sex of the embryo.

The second biological definition of sex is based on gonads. In males the gonads are testes, and in females, ovaries. Until an embryo attains the age of about 6 weeks, there is really no way of knowing whether it will be male or female, without examining its chromosomes. "Every embryo contains tissues that eventually will develop into either testes (the male gonads) or ovaries (the female gonads)" (Tavris and Wade, 1984: 137). If the embryo is chromosomally male, i.e., if it has an X and a Y chromosome, one theory is that a gene on the Y chromosome results around the sixth week after conception in the formation of male gonads, or testes. If the embryo is chromosomally female, that is, if it has two X chromosomes, female gonads, or ovaries, appear a few weeks later. Scholars are not entirely sure how this occurs. It was once thought that if the Y chromosome was absent (as is the case in a chromosomally female embryo), then the lack of this chromosome "would prompt the indifferent gonad of an XX embryo to transform into ovaries at about the 12^{th} week of gestation" (Renzetti and Curran, 2003: 32-33). This hypothesis is no longer accepted universally (Renzetti and Curran, 2003: 33). There is still some discussion about the mechanisms that lead to the development of ovaries in XX embryos around the twelfth week after conception.

The gonads produce the sex-specific hormones, which are the basis for the third biological definition of sex. The human endocrine system is comprised of glands, including the adrenal, ovaries, and testes, which produce hormones that are released into the bloodstream. This results in the various organs beginning or ceasing to perform such functions as spermatogenesis (in males), and periodic ovum release (in females).

Androgens are a class of hormones, found mainly in males, although also in females, of which testosterone is the most important. Manufactured in the testes of males, and in the adrenal cortex and ovaries of females, testosterone is responsible for the differentiation of male and female primary sex characteristics at about the seventh week of fetal life.

Kimmel has written (2004: 40) that "on average men … have about ten times the testosterone level that women have, but the range among men varies greatly, and some women have levels higher than some men." Without the release of testosterone and other androgens, the male fetus will not develop male external genital organs. Males also receive major surges of testosterone at puberty so that the task of sex differentiation can be completed. Estrogen surges also occur at puberty in females.

Every embryo contains "two sets of ducts, one of which will become the internal reproductive structures appropriate to the embryo's sex" (Tavris and Wade, 1984: 137). These internal sexual properties constitute the fourth biological definition of sex. In males these tissues are known as Wolffian ducts and they result in the vas deferens, the seminal vesicles, and the prostate. In females they are known as Mullerian ducts, and they become the "Fallopian tubes, the uterus, and the inner two-thirds of the vagina. In each sex, the ducts that do not develop eventually degenerate, except for traces" (Tavris and Wade, 1984: 137; Kimmel, 2004: 39-40).

The sex hormones that are manufactured by the testes in chromosomal males and by the ovaries in chromosomal females thus end up determining which set of internal reproductive structures and external genitals the embryo will have. One theory is that the embryo will become a female unless two extra factors make it male: 1) "the Y chromosome which turns the embryo's unisex gonads into testes" (Tavris and Wade, 1984: 137); and 2) if the male gonads do not produce testosterone, the result is not a neuter organism, but rather one with female genitals. However, endocrinologists do not all agree that the anatomical development of the female fetus does not require female hormones.

The sex-specific internal sex structures of the fetus lead finally to the development of sex-specific external genitals, namely, a penis and scrotal sac for males, and a clitoris and vagina for females. The external sex structures are the basis for the fifth biological definition of sex. We noted earlier in this chapter that this fifth biological definition is the basis for the assignment of sex at the birth of the baby. If the baby's genital tubercle is a penis ranging from around 2.9 to 4.5 centimeters in length, the baby is said to be a male. If its genital tubercle is a clitoris around 0.2 to 0.9 centimeters in length, it is designated as a female. Sex assignment at birth is seldom based on chromosomal structure or on any of the other first four biological definitions of sex. The external sexual organs almost always determine the assignment of sex at birth.

3.2. Intersex

Most embryos are consistent on the five biological definitions of sex. If it is chromosomally a male, it will also be a male gonadally and hormonally, and will possess male internal and male external sex structures. An analogous statement applies with respect to a chromosomally female embryo.

