COVENANT UNIVERSITY
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TUTORIAL KIT
OMEGA SEMESTER

PROGRAMME:
DEMOGRAPHY AND SOCIAL STATISTICS

COURSE: DSS 321

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DSS321
MEASURES OF POPULATION CHANGE
BY
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QUESTIONS

(1a) Explain the concept of the life table, and the uses

(b)The life table below shows the mortality history of Brazil in 2000. Complete the table and solve the following questions

X	Nlx

(I) What is the probability for an individual under 1 to die in Brazil in 2000?

(ii) How many years can an individual born in 2000 in Brazil expect to live?

(iii) What is the probability of dying of an individual between 5 and 10 years of age?

(iv) What is the mortality rate between 5 and 10 years of age?

(v) What is the probability that an individual reaching 5 years of age reaches 10?

(vi) How many additional year is an individual between 5 and 10 years of age in 2000 in Brazil expected to live?

(vii) What is the person-years lived at exact ages 15 and 20

1 (c) For a certain life table population, lx = $x(x-4) = 5$
Find
(i) qx
(ii) ${}^{10}p_{20}$

1(d) Simplify the Life Table Population, if $Xp_o = 1 \frac{-}{208} x$

(2a) The table below shows the age distribution of women of reproductive age and age specific fertility rates in a certain population.

Age Group	Number of women	Number of women	$\frac{nlx}{lo}$
15-19	480162	138537	3.32822
20-24	428007	100210	3.16133
25-29	381755	94573	2.96847
30-34	308741	62822	2.76963
35-39	279640	43192	2.56913
40-44	211469	14745	2.37545
45-49	187480	4240	2.18069

The midyear population is 12,046,753 and the number of children under 5 is 1,829,474. Calculate and explain;

(i) The General Fertility Rate
(ii) The Child – Woman Ratio
(iii) The Total Fertility Rate
(iv) The Gross Reproduction Rate assuming a sex ratio at birth of 1.03
(v) The Net Reproduction Rate
(vi) The ASFR for the total population
(vii) Number of female birth

(2b) Explain demographically which of the analysis is more complex: **Fertility analysis versus mortality analysis.**

(c). Different types of internal migration and the possible factors responsible for each type

(d) Explain the concept Age Specific Fertility Rates. Why do we need them?

(3) For the Life Table define below;

Age x	lx (Male)	lx (Female)	LX (Male)	LX (Female)
0	1000	1000	67,460	72,860
15	962	970	52,958	58229
20	958	968	48159	53385
25	952	965	43373	48559
45	916	937	24622	29506
60	778	854	11801	15944
65	676	795	8065	11830

Calculate:

(i) CBR for male and female

(ii) The expectation of life for male at age 15 and female at age 45

(iii) The chance that a male age 25 will survive to age 60

(iv) The probability that a woman age 15 marry to a man age 20 will herself survive to age 60 but then will be a widow

(v) Differentiate between Children ever born and Parity as measure of fertility.

(4) The mid-year population of Kenya was 18 million in 1982. Between 1970 and 1982 the average annual rate of growth was 4%. The World Bank estimated that, in mid-1990, Kenya's population was 26 million and that by the middle of the year 2000 it will be 40 million.

(a) Assuming that the growth in the population of Kenya between 1982 and 1990, and between 1990 and 2000, is exponential, calculate the annual growth rates using the World Bank's estimates of the population.

(b) Assume that the World Bank's estimate of 40 million in 2000 is correct. If Kenya's population continues to increase after 2000 at the same rate as the World Bank assumed it would increase between 1990 and 2000, when will it reach 80 million.

(c) Using the data below, how long will it take Nigeria's population of about140 million to **Double** and **Triple** if the population is growing at the rates stated below?

Note: Show your working

Rate Per Annum	**0.5**	**0.7**	**1.0**	**1.2**	**1.5**	**1.7**	**2.0**

5(a)(i) Migration is a necessary product of Urbanization. Discuss. (ii)What are the possible Obstacle of migration

(b) What distinguishes a potential migrant from the non-migrant?

