

Use of Geographical Information System within Web-Based Saudi National Diabetes Registry

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Abstract

Because diabetes is an extremely common disorder in Saudi Arabia, the National Diabetes Registry was designed by King Saud University Hospital, Diabetes Center in collaboration with King Faisal Specialist Hospital and Research Center in the year 2001. The registry was designed to provide information on the extent and nature of specific types of diabetes, diabetes complications and treatment of diabetes in Saudi Arabia. Using a secured login module, over 41,000 cases have been registered in the web-based registry database as of December 31, 2007. In order to give a better, geographical insight into the registry data, an Internet mapping facility has been incorporated into the registry software. This Internet Mapping Service allows the users to query the distribution of diabetes patients within the Kingdom of Saudi Arabia along with spatial data. The key feature is the availability of "real-time" patient data for patient-related queries, which was made possible by establishing a direct connection "Open Database Connectivity" with the SQL Server database.

1. Introduction

With the explosion of Internet availability, web-based applications became extremely popular, especially in cases where distributed centers needed to enter, update and analyze information stored in one centralized place. Therefore, disease registries were one of the best candidates to be enhanced as Internet-enabled applications as they serve an important role in the support, investigation and application of emerging treatments and technologies in health care, and in the study of various diseases and treatments. The Saudi National Diabetes Registry (SNDR) is a joint project of King Saudi University Hospital (KSU) and King Faisal Specialist Hospital & Research Center (KFSH&RC). Currently the registry is registering patients from several hospitals in Riyadh. This is a pioneering registry in its field and will serve as an outstanding central source to improve the understanding and treatment of the Diabetes mellitus (DM). Specifically, the SNDR aims to:

- Estimate the prevalence and incidence of DM among Saudis.
- Identify geographic or family clusters of the disease.
- Monitor temporal changes in pattern of diabetes.
- Study the demographic characteristics of affected patients.
- Evaluate the different treatment regimens used in Saudi Arabia.

- Find and monitor the secular trend of the disease and its complications and deaths from the disease over the years.
- Provide the Ministry of Health and medical researchers with timely and accurate epidemiological and clinical data needed for planning purposes and research in the clinical and basic sciences.
- Identify modifiable behavioral risk factors needed for intervention programs to delay undesirable outcomes of the disease and to promote education and treatment for all persons with DM.

So far over 41,000 diabetes patients' data have been acquired and stored in the centralized database. The collected data include demographics, various type of diabetes, patient history of the disease, family history of diabetes, medical history, complications, associated diseases, family structure and treatment methods. Based on the information gained from this initial assessment a patient is classified into the proper type of DM. Every effort has been made programmatically in the software to match patient identifiers, so that a diabetic case is counted or registered only once in the registry. The registry has already been quite useful in recognizing the burden of disease in cost, disabilities due to complications and mortality. In this paper, discussion is based on the technical aspects of the design and development of a GIS functionality programmed within the

SNDR so that it might provide guidelines to similar disease registries to be designed elsewhere.

2. Materials and Methods

The web-based SNDR application has an embedded mapping functionality that allows users to query “real time” patient data in the form of maps. A sophisticated mapping software from ESRI namely, ArcIMS 9.0 (Internet Mapping Services) has been incorporated within the SNDR. A few maps are published using ArcPublisher as well. In order to provide dynamic data to the researchers, various views have been created on the SQL database. Queries are written to join the patient data with the geographical data in order to display the final results

on the maps. Figure 1 shows a list of all maps embedded within SNDR. Initially all maps were created using ArcMap version 9.0. These maps were then uploaded on the web server. An Open Database Connection (ODBC) is established for a live connection with the database residing on the web server. This connection is used within ArcMap software, thereby providing dynamic registry data from the views created on the SQL Server. Several maps showing comparison of diabetic complications, treatments, and diabetic population are designed and published. Following are some of the examples of the designed maps. These maps can be viewed using ArcReader from ESRI.

