Demography I

STA 342

University of Ibadan Distance Learning Centre
Open and Distance Learning Course Series Development

ISBN 978-021-398-8

General Editor: Prof. Bayo Okunade

University of Ibadan Distance Learning Centre
University of Ibadan,
Nigeria

Telex: 31128NG

Tel: +234 (80775935727)
E-mail: ssu@dlc.ui.edu.ng
Website: www.dlc.ui.edu.ng

Vice-Chancellor's Message

The Distance Learning Centre is building on a solid tradition of over two decades of service in the provision of External Studies Programme and now Distance Learning Education in Nigeria and beyond. The Distance Learning mode to which we are committed is providing access to many deserving Nigerians in having access to higher education especially those who by the nature of their engagement do not have the luxury of full time education. Recently, it is contributing in no small measure to providing places for teeming Nigerian youths who for one reason or the other could not get admission into the conventional universities.

These course materials have been written by writers specially trained in ODL course delivery. The writers have made great efforts to provide up to date information, knowledge and skills in the different disciplines and ensure that the materials are user-friendly.

In addition to provision of course materials in print and e-format, a lot of Information Technology input has also gone into the deployment of course materials. Most of them can be downloaded from the DLC website and are available in audio format which you can also download into your mobile phones, IPod, MP3 among other devices to allow you listen to the audio study sessions. Some of the study session materials have been scripted and are being broadcast on the university's Diamond Radio FM 101.1, while others have been delivered and captured in audio-visual format in a classroom environment for use by our students. Detailed information on availability and access is available on the website. We will continue in our efforts to provide and review course materials for our courses.

However, for you to take advantage of these formats, you will need to improve on your I.T. skills and develop requisite distance learning Culture. It is well known that, for efficient and effective provision of Distance learning education, availability of appropriate and relevant course materials is a *sine qua non*. So also, is the availability of multiple plat form for the convenience of our students. It is in fulfilment of this, that series of course materials are being written to enable our students study at their own pace and convenience.

It is our hope that you will put these course materials to the best use.

Prof. Abel Idowu Olayinka
Vice-Chancellor

Foreword

As part of its vision of providing education for "Liberty and Development" for Nigerians and the International Community, the University of Ibadan, Distance Learning Centre has recently embarked on a vigorous repositioning agenda which aimed at embracing a holistic and all encompassing approach to the delivery of its Open Distance Learning (ODL) programmes. Thus we are committed to global best practices in distance learning provision. Apart from providing an efficient administrative and academic support for our students, we are committed to providing educational resource materials for the use of our students. We are convinced that, without an up-to-date, learner-friendly and distance learning compliant course materials, there cannot be any basis to lay claim to being a provider of distance learning education. Indeed, availability of appropriate course materials in multiple formats is the hub of any distance learning provision worldwide.

In view of the above, we are vigorously pursuing as a matter of priority, the provision of credible, learner-friendly and interactive course materials for all our courses. We commissioned the authoring of, and review of course materials to teams of experts and their outputs were subjected to rigorous peer review to ensure standard. The approach not only emphasizes cognitive knowledge, but also skills and humane values which are at the core of education, even in an ICT age.

The development of the materials which is on-going also had input from experienced editors and illustrators who have ensured that they are accurate, current and learner-friendly. They are specially written with distance learners in mind. This is very important because, distance learning involves non-residential students who can often feel isolated from the community of learners.

It is important to note that, for a distance learner to excel there is the need to source and read relevant materials apart from this course material. Therefore, adequate supplementary reading materials as well as other information sources are suggested in the course materials.

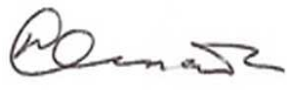
Apart from the responsibility for you to read this course material with others, you are also advised to seek assistance from your course facilitators especially academic advisors during your study even before the interactive session which is by design for revision. Your academic advisors will assist you using convenient technology including Google Hang Out, You Tube, Talk Fusion, etc. but you have to take advantage of these. It is also going to be of immense advantage if you complete assignments as at when due so as to have necessary feedbacks as a guide.

The implication of the above is that, a distance learner has a responsibility to develop requisite distance learning culture which includes diligent and disciplined self-study, seeking available administrative and academic support and acquisition of basic information technology skills. This is why you are encouraged to develop your computer skills by availing yourself the opportunity of training that the Centre's provide and put these into use.

In conclusion, it is envisaged that the course materials would also be useful for the regular students of tertiary institutions in Nigeria who are faced with a dearth of high quality textbooks. We are therefore, delighted to present these titles to both our distance learning students and the university's regular students. We are confident that the materials will be an invaluable resource to all.

We would like to thank all our authors, reviewers and production staff for the high quality of work.

Best wishes.



Professor Bayo Okunade
Director

Course Development Team

Content Authoring	Angela U. Chukwu (Mrs.)
Content Editor	Prof. Remi Raji-Oyelade
Production Editor	Ogundele Olumuyiwa Caleb
Learning Design/Assessment Authoring	SkulPortal Technology
Managing Editor	Ogunmefun Oladele Abiodun
General Editor	Prof. Bayo Okunade

Table of Contents

General Introduction

Demography deals with static as well as the dynamic aspects of population studies. A distinction may be made here between “Demographic analysis” and “Population studies”. Demographic analysis is confined to the study of components of population variation and change (fertility, mortality and migration). While population studies are concerned not only with population variables but also with relationships between population changes and other variables (Social, Economic, Political, Genetic, Geographical and the like). Thus Demography may be understood in a narrow sense as synonymous with Demographic analysis or in a broader sense as encompassing both Demographic analysis and population studies.

Demography deals with the whole population or a section of population rather than individuals. Any variation in the size and composition of a population take place through different vital processes such as births, deaths, migration, marriage, divorce, etc. A numerical portrayal of these vital processes using the different demographic techniques or the study of the functional interrelation of factors of population growth and structure may be the work of a pure demographer. The scope of Demography is far broader and more dynamic than generally understood. A good background in one or more other social or biological sciences is therefore necessary for anybody to become a complete demographer.

Study Session 1: Meaning of Demography and Basic Concepts

Introduction

In this study session, you will be introduce to the meaning of Demography and some basic concepts and terminologies that will enable you understand the course as a whole.

Learning Outcomes for Study Session 1

At the end of this study session, you should be able to:

1.1.Define the word 'Demography'

1.2.Discuss some basic terms used in the study of Demography

1.1 Meaning of Demography

The term ***Demography*** was introduced by a Belgian, **Achille Guillard** in 1855. The word was derived from two Greek words ***demos*** meaning the people and ***graphy*** meaning to draw or write. Demography may, therefore be defined simply as the science of human population.

Population is viewed as an aggregate of persons represented by certain statistics while demography is concerned with the behaviour of the aggregate (or some of its parts) and not with the behaviour of individuals.

According to the **United Nations Multilingual Demographic Dictionary**,

> "*demography is the scientific study of human population primarily with respect to their size, their structure and their development*".

In a narrower sense, demography is concerned with size, distribution, structure and change of human population.

In a broader sense, demography is a science that studies the size, territorial distribution, structure and composition of human populations and of changes over time in these aspects,

the causes and consequences of such changes and the interrelationship of socio-economic factors and changes in the population.

Size of Population: The size of population is simply the number of persons in a well-defined area and at a particular point in time. It increases through births and immigration and decreases through deaths and emigration.

Distribution of Population: The distribution of a population refers to the arrangement of the population in space (geographically or among various types of residential areas) at a given time.

Structure of Population: The structure of population in its narrowest sense is the distribution of the population among its sex and age groupings.

Change of Population: The change of a population is the growth or decline of the total population or one of its structural units. The components of change in total population are births, deaths and net migration.

In-Text Question

Demography is concerned with size, distribution, structure and change of human population. True or false

In-Text Answer

True

1.2 Definition of Terms

Population

Population in a wider sense is the totality of all persons living at a certain time within a territory demarcated by natural, cultural or political boundaries.

The territory may be distinct social communities, whether a village, a nation or the entire world. From the point of view of demographic studies, a greater importance is attached to the population of a country.

In demography, population is all human generation in terms of their settlement and migration within a given territory. In philosophic - sociological terms, population is, the subject and at the same time, the object of social production.

In the political economy, it is the basic source of labour force, on one hand, and the subject of consumption, on the other. In demography, population is all human generation distinguished by their size, age, sex, and other compositional variations.

In-Text Question

Population is the totality of all persons living at a certain time within a territory demarcated by natural, cultural or political boundaries. True or false

In-Text Answer

True

Demographic Statistics

Demographic Statistics, sometimes referred to as population statistics, actually has a dual meaning. It may be used in a singular or plural sense.

In the plural sense, the term demographic statistics is used to indicate the collection of numerical data on population.

Here, demographic statistics are the population figures themselves, suitably classified and tabulated according to the size and territorial distribution of population of an area, distribution by sex, age, social class, kind of employment, nationality, level of education, marital status etc. of the population.

In a singular sense, demographic statistics is used to refer to a subject field of study concerned with methods and procedures for collecting, organizing, presenting, analyzing and interpreting demographic data relating to:

1. The size and the composition of the population
2. Factors of natural increase of the population (births and deaths)
3. Factors of mechanical increase of the population (migration)

Demographic Events

The factors of natural and mechanical increase of population are all sequence of events called demographic events. Events such as entry into school and entry into the labour market are of interest in demographic analysis because of their impact on population change yet they are not categorized as demographic events.

Vital Events

Vital events deal with the individual's entrance into or exit from life and the changes in civil and social status that may occur during a specified duration of time among the members of a population residing within a country or any delimited territory during the same period.

Thus, by vital events, we mean such events of human life as (births, deaths and changes in civil status throughout lifetime (marriages, divorces, adoptions, legitimations, recognitions, annulments and legal separations). Other demographic events such as migration and naturalization are not generally considered as vital events.

Vital Statistics

The term ***vital statistics*** has dual meaning. In the plural sense, it refers to the numerical data pertaining to events occurring in a given section of a population. It is synonymous to vital data.

In a singular sense, it is the methods and procedures that deal with the registration, compilation, analysis, and reporting of aggregates of vital events that occur in a given section of a population during a specified period of time.

Vital Statistics System:

Related to vital events and vital statistics is a vital statistics system, and can be defined as the whole or total process of legal registration, statistical recording, analysis, presentation, and reporting of statistics pertaining to vital events.

Demographic Process:

The demographic process may be defined as the sequence of changes that take place in a population as a result of the interplay of demographic events. It has the following characteristics with respect to an individual:

i. Not all individuals will experience similar sequence.

ii. Certain events cannot take place before others: births, marriages and deaths occur in definite sequences: a birth marks the beginning of life and death the end of life. Such events like entry into school, labour force, marriage and pregnancy occur in between births and deaths in a definite order.

Characteristics

A characteristic is any piece of personal information that can be ascertained in a consistent manner for everyone. It serves to classify each person in a statistical table.

Examples of characteristics that have been found to be generally satisfactory includes: age, sex, marital status, source of livelihood, place of birth, and perhaps number of children ever-born .The distribution of most characteristics in a population is related to age.

Household

A household may be broadly defined as a group of people living together under the headship of an individual who is mainly responsible for looking after the interest and daily needs of its members. The members may or may not be related to the head. The core of a household is a family.

A family is usually defined as the group of people who are related by blood, marriage or adoption. Individual members of a family may live together as a single unit at a place or may be living separately over different places. In both a household and a family, the head may be a male or a female. They may also be single member unit.

In-Text Question

A characteristic is any piece of personal information that can be ascertained in a consistent manner for everyone. True or false

In-Text Answer

True

Branches of Demography

In the broader sense, demography may be conceived as encompassing both ***demographic analysis*** and ***population studies***.

Demographic Analysis:

Demographic analysis deals with the methods, techniques and measures used to study the mechanisms of population change in demography. The study of population, predominantly human population, achieved its mathematical character in the twentieth century and this has become known as ***mathematical demography*** or ***formal*** or ***technical demography***.

It is the study of population and its analysis through mathematical models, and it deals only with demographic variables in a mathematical way. The subject of technical demography can be viewed from either a deterministic viewpoint or from a stochastic viewpoint.

Technical demographers are therefore, usually mathematicians or statistician and they are interested in a question such as: what are the possible effects on the birth rate in the future if the number of women of childbearing age is changing.

Population Studies:

Population studied is the systematic study of population trends and phenomena in relation to their social setting. It deals with the relationship between demographic and non-demographic variables.

Demographic variables include mortality, fertility, age at first birth, age at first marriage and sex. A non- demographic variable includes income, education, occupation and religion.

Population studies are always referred to as ***population analysis*** or ***substantive demography***. Substantive demographers are usually non- mathematicians and non- statisticians.

They are mostly social scientists especially sociologist, economist and geographers who are interested in the effect of a non-demographic variable on a demographic variable on basis of available data. They are interested in say, how changes in income or education can affect fertility or mortality.

In-Text Question

A characteristic is any piece of personal information that can be ascertained in a consistent manner for everyone. True or false

In-Text Answer

True

Summary of Study Session 1

In this study, you have learnt that:

1. In a broader sense, demography is a science that studies the size, territorial distribution, structure and composition of human populations and of changes over time in these aspects, the causes and consequences of such changes and the interrelationship of socio-economic factors and changes in the population.
2. Population in a wider sense is the totality of all persons living at a certain time within a territory demarcated by natural, cultural or political boundaries.

Self-Assessment Questions (SAQs) for Study Session 1

Now that you have completed this study session, you can assess how well you have achieved its Learning outcomes by answering the following questions. Write your answers in your study Diary and discuss them with your Tutor at the next study Support Meeting. You can check your answers with the Notes on the Self-Assessment questions at the end of this Module.

SAQ 1.1 (Testing Learning Outcomes 1.1)

Define the word ‘Demography’

SAQ 1.2 (Testing Learning Outcomes 1.2)

Discuss some basic terms used in the study of Demography

Study Session 2: Types, Sources, and Uses of Demographic Data

Introduction

This study session shall explain the different sources of demographic data and their uses. It shall also look at the advantages and disadvantages of some of the methods of collecting demographic data.

Learning Outcomes for Study Session 2

At the end of this study session, you should be able to:

2.1.Discuss the different sources of demographic data;

2.2.Explain the systems of taking Population Census

2.3.Discuss the history of Ppulation Census in Nigeria

2.1 Sources of Demographic Data

Ideally, the study of demography requires extensive and accurate statistics. The collection of the relevant material is a recent development in Africa and also expensive.

However, cost can be justified in economic terms in a country which can use the results valuably for administrative, social and economic planning purposes. The collection and analysis of data for use by administrative planning and other government agencies are therefore usually designed to provide answers to the following questions:

i. What is the number of persons in the country, and what is the geographical distribution of these persons by various social and economic characteristic?
ii. What are the current levels, trends, patterns of fertility and mortality?
iii. Is the population growing or decreasing?

iv. What are the patterns of movement of the population and how is the population being redistributed over time.

The study of demography therefore requires extensive and accurate statistics. Demographic statistics are derived mainly from the following traditional or conventional sources.

i. Population census or Enumeration
ii. Sample surveys
iii. Vital Registration System
iv. Population Registers (mainly in developed countries).