(c) Expantiate vivdly the consequences of migration for both the source region and areas of destination

(d). Define the following terms as used in demography:

(1) Cohort

(2) Foetal Death

(3) Gravidity
(4) Migration Stream

6 Complete the life table and solve the following question with interpretation

Exact age (years)	Out of 100,000 males born	
	Number alive at exact age	Average number alive in the age interval
x	l_x	L_x
0	100,000	90,505
1	85,591	84,165
2	82,739	82,079
3	81,419	80,954
4	80,488	80,124
5	79,761	79,425
6	79,089	78,810
7	78,532	78,313
8	78,095	77,884
9	77,673	77,484
10	77,294	77,128
11	76,962	76,812
12	76,663	76,521
13	76,380	76,241
14	76,102	75,955
15	75,809	75,644
16	75,480	75,294
17	75,108	74,931
18	74,754	74,571
19	74,389	74,202
20	74,016	73,827

(i) Find Mx
ii) What is the probability of dying at age 15?
7. Define the following terms as used in demography:
Cohort
Foetal Death
Death
Rate of natural increase
Fecundability
Migration Stream
Complete and Abridge life tables
Mean Age of Child bearing
SOLUTIONS

(1a) Explain the concept of the life table, and the uses

(b)The life table below shows the mortality history of Brazil in 2000. Complete the table and solve the following questions

X	nlx

(I) What is the probability for an individual under 1 to die in Brazil in 2000?

(ii) How many years can an individual born in 2000 in Brazil expect to live?

(iii) What is the probability of dying of an individual between 5 and 10 years of age?

(iv) What is the mortality rate between 5 and 10 years of age?

(v) What is the probability that an individual reaching 5 years of age reaches 10?

(vi) How many additional year is an individual between 5 and 10 years of age in 2000 in Brazil expected to live?

SOLUTION

- What is the probability for an individual under 1 to die in Brazil in 2000?
The probability of dying between 0 and 1 is Brazil in 2000 (1q0) is 0.02006.

2- How many years can an individual born in 2000 in Brazil expect to live?
The number of years that a child born in 2000 may hope to live, i.e. the life expectancy at birth in Brazil (e0) is 71.97 years.

3- What is the probability of dying of an individual between 5 and 10 years of age?
The probability that an individual die in 2000 in the 5-9 age group (5q5) is 0.00162.

4- What is the mortality rate between 5 and 10 years of age?
The central mortality rate in the 5-9 age group (5M5) is 0.00032.

5- What is the probability that an individual reaching 5 years of age reaches 10?
The probability that an individual in the 5-9 age group reaches the 10-14 age group (5p5) is 0.99838.

6- How many additional year is an individual between 5 and 10 years of age in 2000 in Brazil expected to live?
The life expectancy of the 5-9 age group is e5 = 68.68

(vii) What is the person-years lived at exact ages 15 and 20 : **ANS** (485,306)

1 (c) For a certain life table population, $lx = x(x - 4) = 5$
Find
(i) qx
(ii) ${}^{10}p_{20}$

1(d) Simplify the Life Table Population, if $Xp_o = \frac{1}{208} x$

SOLUTION:

$x(x-4) = 5 \;= x^2 - 4x - 5 = 0$

$\Rightarrow (x-5)(x+1) = 0 \; ab = 0$

$\Rightarrow x = 5$ or $x = -1$

Therefore, the Ultimate age is **5**

(ii) $q_x = \frac{ndx}{lx} = \frac{lx - lx+n}{lx} = \frac{1 - lx+n}{lx}$

- ⇨ $lx+n = x(x-4) = 5$
- ⇨ $lx+n = x^2 - 4x - 5$
- ⇨ $(x+n)^2 - 4(x+n) - 5$
- ⇨ $(x+n)(x+n) - 4x - 4n - 5$
- ⇨ $x^2 + 2xn\ n^2 - 4x - 4n - 5$