<ul style="list-style-type: none"> • <u>Population w.r.t Diabetic Patients</u> • <u>Age Distribution</u> • <u>Type of Diabetes</u> • <u>Diabetes Complications</u> • <u>Diabetes Associated Diseases</u> • <u>Diabetes Treatment</u> • <u>Regional Diabetic Population</u> 		
Complication	Treatment	
<ul style="list-style-type: none"> • <u>Vasculopathy</u> • <u>Nephropathy</u> • <u>Neuropathy</u> • <u>Retinopathy</u> • <u>HBP</u> • <u>HLiPD</u> • <u>With medication</u> • <u>Without medication</u> 	<ul style="list-style-type: none"> • <u>Diet</u> • <u>Regular Insulin</u> • <u>NPH Insulin</u> • <u>Mixed Insulin</u> 	
	Age Distribution	
	<ul style="list-style-type: none"> • <u>Below 19 years</u> • <u>Between 19 -39</u> • <u>Between 40 -59</u> 	<ul style="list-style-type: none"> • <u>Between 60 - 79</u> • <u>Age 80 and above</u>
Misc. Maps	Type of Diabetes	
<u>Diabetes Mortality</u>	Initial	Current
<u>Map Query Tool</u>	<ul style="list-style-type: none"> • <u>Type I</u> 	<ul style="list-style-type: none"> • <u>Type I</u>
<u>ave Family History</u>	<ul style="list-style-type: none"> • <u>Type II</u> 	<ul style="list-style-type: none"> • <u>Type II</u>
<u>Distribution of Females</u>	<ul style="list-style-type: none"> • <u>GDM</u> 	<ul style="list-style-type: none"> • <u>GDM</u>
<u>Distribution of Males</u>	<ul style="list-style-type: none"> • <u>Secondary</u> 	<ul style="list-style-type: none"> • <u>Secondary</u>
<u>Patients by Regions</u>	<ul style="list-style-type: none"> • <u>IGT</u> 	<ul style="list-style-type: none"> • <u>IGT</u>