Demographic statistics are also derived from non-traditional sources which include:

i. Church or Mosque records.
ii. Hospital Registers.
iii. Immigration records
iv. Administrative records
v. National Identity card etc

Information from international published sources is another source of demographic statistics.

Demographic data are mainly from censuses or surveys (to determine size and composition) or from vital registration system (to determine change).

The statistical distributions of the individuals in a population according to age, sex, marital status, education, occupation etc. are referred to as population composition statistics about population composition and size always refer to as the position at a particular time and date which is as a result of constant change due to the vital events.

Population Census

The word ***census*** is derived from the Latin word '**censere**', which means to access. In modern usage, the term ***census*** refers to a nationwide wide counting of population. According to the United Nations, a population census is the total process of collecting,

compiling, evaluating, analyzing and publishing or otherwise disseminating demographic, economic and social data pertaining, at a specified time, to all persons in a country or delimited part of a country (UN 2006).

Purpose of Population Census

A population census is the most comprehensive source of data on basic demographic characteristics at the macro and micro level for the country. It is aptly called the inventory of the human population of a country at a specified period of time. It collects information on

1. Demographic and social characteristics
2. Educational characteristics
3. Migration
4. Economic characteristics and
5. Other characteristics

A population census provides data on size, structure, composition and growth of population, which are extremely rich data bases for:

i. Planning and policy making, that is, it provides government the essential data required for
    a. the provision of services for the people and
    b. for determining the requirement of service from the people.
ii. Monitoring progress towards the Millennium Development Goals (MDGs)
iii. The study of social and economic trends by government, industry and the academic world and private investigators.
iv. Allowing sound estimates of the country as a whole to be made from sample surveys.
v. Providing the foundation for deciding on the structure for political representation.

Essential Features of Census

A modern population census has several essential features which include:

1. **Individuality:** The individual is the primary unit of enumeration. Hence each individual is enumerated separately and his/her characteristics recorded separately. For characteristics that are common to the whole households or family, the unit of enumeration may be the household or the family itself.
2. **Territoriality:** The census covers a precisely defined territory (the entire country or well-delimited part of it) within which the population count is to be made.
3. **Universality:** The census includes every person present and or residing within its boundary, irrespective of their ethic and socio-economic characteristic. Non-nationals temporarily residing in the country at the time of the census will have to be enumerated although they may not be included while defining the country's population.
4. **Simultaneity:** The population is enumerated with respect to a well-defined reference period. That is everybody is enumerated at a well defined reference time, known as the census night.
5. **Government sponsorship:** Censuses have government sponsorship, i.e. the conduct of a census rests on the national government. This is because; it is only the government that has the adequate administrating apparatus, substantial financial resource and supreme legal authority over the entire population.
6. **Defined periodicity:** Censuses are taken at regular intervals of time, usually ten years. Strict adherence to periodicity tends to improve the quality of data and makes analysis of data easier.
7. **Confidentiality:** The census original record sheets and the raw data on the computer are treated as confidential and are not given out even for legal purposes.
8. **Comparability:** Census results must be comparable within a country over time and among countries. To ensure maximum comparability on national basis, a set of core questions are chosen and additional questions are added to suit regional or country needs.

2.2 Systems of Taking Population Census

A census may be taken on either a ***de facto*** or a ***de jure*** basis.

De Facto Method: Under the de facto method, persons are counted at the place where they are found at the census night, irrespective of whether or not they belong to the place.

Once a person has been counted somewhere, he/she will not be counted again. This method was more common in the English speaking countries in Africa, but of late most countries in the world use this method.

Advantages of De-Facto Method

i. It provides a simple and clear cut definition for enumerating persons.
ii. It offers less chance of double counting.
iii. It is appropriate for a highly mobile population.

Disadvantages of De-Facto Method

i. It is difficult to obtain information about persons in transit (persons traveling on census day or who work at night and consequently would not be found in any of the places where people usually live).

   This is because it does not make a distinction between the place at which a person is enumerated and the place where he/she maintains his /her residence which determines ones legal and political rights and obligations.

ii. It provides incorrect picture of the usual population of a community. It tends to inflate or deflate a population due to the temporary movements of population. But for administrative and other purposes, such as taxation and delination of constituencies, the usual population is essential.

ii. The resident population is needed for many technical purposes like estimating vital rates. These rates may be distorted and would not agree with the definition of a rate since the population base for calculating them will include floating or non resident population (for example, some people usually return to their usual residence for the birth of a child).

It is, therefore, necessary to identify individuals by their place of ***usual residence*** and include them as members of the population of the area.

De-Jure Method

Under the ***de-jure*** method, persons are counted according to their usual place of residence so that temporarily absent members/persons would be counted as if at home. Similarly, temporary visitors get assigned to their usual place of residence although enumerated at the place of visit.

Most of the French speaking countries in Africa follow this system. However all censuses conducted in Africa have tended to follow the de-facto method.

Advantages of de-Jure method

i. It gives the picture of the permanent population of the communities enumerated.

ii. It gives more accurate estimates of vital rates.

Disadvantage of de-jure Method

i. Some persons may be omitted from the count, when they are absent from their usual residence (over coverage).

ii. Foreigners and temporary visitors are excluded and this violates the universality condition of the census.

iii. Second hand information obtained about persons who are temporarily absent may be incomplete or incorrect.

Problems of Population Counts

As stated earlier, population censuses are to obtain the total population of an area but there are a whole lot of problems associated with obtaining this. These include the following:

i. People may appear to have more than one usual residence. People in this category are:

   a. Those who maintain two or more residences.

   b. Students living at school away from their parental home

   c. Members of the armed forces living at military installation but still maintaining private living quarters away from their installation.

d. Persons who sleep away from their homes during the working week but return home at the end of each week.

ii. Persons who stay at the place where they are enumerated for some time but do not consider themselves to be resident of this place because they intend to return to their previous residence at some future time.

iii. Persons who have left the country temporarily but are expected to return after some time.

In these instances, clearly stated time limits of presence in, or absence from, a particular place must be set, in accordance with the prevailing circumstances in the country, to determine whether or not the person is usually resident at that place.

Other problems encountered during population census include:

- Lack of trained manpower.
- Superstition
- Religious problems
- Political problems
- Inadequate means of transportation and communication
- Illiteracy, ignorance and language barriers.

2.3 History of Population Census in Nigeria

In Nigeria, the first census was the enumeration of people in Lagos which was conducted in 1856 and it was enumerated for administrative convenience. Other similar head counts were conducted in Lagos in 1868, 1871,1881,1891,1901 and 1911. The first unified census was conducted in Nigeria in 1921.

Two more pre-independence censuses were conducted in 1931 and 1952/53. The first post independence census was conducted in 1963 which put Nigeria's population at 55.7million. However, the 1973 provisional census figures were cancelled because it was believed to have been highly manipulated and inflated.

Nonetheless, the 1991 census put Nigeria's population at 88.5 million persons, while the last one conducted in 2006 put the population of Nigeria at 150 million.

Advantages of Censuses

i. Censuses are usually the best source of information for the total number of people present in an area at a particular time.
ii. Data from censuses are very comprehensive in coverage.
iii. Censuses provide data for population projections and calculation of vital rates.
iv. Population censuses provide data on size, structure, composition and growth of population which constitute extremely rich data base for planning and policy making.
v. Population censuses provide adequate socio-economic data at the local level which can be used for grass root planning and decision making.
vi. Population censuses provide sample frames for subsequent field inquiries.
vii. Population census data combined with the Living Standards Measurement Survey (LSMS), are used to produce what has come to be termed poverty map of a country.

Disadvantages of Censuses

i. Censuses are gigantic and expensive operations and so most African countries face technical, financial and human resource problems. As a result, data from censuses may not be timely.
ii. A census provides data only as at the time of the census and fails to give any information about the population in the intercensal period.
iii. The two standard schemes for enumerating a population (de facto and de-jure) may yield different population sizes for the same subdivision of a country (for example, “people temporarily away from home” would be counted in one place by the de-facto method, and in another place by the de-jure; they may also give slightly different total population figures for a country).
iv. Hence, we cannot say there is any perfect or “correct” method for obtaining the total population. The selection of either one of these standards (or more commonly, some mixture of the two), has an effect which is present in every figure of the census.

Vital Registration System

Vital registration gives us information of the flow movement in the population in terms of births, deaths, marriages, migration and divorce. This flow of the population will take place continuously. It is continuous, compulsory and a universal source of population data.

History of Vital Registration In Nigeria

Before 1950, registration of events was made compulsory for non-natives in Nigeria and generally limited to the government stations in big cities like Lagos, Kaduna, Calabar, Ibadan, Port-Harcourt etc. For the natives, registration was voluntary.

At about 1950, interest in vital registration was reactivated by regional ministries of Health, but it was never directed at developing a nationally oriented vital registration system. The registration was still voluntary as there were no enough registration centers and so the data generated were limited.

With the setting up of the National Population Commission (NPC), the issue of vital registration is placed under the ministry's jurisdiction. The Commission, among its functions, is to establish and maintain machinery for continuous and universal registration of births and deaths throughout the country.

More registration centers had to be set up. The Federal ministry of internal affairs and state ministries of local government are responsible for the registration of marriages.

As at today, one can say the issues of vital registration has spread but registration is still far from universal, and where a system exists, the data cannot be said to be reliable and complete. These therefore limit the data from the system from administrative and statistical purposes.

The vital registration system has not in any way achieved the required standard of universality, compulsory and continuous. In the advanced countries, there are reports from the hospitals, and from the local centers.

In Nigeria, there are not enough registration centers, no serious legal backing, no penalty. Therefore, there are gaps and omissions. For instance, not all deaths or births, takes place in the hospital.

The date of occurrence and registration is not specified in Nigeria unlike in the advanced countries where about 21 days, 90 days etc are clearly specified after which a penalty can be imposed. There are also misplacement of time and place of occurrence of events.

In addition we can say that the government has placed vital registration in a low priority area in budget allocation.

Methods of Collecting Vital Registration

There are two main methods of collecting vital registration data: the active and the passive approaches.

1. ***The Active Approach*:** In the active system of registration, the staff member visits households to collect information concerning births and deaths. In Africa, where illiteracy is very high, vital registration system depends on active staff effort. Sometimes institutions like Hospitals, Churches or Clinics record events and submit to a central agency. This is a semi active approach.
2. ***The Passive Approach*:** In this system of registration, a member of the household or a person closely associated with the household registers the events himself/ herself at a registration centers. This approach can work well among a literate population which understands and appreciates the importance of registration of vital events.

Uses of Vital Registration

Vital registration is the most important source of obtaining vital statistical data on birth and death. When a country has a good system of registering births and deaths, it can estimate its population size at any given time, assuming that there is no effect of migration.

Vital statistics are also used as legal evidence. In addition, the aggregates serve as basis for planning public health administration, implementing social welfare measures and for distributing public facilities.

Birth registration is the first legal acknowledgement of a child's existence. It is fundamental to the realization of a number of rights, including the right to a name and the right to nationality. It is used to ascertain the correct age of the individual to enroll in school, to

engage in employment, to enter into marriage, and to enjoy special protection under the law etc.

Equally important is the registration of death. Death registration is important in demographic analysis. Records on deaths are used in the:

a. Generation of the numerators required in the calculation of some demographic indicators such as mortality rates, (crude death rate, infant mortality rate, age- specific death rates).
b. Construction of life tables.
c. Estimation of life expectancy.

Governments and other stakeholders use the incidence and causes of deaths to:

a. Initiate measures and monitor interventions.
b. Prioritize health needs of the population**.**

Demographic Sample Surveys

As the names implies, it is a method by which information about the population is derived from a part of the population. Sampling must be done scientifically to be representative of the population since it is a scientific exercise. Sampling can be done on a census and can also be done on vital registration.

But the information must be collected from a part of the population in order to estimate for the population. Demographic surveys are of two main kinds: Single- round and multi- round surveys. In single- round surveys, the population is enumerated only once, at the time of the survey, when retrospective questions on demographic events are asked. The advantages of this type of survey are:

i. Its simplicity,
ii. Its flexibility,
iii. Its ease of administration and
iv. Its relatively low cost.

Its disadvantages are high rates of errors (particularly non-sampling errors), and its serious under-reporting of births and deaths.

In multi- round surveys (repeated surveys or follow-up surveys) repeated visits are made to households in selected sample areas in order to ascertain what events have occurred, during the intervals between the visits.

Multi-round surveys have come into prominence partly in response to the limitations of single- round surveys and partly because of their self-checking nature.

The multi-round system provides information for checking and correcting data collection during the earlier surveys but they are expensive, besides, sampling and administrative problems loom large. Specific surveys can also be undertaken.

The data from this source alone are not sufficient to meet the heavy demands for various population statistics because of financial and technical constraints.

Advantages of Sample Surveys

1. It is more detailed
2. In the past enumeration survey, sampling is used to check the reliability of the census.
3. It can be used to check some flow of information like fertility and mortality and also to estimate the population parameters.

However, some of the errors common in census such as logistic, error of coverage, are also common in sample surveys. In addition, there is also sampling and non-sampling errors. The sampling errors are measurable and can be controlled through the use of appropriate sample design. Non-sampling errors just like the content or logistic errors are not easy to asses.

Population Registers

This is closely related to vital registration. A universal population register gives a picture that makes it possible for records to be kept for individuals in the population, showing vital events, such as divorce, birth, death, marriages and movements.

The maintenance of population registers demands a reasonable accurate address system and a literate population. Historically, the first population registers were kept in china and were later adopted in Japan.

Today, in Nigeria; attempt at having population register has been tried through the Constituted National Civic Education Scheme; whereby everyone has to carry an identity card. This method is known to be too expensive.

In-Text Question

Vital registration is the most important source of obtaining vital statistical data on birth and death. True or false

In-Text Answer

True

Summary of Study Session 2

In this study, you have learnt that:

1. Ideally, the study of demography requires extensive and accurate statistics. The collection of the relevant material is a recent development in Africa and also expensive.
2. **De Facto Method:** Under the de facto method, persons are counted at the place where they are found at the census night, irrespective of whether or not they belong to the place.
3. In Nigeria, the first census was the enumeration of people in Lagos which was conducted in 1856 and it was enumerated for administrative convenience. Other similar head counts were conducted in Lagos in 1868, 1871,1881,1891,1901 and 1911. The first unified census was conducted in Nigeria in 1921.

Self-Assessment Questions (SAQs) for Study Session 2

Now that you have completed this study session, you can assess how well you have achieved its Learning outcomes by answering the following questions. Write your answers in your study Diary and discuss them with your Tutor at the next study Support Meeting. You can check your answers with the Notes on the Self-Assessment questions at the end of this Module.

SAQ 2.1 (Testing Learning Outcomes 2.1)

Discuss the different sources of demographic data;

SAQ 2.2 (Testing Learning Outcomes 2.2)

Explain the systems of taking Population Census

SAQ 2.3 (Testing Learning Outcomes 2.3)

Discuss the history of Ppulation Census in Nigeria

Study Session 3: Basic Analytical Tools in Demography

Introduction

In demographic analysis, extensive use is made of the concepts of rates, ratios, and there is always a misunderstanding and misuse of these concepts. It is necessary therefore to start by clarifying these terms before introducing any of the well- known measures.

Therefore, this study session shall describe these concepts, and show how the measurements of rates of natural increase and growth are calculated.

