PROJECTION OF THALASSEMICS IN KHYBER PAKHTUNKHWA

Saima Wazir[1], Zafar Zaheer[2]

[1,2] Institute of Management Sciences, Peshawar - Pakistan.
Address for correspondence:
Dr. Zafar Zaheer
Assistant Professor, Institute of Management Sciences, Peshawar - Pakistan.
Email: zafar.zaheer@imsciences.edu.pk
Date Received: November 17, 2015
Date Revised: July 18, 2016
Date Accepted: August 17, 2016

ABSTRACT

Objective: To predict the number of thalassemics in Khyber Pakhtunkhwa.

Methodology: In the first step, of estimating the patients and carriers of the disease, population projection is done with cohort component method of analysis. Pakistan Demographic Surveys conducted by Pakistan Bureau of Statistics was used to collect the data for projection of the total population. Then the output of population projection was used to analyze the number of thalassemics in the total population. Hardy-Weinberg Analysis, a technique adopted from genetics, was used to identify the number of thalassemia major and thalassemia minor patients in the population.

Results: There are an expected number of 647 children with thalassemia major each year. Similarly, 35,054 individuals will be added to the population, each year, which may carry thalassemia genes.

Conclusion: With the increasing population the number of thalassemia affected individuals is increasing in the region.

Key Words: Thalassemia, Cohort component method, Hardy-Weinberg analysis

This article may be cited as: **Wazir S, Zaheer Z. Projection of thalassemics in Khyber Pakhtunkhwa. J Postgrad Med Inst 2016; 30(4): 323-7.**

INTRODUCTION

Thalassemia is a genetic disorder in which the patients are dependent on blood transfusions and regular treatment for the rest of their lives. To make the matters worse, the disease is inherited from the parents and cannot be treated easily. The rate of thalassemia varies in different regions, broadly, it ranges from 2.2%-16% of the total population in different countries around the world[1]. However, the increasing prevalence indicates that the population will not be able to shoulder the economic cost or the psychological burden of the life-long suffering inflicted due to thalassemia. The time has now come to probe the population for prevention of thalassemia in the future and involve public itself in seeking medical help[2]. Reports state that in the coming years, 95% of the total thalassemics around the world will be hosted by Asian, Indian and Middle Eastern regions[3]. Therefore, this research is conducted to project the segment of population that is affected by thalassemia. For this purpose, population is projected on a whole with the help of cohort component analysis. After the population is projected, Hardy-Weinberg analysis is applied on the output to calculate the number of the affected individuals in the coming years. The same procedure can be used to calculate the proportion of thalassemia affected population in the future for policy making.

Projection of such population segments that have high disease prevalence is of importance in ensuring that they are provided with such services and support as required to enable them to live a healthier life[4]. Projecting such instances can put the government on alert as they could direct the resources and services in such sectors efficiently and effectively[5].

Due to the inherited nature of the disease, the current research is not only focus on the projection of the population but also the estimation of the major and minor thalassemia cases. This quantitative research has successfully applied genetic models for the prediction of Major/minor cases of halassemia and provided population projection up to 2022. The findings of the research may help the policy makers in policy making to prevent the spread of the disease. The aim of the research was to predict the number of thalassemics in Khyber Pakhtunkhwa.

METHODOLOGY

There are a number of methods that are used around the world for projecting population for different purposes. Some of them are growth rate methods, time series analysis, micro simulation and cohort component method. One of the determining factors for choosing any of these methods is the purpose of projection.

The focus of this study is to project the thalassemia affected population of Khyber Pakhtunkhwa. For this purpose, first of all, the total population of KP is calculated and then within that, the number of thalassemics is estimated.

Cohort component model (CCM) is chosen to project the overall population. This model allows for cohorts (characteristics based groups) such as age and gender etc. while projecting the future population[6]. Once the projection is done with the help of CCM, a categorized population in subgroups of age-sex cohorts is achieved. Cohort Component method is also suitable here because it helps to project population in the future for short intervals of time i.e. in five year segments. This data can then be targeted for future population planning and other health policies.