But this is not always the case. In around 23 per 10,000 births, these five definitions of sex are not consistent, resulting in what is referred to as an intersexed birth. There are numerous types of intersex. We now discuss some of the major ones.

One intersex category is chromosomal. Occasionally, chromosomal inconsistencies occur, sometimes during sperm production, resulting in what Renzetti and Curran (1999: 34) refer to as an "abnormal complement of sex chromosomes." If the sperm fails to divide properly, i.e., if what is called "nondisjunction" occurs, one kind of sperm produced will have neither an X nor a Y chromosome. If this sperm fertilizes a normal egg, the offspring will only have an X chromosome. This type of intersex is known as Turner's Syndrome. The person appears to be a female because although it lacks ovaries, it possesses some external female characteristics. This condition is estimated to occur in about 4/10,000 live births (Fausto-Sterling, 2000: 53). A Turner's Syndrome person is typically of short height with a broad chest and widely spaced nipples, and lacks ovaries, so thus is sterile. The person does not menstruate. Secondary sex characteristics will develop if supplementary estrogen is given at puberty (Money and Ehrhardt, 1972; Fausto-Sterling, 2000: 52).

Another case of nondisjunction is a sperm produced with both an X and a Y chromosome. If this sperm fertilizes an egg, the offspring has two X chromosomes and one Y chromosome. Another type of nondisjunction is the production of a sperm with two Xs; and still another type of disjunction is the production of a sperm with two Ys. If the former fertilizes an egg, the offspring will have three X chromosomes; if the latter sperm fertilizes an egg, the offspring will have one X chromosome and two Y chromosomes.

The combinations of XXY and XYY are two types of chromosome abnormality in which the egg cell has one or more extra sex chromosomes, and the offspring is anatomically male. An XXX offspring is anatomically female.

The XXY is referred to as Klinefelter's Syndrome and occurs in roughly 9/10,000 live births (Fausto-Sterling, 2000: 53). This person has the height of a normal male, with long legs, an absent or weak sex drive, "feminized" hips, some breast development, and a small penis and testes (Money and Ehrhardt, 1972). At adolescence, XXY persons sometimes receive injections of testosterone unable to be produced by their small testes. Testosterone therapy needs to be continued indefinitely to enhance the person's libido. The person can engage in sexual activity, but because of a sparsity of semen will likely be unable to father children. However, Renzetti and Curran (2003: 37) have written that many XXY men are no different from XY men in terms of social and emotional characteristics.

Turner's Syndrome and Klinefelter's Syndrome are the more common forms of what Fausto-Sterling (2000) refers to as "chromosomal variations other than XX or XY." But, there are other chromosomal variations (Conte and Grumbach, 1989: 1810-1847). One is the person with one X chromosome and two Y chromosomes, referred to as Jacob's Syndrome; such a person is an anatomical male with no physical abnormalities, except for unusual height. The extra Y chromosome does not result in their having more androgens than an XY male. They appear to be able to reproduce successfully and rarely come to the attention of investigators, except through large-scale screening of newborns. Another type of chromosomal abnormality is three X chromosomes, which is known as the XXX Syndrome, or Triple X Syndrome. These persons are anatomically female and show few visible signs of abnormality, although they tend to be taller than XX women,

and some have a slightly higher incidence of learning disorders (Renzetti and Curran, 2003: 36).

The above examples of intersex are chromosomal combinations other than the XY male or the XX female. The designation of the sex of these persons at birth is usually based on external sexual organs. There are other forms of intersex in which the persons are chromosomally male (XY) or female (XX), but the sexual distinctions occur at the level of hormones. One such example comes about when an XX fetus receives an excessive amount of androgens. This is known as the Adrenogenital Syndrome (AGS), also referred to as Congenital Adrenal Hyperplasia (CAH). Renzetti and Curran (2003: 37) have estimated the incidence of AGS at between 1/5,000 and 1/15,000. Fausto-Sterling (2000: 53) gives a higher rate of 1.5 cases of CAH per 100.

In chromosomally female human fetuses, one reason for the intersex occurrence is that the fetus produces "too much androgen because of a malfunction of the adrenal glands" (Tavris and Wade, 1984: 139). This may occur because the female system does not produce enough cortisol, a natural steroid that works with the female's adrenal gland. This happens around the third month of fetal development, leading to the masculinization of the external genitals, and if not corrected by cortisol injections after birth, to further masculinization. This occurs too late to affect the internal organs, but influences the appearance of the genitals. The further production of androgens can be suppressed after birth through cortisol. If this is not done, the child develops a masculine appearance and body build (Tavris and Wade, 1984: 139; Renzetti and Curran, 1999: 39).

