Evaluating the Stage of Epidemiologic Transition in Tunis, Tunisia

David Sanders

Thesis Advisor: Chunhuei Chi
Department of Public Health, OSU

Oregon State University

International Degree Thesis

November 28, 2007

Chapter 1

Introduction

With the rapid onset of globalization, there are a large number of political, economic and social factors which are constantly changing. These all have profound effects on the demographics of individual populations. This shift in social demography is accompanied by an epidemiologic transition as well.

In order to gain an understanding of epidemiologic transition, it is necessary to understand the study of epidemiology. Epidemiology is defined as, "the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the prevention and control of health problems." [1] By observing past data from epidemiologic studies and comparing it with data from current studies, one can begin to obtain a picture of the changing causes and manifestations of disease and death in a population. It is also useful to take changing environmental factors into account (such as tobacco/alcohol use, dietary standards, working conditions and water quality) when determining which stage of epidemiologic transition a certain population is in.

Customarily, epidemiologic transition follows a predictable pattern. Omran points out that "during the transition, a long-term shift occurs in mortality and disease patterns whereby pandemics of infection are gradually displaced by degenerative and man-made diseases as the chief form of morbidity and primary cause of death"[2]. When developing countries undergo industrialization and modernization, they are better able to deal with infectious diseases due to increased resources, access to medical care, and

education. The "degenerative and man-made" diseases which follow are also thought of as "chronic", or "non-communicable diseases". They include things such as cardiovascular disease, diabetes, lung disease and various forms of cancer.

There is great importance in discovering the state of epidemiologic transition which a country is in. Once one finds out the relative prevalence of chronic diseases as compared to that of infectious diseases, one can modify the health system in order to better accommodate the health needs of the population. Since the health status of a nation is constantly in transition, it is necessary to change the delivery method of care in order to most effectively combat the health problems present. More funds can be allocated for prevention of certain types of disease and death over other types. Policies may be enacted which could benefit the health status of a larger percentage of people with less money spent.

It is evident that Tunisia is experiencing epidemiological transition. Within the last 15 years, we have seen total mortality is decreasing, life expectancy is increasing, and lifestyles associated with chronic disease, particularly diabetes and CVD, are being adopted.[3] The purpose of this thesis is to answer the question, "What is the current stage of epidemiologic transition is Tunis, Tunisia?"

Chapter 2

Literature Review

There is a considerable lack of health data concerning Tunisia available from before the 1990s. Due to this lack of data, the population of the country of Mauritius in the Indian Ocean is used as a reference point for determining the stage of transition in Tunis. It has a relatively well-documented transition due to the completeness of health records in the country.

To determine what stage Tunisia is at in its transition, it is necessary to see the theoretical progression of the epidemiological transition through its three main stages[4] :

1. *The Age of Pestilence and Famine* when mortality is high and fluctuating, thus precluding sustained population growth. In this stage the average life expectancy at birth is low and variable, vacillating between 20 and 40 years.

2. *The Age of Receding Pandemics* when mortality declines progressively; and the rate of decline accelerates as epidemic peaks become less frequent or disappear. The average life expectancy at birth increases steadily from about 30 to about 50 years. Population growth is sustained and begins to describe an exponential curve.

3. *The Age of Degenerative and Man-Made Diseases* when mortality continues to decline and eventually approaches stability at a relatively low level. The average life expectancy at birth rises gradually until it exceeds 50 years. It is during this stage that fertility becomes the crucial factor in population growth.

It can be seen through the following research that Tunisia is most likely in the third category: “the age of degenerative and man-made diseases”. The degenerative and man-made diseases are thought of most commonly as cardiovascular disease, cancer, Diabetes Mellitus and other chronic diseases. There have been a number of different

studies done in Tunisia to support this claim, backed up with data from the epidemiologic transition in Mauritius.

In the past few years (starting around 2000), there has been an increase in the number of health studies conducted in Tunisia. The majority of these have been focused on basic indicators and cardiovascular disease prevalence. Since increasing prevalence of cardiovascular disease is a good indicator of the stage at which a certain country is at in epidemiologic transition, data arising from said studies can be very useful.

The TAHINA Project (Epidemiological Transition and Health Impact in North Africa) focused on epidemiologic transition from the standpoint of cardiovascular disease and nutrition trends. It contained many different articles concerning chronic and cardiovascular disease risk factors and prevalence. Some of the risk factors for cardiovascular disease include elevated cholesterol levels, hypertension, obesity, Diabetes Mellitus, drinking and cigarette smoking.

There have been studies done by the Institut National de la Statistique (Tunisian National Institute of Statistics) on a number of different areas that may aid in the identification of the health status of the nation. Some of these are basic demographic indicators such as birth rates, death rates and life expectancy at birth, fertility rates and infant mortality rates.

The Tunisian National Institute of Statistics has also done a study on the evolution of the prevalence of contraceptive usage starting in 1988 and performing a study once every 5-6 years until the present. They started an annual study on the different types of family planning methods used since 1991. Some of these include: condom usage,

contraceptive intrauterine devices, birth control pills, and they have included prenatal and postnatal consultations in this section as well.

An interesting phenomenon occurs in high-income countries which have undergone epidemiologic transition where birth intervals are lengthened and there is a decrease in overall reproductive performance. [5] Therefore, one can get a better idea of the state of the transition by looking at indicators such as the infant mortality rate, the under 5 mortality rate and the population annual growth rate (%). These statistics are also available from the Tunisian National Public Health Institute (INSP), and organizations such as WHO and Unicef. WHO was also used as a source for these types of data from Mauritius.

There has been other data compiled by Unicef that included a number of data categories regarding Tunisia that were useful: Immunization, basic indicators and demographic data. Data compiled from Tunisian studies regarding chronic disease compiled by WHO Global InfoBase was also used extensively. The statistics from Tunisian studies on Diabetes Mellitus, cholesterol, high blood pressure, Body Mass Index and tobacco/alcohol use were found here.

Secondary data was obtained from the Oregon State University and Portland State University Libraries as well as several health organization databases, websites of governmental agencies, health organizations and published surveys. Information from scholarly journal articles was also utilized.