Figure 1: List of GIS maps



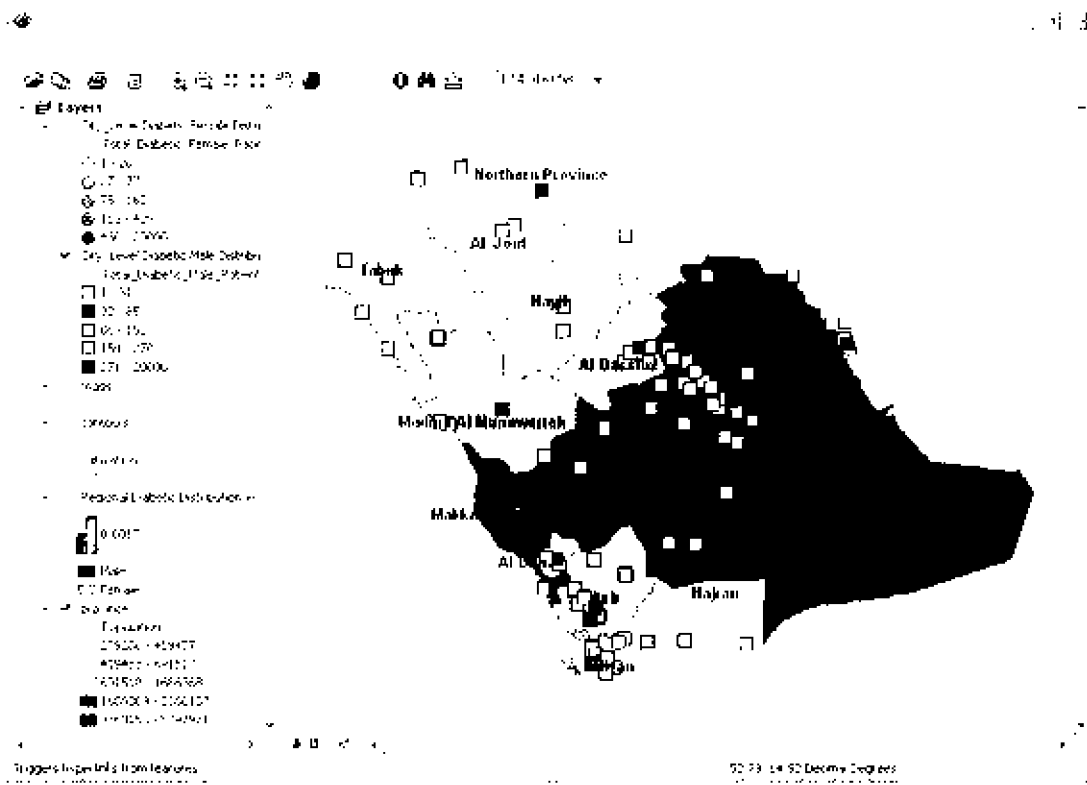


Figure 2: City-level distribution of patients with respect to gender

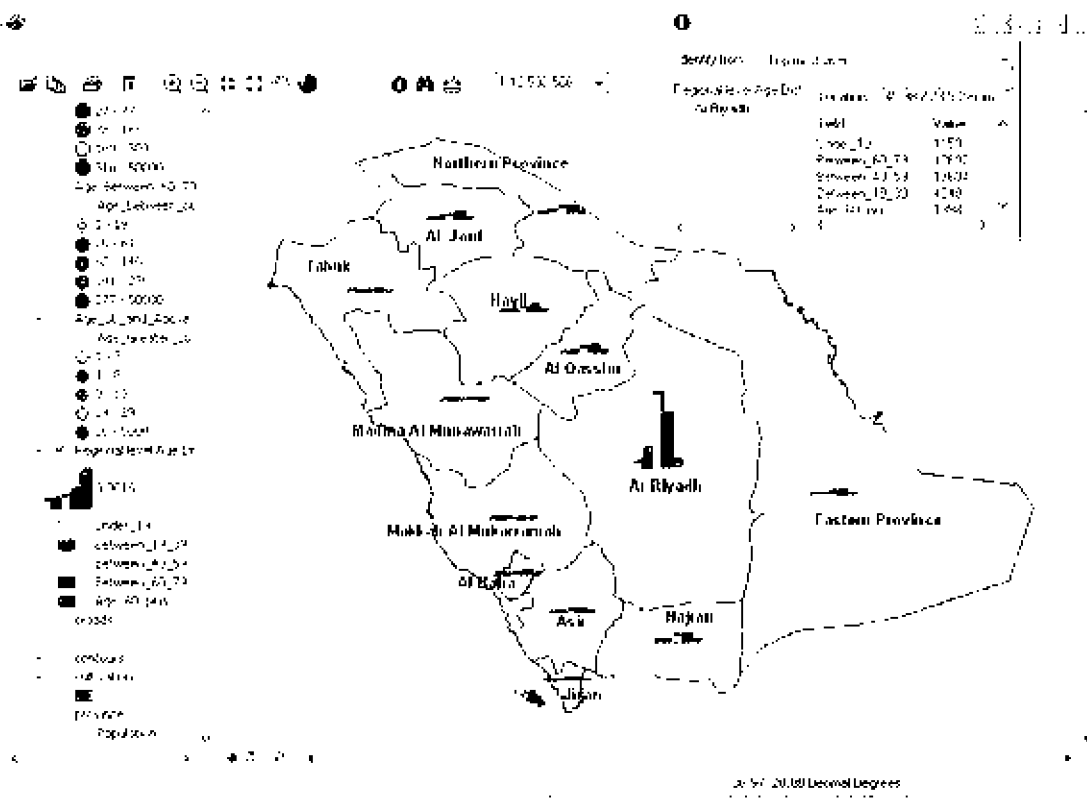