$qx = 1 - \frac{lx+n}{lx}$

⇨ $\frac{x^2 - 4x - 5 - (x^2 + 2xn\ n^2 - 4x - 4n - 5)}{x^2 - 4x - 5}$

⇨ $\frac{x^2 - 4x - 5 - x^2 - 2xn - n^2 - 4x - 4n + 5}{x^2 - 4x - 5}$

$= \frac{-2xn - n^2 + 4n}{x^2 - 4x - 5} = \frac{2xn + n^2 - 4n}{x^2 - 4x - 5} = \frac{n^2 + 2xn - 4n}{x^2 - 4x - 5}$

Therefore, $qx = \frac{n(n-4-2x)}{x^2 - 4x - 5}$

(iii) ${}^{10}p_{20} = {}^{n}p_x = \frac{lx+n}{Lx} = \frac{l30}{l20}$

Therefore, $lx = x^2 - 4x - 5$

⇨ $\frac{x^2 + 2xn + n^2 + 4x - 4n - 5}{x^2 - 4x - 5}$

⇨ $\frac{(20)^2 + 2(20)(10) + (10)^2 - 4(20) - 4(10) - 5}{(20)^2 - 4(20) - 5}$

⇨ $\frac{400 + 400 + 100 - 80 - 40 - 5}{400 - 80 - 5}$

⇨ $\frac{900 - 125}{400 - 85} = \frac{775}{315}$

⇨ **2.46(The probability of surviving from age 20 to 30)**

1(c) Simplify the Life Table Population, if $Xp_o = 1 - \frac{X}{208}$

$Xp_o = 1 - \frac{X}{100}$

$Xp_o = 1 - \frac{lo+ n}{lo}$

$Xp_o + - \frac{X}{208} = 1$

$\frac{L(o+ x)}{lo} = 1 - \frac{X}{208}$

$\frac{lx}{lo} = \left[1 - \frac{x}{208}\right]$

$lx = lo\left[1 - \frac{x}{208}\right]$

$Lo = \frac{lx(208)}{208-x}$

$\frac{lx}{\frac{lx(208)}{208-x}} + \frac{X}{208} = 1$

$\frac{208}{208} = 1$

(2a) The table below shows the age distribution of women of reproductive age and age specific fertility rates in a certain population.

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The midyear population is 12,046,753 and the number of children under 5 is 1,829,474. Calculate and explain;

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(x) The Total Fertility Rate
(xi) The Gross Reproduction Rate assuming a sex ratio at birth of 1.03
(xii) The Net Reproduction Rate
(xiii) The ASFR for the total population
(xiv) Number of female birth

(2b) Explain demographically which of the analysis is more complex: **Fertility analysis versus mortality analysis.**

(c). Different types of internal migration and the possible factors responsible for each type

Types of internal migration

(a) Rural – rural
(b) Rural – urban
(c) Urban- rural
(d) Urban - urban

(d) Explain the concept Age Specific Fertility Rates.

Number of births per year per 1000 women of a specific age (group)

Why do we need them?

- For comparisons in fertility behavior at different ages
- For comparison of fertility at different ages over time
- For comparison of fertility across countries/populations

(3) For the Life Table define below;

Age x	lx (Male)	lx (Female)	LX (Male)	LX (Female)
0	1000	1000	67,460	72,860
15	962	970	52,958	58229
20	958	968	48159	53385
25	952	965	43373	48559
45	916	937	24622	29506
60	778	854	11801	15944
65	676	795	8065	11830

Calculate:

(vi) CBR for male and female
(vii) The expectation of life for male at age 15 and female at age 45
(viii) The chance that a male age 25 will survive to age 60
(ix) The probability that a woman age 15 marry to a man age 20 will herself survive to age 60 but then will be a widow
(x) Differentiate between

Children ever born: -This is computed from censuses or sample surveys by asking women their age and number of live births they ever had (including those having died since birth)

Parity as measure of fertility: - A woman's parity is defined in the usual way as the number of children she has ever borne, but with parity zero subdivided into two states: never married with no children and ever married with no children.