Population projection with Cohort component method is done with the help of the following formula:

$$P_t = P_{t-1} + B_{t-1,t} - D_{t-1,t} + M_{t-1,t}$$

where: P_t = population at time t;,P_{t-1} = population at time t-1; $B_{t-1,t}$ = births, in the interval from time t-1 to time t;$D_{t-1,t}$ = deaths, in the interval from time t-1 to time t; and$M_{t-1,t}$ = net migration, in the interval from time t-1 to time t.

The next step of analysis is to estimate the number of thalassemia affected individuals in the population. To ensure that updated information on the number of thalassemic patients is available, a recent estimate of populations is required. However, in Pakistan the census data is available only until 1998, whereas Demographic Survey data is present up to 2007. Both these databases are out dated. Therefore, population is projected for 2012 with the help of 2007 data and then prevalence of thalassemia is measured among them. This is done to compare the projected data with the government estimate of the total population.

Thalassemia, unlike other diseases, is genetically inherited. Hence, the usual disease projection models cannot be applied here. Genetic model of estimation is most suitable here. One of the models that specifically focus on identification of genetic disease inheritance from parents to children in case of two alleles presence is Hardy-Weinberg Equilibrium. It is suitable for the purpose thalassemia can be inherited only in case double alleles are present in parents of the future thalassemia patients. In order to calculate the number of thalassemics in the projected population, Hardy Weinberg analysis is used.

The equilibrium can be understood with the help of the following equation, which is fit for a population that has random mating patterns.

$$p^2 + q^2 + 2pq = 1$$

p in this equation report the normal population, q stands for the homozygotes (also referred to as thalassemia major patients), whereas, 2pq report the number of heterozygotes i.e. the carriers of a genetic disease.

In Pakistan however, random mating is not observed therefore coefficient of inbreeding denoted by F needs to be incorporated in the equation, i.e.,

$$(p^2 + Fpq) + (q^2 + Fpq) + 2pq\ (1-F) = 1$$

In this case the first factor $(p^2 + Fpq)$ measures the number of thalassemia major patients, whereas the last component i.e. 2Fpq gives results for thalassemia carriers.

For projection of population secondary data for stationary population divided per age-sex cohort, number of deaths, number of children born, number of women in the reproductive age and sex ratio are collected. With the help of these variables, mortality rate, survival rate, fertility rate and migration rates are calculated according to World Bank definitions of these variables[7]. To calculate these rates; the data for these variables is collected from Pakistan Demographic Survey published by Pakistan Bureau of Statistics for 2001, 2003, 2006 and 2007. Information required for application of Hardy Weinberg Equilibrium, was adopted from previous research studies. Calculating them in itself is out of the scope of this research study therefore, their adoption from others' findings is a more suitable option.

RESULTS

Table 1 here shows the projections for the coming 10 years divided into age cohorts of the population.

The last two columns in the table indicate the population projected in the next 10 years for Khyber Pakhtunkhwa. This projection is done in five-year intervals and presents the total population divided in the age cohorts of the population. Adolescents and younger population is significantly higher than the older members of the region.

After projecting the population broadly, the number of thalassemics that are added to the population are reported in table 2.

DISCUSSION

The projected number of thalassemia major and minor is an alarming number. With the increase in population, the number of major and minor children are also increasing and hence a larger population at risk.