Learning Outcomes for Study Session 3

At the end of this study session, you should be able to:

3.1.Discuss the term ‘Rates’

3.2.Explain the term ‘Ratios’

3.1 Ratios

Generally in demography, a ratio is a single number that express the relative size of two numbers. In a narrower sense, a ratio is a relative measure that expresses the size of one quantity to the size of another quantity of the same unit.

When the quantities are frequencies of two non-overlapping groups possessing some common characteristics, a ratio is a relative measure of the sizes of the two groups. Thus a ratio is of the form $\frac{c}{d}$.

Where c and d refer to two quantities measured in the same unit or the frequencies of two items with common characteristic. An example of a ratio is the sex ratio, (number of males and females), dependency ratio etc.

E.g 1. The population of a country *X* in 2000 was 18,912,079, out of this number 9,357,382 were males and 9,554,697 were females. Calculate the ratio of males to females.

Solution; let c = 9,554,697 be the population of females.

let d= 9,357,382 be the population of males, then

$$\text{Ratio of male to female} = \frac{c}{d} = \frac{9,554,697}{9,357,382}$$
$$= 0.979$$

That is, the male population in country *X* is about 0.98 of the female population. In other words, for every 100 females there are 98 males.

A sex ratio at birth with a value of more than 100 indicates an excess of male over female births. A value of less than 100 indicates an excess of female over male birth. The sex ratio at birth also has a number of important uses. First, it is needed in the calculations in situation where total births have to be separated into male and female birth.

e.g. 2. If the total number of birth registered in the compulsory registration areas of a community is 32,503 and if there is an additional information that the sex ratio at birth is 103. Then the number of male and female birth in that community will be given as:

$$\textbf{Number of male birth} = \frac{103}{203} X\, 32,503$$
$$= 6,517$$

$$\textbf{Number of female birth} = \frac{100}{203} X\, 32,503$$
$$= 15,986$$

Note that the denominator 203 is equal to the sex ratio at birth for males plus the sex ratio at birth for females.

General Sex Ratio

The general sex ratio is the ratio males to females in a given population. This ratio can be obtained from census enumerations of the total population or from sample surveys. The general sex ratio:

$$= \frac{\text{All males X 100}}{\text{All females}}$$

National general sex ratios usually vary in the range 95-100 males per 100 females. Real variation at the national level from this range may occur in exceptional cases, such as losses from wars epidemics and migrations**.**

Dependency Ratios

The dependency ratio is defined as the ratio of youths under 15 years of age plus persons aged 65 years and above to adults aged 15- 64 years. It indicates the relative predominance of persons in the 'dependent' ages. In relation to those in the productive ages as broadly defined in most social and economic systems.

Dependency Ratio

$$= \frac{\text{(children under 15years)+(persons aged 65+)}}{\text{Persons aged(15-64years)}} \text{ X } 100$$

3.2 Rates

Rates may be regarded as special cases of ratios. They usually measure the likelihood of the occurrence of phenomenon within a given population defined by the spatial and temporal characteristics.

Rates that use the population at the midpoint of a time interval (mean population) as a denominator and the number of events of the specified type in the interval as a numerator are termed central rates. In demographic analysis, two types of rates are usually used: crude rates and specific rates.

But before we discuss what crude and specific rates are, let us first of all explain three concepts: exposed to the risk of; mid year population; and the estimation of the mean population.

'Exposed to the Risk of': This is a term which is frequently used in relation to the estimation of rates.

By the usual convention "exposed" means currently exposed; for example, the population exposed to risk of death is the population currently alive who are exposed to the risk of dying; a person who is dead has no exposure at all (he has no risk of dying).

Other examples are women exposed to the risk of conception or 'child bearing'. For example, if a woman is currently pregnant, she has no risk of conceiving in the next month.

Mid-Year Population: The midyear population is the population as at 30th June or July 1st of the year in question. Estimates of the mid year population (mean population) are most suitable as standards of comparability with regards to time reference.

It is practically a sufficient approximation for the computation of annual rates (births, deaths and marriage rates).

When the population is subject to considerable seasonal fluctuations, the mid year population differs from the mean population; otherwise for all other cases, the difference is practically negligible.

Therefore the arithmetic mean of the population for the two, 1 January dates that bound the year in question is often used as an approximation of the mean population or the midyear population.

Estimation of the Mean Population: The mean population can be estimated by methods of arithmetic linear interpolation (estimation of a value lying between two values), when the interval between the given values is small, we can assume that a linear relationship holds within this interval.

Suppose p_{t+n} is the size of the population at time $t+n$

P_t = the size of the population at time t

n = the length of the time interval.

h = the amount of growth in numbers per unit time

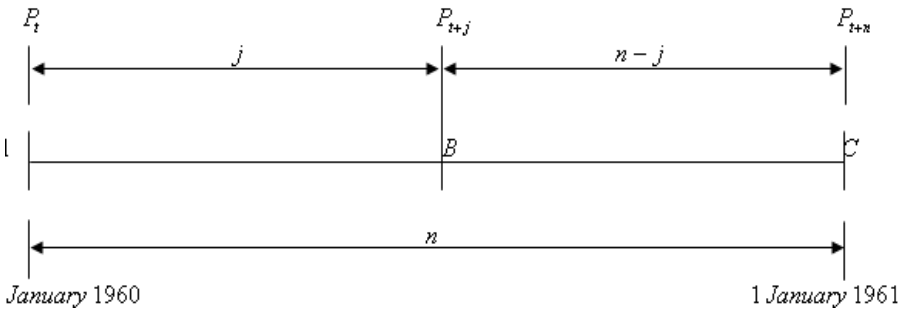
Then we define h as

$$h = \frac{p_{t+n} - p_t}{n}$$

Let *i* be the length of time between the earlier known date and the estimated date $t+i$, the we can show that any value $P_t + i$ within intervals t and $t+i$ can be obtained using arithmetic linear interpolation.

$$P_t + i = P_t + i/n\left(P_t + n - P_t\right) = P_t + ih$$

Where $P_t + i$ is any value between A and C. The fig. below illustrates these concepts in diagrammatic form



Rearranging the equation below, we have

$$i/n = \frac{\left(P_t + i - P_i\right)}{\left(P_t + n - P_t\right)} \text{.....(**)}$$

$$\left(P_{t+i} - P_i\right) = i/n(P_{t+n} - P_t) \text{.....(***)}$$

$$\left(P_{t+i} = P_t + i/n(P_{t+n} - Pi\right) \text{.....(****)}$$

The last equation (****) is a general formula for locating any value between two data or points in time. In the figure below the two points in time are 1 January 1960 and 1 January 1961. In this particular example, $P_{t+i} = P$, mean population. If we choose months as unit of time, the length of the time between the two points A and C is *n*, 12 months and the length of time between A and B is *i*, 6 months. Therefore,

$P = P_{t+6} = P_i + 6/12(P_{t+12} - P_t)$.

$P = 1/2(P_t + P_{t+12})$ = mean population

Example: Suppose in a baseline enumeration, the total population at the beginning of the survey, 1 January 1960 was 10,572. After 12 months, 1 January 1961, the total population was counted again and it was 13,124. What was the estimate of the mid year population (mean population on 30th June 1960)?

$P = 1/2(P_t + P_{t+12})$
$P = 1/2(10572 + 13124)$
$= 1/2(23696)$
$= 11,848$

The mean population as at 30 June 1960 (July for the year) was 11,848.

Alternatively, we can find the mean population p as follows.

If the population on 1 January 1970 is 10,572 and on 1 January 1971 is 13,124, it is assumed that the population is increasing by:

$$h = \frac{13124 - 10572}{12} = \frac{2552}{12}$$
$$= 212.7$$

Hence, the population P on 30 June / July 1 1970 may be estimated as;

P = 10,572 + 6(212.7)

= 10,572+ 1276.2

= 11,848.

Note that a constant monthly increase in population is assumed. The argument holds for annual absolute increase too.

Crude Rates

These are obtained by relating the number of events of a specified type occurring within an interval usually one year, to the size of the population which the events occur. For many purposes the mid interval population is taken as the best estimates.

The annual crude death rate, the crude birth rate, the crude marriage rate, the crude economic activity rate are examples of crude rates. To fix our ideas, let us look at examples of how to define and calculate the crude death and birth rates in a given population.

Crude death rate $= \frac{D}{P} \times K$

Where D is the total number of deaths in the given year, P is mean population and k is a constant usually, 1000. Similarly, the annual crude birth rate is given as;

Crude birth rate $= \frac{B}{P} \times K$

Where B is the total number of live birth in a given year, P is the mean population and k = 1000.

***Specific Rates*:** Specific rates are analogous to crude rates but are computed on the basis of events occurring in or to particular subpopulations specific rates can be calculated as follows: $nMx = \frac{nEx}{nPx} \times K$

Where ${}_nE_x$ is the actual number of events at ages x to $x+n$, ${}_nP_x$ is the mean population at ages x to $x+n$ and k =1000.

Thus in calculating specific rates, we have to relate the numerator within the respective age groups to the populations from which the events occur within the same age groups.

The rates can be calculated for either single years of age or for grouped intervals.

Proportion

A proportion is relative number that expresses the size of one subgroup to the total of all subgroups.

Proportion is given by:

$$\frac{X_i}{\sum_{i=1}^{n} X_i} = \frac{n_i}{N}$$

Where X_i is the size of the subgroup i, $\sum_{i=1}^{n} Xi = N$ is the total of the sizes of all the n_i subgroups.

Note: A proportion is a special type of ratio in which the denominator includes the numerator i.e. $c/c+d$

A proportion has the following characteristics.

- It is a relative frequency. This is because the numerator and the denominator represent frequencies of certain events.
- The number c and d are never negatives, and thus a proportion is a number between 0 and 1
- In a large population, a proportion may determine the probability of a certain event; in sample, a proportion can be used as an estimate of probability of an event.

Fraction

A fraction is a proportion of two measurable quantities i.e.

$$c/c+d$$

Where, c and d, are measurable quantities such as weight, age, height, volume, space, income etc.

Percentage

A percentage is a special type of proportion or fraction, one in which the proportion or the fraction is multiplied by 100. i.e. $\frac{c}{c+d} \times 100$

Definition of Some Events

For the purpose of uniformity in definition of concepts and identification of events, The Statistical Commission of the United Nation (UN) and the World Health Organization (WHO) recommended certain definitions for uniformity.

- **Live-birth**: This is the complete expulsion or extraction from the mother of the product of conception irrespective of the duration of pregnancy which after such separation breaths or shows any other evidence of life such as beating of the heart, pulsation of the umbilical cord or definite movements of the voluntary muscle whether or not the umbilical cord has been cut or the placenta attached.
- **Death**: This is the permanent disappearance of all evidences of life at any time after live-birth has taken place (post natal cessation of vital functions without capacity of resuscitation) .
- **Still- birth**: This is late fetal death or the death prior to complete expulsion or extraction from its mother of a product of conception which has attained 28 or more weeks of gestation or pregnancy i.e. when a baby dies 7 months before delivery.
- **Foetal Death**: This is defined as the opposite of live-birth. Abortions and still-birth are foetal deaths.
- **Divorce**: This is defined as the final legal dissolution of marriage.
- **Marriage**: This is the legal union of persons of opposite sexes. The legality of the union may be established by civil, religious or other means as recognized by the law of each country and irrespective of the type of marriage. Trial marriage is a marriage between two opposite sexes who are not legally married, whether religious, traditional or registry marriage.

Summary of Study Session 3

In this study, you have learnt that:

1. Generally in demography, a ratio is a single number that express the relative size of two numbers. In a narrower sense, a ratio is a relative measure that expresses the size of one quantity to the size of another quantity of the same unit.
2. Rates may be regarded as special cases of ratios. They usually measure the likelihood of the occurrence of phenomenon within a given population defined by the spatial and temporal characteristics.

Self-Assessment Questions (SAQs) for Study Session 3

Now that you have completed this study session, you can assess how well you have achieved its Learning outcomes by answering the following questions. Write your answers in your study Diary and discuss them with your Tutor at the next study Support Meeting. You can check your answers with the Notes on the Self-Assessment questions at the end of this Module.

SAQ 3.1 (Testing Learning Outcomes 3.1)

Discuss the term ‘Rates’

SAQ 3.2 (Testing Learning Outcomes 3.2)

Explain the term ‘Ratios’

Study Session 4: Measures of Population Composition

Introduction

Population composition is the internal structure of a human population with respect to one or more demographic attributes or traits at a particular point of time.

The traits which are of particular concern to demographers are sex, age, marital status, urban-rural residence, educational and economic characteristics, religion and family types. In population literature, the term "***Population composition***" is often used interchangeably with "*Population structure*" or "*Population distribution*."

Learning Outcomes for Study Session 4

At the end of this study session, you should be able to:

4.1.Discuss Population Composition

4.2.Explain the evaluation of the Quality of Demographic Data

4.1 Population Composition

In a broad sense, population distribution implies any division of population entity into constituents arranged in a definite pattern.

The term "population structure" is however usually used to relate only to age and sex composition of the population and "population distribution" is used in a more general sense to include the distribution of other attributes (geographic, residential, marital etc).

In this study session, you shall consider only population structure i.e. composition of population by age and sex.

Uses of Population Composition

The study of population composition constitutes a basic and the most relevant field of study for demographers. It is helpful in

1. Describing and comparing the make up of a population at a given date with some other populations at the same time and at some previous dates with that of the same population.
2. Determining the structural requirement of population at any time.
3. Understanding and providing a clearer vision of the dynamics of population change.
4. Making population projection

Population Composition by Sex

Sex is one of the important personal and natural characteristics of a population. It is the biological characteristic that divides the human race into males and females unlike other demographic characteristics. It is determined at birth and it is dichotomous. It undergoes no change.

The number of males and females in a population expressed either in absolute numbers or as percentages of the total is called sex distribution of the population.

Uses of Population Composition By Sex

Population data tabulated in terms of males and females are important for:

i. Drawing several inferences regarding the dynamics of demographic phenomena.
ii. Evaluation of the completeness and accuracy of the census counts of the population
iii. Its bearing directly on;
    a. racial and ethnic composition
    b. educational status, and citizenship status
    c. fertility, mortality, migration, marital status, and economic characteristics;
iv. The sole study of reproductivity.

v. Determination of family rights and responsibilities and the social status in a community, especially in Africa.

vi. Planning, both public and private, such as military planning, planning of community institutions and services, particularly health services and planning of sales programmes that require separate population data for males and females.

It is customary to consider only the female segment of the population when analysis is being done in the demographic field, this is because;

1. During the course of one year, a woman can be responsible for at most two birth cycles, while a man may be responsible for several cycles.
2. The childbearing years for a woman range approximately from 15 to 50 years of age, while that of a man range from 15 t0 80 years of age.
3. Registration of births more than often includes the age of the mother than that of the father especially in the case of illegitimate birth.

Demographic Measures of Sex Composition

Masculinity Proportion: The masculinity proportion is the simplest and most commonly used measure of sex composition in non technical discussion; it is the percentage of males in the population. It is defined as;

$$MP = \frac{P_m}{P} X100$$

$$= \frac{P_m}{P_n + P_f} X100$$

Where P_m and Pf are number of males and females respectively.