Chapter 3

Research Method

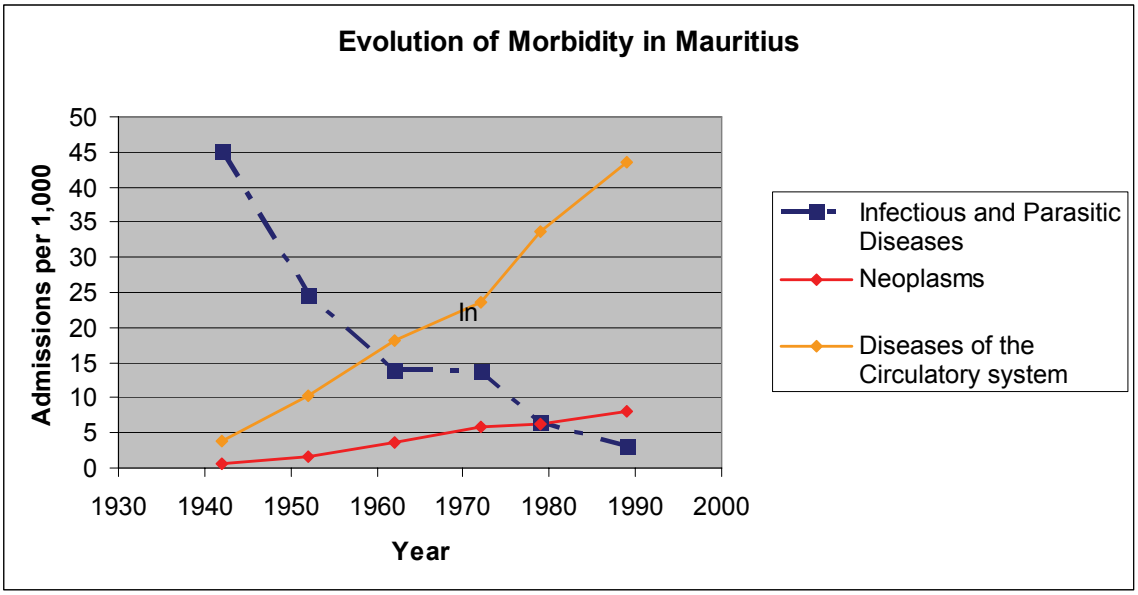
Epidemiologic transition occurs when a population overcomes the position of infectious and communicable diseases constituting the majority of their mortality causes, and begins to experience the problems of modern or non-communicable diseases. There are no clear-cut, established criteria for when a country is at a certain stage of epidemiologic transition. However, one can get a good idea as to how far along a country is in its transition by looking at the history of the leading causes of death within a country. To supplement mortality cause data, the prevalence of non-communicable diseases versus that of communicable diseases, as well as the level of demographic transition which has occurred is also useful to gain a clearer picture of the state of transition.

A common approach is to gather health data that have been gathered at least within the last 30 to 50 years, and observe the changes that have occurred in the causes of mortality and morbidity. In Tunisia's case, this data is not available. So, one option to pursue is to find another country which has documented its transition and has undergone it relatively recently and use it as a reference point for the literature and Tunisia. In this study, Mauritius is that country. Mauritius has a relatively well-documented epidemiologic transition due to health studies that were undertaken much earlier on.

By looking at figure 1, one can see that there is distinct, long-term shift in the disease prevalence in Mauritius. During the 50 year period, the prevalence of communicable (infectious and parasitic) diseases decreases markedly, while the

prevalence of non-communicable diseases (circulatory diseases and neoplasms) increases greatly.

Figure 1: Morbidity Trends in Mauritius (1942-1989)



Source: Kalla, A.C. (1994) "Health Transition in Mauritius: characteristics and Trends" Mauritius Institute of Education.

Another phenomenon occurs in high-income countries which have undergone epidemiologic transition where birth intervals are lengthened and there is a decrease in overall reproductive performance, that is, the population growth rate decreases. One of the reasons for this decrease in reproductive performance is that there is a decrease in mortality rates accompanied by an increase in infant and childhood survival rates. These both occur as socioeconomic and other areas in the population's environment ameliorate. [6] It seems counterintuitive, but as mortality rates decrease, population growth rates begin to decline.

This is thought to be due to several factors. One of these is recognition of improved survival of offspring. Another is that changes in the social and economic system can turn a child into an economic liability instead of an asset. [7] Therefore, one can get better idea of the stage of the transition a country is in by looking at demographic indicators such as the infant mortality rate, the under 5 mortality rate and the population annual growth rate.

To provide a frame of reference for evaluating Tunisia's state of transition, all available pertinent mortality, morbidity and demographic data was gathered concerning Tunis's transition. Then, it was compared with the same data from Mauritius. These data were used as a reference point for Tunis to get a better picture of the epidemiologic transition occurring there. Mauritius has clearly undergone epidemiologic transition. Therefore, one can use its trend and prevalence data as the criteria to evaluate whether Tunis has undergone epidemiologic transition.

Chapter 4

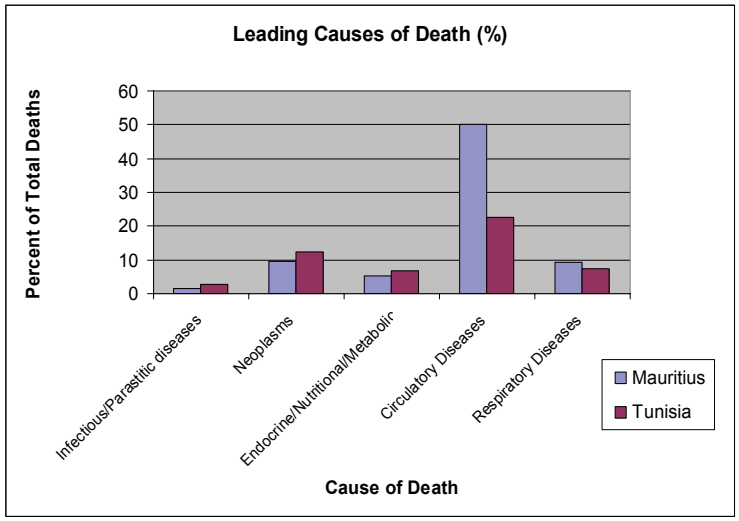
Research findings

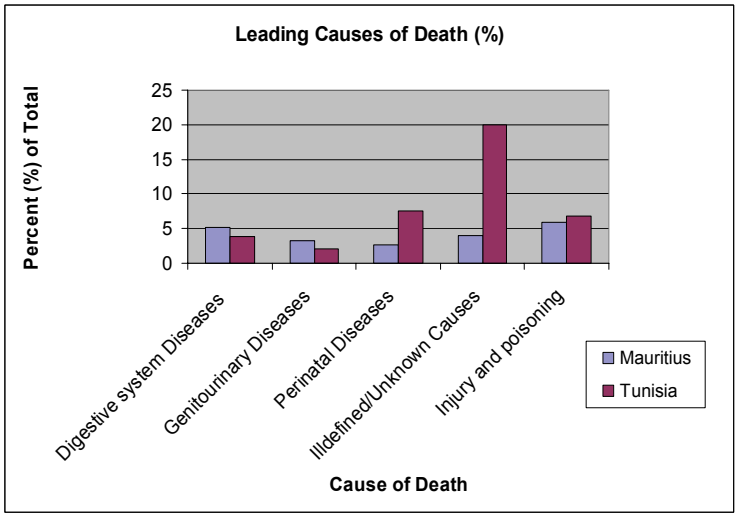
The epidemiologic transition currently occurring in Tunisia is accompanied by a variety of different factors. Data concerning mortality, morbidity and risk factors obtained from Tunisian governmental sources as well as health organizations and special focused studies are presented in this chapter. Certain mortality and morbidity data from Mauritius is compared in order to act as a reference population that has a more complete documented history of transition.

When determining the state of epidemiologic transition it is necessary to assess the prevalence and incidence of existing cardiovascular disease in a population. Yet, there is a lack of systematic monitoring of cardiovascular disease morbidity and mortality in Tunisia and in most of the developing world. The only truly systematic studies that have been done to date in Tunisia have involved risk factors of cardiovascular disease. [8] However, there has been some data on different types of cardiovascular disease prevalence obtained by cardiologists and epidemiologists working on the TAHINA project, in 1992 and 2002.