Figure 3: Regional distribution of patients with respect to age

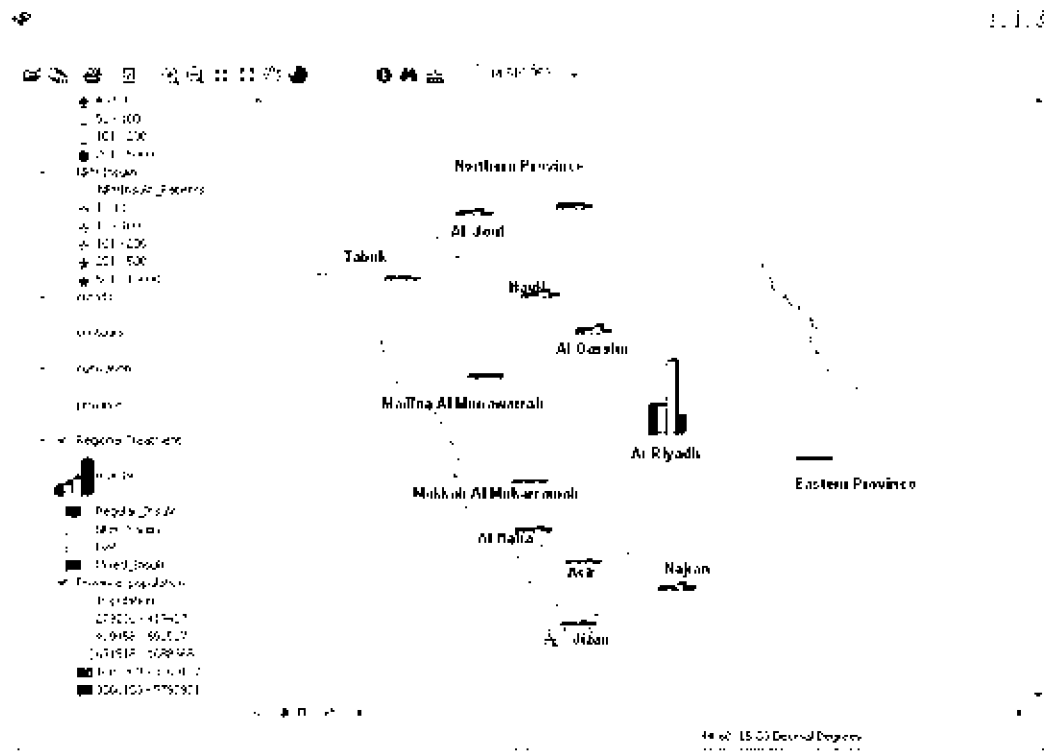


Figure 4: Regional comparison between various treatment regimens provided to registered diabetic patients