Fifty percentage is the point of balance of sexes or the standard according to this measure. A higher figure denotes an excess of males and a lower figure denotes an excess of females.

- Feminity Proportion: Similarly, we may defined feminity proportion as:

$$FP = \frac{P_f}{P} X100$$

Or as a complement to the masculinity proportion;

FP = 100- MP

- Sex Ratio: The sex ratio (SR) sometimes called the masculinity ratio (MR), is the most widely used principal measure of sex composition used in technical studies. It is used to compare the relative strength of the number of males and females in a population. It is usually defined as the number of males per 100 females in a population.

$$SR = \frac{P_m}{P_f} x100$$

Where P_m and P_f are as defined above. The point of the sexes according to this measure is 100%. A sex ratio above 100% denotes an excess of males and when it is below 100 denotes an excess of females.

Relationship among the Various Measures of Sex Composition

When basic data on the number of males and females are not available, it is possible when required, to convert the masculinity ratio or the percent excess or (deficit) of males and vice versa.

(1) The masculinity proportion may be defined from sex (masculinity) ratio as follows:

$$MP = \frac{SR}{1+SR} X100$$

- Percent Excess (or Deficit) of males.

The excess (or deficit) of males as a percentage of the total population, is given by following formula:

$$E = \frac{Pm - P_f}{P_t} X100$$

The standard or the point of balance of the sexes according to this measure is zero, a positive value denotes an excess of males and a negative value denotes an excess of females.

Population Composition by Age

Age is an important demographic variable. It is the primary basis of demographic classification in vital statistics, census and survey work. Much of the demographic information in use is expressed in terms of the age at which something happens; for example, when an individual leaves school, enters employment or dies.

Age data provide an indispensable basis for studies of a nations manpower potential and its requirements for schools, housing, foods and various other kinds of goods and services.

Therefore, the age structure of a population is considered basic to the study of population problems.

The age of an individual is defined as his duration of life from the moment of birth to the moment of death. A person's exact age at any given time is the time elapsed since the person was born. Usually age is measured as a discrete variable gives in completed year. A person's age in completed years is the greatest integral number (0,1,…) less than the person's exact age. An age less than one year is considered as age zero.

In a census, age is commonly defined in terms of the age of the person at his last birthday in years for people of more than one year, in months of children of less than one year but more than one month, and in days for children of less than one month.

A class of individuals of the same age forms an age group**.**

Generation: A generation is the progeny of individuals born during the entire reproduction period throughout the lifespan. The end of a generation corresponds to the average reproductive age of a given population.

Cohort: A cohort is a group of persons experiencing the same demographic event during the same time interval, usually during the same year. The most common and most important type of cohort considered in demographic studies is the birth cohort. A birth cohort is the set of individuals born during a particular time interval.

Thus the newborns of the year 1980 are readily referred to as "the 1980 birth cohort". Consequently, a population at a given time is the aggregate of the survivors of different cohorts of people born during different years.

These surviving cohorts are pieced together to behave like a single cohort which is called a synthetic cohort. There is also a marriage cohort, labour force cohort, and migration cohort etc.

Period: A period is an interval of time (usually between two dates) within which different or the same vital events take place. Period data relate to a type of demographic event which occurred over a great number of years (i.e involving many cohorts) bu which is observed during a specified brief period of time (usually one year). This is also referred to as **cross – sectional data**

Uses of age Composition

The number of persons against each age interval (1year, 5year, 10year or any other equal or unequal classes) expressed in absolute numbers or as percentages is called the age composition of the population

1. Age is the primary basis of demographic classification in vital statistics, census and survey work.
2. It is one of the most fundamental demographic characteristics interrelating all other characteristics of a person.
3. It is the most important variable in the study of mortality, fertility, nuptiality, migration and certain areas of demographic analysis.
4. It determines the social role and place of a person in the society.
5. Age composition is important for the evaluation of the quality of the census counts of the population.
6. Age composition of a country has enormous socio-economic significance. It affects all spheres of life of its citizens: the level of consumption, income social services needed (schools, teachers, health services, food and housing), potential manpower, participation of people in productive work, taking part in reproduction process, potential voting population.

4.2 Evaluation of the Quality of Demographic Data

Even in the most developed countries, where considerable care is taken to ensure that the demographic data collected are both complete and accurate, errors do occur.

They occurs with greater frequency in the developing countries where the skills and training of the data collection personnel and the educational level of the respondents may be lower errors could occur at any stage; planning, recording, compiling or analysis stage.

Some errors occur with regularity not randomly and tend to be cumulative. Experience shows that some errors go undetected.

Types and Sources of Error

They are two main types of errors.

i. Errors of coverage
ii. Errors of content

Errors of coverage: These are errors of over counting or omission. In taking a census, some individuals, households may be missed. In vital statistics, some vital events escape registration.

Errors of content: This refers to instances where the characteristics of a person counted in a census enumeration or the registrations of vital events are incorrect reorted or tabulated e.g preference for ages ending with certain digits.

The five principal sources of errors are the respondent, the recorder, the enumerator, the editing process, the data compiling process and the coding process.

Testing Procedures for Errors

Some of the ways to ascertain the presence of errors are:

i. External checks: to compare the result with other records.
ii. Internal comparisons may reveal inconsistencies among related data in the tabulated results from a census.
iii. Post enumeration surveys or re-enumeration surveys.

Assessing the Quality of Demographic Data

There are three main approaches:

i. The accuracy of census totals

ii. The completeness of vital statistics

iii. The accuracy of age and sex statistics.

The most important is the third approach.

The Accuracy of Age and Sex Statistic

The quality of the age-sex data is of great importance since most demographic analysis are made on the basis of the age sex structure gross errors in the age sex data can be perceived from the population pyramid.

Sudden troughs and bulges in the population pyramid which cannot be explained in terms of past demographic events must suggest the existence of error in the age-sex data, other 'hidden' errors in the age sex data can only be brought to light through the calculation of certain ratios and indexes. Among the most commonly used are;

Age structure of a Population

Age structure means the particular way the population is composed of people of different ages i.e. a comparative appraisal of the relative size of different age-groups. For most analytical purposes age-group formation is based on a 5- year interval, i.e. 0-4, 5-9, 10-14.etc. Single year age group though minimizes loss of information, makes analysis unwisely because of large number of groups.

At times, 10 years interval is helpful but age-group as large as that will lead to loss of information. Sometimes unequal age interval is used depending on the problem at hand.

For mortality, the age interval 0-1, 1-4, 5-9, 10-19. etc. will be suitable while for migration, the interval 0-19, 20-44, 45+ will be adequate as it is age selective.

For analysis on economic activities and social problems, the interval 0-14, 15-64 and 65+ will be adequate changes in birth and death rates get easily reflected in the size of population under 15 and 65+. Also since, those under 15 and above 65 will be economically.

Unproductive and will be depend on those in the interval 15-64. Then in studying age structure two measures that are important are:

% of persons < 15year = $\frac{{}_{15}P_0}{P} X100$ and

% of persons > 65 years = $\frac{{}_{15}P_{65^+}}{P} X100$

The number of persons against each interval expressed either in absolute number or as % is called the age-composition of a population, thus the dependency ratio is defined as ;

DR = children < 15 years + persons aged 65+

Persons aged 15-64 years.

This gives the average number of dependents/R persons of the employed age group

Naturally, the lower its value, the greater the potentiality of economic development. It is a good and useful tool for studying the economic advantage of age structure.

Causes of Error In Age Data.

Age reporting suffers from a number of errors due to a variety of causes. The reasons vary but the causes can be classified as follows;

1. Ignorance in correct age.
2. Carelessness in reporting and recording
3. A general tendency to state age in figures ending in certain preferred digits
4. A tendency to exaggerate length of life at advanced ages.
5. A possible subconscious aversion to certain numbers
6. Misstatements arising from motives of an economic, social, political or purely personal character.

Method of Detecting Errors in Age Data

Gross errors in the age-sex data can be perceived from the population pyramid.

A population pyramid shows the total picture of a population by age and sex. The pyramid is constructed based on absolute number of proportion. Ages are located on the vertical axis and the totals or proportions at each age group are shown on the horizontal axis.

Rectangular bars representing the proportions or absolute number in each age group are place on each others. Males are represented on the left and females on the right hand side.

Pyramids are of different shapes. The shapes are determined by three factors: Fertility, Mortality and migration.

Sudden troughs, (depression) and bulges (shoot-out) in the population pyramid which cannot be explained in terms of past demographic events suggests the existence of errors in the age-sex data.

Other hidden errors in the age-sex data can only be brought to light through the calculation of certain ratios and indexes. Among the commonly used are:

Sex Ratio: An age specific ratio may be defined as simply as the number of males per 100 females in that age group. One method of testing the accuracy of age distributions in five years groups is to compare the sex ratio for successive age groups as recorded in a census survey.

If the age distributions are accurate or if the errors for males are frequent and of the same kind as those for females, sex ratios will change very gradually from one age group to another as a result of sex differences in mortality and migration but cannot vary abruptly or fluctuate violently.

The presence of marked fluctuations, in these ratios testifies to errors, which are not the same for both sexes.

Age Ratio: The age ratio is usually defined as the ratio of the population in the given age group to half of the population in the two adjacent age groups. Mathematically, this can be defined as;

$$\text{Age Ratio} = \frac{{}_5P_x}{1/2\left({}_5P_{x-5} + {}_5P_{x+5}\right)} X100$$

Where ${}_5P_x$ be the age group from age x to $x+5$, while ${}_5P_{x-5}$ and ${}_5P_{x+5}$ is the preceding and the following age group respectively.

The computed age ratios are then compared with the expected value which is 100. The assumption of an expected value of 100 implies that coverage errors are about the same from one age group to another and that age reporting errors for a particular group are offset by complementary errors in adjacent age group.

The age ratios are usually calculated for males and females separately and can be calculated for each age group (except the youngest and the oldest) provided the intervals are equal. Age ratio of less than 100 indicates under enumeration while the age ratio of greater than 100 indicates over enumeration.

Age-group	Number	Age-ratio	Deviation from 100	Number	Age ratio	Deviation from 100	Sex ratio
0-4	643,041	103.01	+3.01	654,258	102.91	+2.91	98.29
5-9	515,520	90.47	-9.53	503,070	84.71	-15.83	102.47
7-14	357,831	88.01	-11.99	323,460	82.20	-17.80	110.63
15-19	275,542	96.85	-3.15	265,534	112.82	412.82	103.77
20-24	268,336	109.07	+9.07	322,576	107.78	+7.78	83.19
25-29	278,601	101.72	+1.72	306,329	101.29	+1.29	90.95
30-34	242,515	96.36	-3.64	245,883	91.55	-8.45	96.63
35-39	198,231	105.26	+5.26	179,182	105.96	+5.96	110.63
40-44	168,937	92.40	-7.60	145,572	84.11	-15.89	116.06
45-49	122,756	106.31	-6.31	95,590	113.49	+13.49	128.42
50-54	96,775	74.02	-25.98	85,715	71.04	-28.95	118.43
55-59	59,307			48,412			122.50
60-64	63,467			54,572			116.30
64+	113,185			100,399			112.74
Total	3,404,044			3,326,545			

The two methods suffer from fluctuations in age ratios and sex ratio which can be due to irregular demographic events (epidemics, military action) etc. even when the population is closed to migration.

In Africa, sex ratio is poorly recorded. In Nigeria, the ratio as at July 2002 was given to be sex ratio in (Nigeria).

At birth 103 male/female

Under 15 years 101 male/female

15-64 years 104 male/female

65+ 0.99 male/female

Total population 102 male/ female

Other indices employed in investigating errors in age data include the following;

i. Whipple's index
ii. Myers index
iii. United Nation's index

Whipple's index: (W.I) is applicable where age is recorded in single years. The indexes obtained by summing the age returns between 23 and 62 years inclusive, and finding what percentage is borne by the sum of the returns of years ending with 5 or 0 to one-fifth of the total sum.

W.I is not an efficient method since it only measures errors on ages ending with 5 and 0 digits. The result varies between minimum of 100 and maximum of 500. The following scale can be used for estimating the reliability of the data

Symbolically, the Whipple's index is given as

$$\text{W.I} = \frac{P_{25} + P_{30} + ... + P_{60}}{\frac{1}{5}\sum_{23}^{62} P_x} \text{ x } 100$$; where P_x is the number of people reporting their ages as

x – years.

Interpretation of the WI

The Whipple's index lies in the range 100 and 500, that is $100 \leq WI \leq 500$

A value of WI = 100

Suppose there is no age heaping at 0 and 5, that is, there is no universal tendency to report ages 25, 30, 35, 40, 45, 50, 55, 60. Assuming that the ages from 23 to 62 years are equally reported among the population.

But the numerator of whipple's index gives ages ending in only two digits ('0' and '5'), out of the 10 (0, 1, 2,…..9) digits. This represents approximately 1/5 of the total population in that range, equivalent to the denominator, resulting in WI being equal to 100.

Thus, WI = 100 as the theoretical minimum if there is no age heaping at 0 and 5.

A value of WI = 500

Suppose there is a complete age heaping, that is, the entire population is concentrated at ages 25, 30, 35,…., 60 with none reporting their ages as 23, 24, 26, …29, 31,…59. the numerator should be approximately the same as the total population in the range23 to 62 years given in the denominator.

Thus, WI = 500 as the theoretical maximum when there is complete age heaping

A value of $100 \leq WI \leq 500$

That is when the value of WI is greater than 100 but less than 500.

The table below shows what meaning may be assigned to any value of WI with that range.

Whipple's index	Quality of the data
0	No concentration at all
0.1 – 104.9	Highly accurate
105 – 109.9	Fairly accurate
110 – 124.9	Approximate
125 – 174.9	Rough
175 – 499.9	Very rough
500	No age with any digits other than 0 and 5

Source: Kpedepo, G.M.K(1982), Essentials of demographic analysis for Africa, Nigeria.

Limitations of the Whipple's Index: Whipple's index has the following limitations.

1. Heaping occurs on digits other than 5 and 0, usually with no particular pattern but WI is applicable when preference for age is limited to 0 and5. hence WI is not an efficient method.
2. WI considers only the arbitrary interval 23 to 62 years and not the entire lifespan of 0 to w, where w is the last age attainable.
3. WI does not take into account the decreasing nature of the age distribution due to depletion by death. That is, population at younger ages would receive greater weight than at the older ages which would bias the index.

Meyers' Index

Meyers has suggested a modified index to overcome the limitations of Whipple's Index. It is the most widely known index among the more complex measures. Similar to the Whipple's Index, Meyers' index has been developed to reflect preferences or dislikes of terminal digits. Unlike the Whipple's Index, Meyers' index is for each of the ten digits from 0 to 9.

A modification of the WI is to ascertain what proportion of the total population reports at an age ending in each of the digits, x (x = 0, 1, 2, …,9). The bias developed by starting only at a particular digit is minimized by beginning the count at each of the 10 digits in turn and then average the results.

The method derives a ***blended population*** for the digit at age x which is essentially a weighted sum of the number of persons reporting ages ending in each of the ten terminal digits, denoted by P_x. the underlying assumption is that if there are no irregularities in the reporting of age, the blended sum at each terminal digit should be approximately equal to 10 percent of the total blended population.