The main cause of death in Tunisia lies in the 'circulatory disease' category (see figure 1). 22.7% of deaths in Tunisia in 2001 were considered diseases of the circulatory system. Circulatory disease was also the primary cause of death in Mauritius in 1990 (at 41.2%) Circulatory disease mortality rose further and not surprisingly, still made up the highest percentage of the total deaths in 2000 (49.6%).[9]

Figure 1: Leading Causes of Death in Mauritius (2000) and Tunisia (2001)





Source: WHO (2001) and Central Statistics Office, Republic of Mauritius (2000)

The increase in mortality rate due to circulatory disease has been documented in Mauritius, as well. In 1972, the death rate due to diseases of the circulatory system was 214 per 100,000. It progressively increased throughout the next 20 years to 280 in 1992.[10] The age-standardized mortality rate in Mauritius due to all cardiovascular disease (the main contributor to circulatory diseases) was 434 per 100,000 in 2002.[11] We can see that there was a marked increase in the mortality rate due to circulatory system diseases. We do not have data regarding the progression of mortality rate increase of circulatory disease in Tunis during the last 30 years. However, we do know that in 2002, the age-standardized mortality rate due to cardiovascular diseases was 417 per 100,000 (compared to 434, in Mauritius).

Circulatory disease morbidity has been climbing since 1942 in Mauritius. There were 3.9 admissions per 1000 due to cardiovascular disease in 1942, and in following

years it has increased substantially: In 1952: 10.3 admissions/1000, 1962: 18.2, 1972: 23.6, 1979: 33.7, 1989: 43.6. [12]

In 1992, ischemic cardiovascular diseases represented 39.2% of all men admitted to the Tunisian cardiology wards and 15.6% of all women admitted. The rheumatic cardiovascular diseases represented 11.8% and 25.3% of men's and women's admissions, respectively. [13] In 2002, ischemic cardiovascular disease was the primary cause of hospitalizations in Tunisian cardiology wards. 45% of all patients were admitted for ischemic heart diseases, 54% for men and 30.9% for women. Rheumatic cardiovascular diseases only made up 7.4% of hospitalizations, being more frequent in women, respectively 4.9% and 11.7%.[14] (See table 2 and figure 2)

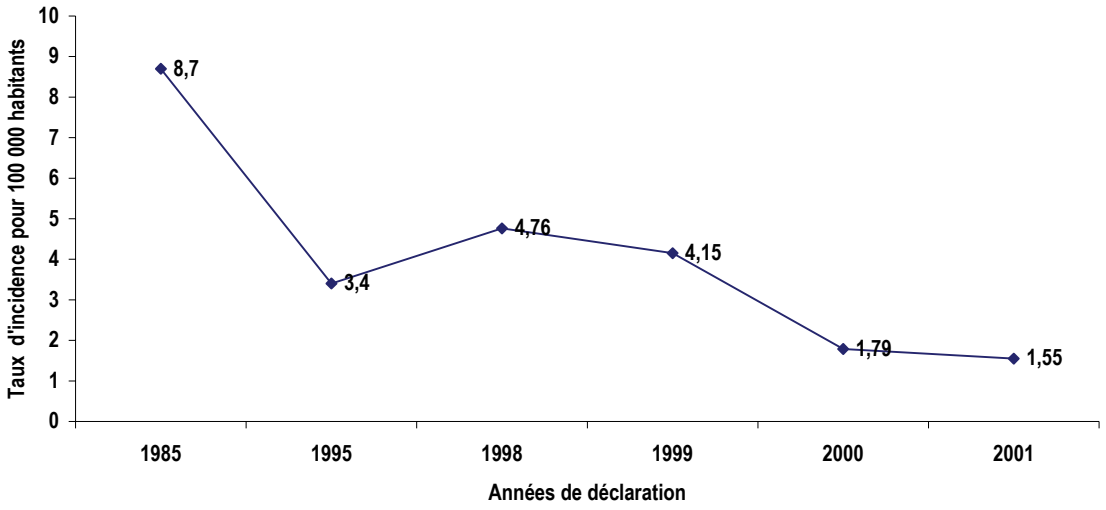
Table 2: Reasons for Hospitalization in Tunisian Cardiology Wards (%) 1992-2002

	Men		**Women**	
	1992	2002	1992	2002
Ischemic Cardiovascular Diseases	39,2	58,6	15,6	38,2
Rheumatic Cardiovascular diseases	11,8	4,4	25,3	11,8
Blood pressure diseases	6,4	6,7	10	14,7
Cardiopulmonary diseases	1,1	0,8	1,2	2,1
Other cardiovascular diseases	34,9	28,4	40,4	35,8

Source: Ben Romdhane, H. "La Transition epidemiologique ses determinants et son impact sur les systemes de sante a travers l'analyse de la tendance des maladies cardiovasculaire en Tunisie." Institut National de Sante Publique. 2002. (graph originally in French)

Figure 2: Incidence of Rheumatic Cardiovascular cases in Tunisia, 1985-2001

Figure 2: Tendence de l'incidence du RAA en Tunisie, 1985-2001

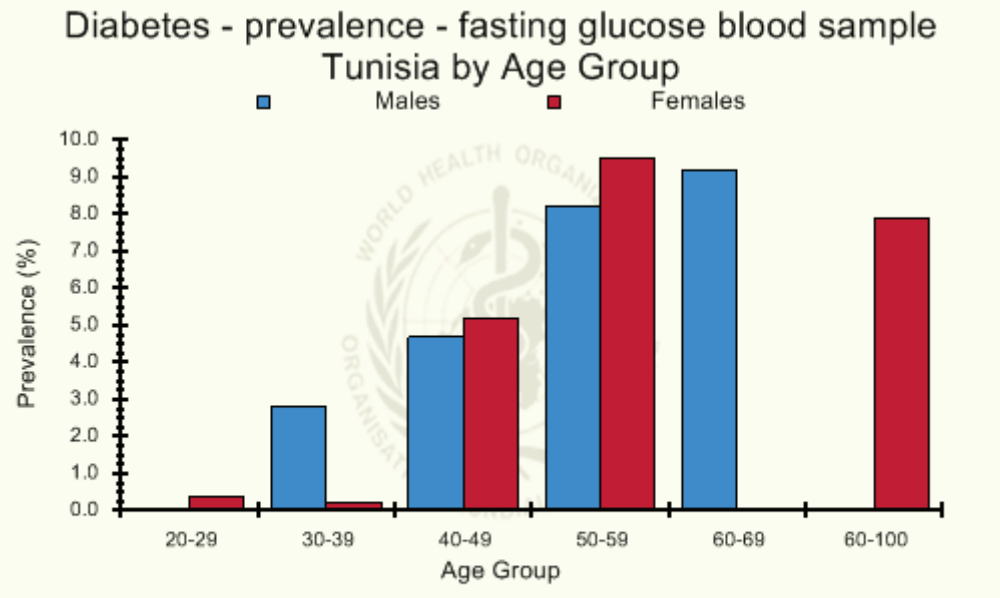


Source: Ben Romdhane, H. "La Transition epidemiologique ses determinants et son impact sur les systemes de sante a travers l'analyse de la tendance des maladies cardiovasculaire en Tunisie." Institut National de Sante Publique. 2002. (graph originally in French)

Some major risk factors for cardiovascular disease include: Tobacco smoke, high blood cholesterol, high blood pressure, physical inactivity, obesity and being overweight, Diabetes Mellitus, hereditary factors and increasing age. [15] The risk factors to be presented in this paper are high blood pressure, diabetes, blood cholesterol levels and obesity and pre-obesity.