SOLUTION

Age x	lx (male)	Dx	Qx	Px	Lx	Tx	ex
0	1000	38	0.038	0.962	67460	256438	256.44
15	962	4	0.004	0.996	52958	188978	196.44
20	958	6	0.006	0.994	48159	136020	141.98
25	952	36	0.036	0.962	43373	87861	92.29
45	916	138	0.151	0.849	24622	44488	48.57
60	778	102	0.131	0.869	11801	19866	25.53
65	676	----------	-------	1	8065	8065	11.93

Age x	lx (Female)	Dx	Qx	Px	Lx	Tx	ex
0	1000	30	0.030	0.97	72,860	290313	290.313
15	970	2	0.002	0.998	58229	217453	224.178
20	968	3	0.003	0.997	53385	159224	164.488
25	965	28	0.029	0.971	48559	105839	109.678
45	937	83	0.089	0.911	29506	57280	61.131
60	854	59	0.069	0.931	15944	27774	32.522
65	795	-------	--------	1	11830	11830	14.881

(1) CBR = 1/ex = 1/Tx/Lx = 1/290313/1000 = 1/290313*1000 = 0.0034

(2) Expectation of life for male at Age 15 = 196.44

(3) Expectation of life for male at Age 45 = 61.13

(4) The probability that a woman age 15 married to a man age 20 will herself survive to age 60 but then will be a widow

Man	Woman
20	15
65	60

${}^{N}p_x = {}^{45}p_{15} = l60/l15 = 854/970 = 0.88$

Man = $nqx = ndx/lx = lx - lx+n$

$Lx \frac{\quad}{\quad} = 1 - \frac{lx+n}{lx} = 1-676/958 = 0.29$

(4) The mid-year population of Kenya was 18 million in 1982. Between 1970 and 1982 the average annual rate of growth was 4%. The World Bank estimated that, in mid-1990, Kenya's population was 26 million and that by the middle of the year 2000 it will be 40 million.

(a) Assuming that the growth in the population of Kenya between 1982 and 1990, and between 1990 and 2000, is exponential, calculate the annual growth rates using the World Bank's estimates of the population.

Solution:

Pt = 1990 = 26,000,000

$Pt + n = 2000 = 40{,}000{,}000 \quad n = 10 \; ; \quad r = ?$

$Pt + n = Pt\, e^{rn}$

$$\frac{Pt + n}{Pt} = e^{rn}$$

$$\text{Log}_e \left[\frac{Pt + n}{Pt}\right] = \log_e e^{rn}$$

$$rn = \text{Log}_e \frac{Pt + n}{Pt}$$

$$r = \frac{1}{n} \text{Log}_e \frac{40{,}000{,}000}{26{,}000{,}000}$$

$$r = \frac{1}{10} \text{Log}_e \text{In}1.54$$

$$r = \frac{1}{10} \text{Log}_e \text{In}1.54 = \frac{0.4371}{10} = 0.04317 = 4.3\%$$

(b) Assume that the World Bank's estimate of 40 million in 2000 is correct. If Kenya's population continues to increase after 2000 at the same rate as the World Bank assumed it would increase between 1990 and 2000, when will it reach 80 million.

Solution:

Thus the number of years it will take for the population to reach 80million, if it is 40million in the year 2000, and continues growing at an annual rate of 0.043, is given by the equation;

$Pt = 1990 = 80{,}000{,}000$

$Pt + n = 2000 = 40{,}000{,}000 \quad n = ? \; ; \quad r = 4.3\%$

$\text{Log}_e \; Pt + n - Pt = \log_e e^{rn}$

$rn = \text{Log}_e \; Pt + n - Pt$

$$n = \frac{1}{r} \; \text{Log}_e \; Pt + n - Pt$$

$$n = \frac{1}{0.04} \; \text{In}80{,}000{,}000 - \text{In}40{,}000{,}000$$

$$n = \frac{1}{0.04} \times (18.197 - 17.504) = 16.05 = 16.1 \text{ years}$$

(c) Using the data below, how long will it take Nigeria's population of about140 million to **Double** and **Triple** if the population is growing at the rates stated below?