The blended population at each of the ten digits $\left(b_x{}^P\right)$ can be compared with the total of the blended population, called the blended sum, to obtain the percentage distribution of the blended sum (BSD):

$$BSD_x = \frac{b_x^P}{\sum_{x=0}^{9} b_x^P} \times 100$$

BSD is the proportion of the total population reporting on the given terminal digit. Any b_x^P must therefore be 10 percent of $\sum_{x=0}^{9} b_x^P$ when there is no preference for any digit x.

Interpretation of BSD

The blended sum BSD lies in the range 0 and 100, that is,

$$0 \leq BSD \leq 100$$

The point of balance of heaping is 10.

A value of BSD = 10, when BSD = 10, then there is no age heaping.

A value of BSD > 10,

When BSD > 10, it indicates a tendency towards preference for a particular digit.

Overall Measure

An overall measure of the index of performance for all terminal digits, the Meyers' index, is one half the sum of the absolute deviations from 10. That is

$$\text{Meyers' Index (MI)} = \frac{1}{2} \left| \sum_{x=0}^{9} BSD_x - 10 \right|$$

The theoretical range of Meyers' index is 0, representing no heaping (that is, an indication of excellent age reporting), and 90 which will result if all ages were reported at a single digit, say zero.

Summary of Study Session 4

In this study, you have learnt that:

1. There is no technique which is right for carrying out a graduation procedure. The best procedure would be the one which makes the graduated distribution close to the true ones and minimizes the influence of errors when they are present.
2. The characteristic feature of mathematical smoothing procedure is that it is accepted that the measurements for the age group are in error .An attempt is made, therefore to fit a function which is closer to the true value. Unless the sets of data are very consistent, any fitting process will smooth some of the real divergences along with those due to error.
3. When the causes of measurement errors are substantial, a smoothing operation would merely give one a false sense of security regarding the quality of the data presumably, the problems are with the data collection, so any statistical manipulation will be non-corrective.

   However if one were willing to make the assumption that errors are primarily of a particular type (e.g. using ages rounded to the nearest five or ten years or to even numbered years), then these procedures might be expected to give useful results.

Self-Assessment Questions (SAQs) for Study Session 4

Now that you have completed this study session, you can assess how well you have achieved its Learning outcomes by answering the following questions. Write your answers in your study Diary and discuss them with your Tutor at the next study Support Meeting. You can check your answers with the Notes on the Self-Assessment questions at the end of this Module.

SAQ 4.1 (Testing Learning Outcomes 4.1)

Discuss Population Composition

SAQ 4.2(Testing Learning Outcomes 4.2)

Explain the evaluation of the Quality of Demographic Data

Study Session 5: Fertility Concepts and Measures

Introduction

In this study session, the definition of some of the basic concepts and measures encountered in the study of demography shall be looked into. Because the discipline is still relatively young, there is no universally accepted standardized notational system.

Consequently, various authors use a given symbol to represent quite different concepts while the same concept may be symbolized in diverse ways.

e.g. m has been used to symbolize migration rates, the masculinity ratio, mortality ratio, maternity rates, and the mean age at child bearing; age–specific fertility rates have been represented in various contexts by i, f, and m; have been used to designate population, the probability of survival, and parity.

To avoid confusion, the definitions have to be studied very carefully.

Learning Outcomes for Study Session 5

At the end of this lecture, you should be able to:

5.1.Discuss Fertility and Fecundity

5.2.Explain the method of Computing Average Age of Childbearing

5.1 Fertility and Fecundity

Fertility: Fertility refers to the actual reproductive performance of a population. It measures the number of live births in a given population at a particular time.

Fecundity: This is the physiological capability of couples to reproduce.

Fecundability: This is the probability that a woman will conceive within an ovulatory cycle without the absence of contraceptives

Fertility rate: This refers to the relative frequency with which births actually occur within a given population of women within childbearing age. i.e. between (15-49) years.

Fertility Measures

There are a number of conventional rates for measuring childbearing within a population, and these are actually expressed as a ratio or rate of the number of births that occur in the population during a specified period, usually a year, to the size of the population. A number of these indices or measure will now be discussed; the advantages of each rate and the disadvantages of each rate and the uses will be stressed during the discussions.

Crude Birth Rate: The crude birth rate measures the number of births in a year per 1000 population. It is defined as

$$\text{CBR} = \text{b} = \frac{B}{P} \times K$$

Where b crude birth rate

B = Total number of lives during a year.

P = mid year population

K = 100

The crude birth rate usually lies between 10 and 55 per thousand.

Advantages

i. It is simple to calculate

ii. It is a simple concept to a layman

iii. It provides an index of the relative speed at which additions are being made through childbirth

Disadvanges

i. It is crude indicator of fertility because the denominator (midyear population) is not really the population at risk as it includes men, children or women who are not in the reproductive ages.

ii. It is not a good index for comparing levels of fertility because it is affected by the composition of the population with regard to age, sex and marital status, thus

   a. If there is another unusually large proportion of the population at the childbearing ages, we would expect birth rate to be high, even though each mother was having relatively few children. Such a high birth rate would be deceptive, because as the structure of the population changes and the proportion at the child bearing ages drops, the birth rate will fall, even though the same number of children born per mother remains the same.

   b. All things being equal, a population with an unusual concentration of women in the childbearing ages will have higher crude birth rates than another population that may have the same rate of child bearing per woman but that has small proportion of women in the childbearing ages.

iii. Crude birth rate will tend to underplay changes in the fertility because:

   a. It does not tell whether changes are due to a tendency for people to have more or few children or merely reflects a temporary change in the ratio of the childbearing population, to the total.

   b. Every birth is counted directly as an event and therefore as an addition to the population: consequently, both the numerator and denominator of the crude birth rate get increased and the rate will not reflect the actual chance of childbearing.

General Fertility Rate

The crude birth rate, as indicated earlier suffers from the limitation that it relates the total number of live births to the total mid year population. But we know that the total number of live births depends on the population of women of the fertility age and not on the entire population.

To overcome this limitation, we use the general fertility rate, (GFR) simply referred to as 'fertility rate' f is a single ratio of all births to the number of women of fertility age (childbearing age):

$$\text{GFR} = \frac{B}{W_x} Xk$$

Where B = as defined earlier

W_x = mid year population of women of childbearing age

(x = 15 to 44 or x = 15-49).

K = 1000.

GFR is a general ratio because it relates all births to all women within the age limit 15-44 or 15-49 years of age. Without further distinctions among them.

It is important to note that GFR can be registration of births and the enumerations of population are satisfactory.

Advantages of the GFR

1. The denominator of the GFR, when compared to the crude birth rate approximates the number of persons actually exposed to the risk of bearing a child.
2. GFR is a typical type of standardize rate, standardized for the proportion of women in reproductive ages.
3. GFR is useful in situation in which direct evidence of births by age of parents is lacking.
4. GFR is mainly useful in comparing populations with quite dissimilar age compositions.
5. GFR is particularly useful in the case of studies and comparisons of small human groups (e.g small geographic units).

Disadvantages of the GFR

1. GFR is not adequate for a very detailed examination of fertility patterns because it ignores the age distribution of women in the reproductive age groups. It therefore conceals a large amount of variation according to age. Among the various populations with similar patterns of fertility, a population with higher proportion of fertile age women in the age of fertility peak will produce a higher value of GFR and vice versa.
2. It is rather crude because all unmarried women are included in the denominator. Of course, in most part of the world it is not uncommon to have unmarried women giving birth to children.

Aged-Specific Fertility Rate

Although the GFR is an improvement over CBR, it gives only a general view of the fertility of the child bearing age group (15-49) years. But the rate of child bearing is not uniform throughout childbearing ages. A detailed and more meaningful analysis of the pattern of fertility in a population is provided by the fertility rates calculated for different childbearing ages. This gives what is being referred to as age-specific fertility rate.(ASFR).

The ASFR may be calculated separately for single ages x or for age groups a

Definition: The ASFR calculated separately for single age x, are given as:

$$f_x = \frac{B_x}{W_x} Xk$$

Where fx = Age specific fertility rate for single age x.

Bx = Number of births to women of age x

Wx = mid year population of women in age x

K = 1000

Limitation of (ASFR) for Single Ages

A set of fertility rates calculated for single years is;

i. Too detailed and clumsy for comparative purposes and

ii. Affected by the misreporting of age by mothers.

ASFR for Age Group

The five years age groups are more commonly used in demographic literature in calculating age- specific rates and hence ASFR is defined as the number of births to women of a given age group per k women in that age group.

$$f_a = \frac{B_a}{W_a} Xk$$

Where f_a = age specific fertility rate for age group a.

B_a = number of births to women of age group a

W_a = midyear population of women in age group a

K = 1000.

Advantages of Age-Specific Fertility Rates

1. For a given data population groups, age specific fertility rates serves as a basis for a detailed comparison, with corresponding rates for other population groups that are unaffected by difference between the groups in age- sex composition.
2. ASFRA reveals the distribution of frequencies of births among women according to age.
3. ASFRs represent the most useful single step in analyzing the fertility performance of a calendar year. It permits the study of fertility in terms of real cohorts of women, tracing out their fertility behavior as they passed through life.
5. It is a large improvement in precision, because these rates are not significantly distorted by variations of age composition either in the total population or among the women of childbearing ages.

6. ASFRs are the raw materials for computing other important measures, such as the totality fertility rate, the average age of childbearing in the usual sense, the standardized fertility rates, and net reproduction rates.

Disadvantages

1. ASFR are difficult to interprets as they involve referring to a different stage for each age group of women
2. One has to look for several numbers of figures to make comparisons over a series of years.

Total Fertility Rate

The total fertility rate (TFR) is one of the most important fertility measures which answers as nearly as possible the question: ‘ How many children are women having nowadays? It summarizes the pattern of fertility exhibited by the age specific fertility rates and presents a single index of total fertility TFR assumes that

i. Mortality is constant
ii. Fertility is also constant
iii. There is no migration

TFR may be computed using single year x or age groups a and may have being expressed as per woman or per a cohort of 1000 women.

Definitions: TFR for single years TFR for single ages x is defined simply as the sum of the age-specific fertility rates of women over their reproductive span (i.e all ages of the childbearing period).

$$TFR = \sum \frac{B_X}{W_X}$$

Where Bx = the number of births to women aged x, denoted as Wx in a given year (x = 15, 16, 17,..49)

Total fertility rate as defined above, indicates 'the average number of children a woman would have at the end of the reproductive years if she were to bear children at the prevailing ASFR while living through the entire reproduction period, To put it in another way, the TFR of a given year indicates the total number of children who would be born by a woman, if she were to behave throughout her childbearing age the way all or other women did in that year (i.e. if she experienced that years fertility rates for women aged 15 for women aged 16, for women aged 17 etc all the way up to 49).

For a cohort of 1000 women, the TFR for single age x may be computed as;

$$\text{TFR} = \sum {}^{B_x}\!/_{W_x}\, XK \quad \text{or TFR} = \sum_{x=15}^{49} fx$$

Where fx is defined above

This definition of TFR gives an estimate of the number of children a cohort of 1000 women would bear in their lifetime at the prevailing age specific fertility rates, if none of them dies before crossing the childbearing age.

TFR for equal interval of Age groups

Usually, TFR is calculated for age groups. If the age-groups have equal intervals (a = 15-19, 20-24,etc), then TFR per women is computed as:

$$\text{TFR} = n \sum_{a=15-19}^{m} {}^{B_a}\!/_{W_a}$$

Where n = common interval width of the age groups

m = age group 45-49

B_a = number of births in age group

W_a = midyear population of women of childbearing age 15-45

For a cohort of 1000 women, the TFR for equal interval of age groups may be computed as

$$TFR = n\sum_{Wa}^{Ba} B_a \big/ W_a \; X1000 \text{ or } TFR = n \sum_{a=15-19}^{m} fa$$

Where fa = age specific fertility rates for age group a

For unequal interval of age group the total fertility rate may be defined

Thus, if the age groups are not of equal intervals then

$$TFR = \sum_{a=15-19}^{m} n_a f_a$$

Where n_a = interval width of the age groups a i.e for unequal intervals, TFR is the sum of the age-specific fertility rates for all ages multiplied by the size of the class it interval into which the ages were grouped.

Advantages

TFR is generally regarded as the best single cross-sectional measure of fertility because

i. It is rather closely restricted to the childbearing population; and
ii. It is not influenced by differences in the age composition between childbearing populations

Disadvantages

TFR is constructed to be independent of the age distribution both of women in the reproduction age and the births. It assumes the number of women to be one $(k = 1)$ for each age x. This implies that the measure ignores the impact of mortality as well as growth of population which could have persisted in an unequal number of persons at each age x, usually as a decreasing function of age.

Average Age of Child Bearing

The average age of childbearing measures differences in the age pattern of childbearing. It describes the age pattern of childbearing of synthetic cohort of women that is a hypothetical group of women who are viewed as having in their life time the (fertility) experience recorded in a single calendar year.

5.2 Method of Computing Average Age of Child Bearing

The term average is a general term applying to three kinds of measures of central location, namely, the mean, median and the mode.

Therefore, by average age of childbearing (also referred to as average age of mother).we refer to the mean age as childbearing, the median age of childbearing, and the modal age of childbearing. From the knowledge of age pattern of fertility, it is possible to calculate the average age of childbearing in its usual sense.

The calculations are however, based on the age-specific fertility rates than number of births. This is to eliminate the effect of differences in the age composition of the populations being compared. The average age of childbearing may be calculated using;

i. the actual age-specific fertility rates $f_a^{(a)}$, or

ii. the relative age- specific fertilities of the distributions $f_a^{(r)}$.

When data are from a survey (census or sample), the class intervals for the age groups are 14.5-19.5, 19.5-24.5 …. 44.5-49.5. This is because the women were half a year younger at the time of the birth of their children.

The mid points x, therefore become 17, 22,47. Important to note that this method of defining class intervals is the same as defining class boundaries in statistical methods. When data are from vital registration, the mid point x, of the age groups should be 17.5,22.5…..47.5, because the registration should have been taken place at the time of birth of a child.

Mean Age at Child Bearing

The mean age at child $\tilde{x}$ may be defined as;

$$\tilde{x} = \frac{\sum_{a=15}^{49} f_a x}{\sum_{a=15}^{49} f_a x}$$

Where fa is the age specific fertility rates and x is the mid point of the age intervals.

NOTE

1. The formula follows the form of a weighted mean of the ages, the weights being the age specific fertility rates.
2. In populations where there is early childbearing which continuous till late ages and where the peak of fertility is also high, it is observed that the mean age of childbearing is usually high and a large of fraction of fertility relates to the later years of child-bearing.

   On the other hand, in the population where child-bearing starts and terminates early and where fertility is low, the mean age of child-bearing is lower and a small fraction of total fertility occurs in later years of child-bearing.

Mean Age of Childbearing in terms of Relative Age Specific Fertility Rates

The mean age of child-bearing may be given as:

$$\tilde{x} = \sum_{a=15}^{49} f_a^{(r)} x$$

Median Age at Childbearing

The median age of child bearing may be defined as;

$$M_e = L_{me} + \frac{N/2 - F}{f_{me}} X \text{ h}$$

Where Me = median age of child bearing

L_{me} = lower boundary of the median class, i.e the age of group upon which the median lies.