One of the earlier studies concerning cardiovascular disease focused on Diabetes Mellitus prevalence in Tunisia in 1988. Diabetes prevalence in men and women in the urban population studies was 4.3% and 5.2%, respectively. [16] (see figure 3)

Figure 3: Diabetes Prevalence (%) in 1988

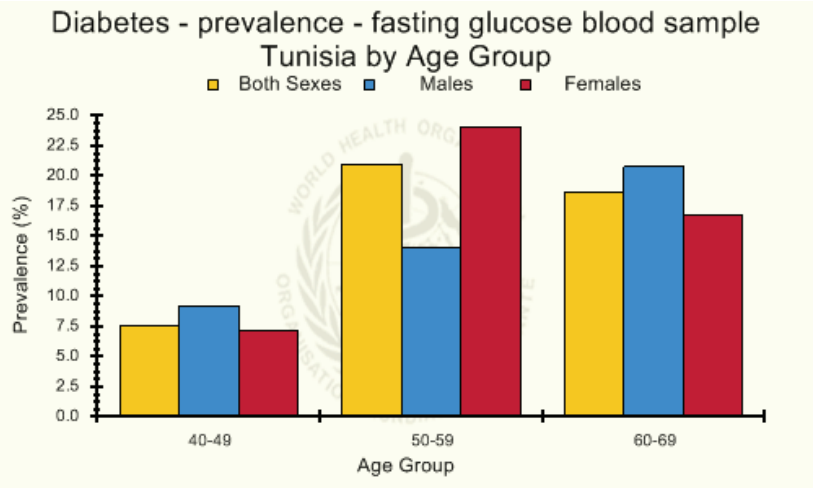


Source: Papoz L et al. Diabetes mellitus in Tunisia: description in urban and rural populations, 1988 (http://www.who.int/infobase IBRef: 100537)

A study performed in 2001 on both urban and rural populations showed a marked increase in the prevalence of diabetes in both Tunisian urban and rural populations around Tunis. (see Figure 4 and Table 3) Males showed a prevalence of 15.7% compared to the earlier prevalence of 4.3%. Females displayed a prevalence of 14.9 compared to the 1988 prevalence of 5.2%. One can see that the prevalence of Diabetes Mellitus from 1988 to 2001 almost tripled.

Diabetes prevalence in Mauritius is incredibly prevalent, although it is on the decline. [17] The percentage of deaths due to diabetes mellitus and hypertensive diseases decreased during the last decade, from 5.1% to 4.6%. This trend could be partly due to the aggressive campaigns made by the Ministry of Health & Quality of Life against these diseases. [18]

Figure 4: Diabetes Prevalence (2001-2001, 2003)



Source: Ben Romdhane H, Achour N. Prevalence des cardiopathies ischemiques dans la population generale: resultats d'une étude populationnelle EPCI, 2000-2001, 2003 (http://www.who.int/infobase IBRef: 101055)

[+] click to enlarge graph

Table 3 : Diabetes Prevalence in 2000-2001

Males

Age Group	Sample Size (n)	Prevalence (%)	95 % CI
40-49	280	9.2	-
50-59	205	14.1	-
60-69	259	20.8	-

Females

Age Group	Sample Size (n)	Prevalence (%)	95 % CI
40-49	493	7.2	-
50-59	329	24.1	-
60-69	270	16.8	-

Source: Ben Romdhane H, Achour N. Prevalence des cardiopathies ischemiques dans la population generale: resultats d'une étude populationnelle EPCI, 2000-2001

Raised cholesterol is another major risk factor in cardiovascular disease. The only data available before 2001 concerning elevated cholesterol levels in Tunisia was a study done among residents of Kalaa Kebira, a semi-urban community near Sousse between 1990 and 1991. The study resulted in the elevated cholesterol prevalence data shown in table 4. The criteria of elevated cholesterol: total cholesterol ≥ 6.2 mmol/L.

Table 4: Prevalence of Elevated Cholesterol in Kalaa Kebira, (1992)

Males

Age Group	Sample Size (n)	Prevalence (%)
20+	221	7.0

Females

Age Group	Sample Size (n)	Prevalence (%)
20+	334	14.0

Source: Ghannem H, Limam K, Abdelaziz AB, Mtiraoui A, Fredj AH, Marzouki M. Facteurs de risque des maladies cardiovasculaires dans une communaute semi-urbaine du Sahel Tunisien *Revue d'Epidemiologie et de Sante Publique*, 1992, 40:108-112

Another study on elevated cholesterol levels performed in 2001 in Tunis and surrounding areas (including both urban and rural populations) showed an increase in the elevated level of cholesterol in both sexes. (See table 5 and figure 5)

Table 5: Prevalence of Elevated Cholesterol (%) in 2001

Males

Age Group	Sample Size (n)	Prevalence (%)	95 % CI
40-49	280	9.4	-
50-59	205	4.3	-
40-69	744	7.4	5.5-9.3
60-69	259	15.1	-

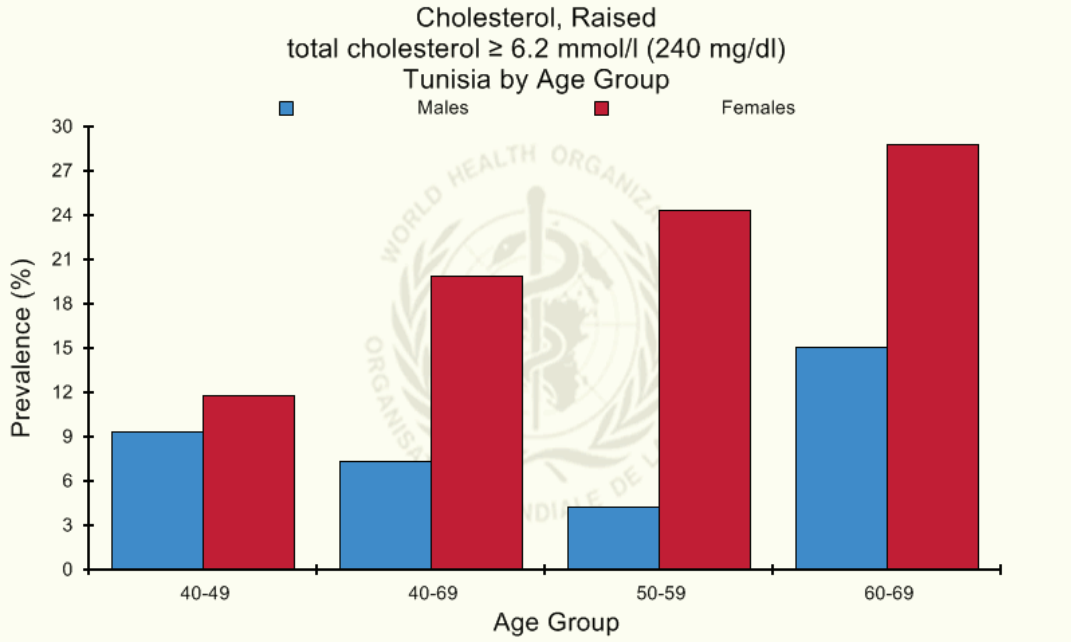
Females

Age Group	Sample Size (n)	Prevalence (%)	95 % CI
40-49	493	11.8	-
50-59	329	24.4	-
40-69	1,092	19.9	17.5-22.3
60-69	270	28.8	-