Untreated females with AGS have normally functioning ovaries and normal internal female sexual organs, but a masculinized external appearance. This can vary from a slightly enlarged clitoris to a nearly normal-sized penis with an empty scrotum. If treated with cortisol from birth, these females will have a later menarche than normal, but will be able to conceive, lactate and deliver babies (Money and Ehrhardt, 1972).

Another type of intersex occurs at the hormonal level among XY fetuses. Fetuses that are chromosomally male may develop into intersex persons with genitals that are ambiguous or that look more like a clitoris than a penis, and with feminized breasts. One way this happens is via a genetic defect that causes the cells of the fetal organs to be insensitive to androgen. The testes produce testosterone normally, but the body is not able to use or absorb it, "so neither the (male) internal reproductive organs nor the (male) genitals develop normally" (Tavris and Wade, 1984: 139-140). Externally the baby at birth appears to be female. This condition is known as Androgen Insensitivity Syndrome (AIS). Because the cells remain incapable of responding to androgen, AIS cannot be treated by administering androgen after birth. AIS babies are born with feminized genitalia. At puberty they develop breasts and a feminine body shape. This occurs because they can respond to estrogen, secreted by the testes, so at puberty the secondary sex characteristics of a female appear (Money and Ehrhardt, 1972). The AIS person does not menstruate and as an adult cannot become pregnant, yet "she" can have intercourse. In fact, Renzetti and Curran (2003: 38-39) have noted that it is "her" inability to menstruate that often leads to the discovery of the condition. XY persons with AIS are born phenotypically females. They have no internal female organs. The

vagina is short, but the clitoris and breasts are usually of normal size. The person has little if any pubic hair, since this depends on androgens (Money and Ehrhardt, 1972).

The above are several examples of intersex occurrences at the level of chromosomes and at the level of hormones. Intersex persons by definition are inconsistent on the five biological definitions of sex, but the designation of their sex at birth is most always based on the external organs, i.e., the presence, or lack thereof, of a penis. Sexual consistency on the five biological conditions is not a requirement for sex designation. Indeed, we noted earlier that over 23 per 10,000 live births are inconsistent on the five biological definitions.

Several well-known individuals are alleged to be/have been intersexed. The case of Joan of Arc is of particular interest. Joan may be "the one person born before 1800, with the exception of Jesus Christ, that the average Westerner can name" (Gordon, 2000: xix). In writings, movies and plays about her, she is often referred to as a "girl/boy." She reportedly had "beautiful" breasts, yet she was not known to have ever menstruated (Gordon, 2000: 144, 145, 169). All of these characteristics are consistent with those of persons with the Androgen Insensitivity Syndrome.

Recently, the practice of surgically correcting the genitals of intersex infants has been called into question (Blackless et al., 2000). While our culture imagines sexual development as a bimodal pathway, scientists know that "absolute dimorphism is a Platonic ideal not actually achieved in the natural world" (Blackless et al., 2000: 151). In fact, sexual variation across the population is best represented by two overlapping bell-shaped curves, not two distinct distributions. Blackless and colleagues (2000: 163) are optimistic that this knowledge will generate enough attention to precipitate a reexamination of medical interventions performed on intersex infants.

Eric Vilain, a French geneticist who directs a genetics laboratory at the University of California, Los Angeles, also opposes hurried sex-assignment surgery conducted to placate parents and physicians (Lehrman, 2007). Vilain has remarked that "what really matters is what people feel they are in terms of gender, not what their family or doctors think they should be" (Lehrman, 2007: 40). There is growing awareness of intersex individuals and related concerns through such organizations as The Intersex Society of North America (ISNA). Cheryl Case, executive director of the ISNA, has been a long time combatant of surgeries performed to forge a social gender chosen by parents and physicians (Lehrman, 2007: 41). "Recalling how a doctor once called her 'formerly intersex,' she hopes physicians will begin to see mixed sex characteristics as a lifelong medical condition instead of a problem to be quickly fixed" (Lehrman, 2007: 41).

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