$N/2$ = one half the number of observations

f_{me} = ASFR of the median class

F = cumulative ASFR immediately before the median class, that is sum of the observations on all groups above L_{me}

h = width of the median class

Child-Women Ratio (CWR): The CWR is the number of children under 5 years of age per 1000 women child bearing age in a given year. The measure is used as a rough fertility indicator especially when detailed data on births are not available.

$$CWR = \frac{{}_5P_0}{{}_{30}W_{15}} or \frac{P_{0-4}}{P^f{}_{15-49}} or \frac{p_{0-4}}{f_{15-45}}$$

The index is influenced by the level of infant and childhood mortality.

Or CWR = No of children below 5year of age X 1000

No of women in reproductive age

Example: 5.1

Live births in a year and the number of women in child bearing ages for a country are given below.

Age –group (x)	No. of women in ('000')	No of Live births in (000)	L_x/L_0
15 – 19	410,352	56403	0.788
20 – 24	378,163	97168	0.770
25 – 29	377,011	93415	0.748
30 – 34	296,799	57694	0.723
35 – 39	235,097	34478	0.698
40 – 44	190,328	13078	0.668
45 – 49	148,534	4548	0.635

Let L_x/L_0 be the proportion of women surviving from birth to the mid-point of the age interval. From the table below;

i. Construct a column for the age-specific fertility rates and hence compute
ii. The general fertility rate
iii. The total fertility
iv. Net reproduction rate
v. Gross reproduction rate if the sex ratio at birth is 105 : 100

Solution:

Age –group (x)	No. of women in ('000')	No of Live births in (000)	L_x/L_0	ASFR
15 – 19	410,352	56403	0.788	0.1375
20 – 24	378,163	97168	0.770	0.2567
25 – 29	377,011	93415	0.748	0.2478
30 – 34	296,799	57694	0.723	0.1944
35 – 39	235,097	34478	0.698	0.1463
40 – 44	190,328	13078	0.668	0.0687
45 – 49	148,534	4548	0.635	0.03062
Total	2,036,893	356,780		1.082

i. General fertility rate (GFR) $= \frac{Total\ no.\ of\ \ Livebirths}{Total\ no.of\ \ women\ in\ reproductive\ age} \times 1000$

$= \frac{356780}{2036893} \times 1000$

$= 0.175\ (1000) = 175.16$

ii. Total fertility rate (TFR) $= 5\sum ASFR \times 1000$

$= \mathbf{5}(1.082) \times 1000$

$= \mathbf{5410}$

iii. Gross Reproduction rate (GRR) = $\frac{1}{(SR+1)} \times TFR = \frac{5410}{(105/100)+1}$

= 2639.02

iv. Net Reproduction Rate = $\frac{5B_F}{B_T}\left\{\sum_{i=1}^{n} ASFR \times \frac{l_x}{l_0}\right\}$

= $5\left(\frac{100}{2.05}\right)0.7998$

= **1.9507**

Summary of Study Session 5

In this study, you have learnt that:

1. Fertility: Fertility refers to the actual reproductive performance of a population. It measures the number of live births in a given population at a particular time.
2. Fecundity: This is the physiological capability of couples to reproduce.
3. The term average is a general term applying to three kinds of measures of central location, namely, the mean, median and the mode.

Self-Assessment Questions (SAQs) for Study Session 5

Now that you have completed this study session, you can assess how well you have achieved its Learning outcomes by answering the following questions. Write your answers in your study Diary and discuss them with your Tutor at the next study Support Meeting. You can check your answers with the Notes on the Self-Assessment questions at the end of this Module.

SAQ 5.1 (Testing Learning Outcomes 5.1)

Discuss Fertility and Fecundity

SAQ 5.2 (Testing Learning Outcomes 5.2)

Explain the method of Computing Average Age of Childbearing

Study Session 6: Measures of Reproductivity

Introduction

So far you have been familiarized with the measures of fertility separately. But fertility rates are inadequate in giving us any idea about the extent at which the population is replacing itself since they ignore the sex of the newly born children and their mortality.

How then can fertility and mortality be combined so that we can assess whether one is more or less offsetting the other, whether fertility is sufficient to balance mortality. Measures that are appropriate for this purpose are reproductivity rates.

Learning Outcomes for Study Session 6

At the end of this study session, you should be able to:

6.1 Define Reproductivity

6.1 Reproductivity

Reproductivity or population replacement refers to the extent to which a cohort is replacing its own numbers by the natural processes. It is the net force of fertility and mortality and is usually expressed in terms of a generation rather than a year or other brief period of time.

Types of Reproductivity Measures

Reproductivity may be measured using simple and conventional rates.

Simple Measures of Reproductivity

Simple measures of reproductivity are measures of comparing the number of births and deaths on an annual (instead of a generation) basis. These measures include;

i. Natural increase
ii. Crude rate of natural
iii. Vital index

Natural Increase: Natural (NI) is the change in population due to the net effect of fertility and fertility. It is defined as the difference between the number of births and deaths in a given year. Thus,

$$NI = B - D$$

Where

B = births during a calendar year;

D = deaths during a calendar year.

When the B – D is negative, the change is referred to as natural decrease

Example 6.1

In Mauritius, 20,875 children were born and 6,946 people died in 1989 calculate the natural increase.

Solution

B = 20875; D = 6946

NI = B – D

20,875 – 6946 = 13,929

That is the population of Mauritius increased naturally by 13,929 people in 1989.

Crude Rate of Natural Increase

The crude rate of natural increase (CRN), also referred to as crude rate of reproductive change, is the simplest measure of population growth. It is defined as the (algebraic) excess of births over deaths per 1000 of the population, i.e.

$$\text{CRN} = \frac{B - D}{P} X\ 1000$$

Example 6.2 In addition to the data in example 6.1, the midyear population of Mauritius was 1,064,000. Calculate the crude rate of natural increase.

Solution: B = 20,875; D = 6,946; P = 1,064,000

$$\text{CRN} = \frac{B - D}{P} X 1000$$

$$= \frac{20{,}875 - 6946}{1064000} X 1000 = 13.1$$

That is the population of Mauritius increased naturally by 13.1 per 1000 persons in the 1989.

Depending also on the data at hand the crude rate of natural increase may be defined as the difference between the crude birth rate and the crude death rate.

CRN = b – d; where b = birth rate and d = death rate.

Advantages of the Crude Rate of Natural Increase

1. It is simple and easy to compute
2. The rate of natural increase is the most direct indication of how rapidly a given population actually grew over a given year as a result of vital processes. It is the current annual rate of growth, exclusive of migration. If births exceeds deaths, the is growth and the rate is positive. If deaths outnumber births, the population fails to increase during the year, and the rate is negative.

Disadvantages of Crude Rate of Natural Increase

1. This rate represents only the change due to the balance of births and deaths and does not include the effect of migration. Hence it dose not give the actual population change.
2. It suffers from the drawbacks f crude birth and death rates.
3. The rate of natural increase may be affected indirectly by migration. If migrants have higher or lower fertility and mortality than the remainder of the population, their movements will have some influence on the annual birth and death rates.

Vital Index

The vital index (VI) is the ratio of the number of births to the number of deaths times 100, that is,

VI = $\frac{B}{D}x100$, or equivalently, the ratio of the birth rate to death rate times 100:

VI = $\frac{b}{d}x100$

Advantages of Vital Index

1. It is simple and easy to calculate
2. It is regarded as a fairly reliable statistical constant reflecting the non biological status of the population as a whole. Thus; (i) if the ratio VI > 100 the population is regarded as having good medical care. (ii) If VI< 100, then the population is not holding its own.
3. It can be calculated for an area for which post-censal population estimates are not available.

Disadvantages

The two main disadvantages are;

1 It merely gives a measure of whether births exceeds deaths or not. it fails to give us any idea about the trend in the population growth, that is, it does not tell us anything about whether population has a tendency to increase or decrease.

2 It suffers from the drawbacks of crude birth and death rates.

Gross Reproduction Rate: (GRR): The GRR is similar to the TFR, except that it refers only to female births. In other words, it is the average number of daughters that would be born to a woman (or group of women) during her life time if she passed through her child bearing years conforming to the age specific fertility rates of a given year.

$$GRR = \frac{TFR}{1 + \text{sex ratio at birth}}$$

Net Reproduction Rate

The net reproduction rate (NRR) introduces a further refinement, namely, the recognition that not all women survive to the end of their reproductive lives. It measures the average number of daughters that would be born to a woman (or group of women).

If she passed through her lifetime from birth, conforming to the age specific fertility and mortality rates of a given year, this rate is similar to the GRR, because it takes into account the fact that some women will die before completing their childbearing years.

$$NRR = \sum f_i^t \frac{\ell_x}{\ell_0}$$

Where ℓ_x / ℓ_o = the probability of surviving from birth to age x, where x is the mid point of the ith age interval.

The NRR therefore measures the extent to which women are reproducing themselves and, when calculated on a cohort basis, can be used as an approximation to intergenerational growth.

Example

The table below gives the midyear population and female live births of country XYZ by unequal age-group in the year 1989.

Age group in years	Midyear women population	Female Births
15-19	46,417	993
20-24	51,462	3424
25-34	96,486	4789
35-49	89,864	854

Calculate the Gross reproduction rate.

Solution: The procedure for the calculation is illustrated in the table below.

Age group (years)	Mid-year women population	B_a^w	Class width	Birth rates of daughters only $f_a^w = \frac{B_a^w}{W_a}$	Expected female births per woman $n_a = \frac{B_a^w}{W_a}$
1	2	3	4	5	6 = 4X5
15-19	46417	993	5	.02139	.10695
20-24	51452	3424	5	.06653	.33265
25-34	96486	4789	10	.04963	.49630
35-49	89864	854	15	.00950	.14250
Total	284229	10060			1.07840

GRR = $\sum_{a=15-19}^{m=45-49} n_a X \frac{B_a^w}{W_a} x1000$

= 1.07840 X 1000

= **1078.4**

Interpretation: this means that 1,078.4 daughters would be born by a group of 1000 women at the current fertility level if all the initial group of 1000 women survived the child bearing age; or about one daughter on the average would be born by a woman if she survived the child bearing age at the current fertility levels. the Total fertility rate (TFR).

Summary of Study Session 6

In this study, you have learnt that:

The defination reproductivity and also how it differs from fertility, this study session also highlighted the different measures of reproductivity, their advantages and disadvantages also.

And like earlier mentioned, the GRR can also be computed from the TFR, and the Net reproduction rate can also be computed from abridged life table, we have carefully avoided this complex computations here since they are beyond the scope of this course.

Self-Assessment Questions (SAQs) for Study Session 6

Now that you have completed this study session, you can assess how well you have achieved its Learning outcomes by answering the following questions. Write your answers in your study Diary and discuss them with your Tutor at the next study Support Meeting. You can check your answers with the Notes on the Self-Assessment questions at the end of this Module.

SAQ 6.1 (Testing Learning Outcomes 6.1)

Define Reproductivity

Study Session 7: Mortality Concepts and Measures

Introduction

Mortality refers to deaths as a component of population change. Eventually death occurs to every population member, but the rate at which it occurs is linked to may factors, such as age, sex race, occupation, and social class and its incidence can reveal much about a populations standard of living and health care

Learning Outcomes for Study Session 7

At the end of this study session, you should be able to:

7.1.Discuss the meaning of mortality

7.2.Explain basic Mortality Measures

7.1 Mortality

Mortality is one of the components of population change. It is usually measured by a number of indices, most efficiently; it is measured by relating deaths in periods of time among particular categories of persons (distinguished by age, sex, occupation etc.) to the total number at risk in this groups.

Uses of the Study Of Mortality

The level of mortality in a society is a fundamental indicator of health and development. The study of mortality, therefore, is important to a wide range of people and professionals.

a. Demographers

It is an instrument for demographers

i. To measure the growth potential of a population

ii. To look into the probable changes in population composition;

iii. In the study of other demographic variables

iv. In making population projections.

The concept and methods developed for mortality analysis are needed to build the systems for the analysis of marriage, fertility and migration.

b. Medical professionals: It helps the medical professionals to understand the prevailing patterns of the various causes of deaths with varying dominance.

c. Researchers: It is of vital interest to researchers involved in public programmes

d. Policy makers: It is important to the government and other agencies who are concerned with taking policy- decisions in relations to the levels and variation of mortality.

7.2 Basic Mortality Measures

The analysis of mortality is generally considered under two main headings;

1. infant mortality
2. child and adult mortality

This is in view of the special problems associated with each.

The following measures and concepts are commonly encountered in demographic

1. Crude Death Rate (CDR)

This is convenient because it measures mortality experience of all ages of the population,

It is the number of deaths per 1000 population in a given year, it is given by

$$\text{CDR} = \frac{D}{P} X 100\,0$$

Where D = total number of deaths in a given year

P = number of person per years exposed to the risk of death during the year (usually taken as the mid year population).

K = 1000.

Advantages of the Crude Death Rate (CDR)

i. It shoes the level of mortality in an entire population.
ii. It is easy to understand
iii. It is easy to estimate and requires only a minimum amount of data for a vital rate
iv. It is a key determinant of population growth but not a very good index for comparing mortality levels.

Disadvantages of Crude Death Rate

It can be misleading because the age structure influence over-rides the impact of levels of mortality. For example,

A population with an old age structure is likely to have a higher crude death rate when compared with a young age structure.

Average Crude Death Rates

We may sometimes be interested in computing the mean of crude death rates which, covering data for two or three years, is computed in order to:

i. Represent the longer period with a single figure,
ii. Add stability to rates based on small numbers,
iii. Use it in extensive comparative analysis.

These annual average rates may be computed in several different ways. For lack of appropriate terminology, we have adopted expressions “mean annual rate”, “annual average rate”, and “mid period rate” to describe the method for computation.

Method 1

Crude death rates are computed for each year and averaged, i.e.

$$\bar{d} = \frac{1}{n}\left(\frac{D_1}{P_1}\times 1000 + \frac{D_2}{P_2}\times 1000 + ... + \frac{D_n}{P_n}\times 1000\right)$$

$$= \frac{1}{n}\left(\frac{D_1}{P_1} + \frac{D_2}{P_2} + ... + \frac{D_n}{P_n}\right)\times 1000$$

$$= \frac{1}{n}\sum_{t=1}^{n}\frac{D_t}{P_t}\times 1000$$

$$= \frac{1}{n}\sum_{t=1}^{n} d_t \times 1000$$

Where $\bar{d}$ = mean annual crude death rate covering data for n years;

N = number of years

$D_1, D_2, \ldots, D_n$ = total number of deaths of year 1, year 2, …., year n, respectively;

$P_1, P_2, \ldots, P_n$ = mid year population of year 1, year 2, …., year n,respectively;

d_t = crude death rate of year t (t = 1, 2, ….,n)

Example 6.1

The mid – year population of a country was 16 million in 1985, 18 million in 1986 and 19.5 million in 1987. In these years the number of people who died were 250,000; 245,000; 240,000 respectively. Find the mean annual crude rate for the entire period (1985 – 1987).