Source: Ben Romdhane H, Achour N. Prevalence des cardiopathies ischemiques dans la population generale: resultats d'une étude populationnelle EPCI, 2000-2001. L'Institut National de Santé Publique, 2003.

Another major risk factor for cardiovascular disease is tobacco use. There are currently no data available for the prevalence of smoking and its effects on health in the greater Tunis area, however, there is national data available. Mortality due to tobacco in Tunisia was estimated to be 6430 deaths in 1997, much higher in men than in women, (5580 males and 850 females). These numbers of smoking-attributable deaths represent, respectively, 22% of all male deaths and 4% of female deaths. In men, tobacco would be responsible for 3050 deaths by cardiovascular diseases and 1500 deaths by cancer. [19]

Figure 5: Prevalence of Elevated Cholesterol (2000-2001, 2003)



Source: Ben Romdhane H, Achour N. Prevalence des cardiopathies ischemiques dans la population generale: resultats d'une étude populationnelle EPCI, 2000-2001, 2003 (http://www.who.int/infobase IBRef: 101055)

Mortality attributed to tobacco use in Tunisia in 1990 was similar to those of some high-income countries, such as France, where the tobacco caused around 21% of deaths in men and 1% in women. [20] However there are also some developing countries, such as China, who had similar estimated mortality rates (close to 20%) in 1997, due to tobacco use. [21]

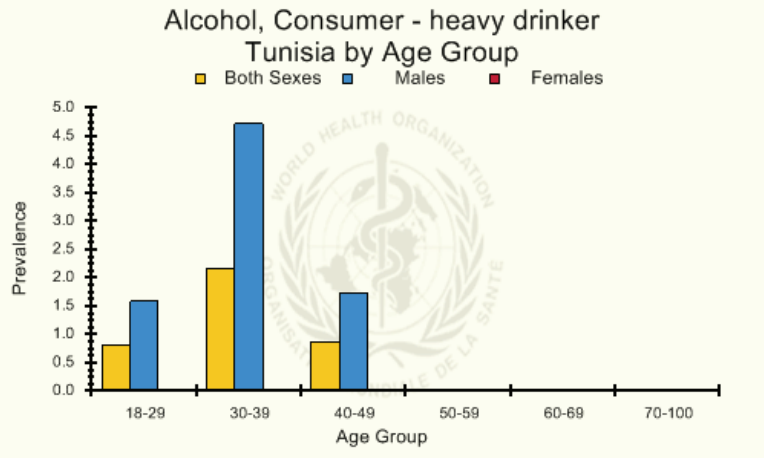
Drinking has also been causally linked to cardiovascular disease, and its abuse is considered a major risk factor. The majority of the population in Tunisia claims Islam as their religion. In the religion of Islam, drinking alcohol is discouraged. Therefore, the prevalence of heavy drinkers (or the perceived prevalence) is lower than that of some

high-income countries,[22] such as western European countries. However, alcohol consumption should not be discounted as a possible factor for cardiovascular disease.

A survey was done by the World Health Organization in 2003 determining prevalence of drinking in Tunis. The criteria for a heavy drinker was >=20g/day for females, >=40g/day for males, within a one week period. The data for the study are found in Figure 6, and Figure 7.

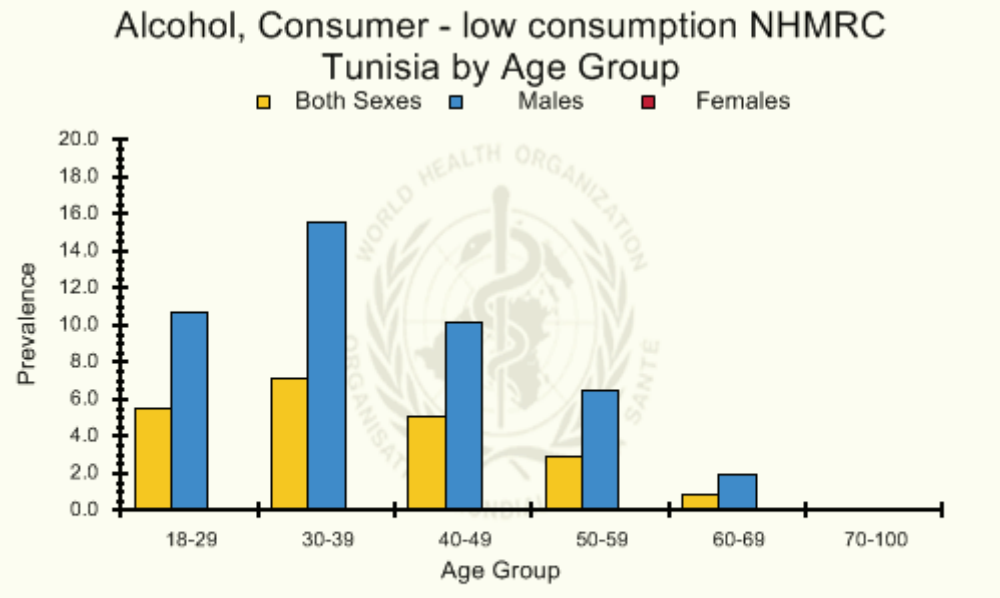
It can be seen that there is a relatively low prevalence of females who consume alcohol in Tunis compared to those of modernized countries, such as the United States [23] and England. [24] According to this study there is a 1.9% prevalence of urban male heavy drinkers and 9.8% of the male population who partake in low consumption. This is compared to zero percent (0%) of the female population in all age groups who partake in low or heavy consumption of alcohol. This data should clearly be evaluated with caution however, due to the cultural stigma surrounding alcohol consumption and the resulting bias possibly present in the study (See chapter 5).