Analyzing the projection of population of KP for 2012, the number of children born with thalassemia may be both thalassemia major (patients) and thalassemia minor/carriers (table 2). The distinction of these

Table 1: Projected population of Khyber Pakhtunkhwa

Age	2012	2017	2022
<4	3202317.605	3431408.458	3784758.297
5-9	3854242.317	4102402.945	4399327.201
10-14	3498570.912	3651206.131	3936778.383
15-19	2810401.509	3116844.434	3269112.835
20-24	1967824.029	2202276.092	2462742.664
25-29	1464077.514	1605954.482	1796110.531
30-34	976874.7045	1119514.464	1244232.185
35-39	957940.3149	968692.3546	1117047.362
40-44	849632.4955	870815.0928	900746.8577
45-49	837434.6506	878054.3751	914006.5822
50-54	645771.8329	700586.6831	741562.6337
55-59	513487.4192	578999.5429	630194.9239
60-64	471389.5786	458693.8549	513450.1338
65-69	370975.5967	390830.0818	384552.8914
70-74	239864.2368	280388.1007	296969.6705
75-79	115931.7353	121860.2816	144302.7439
80-84	88860.63447	114859.646	121029.3068
85+	97464.57973	159108.0928	258930.616
TOTAL	22963061.67	24752495.11	26915855.82

Table 2: Number of thalassemia patients and carriers

Calculating the number of thalassemics								
Thalassemia Major	Population	Carrier rate	P	Q	F	p2+ Fpq	Annual Births	Thalassemic Patients
	22963061	7	0.035	0.965	0.0165	1.225	527634	647
Thalassemia Carrier	Heterozygous	Carrier rate	P	Q	F	2pq(1-F)	Annual Births	Thalassemia Carriers
	22963061	7	0.035	0.965	0.0165	66.435	527634	35054

two is important because it is the marriage of the carriers that result in the birth of thalassemia major (there is a 25% probability that a children born to thalassemia minor couples may be thalassemia major patients). Hardy-Weinberg Equilibrium deals with the genetic disease that is transmitted from parents to children with two gene alleles. Thalassemia is also such a disease in which both the parents as carriers transmit the disease to their children only if they marry another carrier, with 25% probability. Adopting the segregated population into age-sex cohorts is not necessary here because the disease may affect anyone whose ancestors may carry thalassemia genes. Information on carrier and prevalence rate of thalassemia in KP is required for projection of thalassemics. Carrier rate is reported as 7% in KP[8]. "p" represents the carrier rate of the gene responsible for transmission of the disease. As mentioned above, the affected gene is transmitted in case both the parents are gene carriers, so p equals 3.5%. However, q on the other hand represents normality in transmission. Another matter of interest is the pattern of mating in the population. It may be that the carriers do not reproduce with other carriers, or it may be that mating is random. In Pakistan, especially Khyber Pakhtunkhwa, the trend is more inclined towards consanguineous marriages. This means that there is a higher possibility of marriage between off springs of the same ancestors, thus, car-

riers marrying each other. This is measured quantitatively with the help of inbreeding coefficient denoted by F. F-value is adopted from researches conducted previously in the province. It is reported to be 0.0165[9]. With the help of Hardy-Weinberg analysis, the formulae for calculation of both thalassemia major patients and thalassemia minor carriers are calculated in the form of their prevalence[10]. The results reveal that there are an expected number of 647 children with thalassemia major. Similarly, 35,054 individuals will be added to the population, each year, which may carry thalassemia genes.

To verify the projections from cohort component method, the first five year projection is done till 2012. These projected values can be compared with the official estimates of the provincial population. According to estimates Khyber Pakhtunkhwa hosted 22-23 million of individuals in 2012[11]. According to our model, a total of 22.96 million individuals are projected in 2012. This synchronizes with the official estimates, confirming that results for succeeding years can be relied upon. It should be noted that, taking longer intervals for projection is neither feasible for Cohort Component method of projection, nor is it advisable for the purpose of future planning. One should have the projections for the intervals in which different plans cannot only be made, but implemented and monitored as well. Any length of interval longer than this will give rise to inaccuracies whereas a shorter interval is not feasible for policymaking. The age cohort of interest in this research is the population between 0-20 years of age. It is in this age group that prevalence of thalassemic patients is observed. Life expectancy of thalassemics in Pakistan is expected up to 30 years of age. On the other hand Khyber Pakhtunkhwa does not have standard health facilities required for management of the disease. It may be this reasons that life expectancy in this region falls as compared to the rest of the country.