Solution

$$d_{1985} = \frac{D_{1985}}{P_{1985}}\times k = \frac{250{,}000}{16{,}000{,}000}\times 1000 = 15.6$$

That is, the death rate of the country in 1985 was about 16 per 1000 people.

$$d_{1986} = \frac{D_{1986}}{P_{1986}}\times k = \frac{245{,}000}{18{,}000{,}000}\times 1000 = 13.6$$

That is the death rate of the country in 1986 was about 14 per 1000

$$d_{1987} = \frac{D_{1987}}{P_{1987}} \times k = \frac{240{,}000}{19{,}500{,}000} \times 1000 = 12.3$$

That is, the death rate of the country in 1987 was about 12 per 1000 people.

Therefore

$$\bar{d} = \frac{1}{n}\sum_{t=1}^{n} d_i$$

$$= \frac{1}{3}(15.6 + 13.6 + 12.3) = 13.8$$

That is, the mean annual death rate of the country for the period 1985 – 1987 is about 14 per 1000 people

2. **Age- Specific Death Rate: *(ASDR*)**

This contributes greatly to the study of mortality. Differences of risks of death are related to age and calculating the rates by age is the most efficient means of reducing effect of this diversity in the death rate. ASDR is defined as the number of deaths per year per 1000 population of a given age group, usually by sex.

ASDR forms a good basis for comparing mortality levels since they are not affected by age and sex composition of the population

ASDR = $\frac{D_x}{P_x} \times 1000$, D_x and P_x are deaths and population at each respectively.

Advantages

i. It measures risk of death among people in a specific age and sex group.
ii. It is simple to calculate
iii. It can be used to compare the mortality of two populations of the same specific age and sex group even when the age and sex composition of these populations are different.

Disadvantages

i. It does not summarize total mortality in a single figure.
ii. It takes no account of differences in the population structure in terms of race, occupation, religion etc.
iii. It gives essential component for constructing life tables.

Mortality rate can be obtained for specific age groups for comparison of mortality at different ages or a change in mortality at the same age over time. Comparisons can also be made between countries or areas.

Since mortality varies greatly by sex and race, age-specific death rates are often given separately for males and females and for different racial groups in a population.

Cause Specific Death Ratios and Rates

Mortality by cause of death is a matter of concern in the control of diseases. It may be analyzed in terms of two observed measures, namely, cause specific death rate and cause specific death ratio. In both cases, they are computed by including in the numerator only those deaths due to a particular cause of death, say, cancer, heart disease, malaria, or accidents.

Uses of Cause Specific Death Rates and Ratio

The study of mortality by cause provides researchers, planners and the policy maker a detailed picture of the general state of health and mortality situation prevailing. Cause – specific death ratio and rate are used to

1. Compare the cause of deaths in one area to another area, or in one year to another year for the same are;
2. Prepare multiple decrement life tables by cause of death and to describe how much sensitive the expectation of life at specified ages for the changes in mortality due to one or more causes.

Cause- Specific Death Ratio

Cause – specific death ratio (C) represents the percentage of all deaths due to a particular cause or group of causes in a given year. This is defined as;

$$C = \frac{D_c}{D} \times 100$$

Where;

D_c = Death from a cause or group of causes c;

$D = \sum D_c$ = total number of deaths from all causes

Cause specific death ratio C gives the relative risk due to any particular cause of death

Cause- Specific Death Rate

Cause specific death rate (***CSDR)*** is defined as the number of deaths from a given cause or group of causes during a year per 100,000 of the mid – year population;

$$\text{CSDR} = \frac{D_c}{P} \times k$$

Where k = 100,000, this rate employs a larger k than a crude death rate or an age specific death rate because there are relatively few deaths from many of the causes.

Note: the cause specific death rates in a set covering all causes sum up to the crude death rate.

3. **Infant Mortality Rate *(IMR)*;**

This is the number of deaths to infants under 1 year of age, per 1000 live birth in a given year.

$$IMR = \frac{D_{0-1}}{B} Xk$$

Where D_{o-1} = the annual number of……..

Infant mortality: This is important measures mortality between 0 and 1 year. It shows the level of hygiene and standards of living health wise of a community. The causes of death can be divided into two groups; endogenous death and exogenous causes of deaths.

i. Endogenous causes of death are death due to circumstances of the confinement condition resulting in disability existing at birth such as congenital malformation, birth injuries, prematurity which generally brings about death with the first four weeks of life. Neo-natal mortality is usually used to describe mortality in this period.(0<4 weeks)

ii. Exogenous causes of death are caused by infections and accidents. Mortality after four weeks but within the first year of life is termed post-natal mortality.

Perianatal mortality is late foetal death combined with infants' death under four weeks. The denominator for infant rate is usually total number of live birth.

Infant mortality rate = $\frac{\text{infant death } \{0 - < 4\text{weeks}\}+\{4\text{weeks} - < 1\text{year}\}}{\text{Total number of live births}} \times k$

b) Neonatal mortality rate = $\frac{\text{infant death under 4weeks}}{\text{Total number of live births}} \times k$

c) Post-natal mortality rate = $\frac{\text{infant death between exactly 4weeks and} < 1 \text{ year}}{\text{Total number of live births}} \times k$

d) perinatal mortality rate = $\frac{\text{late fetal deaths + infant deaths under 4weeks}}{\text{Total number of live birth}} \times k$

Summary of Study Session 7

In this study, you have learnt that:

1. Mortality is one of the components of population change. It is usually measured by a number of indices, most efficiently; it is measured by relating deaths in periods of time among particular categories of persons (distinguished by age, sex, occupation etc.) to the total number at risk in this groups.
2. The analysis of mortality is generally considered under two main headings;
   - ❖ Infant mortality
   - ❖ Child and adult mortality

   This is in view of the special problems associated with each.

Self-Assessment Questions (SAQs) for Study Session 7

Now that you have completed this study session, you can assess how well you have achieved its Learning outcomes by answering the following questions. Write your answers in your study Diary and discuss them with your Tutor at the next study Support Meeting. You can check your answers with the Notes on the Self-Assessment questions at the end of this Module.

SAQ 7.1 (Testing Learning Outcomes 7.1)

Discuss the meaning of mortality

SAQ 7.2 (Testing Learning Outcomes 7.2)

Explain basic Mortality Measures

Study Session 8: Life Tables

Introduction

The life table is another and effective way of expressing the death rates experienced by a population during a chosen period of time.

A life table is designed essentially to measure mortality; it is employed by a variety of specialist in variety of ways.

It is used by public health workers, demographers, actuaries and many others in studies of longevity, fertility, migration and population growth, as well as in making projections of population size and characteristics and in studies of widowhood, orphanhood, length of working life. etc

Learning Outcomes for Study Session 8

At the end of this study session you should be able to:

8.1.Discuss Life Table

8.2.Explain the different types of life tables

8.1 Life Table

The life table (sometimes referred to as the mortality table), is one form of combining mortality rates of a population at different ages into a single statistical model. **Ramakumar** (1986) defines a life table as a statistical history of a hypothetical cohort of persons born at an instant of time followed through till all the members of the cohort are no more.

Mathematically, suppose P_0 individuals are born at an instant of time. Suppose that these individuals are observed at the end of each year. What would happen is that the number in the cohort would decrease to P_1, P_2, …, P_w, where P_w is zero, if w is the highest number of years the last person lived.

The sequence P_0, P_1, P_2,….,P_w described the death process in a cohort that is, the life table model conceptually traces a cohort of new born babies through their entire life under the assumption that they are subject to the current observed schedule of age-specific mortality rates.

The cohort of new born babies, called the radix of the table, is usually taken to be 100,000.

A life table is generated from age-specific death rate and the resulting values are used to measure mortality, survivorship and life expectation.

In other applications, the mortality rates in the life table are combined with other demographic data into a more complex model, which measures the combined effect of mortality and changes in one or more socio-economic characteristics e.g a table of working life which combines mortality rates and labour force participation rates and measures their combined effect on working life.

In-Text Question

The life table (sometimes referred to as the mortality table), is one form of combining mortality rates of a population at different ages into a single statistical model. True or false

In-Text Answer

True

Life tables are, in essence, one form of combining mortality rates of a population at different ages into a single statistical model. There are principally used to measure the level of mortality of the population involved.

One of their main advantages over other methods of measuring mortality is that they do not reflect the effects of the age distribution of an actual population and do not require the adoption of a standard population for accepting comparisons of levels of mortality in different populations.

Another advantage is that a life table readily permits making mortality allowances for age cohorts, eliminating the burdensome task of compiling death statistics for age cohorts from annual death statistics by age even when the latter are available.

In-Text Question

Life tables are, in essence, one form of combining mortality rates of a population at different ages into a single statistical model. True or false

In-Text Answer

True

8.2 Types of Life table

Life tables differ according to the reference year of the table, age detail and the number of factors comprehended by the table.

We may distinguish two types of life tables according to the reference year of the table.

The current or period life table is based on the experience over a short period of time, such as a year, three years or an intercensal period in which mortality has reminded substantially the same. The death statistics used for a current life table relate to a period of one to three years.

And the population data used relate to the middle of that period (usually close to the date of census). This type of table, therefore represents the combined mortality experience by age of the population in a particular short period of time, it does not represent the mortality experience of an actual cohort. Instead, it assumes a hypothetical cohort that is subject to the age-specific death rates observed in a particular period.

Generation or cohort life table is based on the monthly rates experienced by a particular birth cohort. e.g all persons born in the year 1940. According to this type table, the mortality experience of the persons in the cohort would be observed from their moment of birth through each consecutive age in successive calendar years until all of them die.

Obviously, data of over a long period of years are needed to complete a single table. This type of table is useful for projection of mortality, for studies of mortality trends, and for measurement of fertility and reproductively.

In general, unless otherwise specified, the term life table shall be understood to refer to a current or period life table.

Life tables are also classified into two types- complete (unabridged) and abridged according to the length of the age interval in which is concerned only with the general mortality experience of a cohort by age, from a multiple decrement table (depending on the number of factors e.g double decrement) which describes the separate and combined effects of more than one factor. Mortality is always one of the factors

In-Text Question

Life tables differ according to the reference year of the table, age detail and the number of factors comprehended by the table. True or false

In-Text Answer

True

8.2.1 Uses of Life Table

Although the basic objective of life table is to give a clear picture of the age distribution of mortality in a given population group, it has been used widely in a large number of areas. Today, life table is widely accepted as an important basic material in demographic and public health studies. Among the uses of the life table are the following:

1. The life table is designed essentially for the purpose of measuring mortality, survivorship, and life expectation. It has proved to be the most useful and reliable model to date in the study of these phenomena even though the assumptions underlying its use may not be reasonable in real life situation.

   There has been no superior method suggested so far. It provides answers to questions such as the following:

   a. What is the probability of dying within one year of persons at each age?
   b. What is the probability that persons of specified age will survive a specified number of years?
   c. How many persons, out of selected number of persons living at some initial age, survive on the average to each attained age

2. The life table is used by demographers, actuaries and many others to:
   i. Study longevity, fertility, reproductivity, migration, and population growth.
   ii. Make projections of population size and characteristics
   iii. Make relative comparisons of various measures of mortality such as, death rate, expectation of life for two or more different groups of populations
3. The life table readily permits making mortality allowances for age cohort, eliminating the burden of compiling data on death for age cohorts from annual deaths statistics by age even when the later are available.
4. Life tables are indispensible for the solution of all questions concerning the duration of human life. These tables, based on the scientific use of statistical methods, are the key stone or pivot on which the whole science of life assurance hinges.

   Life tables form the basis for determining the rates of premium necessary to various amount of life assurance. Life tables provide the actuarial scientist with a sound foundation, converting the insurance business from a mere gambling in human lives to the ability to offer well calculated safeguard in the event of death.

8.2.2 Function of the Life Table Relationship Between the Life Table Columns

Life table functions can be classified into two categories. Those which refers to intervals of age and those which refers to exact age. The former include the rates probabilities, deaths and populations while the latter refers to surviving to an exact age, populations over a given age and the complete expectation of life at an exact age.

L_x - The number of persons living at the beginning of the indicated age interval. it as assumed as the radius of the table.

${}^{n}d_x$ - The number of persons who will die within the interval (x to x+n) of the total number of birth assumed in the table

$$ {}_{n}d_x = l_x - l_x + n \qquad \text{or} \qquad d_x = l_x - l_{x+1} $$
$$ = l_x x_{\,n} q_x \qquad\qquad = l_x x^{n} q_x $$

${}^{n}q_x$ - The probability that a person at lies x^{th} birthday will die before reaching his $(x+n)^{th}$ birthday. ${}^{n}q_x = 1 - {}^{n}p_x$

$${}_{n}p_x = 1 - {}^{n}q_x$$

${}_{n}p_x$ - The probability of person years that would be lived within the indicated age interval (x to x +n) by the cohort of births assumed.

$${}_{n}L_x = \frac{n}{2}[1_x + 1_x + n]$$

$l_o = 0.3l_o + 0.7l_1$ (for age 0)

${}_{4}L_{1} = 1.3l_1 + 2.7l_5$ (for ages (1-4)).

$T_x -$ The total number of person- years that would be lived after the beginning of the indicated age interval by the cohort of births assumed.

$$T_x = T_{x+n} + {}_{n}L_x = \sum_{y=x}^{\omega} L_y$$

$\ell^0{}_x -$ The average remaining life time (in years) for a person who survives to the beginning of the indicated age interval. It is called complete expectation of life or life expectations.

$\ell^o{}_x \frac{T_x}{L_x}$

Treatment of open ended intervals

Age 75th the following approximate formulae are used.

${}^{0}q_{75} = 1.00$

$oP_{75} = 0.00$

$L_{75} = {}_{n}d_x$

$T_x = L_x \infty L_{75} = L_{75} \log_{10} L_{75}$

Constructing a Life Table

A typical life table has generally the following columns:

(1)	(2)	(3)	(4)	(5)	(6)	(7)
X	l_x	d_x	q_x	L_x	T_x	e_x^0

The various symbols entered in this table are as defined above, data on l_x are available. Suppose we have age x and l_x alone, we can use the relations defined in the previous section to construct the entire life table.

Example 8.1

The following is the part of a life table for the young population of a community.

X	0	1	2	3	4	5	6
l_x	100	95	80	75	55	40	0

Complete the columns for d_x, q_x, L_x, T_x and e_x^0

Solution

Computation of d_x:

$d_x = l_x - l_{x+1}$

$d_0 = l_0 - l_1 = 100 - 95 = 5$

.

.

.

$d_6 = l_6 - l_7 = 40 - 0 = 40$

The remaining d_x are given in the table below

Age(x)	l_x	$d_x = l_x - l_{x+1}$	q_x	L_x	T_x	e_x^0
(1)	**(**2)	(3)	(4) = (3)/(2)	(5)	(6)	(7) = (6)/(2)
0	**100**	**5**	**0.05**	**97.5**	**395.0**	**3.95**
1	**95**	**15**	**0.16**	**87.5**	**297.5**	**3.13**
2	**85**	**5**	**0.06**	**77.5**	**210.0**	**2.63**
3	**75**	**20**	**0.27**	**65.0**	**132.5**	**1.77**
4	**55**	**15**	**0.27**	**47.5**	**67.5**	**1.23**
5	**40**	**40**	**1.00**	**20.0**	**20.0**	**0.50**
6	**0**	**-**	**-**	**--**	**-**	**-**

Summary of Study Session 8

In this study, you have learnt that:

1. Life tables provide a description of the most prominent aspects of human mortality. Essentially they illuminate and summarize the mortality experience of a population.
2. In addition to these function, life tables also constitute one of the most important tools in demographic analysis, with wide further applications. Life tables can be specifically applied to the following aspects of population analysis:

a. The preparation of population projection and estimates.

b. In the analysis of data from developing countries, life table models or reference sets can be used for the graduation, adjustment and extension of limited and defective data.