Figure 6: Prevalence of Heavy Drinkers in Tunisia (2003)



Source: World Health Organization. World Health Survey, Tunisia (http://www.who.int/infobase IBRef: 101737)

Figure 7: Prevalence of Low Consumption Drinkers in Tunisia (2003)

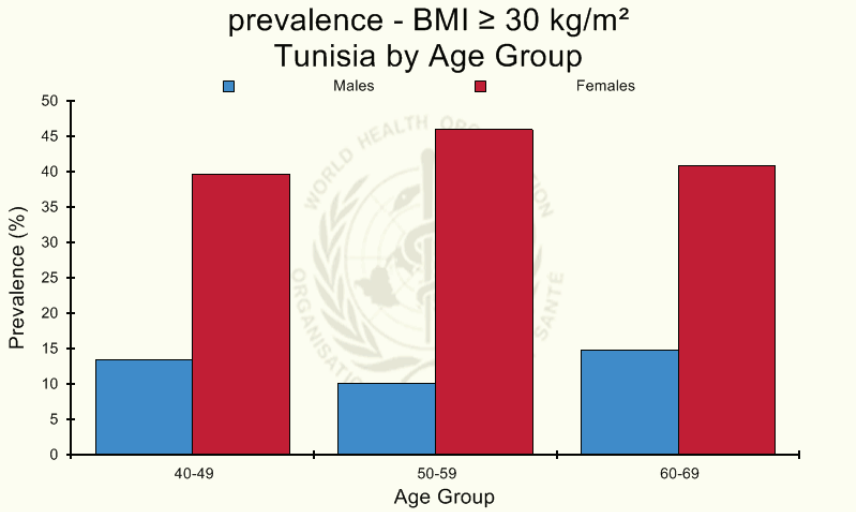


Source: World Health Organization. World Health Survey, Tunisia (http://www.who.int/infobase IBRef: 101737)

Obesity prevalence in the greater Tunis area (BMI≥ 30 kg/m2) rose from 5.9% in 1980 to 11.2% in 1995. Obesity rose in women the fastest. It increased from 8.7% in 1980 to 17.4% in 1995 among women and 2.8% to 4.8% among men. The proportion of people with a BMI between 25.0 and 29.9 (pre-obesity status) increased from 22.4% to 37.4% in the population. Pre-obesity in men rose from 18.7% to 39.3%, and in women, 25.6% up to 35.5%. [25]

There was another study performed during 2000-2001 which focused on determining the prevalence of (BMI≥ 30 kg/m2). The population consisted of middle-aged individuals (n=1837), 40-69 years old. The study was based in and around Tunis with both urban and rural populations participating. See Figure 8 and Table 6 for study results.

Figure 8: Prevalence of BMI ≥ 30 kg/m2 (2000-2001, 2003)



Source: Ben Romdhane H, Achour N. Prevalence des cardiopathies ischemiques dans la population generale: resultats d'une étude populationnelle EPCI, 2000-2001, 2003 (http://www.who.int/infobase IBRef: 101055)

Table 6: Prevalence of Tunisians with BMI ≥ 30 kg/m2 (2000-2001, 2003)

Males

Age Group	Sample Size (n)	Prevalence (%)	95 % CI
40-49	280	13.5	-
50-59	205	10.2	-
60-69	259	14.8	-
40-69	**744**	**13.1**	**10.7-15.5**

Females

Age Group	Sample Size (n)	Prevalence (%)	95 % CI
40-49	493	39.7	-
50-59	329	46.0	-
60-69	270	40.9	-
40-69	**1,092**	**41.9**	**39-44.8**

Ben Romdhane H, Achour N. Prevalence des cardiopathies ischemiques dans la population generale: resultats d'une étude populationnelle EPCI, 2000-2001

High blood pressure is also a major risk factor for cardiovascular disease. In 1976, a study was performed in the greater Tunis area concerning high blood pressure. In the 40-50 age bracket, high blood pressure prevalence was between 19 and 22%, and for the 50-60 age bracket, it was between 25 and 39.4%.[26] These percentages of prevalence have increased dramatically.

There was a study done on elevated blood pressure prevalence in 2000-2001, and 2003 based out of Tunis that included individuals 40-69 years old, from both urban and rural areas (n=1837). The 40-50 year old group of women showed a prevalence of high blood pressure of 25.4% and the 50-59 year old bracket showed a prevalence of 49.8%. (See figure 9 and table 7 for results)

Table 7: Elevated Blood Pressure Prevalence (%) (2000-2001, 2003)

Males

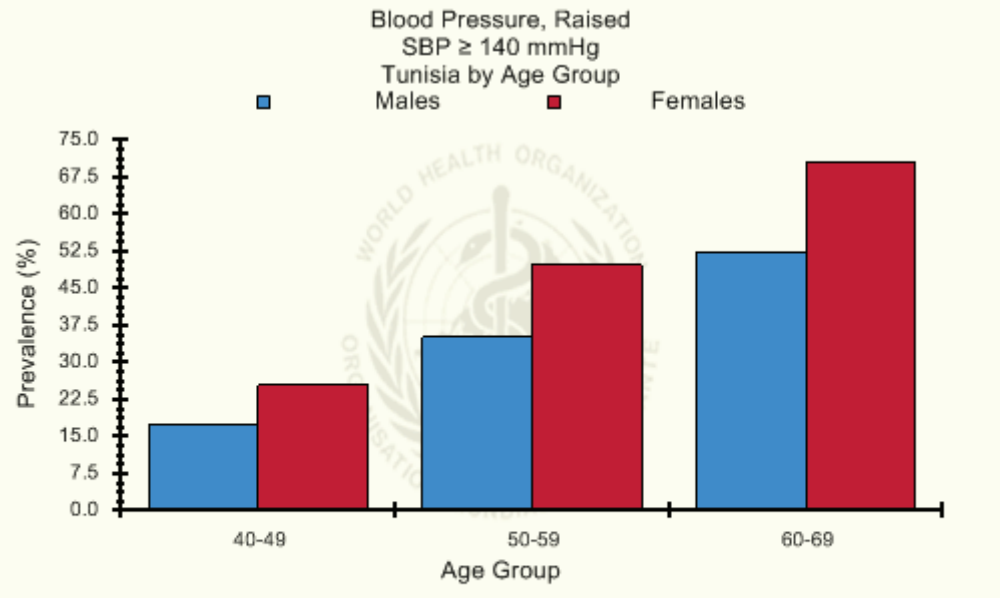
Age Group	Sample Size (n)	Prevalence (%)
40-49	280	17.5
50-59	205	35.1
60-69	259	52.1

Females

Age Group	Sample Size (n)	Prevalence (%)
40-49	493	25.4
50-59	329	49.8
60-69	270	70.7