These children would require standard thalassemia treatment to live a healthy life. If these individuals are not made aware of the challenges they may face during reproduction, they may have to face the misery of supporting a thalassemia patient. The disease burdens a family not only financially but socially and psychologically as well. Zaheer, et al[12] reported that the parents and families of the affected children go through many psychological and financial problems, such as anxiety, worries about the future of the affected child, availability of blood and their marriages. An effective policy to prevent the disease and release the social and economic burden is required to deal with such situations. Similarly, the lack of knowledge and awareness about the chronic disease is a hurdle in thalassemia prevention[13].

CONCLUSION

With the increasing population of Khyber Pakhtunkhwa the prevalence of thalassemia is increasing. Projection of population shows that a total of 647 individuals with halassemia major and 35,054 with thalassemia minor are born every year if the health and population demographics remain the same.

RECOMMENDATIONS

Keeping in view the Knowledge of the masses and the alarming increase in the major/minor cases, the government is required to take the required steps to ensure that awareness about the disease is created and parents are informed about prenatal tests which can help them in early detection of disease in their child. Further decision should be facilitated with the help of genetic counseling. However, most of these facilities are unavailable in the region and needs attention of the policy makers.

ACKNOWLEDGEMENT

This research paper is written as a result of the data collected during a project funded by Higher Education Commission (HEC) of Pakistan. We are thankful to HEC for funding the project, "Persistence of Thalassemia in Joint Family System, Khyber Agency."

REFERENCES

1. Thalassemia International Federation. Activity Report 2012.
2. Rahman M, Lodhi Y. Prospects and Future of Conservative Management of Beta Thalassemia Major in a Developing Country, Pakistan Journal of Medical Sciences 2004; 20(2)
3. Weatherall D J, Clegg J B. Inherited haemoglobin disorders: an increasing global health problem. Bull. World Health Organ 2001; 79: 704–712.
4. Marshall A. Developing a methodology for the local estimation and projection of limiting long term illness and disability, Doctoral Dissertation submitted to School of Social Sciences, University of Manchester 2009.
5. Siegel J. Applied Demography. London, Academic Press 2002.
6. Jiang B. Better Long-Term Population Projection Method: A Case Study for Canberra Suburbs. Thesis submitted to The Department of Computer Science Australian National University 2017.
7. http://databank.worldbank.org/data/reports.aspx?-source=world-development-indicators 2015.
8. Khattak A ., Taj A S, Shah S, Khattak,M F. Clinical And Haematological Presentations Of Haemoglobin E Disorders From Northern Pakistan, Journal of Medical Sciences 2013; 21: 134-136.
9. Wahab A, Ahmad M. Biosocial perspective of consanguin-

eous marriages in rural and urban Swat, Pakistan. Journal of Biosocial Sciences 1996; 28(3):305-313.

10. Ahmed S. An Approach for Prevention of Thalassemia in Pakistan. Thesis submitted to Department of Obstetrics and Gynaecology, University College London Medical School, University of London 1998.
11. Khyber Pakhunkhwa Government. Home Department Estimates. 2013
12. Zaheer Z, Zaman Q, Hameed B, Wazir S, Iqbal M. Knowledge, Attitude and Practices with relevance to thalassemia. J. Med. Sci. 2015;23:109-112.
13. Zaheer Z, Wazir S, Hameed B, Zeeshan S, Zaman Q, Iqbal M. Psychological burden in β-thalassemia affected families. J Postgrad Med Inst 2015; 29(4): 260-3.

CONTRIBUTORS

ZZ conceived the idea, planned the study and critically reviewed the manuscript. SW helped acquisition of data and did statistical analysis. All authors contributed significantly to the submitted manuscript.