Self-Assessment Questions (SAQs) for Study Session 8

Now that you have completed this study session, you can assess how well you have achieved its Learning outcomes by answering the following questions. Write your answers in your study Diary and discuss them with your Tutor at the next study Support Meeting. You can check your answers with the Notes on the Self-Assessment questions at the end of this Module.

SAQ 8.1 (Testing Learning Outcomes 8.1)

Discuss Life Table

SAQ 8.2 (Testing Learning Outcomes 8.2)

Explain the different types of life tables

Study Session 9: Method of Standardization of Mortality Data

Introduction

Standardization is used in demographic analysis to mean procedures for controlling the effect of differences in population composition due to age, sex and other variables.

Standardization is usually by age and sex. Standardization involves the choice of a standard or a reference population and the substitution of this population's composition for that of each population of interest.

Learning Outcomes for Study Session 9

At the end of this study session, you should be able to:

9.1.Discuss the term Standardization

9.2. Explain the different methods of standardization

9.1 Standardization

Generally, standardization is a technique which reduces variables to the same scale and thus allows for the differences in the composition of groups to be compared in respect of a particular measure.

In demography, standardization is the process of adjusting the rates to eliminate from them the effect of differences in population composition with respect to age, sex, marital status, race, or other categories of the population.

Selection of a Standard Population

Standard indices are usually influenced by the particular standard or set of weights employed. The general rule is to select as a standard an age distribution that is similar to the age distribution of the various populations under study e.g the average of the two populations by age could be used.

When several populations of approximately equal size are to be compared, an appropriate standard might be obtained by adding together the individual populations and using the pooled result as the standard population.

If the populations are of unequal size, the distribution of the largest population will be dominant if the populations are simple added together. A better choice of standard population in such a situation would be to average the relative frequencies Pi/P in each category. Different standards would produce different results.

In-Text Question

Standard indices are usually influenced by the particular standard or set of weights employed. True or false

In-Text Answer

True

9.2 Methods of Standardization

There are two methods of standardization and they are:

i. Direct method
ii. Indirect method

Direct Method of Standardization

It is a measure of the crude rate that would have occurred if the standard population had experienced the age- specific rates of the observed population.

The only data available on the population groups are compared with the age specific rates of the population.

First, we select a standard population; secondly, the available age- specific rates in the population groups are multiplied by a set of standard population over the same age groups. Thirdly, summation of the products over all sub-groups gives the expected number of events. Then divide the expected events by the total population of the standard giving the standard rate.

Example 9.1

Age group	Pop 1 rate	Pop 2	Standard population 1000	Pop 1	Pop 2
1	2	3	4	5=2x4	6=3x4
0-4	59.80	7.50	500	29,900	3750
5-24	3.00	2.25	1710	5,130	3848
25-44	5.02	3.15	1810	9,066	5702
45-64	16.12	17.50	1500	24,180	26250
65+	109.10	117.50	660	72,006	77550
All ages	18.47	18.55	6180	140,302	117,100

$$\text{SDR} = \frac{\text{Total expected deaths}}{\text{Total standard population}} \times 1000$$

$$\text{Standard Rate in 1} = \frac{140{,}302}{6180{,}000} \times 1000$$

$$= 22.70 \text{ per } 1000$$

$$\text{Standardized Rate in 2} = \frac{117{,}100}{6180{,}000} \times 1000$$

$$= 18.95 \text{ per } 1000$$

Indirect Standardization

The direct method would involve a very large amount of computation where a large number of distinct or region rate mortality require standardization on the basis of sex, the national population. For ease in computation the indirect method can be used.

In the application of the method, we need to select a standard age- specific death rate. The crude death rates for the standard population must be available. The actual total death in each area and the distribution of the population by age must also be available. This method is essential.

In-Text Question

There are two methods of standardization and they are direct and indirect methods. True or false

In-Text Answer

True

Summary of Study Session 9

In this study, you have learnt that:

1. The principal shortcoming of the methods we have discussed is that the choice of the standard population is somewhat arbitrary. Most commonly, it is some country for which accurate data have long been available or else a population of interest.
2. In comparing mortality for different areas or countries one might wish to add another country to the set of population of interest, and any such addition may require a recalculation of the standard distribution and then of all he standardized rates.

   Moreover, when comparing national entities, it is not at all clear whether they should be included in proportion to their population sizes, or all should be given equal weights. Not is this all, interpretations are always limited to differences, between countries or areas, in the standardized quantities.

Self-Assessment Questions (SAQs) for Study Session 9

Now that you have completed this study session, you can assess how well you have achieved its Learning outcomes by answering the following questions. Write your answers in your study Diary and discuss them with your Tutor at the next study Support Meeting. You can check your answers with the Notes on the Self-Assessment questions at the end of this Module.

SAQ 9.1 (Testing Learning Outcomes 9.1)

Discuss the term Standardization

SAQ 9.2 (Testing Learning Outcomes 9.2)

Explain the different methods of standardization

Study Session 10: Measures of Migration

Introduction

Migration is the third vital process which alters the size of a population, the other vital processes being births and deaths already discussed. These two processes do not take into consideration space. Population change through this natural increase has been viewed independently from the area in which the population lives.

Migration considers area, since it implies moving from one area to another. However, the records of migration do not lend themselves so well to study as those of births and deaths.

Learning Outcomes for Study Session 10

At the end of this study session you should be able to:

10.1. Discuss the term 'Migration'

10.2. Explain the different types of Migration

10.1 Migration

The definition and analysis of migration presents some peculiar problems.

Migration is a vague statistical concept with few uniform criteria to distinguish who is a migrant and who is not. In the broader sense, a migrant is first of all a person who travels.

This is the only unambiguous element in the entire subject. "Migrants are obviously some smaller category of travelers, but the difficulty is encountered whenever the limits of that category are to be defined.

Although a single individual may make several moves within his or her lifetime, most censuses and surveys only record one of these moves. Even if all moves are described in some sample surveys, the data are incomplete because a person remains a potential migrant

until death. Thus the analysis of population movement from any type of data source can only provide an extremely complex phenomenon.

Definition of Terms

In spite of these difficulties we shall attempt to define some concepts in migration.

Mobility: Some writers suggest that since migration cannot be defined exactly, it should be considered as a part of a continuum covering all types of population movements.

Population Mobility: Population mobility or spatial mobility is defined as the ability to move in space. These movements may be either

a. Daily commuting journeys (between a given place of residence and some other points in space), from a few meters to thousands of kilometers, or
b. Long run shifts of residence (the length of stay at destinations from minutes to the remainder of lifetime). Since commuting does not directly affect the level and the structure of the population of a given territory, it is not strictly speaking, a demographic phenomenon and will not be considered further.

Mover: A mover is a person who moved from one address (house or apartment) to another.

Migration

Not all geographic movements qualify as migration. Moves which are included in the migration process are generally considered to be at least semi-permanent and to take place across definite geographical boundaries.

Migration is defined as the movement from a place of departure known as origin to another point at which the movement terminates known as the of destination. “The operational definition of migration is that it is a change from one administrative spatial unit to another, made between two points in time”.

The concept of residence is of particular significance to the definition of migration, for it combines the two elements on which the definition must hinge. There are, however, some changes of residence which we exclude from migration.

These are;

1. Temporary changes which do not involve changes in usual residence: these are usually excluded from “migration”, which includes brief visits, excursions, vacation or business travels even across national boundaries;
2. other changes in residence although permanent are short-distance movements, and hence, are also excluded from migration.

Thus, the term migration has, in general usage, been restricted to relatively permanent changes in residence between specifically designated political or statistical areas or between type-of-residential areas. (Shryock, H. S et al, 1970).

A migrant is a person who changes his usual place of residence and if this place of residence involves crossing a national boundary, this type of movement is referred to as international migration. Emigration and immigration therefore refers to migration away from and into a given country respectively. This type of migration does not affect the size of the population at large.

An out-migrant is a person who departs from an area by crossing its boundary to a point outside it, but within the same country while an In-migrant is a person who enters an area by crossing its boundary.

Uses of Migration

1. Migration influences the socio-demographic structure of a population. As a consequence, it
    a. influences the growth of population by influencing fertility and mortality of the areas of origin and destination (for example, it can influence birth rates by altering the proportion of women of child-bearing ages in the population)
    b. Affects the characteristics of the labour force of the areas of origin and destination.

2. The measurement and analysis of migration are important in the preparation estimates and projections for a nation or parts of a nation.
3. Migration data (sex, age, citizenship, occupation etc, of the migrant) are required together with census data and vital statistics for;

   a. analyzing changes in the structure of the population and labour force of an area;

   b. the assessment of other basic demographic characteristics.
4. Migration facilitates an understanding of the nature and magnitude of the social and cultural problems that often result in areas with heavy immigration.

10.2 Types of Migration

Migration may be classified by the following types:

1. By type of boundary, namely,
   i. International migration
   ii. Internal migration
2. By duration, that is,
   i. Regular (daily or periodic) migration which is a regular trip to place of work or studies beyond the person's place of residence;
   ii. Seasonal migration
   iii. Temporary migration
   iv. Permanent migration
3. By direction
   i. Urban-Urban Migration – Job Transfer
   ii. Urban- Rural Migration – Retirement
   iii. Rural-Rural Migration – Agriculture, War
   iv. Rural- Urban Migration – Greener Pasture

4. According to decision to migrate
    i. voluntary migration
    ii. Involuntary migration

The sources of data, the type of data available, and the techniques of estimation and analysis are sufficiently different for international and internal migration, and so are always treated separately.

Basic Measures of Migration

1. Immigration Rate: This is the number of immigrants arriving at a destination per 1000 population at that destination in a given year;

$$IR = \frac{\text{Number of immigrants arriving at a destination}}{\text{Population at the destination}} \times K$$

Where K = 1000

2. Emigration Rate: This is the number of emigrants departing an area of origin per 1000 population at that area of origin in a given year

$$ER = \frac{\text{Number of Emigrants departing an area of origin}}{\text{Population at the area of origin}} \times K$$

3. Net Migration: This is the balance of immigration and emigration for a country. It may be referred to as net immigration if immigration is larger than emigration and net emigration, if emigration is larger than immigration. That is,

Net immigration = I – E, if I > E,

Net Emigration = E – I, if E > I

The term “Net migrant” as far as possible must be avoided because it is not reasonable to think of a group of people as being net migrant.

4. Gross Migration: Gross migration is the sum of the total immigration and total emigration, that is,

Gross migration = I + E

5. **Net Migration Ratio**: This gives the net effect of immigration and emigration on an areas' population expressed as increase or decrease per 1000 population of the area in a given year.

NMR = $\frac{I - E}{}$, where I > E

It may also be defined as;

NMR = $\frac{E - I,}{E}$ where E > I

This figure, also called migration turnover, is intended to represent the total movement across the boarders of a country during a period of time.

6. **Migration Ratios and Index**:

Migration Index (MI) may be defined as

MI = $\frac{E ,}{I}$ where E > I , and MI = $\frac{I,}{E}$ where I > E

7. Migration Effectiveness Ratio: Migration effectiveness ratio **(MER)** is defined as the ratio of net migration to gross migration.(migration turnover). That is,

MER = $\frac{I - E,}{I+E}$

This ratio measures the relative difference between the effective addition or loss of loss of population through migration and the overall gross movement.

8. Intercensal Component Equation

The intercensal component equation is stated as

$P_1 = P_0 + (B - D) + (I - E)$ or

$(P_1 - P_0) = (B - D) + (I - E)$

Where;

$(P_1 - P_0)$ = the net change in the population during the period

$(B - D)$ = natural increase or decrease during the period

$(I - E)$ = mechanical increase or decrease (net migration during the period)

The general formula for estimating the total volume of net migration is, therefore, to arrange the element of the intercensal component equation as

$M = (P_1 - P_0) - (B - D)$

Where, $M = I - E$ is the net migration

Thus net migration equals population change during the intercensal period minus natural increase during that period. The result is the total number of persons moving into a country and the number moving out from the country during a given intercensal period.

Although there is an interest on separate figures on immigration and emigration, these formula does not permit making adequate estimates of immigration and emigration separately.

9. Crude Migration Rates

The crude immigration rate (CIR) is defined as

$$\text{CIR} = \frac{I}{P} X 1000$$

Where, P is the mid-year population.

The crude emigration rate (CER) is defined as

$$\text{CER} = \frac{E}{P} X 1000$$

Example 10.1

In 1986, the number of persons who departed from Nigeria to various countries was 635,397, while in that same year 647,763 arrived in the country.

Calculate;

a. net migration, b. gross migration

Solution

I = 647,763, E = 635,397

i. Net migration = I – E

= 647,763 – 635,397 = 12,388

That is in 1986, the Nigerian population increased by 12,366 through migration.

ii. Gross migration = I + E

= 647,763 + 635,397 = 1, 283,160

That is the migration turnover of Nigeria in 1986 was 1,283,160. In other words, 1,283,160 people crossed the Nigerian boarder in 1986.

Summary of Study Session 10

In this study, you have learnt that:

1. Knowledge both of the levels of migration and the characteristics of migrants is needed for appraising the consequences on both sending and receiving areas of migration. But the balance of migration is liable to considerable variation from year to year as a result of changes in political decisions by government.
2. Population redistribution is, however, much more susceptible than population growth to short term changes influenced by relative employment opportunities and the relative appeals of lifestyles offered by different parts of the country.

   It also depends more directly and predictably on the success of the countries in formulating and applying adequate development strategies.

Self-Assessment Questions (SAQs) for Study Session 10

Now that you have completed this study session, you can assess how well you have achieved its Learning outcomes by answering the following questions. Write your answers in your study Diary and discuss them with your Tutor at the next study Support Meeting. You can check your answers with the Notes on the Self-Assessment questions at the end of this Module.

SAQ 10.1 (Testing Learning Outcomes 10.1)

Discuss the term ‘Migration’

SAQ 10.2 (Testing Learning Outcomes 10.2)

Explain the different types of Migration

References

Shrylock, H.S, Seigel J. S et al (1973), *Methods and materials of Demography*, New York, Academic press.

Kpedekpo, G.M.K (1982), *Essentials of Demographic Analysis for Africa*,Nigeria, Hienemann.

Ramakumar, R (1986), *Technical Demography*, New Delhi, New Age International Publisher.

Boyarsky, A.Y (1980), (ed), *Fundamentals of Demography*, Moscow,Statistika.

Keyfitz, N. (1968), *Introduction to the mathematics of population*, Addison- Wesley.

Lucas, D. *et al* (1980) *Beginning population studies,* Canberra, Australian National University

Nuamah, N.N.N.N, (2007), *Demographic Statistics; A Handbook of Methods and measures in Demography*. Acadec press, Accra, Ghana.

Pressat, R (1972), *Demographic Analysis*, Chicago, Antherton.