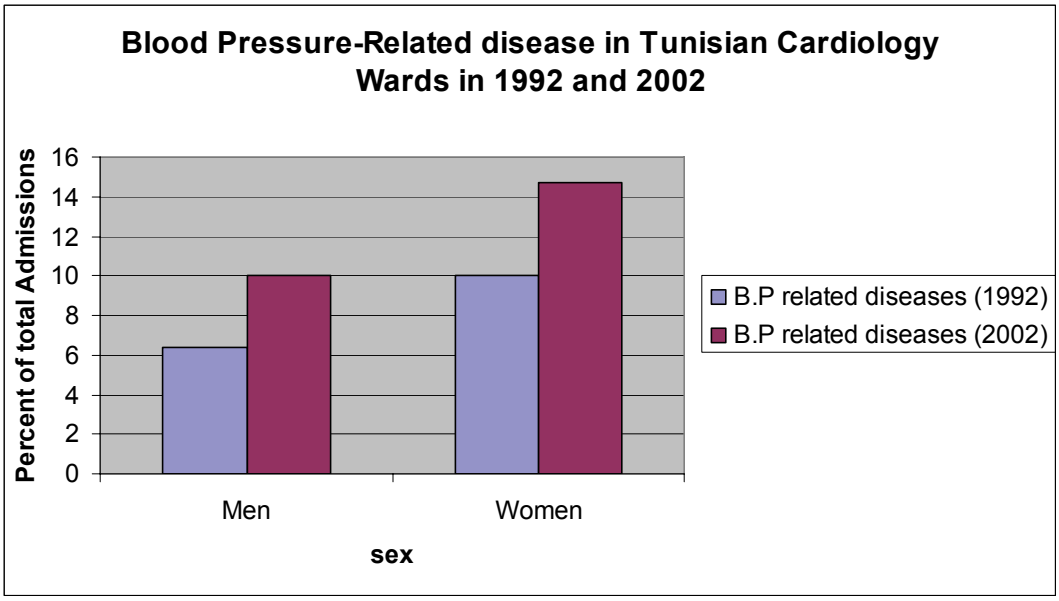
Ben Romdhane H, Achour N. Prevalence des cardiopathies ischemiques dans la population generale: resultats d'une étude populationnelle EPCI, 2000-2001

Figure 9: Elevated Blood Pressure Prevalence (%) (2000-2001, 2003)



Source: Ben Romdhane H, Achour N. Prevalence des cardiopathies ischemiques dans la population generale: resultats d'une étude populationnelle EPCI, 2000-2001, 2003 (http://www.who.int/infobase IBRef: 101055)

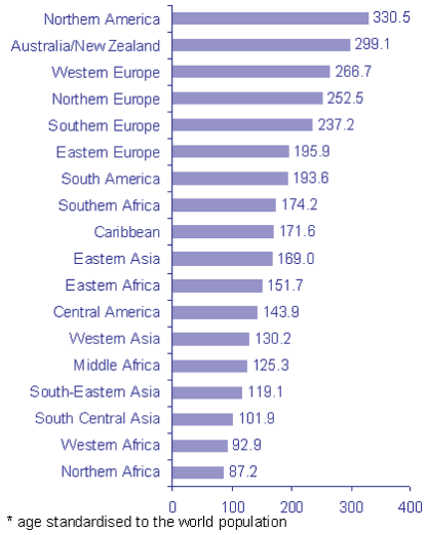
Figure 10: Blood Pressure Related Disease



Source: Ben Romdhane, H. "La Transition epidemiologique ses determinants et son impact sur les systemes de sante a travers l'analyse de la tendance des maladies cardiovasculaire en Tunisie." Institut National de Sante Publique. 2002

Cancer, another chronic, non-communicable disease is responsible for the second highest percentage of deaths in Tunisia. It also shares many of the same risk factors as heart disease. However, Tunisia still has one of the lowest cancer prevalence percentages compared to the rest of the world, especially in developing countries. (see figure 11) Female cancer incidence rates are highest in the USA, Israel and New Zealand and lowest are in Tunisia, Gambia and Oman. [27]

Figure 11: International Cancer Incidence by Region



Source: International Agency for Research on Cancer

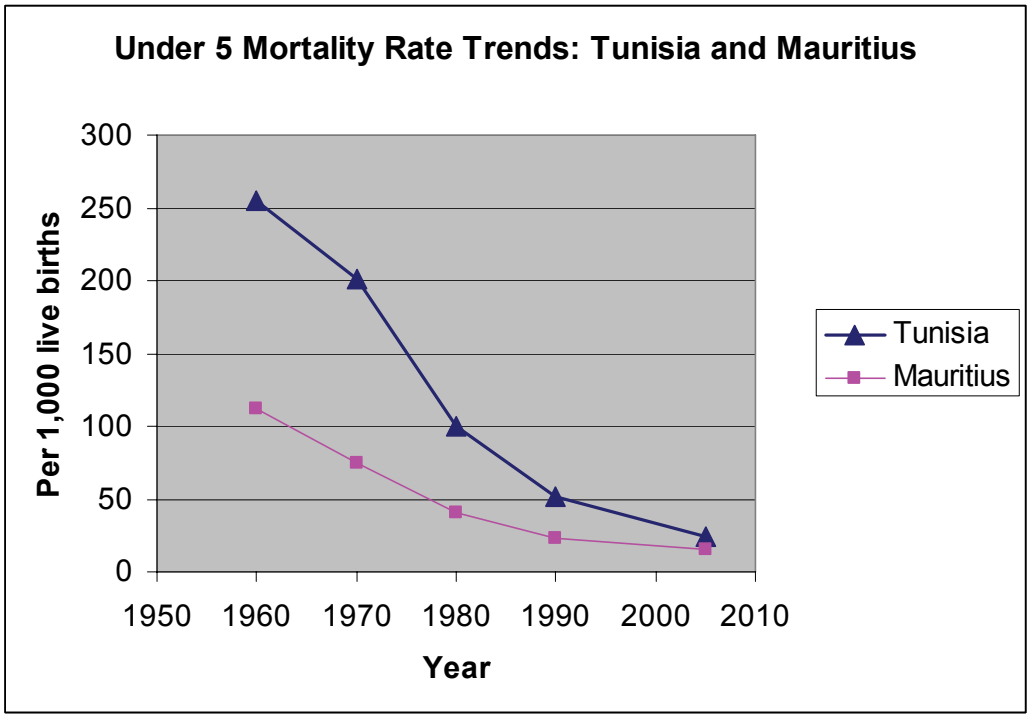
The top three cancers for men in high-income countries are lung, prostate and colorectal cancers. In lower income countries, the top three cancers for men are lung, stomach and liver cancers.[28] Tunisia's top three cancers are lung, stomach and bladder. [29] By looking at cancer incidence rates, we can see that Tunisia has not experienced as high a level as most high-income countries have, the United States, and Western Europe, as examples. [30]

Mautitius has a well-documented increase in cancer morbidity over the past 65 years. In 1942, there were 0.6 admissions per 1,000. In 1952, 62 and 72, it rose to 1.7, 3.7, and 5.8, respectively. By 1989, it had risen to 8.0 admissions per 1,000. [31] From 1989 to 1996, there was another study done, and it was discovered that there were 7,442 new cases of cancer, that is an annual average of 930. About 41.6% were males. For the period 1997 to 1998, 2,484 new cases were diagnosed, that is an annual average of 1,242. Tunisia's current age standardized mortality rate for cancer is at 78.0 (per 100,000 population), incredibly close to Mauritius, with 79.0 (both rates observed in 2002). [32]

Tunisia's basic indicators have ameliorated greatly within the last 30 years. One of the indicators, the under 5 mortality rate has dropped drastically. The under 5 mortality rate is defined as the probability of dying between birth and exactly five years of age expressed per 1,000 live births. In 1960, the under 5 mortality rate was 255. In 1970: 201, 1980:100 and by 1990, the Under 5 mortality rate was 52. In 2005, it had shot all the way down to 24. [33] It is clear that there is an ongoing pattern of reduction in the rate.