Note: Show your working

Rate Per Annum	**0.5**	**0.7**	**1.0**	**1.2**	**1.5**	**1.7**	**2.0**

Rate Per Annum	Double	Triple
0.5	139	220
0.7	99	157
1.0	70	110
1.2	58	92
1.5	47	74
1.7	41	65
2.0	35	55

Solution:

$Pt + n = Pt\ (1 + r)^n$

===Pt +n = 3pt

therefore

$2Pt = Pt\ (1 + r)^n$

3= $(1 + r)^n$

Log both sides

$Log3 = log(1 + r)^n$

Nlog(1+r) = log3

Nlog(1+0.01) = 0.4771

N = 0.3010

Log1.005 = 110

5(a)(i) Migration is a necessary product of Urbanization.Discuss. (ii)What are the possible Obstacle of migration

(b) What distinguishes a potential migrant from the non-migrant?

(c) Expantiate vivdly the consequences of migration for both the source region and areas of destination

(d). Define the following terms as used in demography:

(i) Cohort: - it is a demographic term used to refers to a situation where people experience the same thing at a particular point in time, for instance,marriage cohort, birthcohort, death cohort,e.t.c.

(ii)Foetal Death: - foetal death is the death prior to the complete expulsion or extraction from its mother of a product of conception; irrespective of the duration of pregnancy; the death is indicated by the fact that after such separation the foetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles.

(iii) Gravidity: - Number of pregnancies a woman has had whether or not they produce a live birth

(iv) Migration Stream: - - This consists of all moves of all migrants in the same common area to the same destination. The movement in the opposite direction is the Counter stream.

6.

Exact age (years)	Out of 100,000 males born		Central death rate for the age interval
	Number alive at exact age	Average number alive in the age interval	
X	l_x	Lx	Mx
0	100,000	90,505	0.1592
1	85,591	84,165	0.0339
2	82,739	82,079	0.0161
3	81,419	80,954	0.0115
4	80,488	80,124	0.0091
5	79,761	79,425	0.0085
6	79,089	78,810	0.0071
7	78,532	78,313	0.0056
8	78,095	77,884	0.0054
9	77,673	77,484	0.0049
10	77,294	77,128	0.0043
11	76,962	76,812	0.0039
12	76,663	\76,521	0.0037
13	76,380	76,241	0.0036
14	76,102	75,955	0.0039
15	75,809	75,644	0.0043
16	75,480	75,294	0.0049
17	75,108	74,931	0.0047
18	74,754	74,571	0.0049
19	74,389	74,202	0.0050
20	74,016	73,827	0.0051

(ii) the probability of dying at age 15 is 0.0043

(iii) The relationship between nqx, the probability of dying and Mx, the central death rate obtained from actual population, is an important one in demographic analysis. The two functions represent different concepts. The first represents the total effect of the mortality pressure in terms of those who fail to survive the whole interval without reference to its variations over the course of the interval while the second represents the average risk to which population is subjected during its passage through the interval.

7(a) **Cohort Mortality Rate** : - cohort mortality rate consists of all persons born within a given period of time, such as a calendar year. A cohort mortality rate therefore provides a direct linkage between live births and corresponding infant death. The approach follows the recording of the numbers that die under 12 months.

(b) **Foetal Death** : - foetal death is the death prior to the complete expulsion or extraction from its mother of a product of conception; irrespective of the duration of pregnancy; the death is

indicated by the fact that after such separation the foetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles.

(c) **Death: -** Is the permanent disappearance of all evidence of life at any time after a live birth has taken place. It is the loss of a member of a population.

(d) Rate of natural increase the rate of natural increase over a period of time is usually measure as the difference between Crude Birth Rate and Crude Death Rate. It can be expressed as a percentage.

(e) **Fecundability: -** is defined as the probability that a woman is capable of conception (that is, using contraception nor sterile) will conceive in a given menstrual cycle.

(f) **Migration Stream: -** This consists of all moves of all migrants in the same common area to the same destination. The movement in the opposite direction is the Counter stream.

(g) **Complete and Abridged life tables: -** The complete life table is one in which the mortality experience is constructed in a single year of age. All the columns are in single years and it is extremely detail. Abridge life table is one in which the mortality experience are given not for single year of age but for age group.