This is also evident in Mauritius. (see figure 12) In 1960, the under 5 mortality rate was 112 (less than half that of Tunisia at the time). In 1970, it had decreased to 75, in 1980: 41, 1990: 23, in 2000: 18, and by 2005, it had decreased to 15. We can see that Mauritius is slightly ahead of Tunisia in the decrease of the under 5 mortality rate. The U.S., further yet on its development had a under 5 mortality rate of 8 in 2005. [34]

Figure 12: Under 5 Mortality Rate Trends



Similarly, the infant mortality rate in Tunisia has halved in number. The infant mortality rate is reported as the number of live newborns dying under a year of age per 1,000 live births. The IMR in Tunisia in 1990 was 41, and by 2005 it had dropped to 20.[35] The Infant mortality rate decrease has been well documented in Mauritius. It went from 60.1 (per 1,000 live births) in 1962, to 32.9 in 1979, to 26.3 in 1986, to 18.4 in 1992 and in 2005 it was recorded to be 13.5. Tunisia seems to be trailing somewhat behind Mauritius, as in some other categories.

We can see that both Tunisia and Mauritius have not reached the endpoint in this area of epidemiologic transition when we compare them to high-income countries, such as the United States with infant mortality rate of 7.0 (2005).[36] Yet, similarly to the under 5 mortality rate, both are clearly making impressive progress.

Medical advances and public health initiatives in Tunisia have also greatly affected the rate and level of transition occurring. An example of this has been the push for immunization in Tunisia. Immunization against polio, diphtheria and hepatitis are occurring for 96% of Tunisian children. Immunization efforts lead to a decrease in communicable disease prevalence and corresponding decrease in under 5 mortality rate and infant mortality rate.

One may assume that as infants and toddlers experienced increased survivorship, and that there is a higher fertility rate, there would be a surge in the population. This does occur and is occurring in many developing countries around the world.

However, after this initial spike in the population growth rate, it often falls, as Tunisia's has. (see table 8) This drop can be explained by several different types of factors: Biophysiologic, Socioeconomic, Psychologic. A major biophysiologic factor contributing to the decrease in fertility is the fact that "prolonged lactation associated with reduced mortality among infants and toddlers and parental recognition of improved childhood survival tend to lengthen birth intervals and depress overall reproductive performance." [37]

Socioeconomic factors that lead to a decrease in fertility are things such as improved nutrition and sanitation. Contraceptive prevalence increases may also play a role. All of these factors may indirectly lead to a decrease in population growth rate by changing the economic factors that make children and economic liability rather than a benefit. [38]

Table 8: Demographic Statistics in Tunisia throughout the last 35 years

Population annual growth rate (%), 1970-1990	2.4
Population annual growth rate (%)1990-2005	1.4
Crude death rate, 1970	14
Crude death rate, 1990	6
Crude death rate, 2005	5
Crude birth rate, 1970	39
Crude birth rate, 1990	27
Crude birth rate, 2005	16
Life expectancy, 1970	54
Life expectancy, 1990	69
Life expectancy, 2005	74
Total fertility rate, 2005	1.9

Source: Unicef and WHO

Psychological or emotional factors that can contribute to a decline in fertility and population growth are the knowledge that children will survive past the parents and efforts to "make up" for lost children will decrease in number [39] We can see that Tunisia may have well been affected by these factors, due to the fact that its "life expectancy at birth" has increased dramatically within the last 35 years. In 1970, the "life expectancy at birth" was 54 years old. In 2000, it had risen to 74 years old. (see table 8) The life expectancy has also increased markedly in Mauritius. In 1960, life expectancy was only 59 years old. However, by 2000 it had increased to 69.

The demographic statistics show that the total fertility rate in Tunisia has decreased significantly; from 7.04 in 1960 to 2.32 in 2000.[40] Unicef noted that Tunisia had a fertility rate of 1.9 in 2005. Mauritius has showed a similar trend. It claimed a

fertility rate of 5.97 in 1960 and it had decreased to 2.05 by the year 2000. [41] Nearly all of the high income countries have fertility rates of 2.1 or fewer children per woman, roughly the level of fertility needed for population replacement through natural increase [42] In terms of fertility rate, Tunisia, along with Mauritius, has reached that of many high-income countries.

Discussion

Chapter 5

There were large constraints on the data required for this undertaking. The fact that there was an extreme lack of mortality and morbidity data before 1990 in Tunisia made the project much less concrete, and more reliant on data from other countries, ie Mauritius.

One factor that should be considered when evaluating the majority of the data concerning populations in Tunis is that most populations studied were receiving public healthcare. However, there are increasing numbers of private practices in the Tunisian health system. [43] These may definitely skew the data due to the fact people of lower socioeconomic status make up the majority of people who receive public healthcare.

There is a possibility that the disease prevalence statistics could also be skewed due to this fact. The majority of people who go to private practice probably are eating more nutrient rich diets and have lifestyles and consequently diseases, more closely related to those people in high-income countries, ie chronic diseases. Another weakness of morbidity statistics is the comparability over time as diagnostic means improve.[44] Therefore, the data from Mauritius should be handled with caution as the technology and diagnostic capabilities have made major changes within the longer periods of time in which mortality and morbidity were studied.

Another possible bias in the data, particularly in the alcohol consumption surveys should be considered. The official religion of Tunisia is Islam, with 98% of the population claiming to be Muslim.[45] This can be compared to 16% of the Mauritius population claiming Islam as their religion.[46] Islam strongly discourages alcohol consumption and consequently,

this may have an effect on survey participant responses. In the WHO survey performed in 2003 referred to in Chapter 4, zero percent of the female population (of all ages) interviewed had consumed alcohol within the specified time frame of the study. While alcoholic consumption by women is especially frowned upon, it does exist, as I have seen it occur various times in Tunis. Therefore, the validity of this study, (and others) should be further analyzed with a critical eye.

Large socioeconomic development and medical advancements have been made within Tunisia in the past 30 years. Primary medical care has been advanced greatly, and many infectious diseases have been curbed by major public health initiatives, such as the national vaccination program, the fight against diarrhea, the program against respiratory infections, as well as the advances in perinatal care. [47] It is now necessary to shift the energy and resources used to alleviate those communicable diseases to non-communicable diseases which are becoming more detrimental to the overall health of Tunisians.

The largest contributor to the communicable disease burden in Tunisia is cardiovascular disease. A huge surge in mortality due to cardiovascular disease occurred in the 1950s and 1960s in modernized countries, such as the United States and several western European countries.[48] These high-income countries have implemented programs to decrease the prevalence of heart disease. While cardiovascular diseases are still the main cause of death in high-income countries, their rates are decreasing.

Tunisia can be compared with the aforementioned western countries which are late in the transition or have already undergone it, and should consider a national strategy with increased emphasis on primary prevention (rather than secondary or tertiary prevention) in order to curb the increasing mortality rates due to communicable disease,

especially those associated with cardiovascular disease. According to the World Health Organization, the most cost-effective methods of reducing risk among an entire population are population-wide interventions, combining effective policies and broad health promotion policies. There should be Tunisian government support for allocation of a larger percent of resources to strengthen the involvement of families and communities, and perhaps the private sector with the aims of combating the current surge in chronic diseases.

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