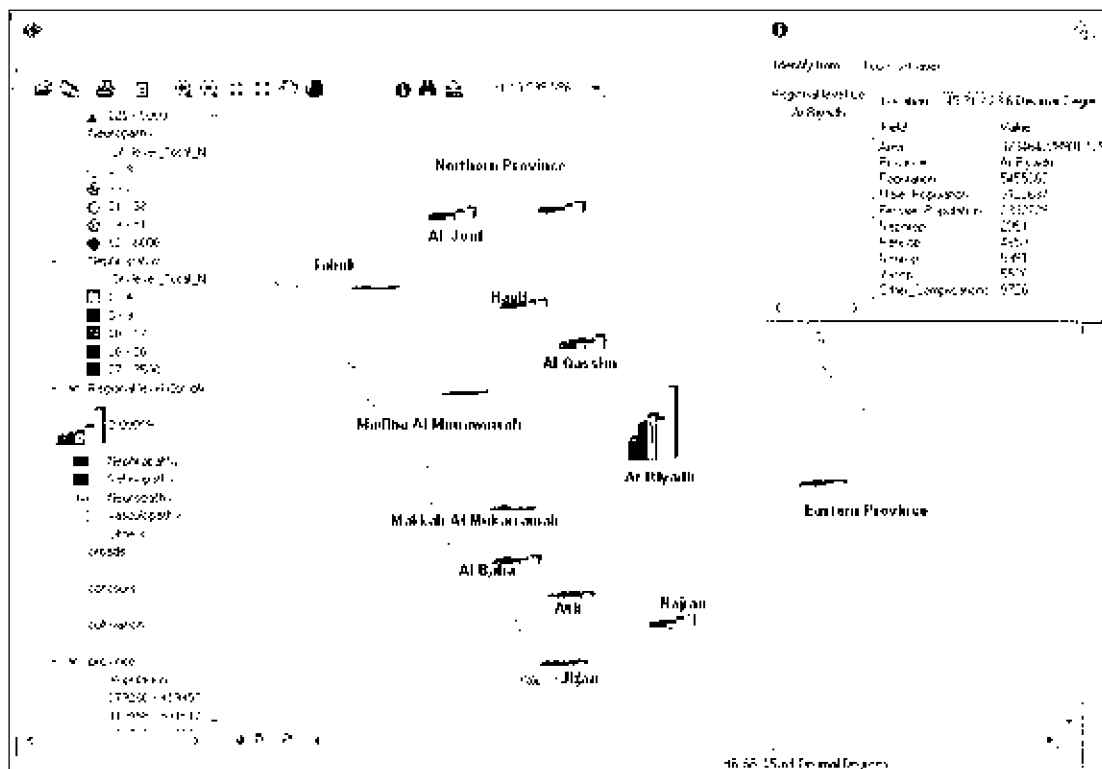


Figure 5: Regional comparison between various diabetic complications among registered diabetic patients.

From Figure 1, clicking any of the links, e.g., "Initial Type I", will result in the display of a map in a new browser window (ArcIMS viewer) as shown in Figure 6. The tools available in the left panel of ArcIMS viewer allow querying the displayed nodes to see the data. (Shown in table marked with an arrow). Another dynamic way of querying patient data was developed using ArcIMS with additional programming and is given the name "Map Query Tool" This option is accessible from the list shown in Figure 1.

User-defined queries on the right panel of Figure 7 allow users to select parameters and see the results from the live data with cities highlighted to indicate the presence of patients. This is reflected in Figure 8. Clicking on the City ID displayed in the resulting table will list the patients from that city with their demographic details as shown in Figure 9. All resulting maps have a built-in toolbox with ArcIMS viewer, which can be used to manipulate the features of the map.

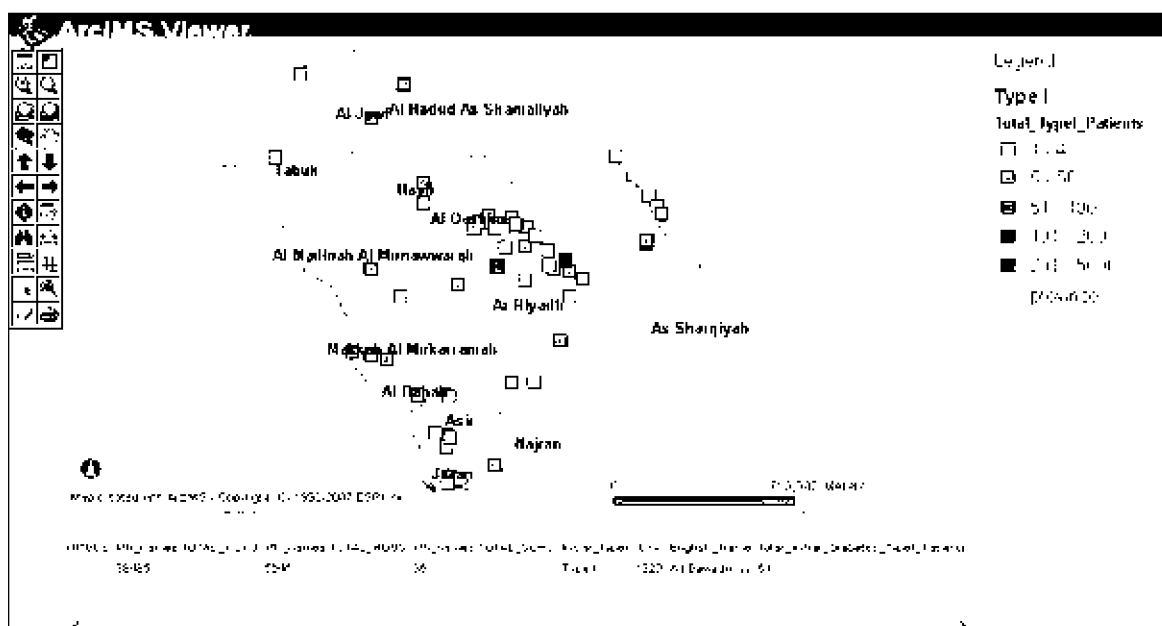


Figure 6: Map showing distribution of type I diabetic patients per city

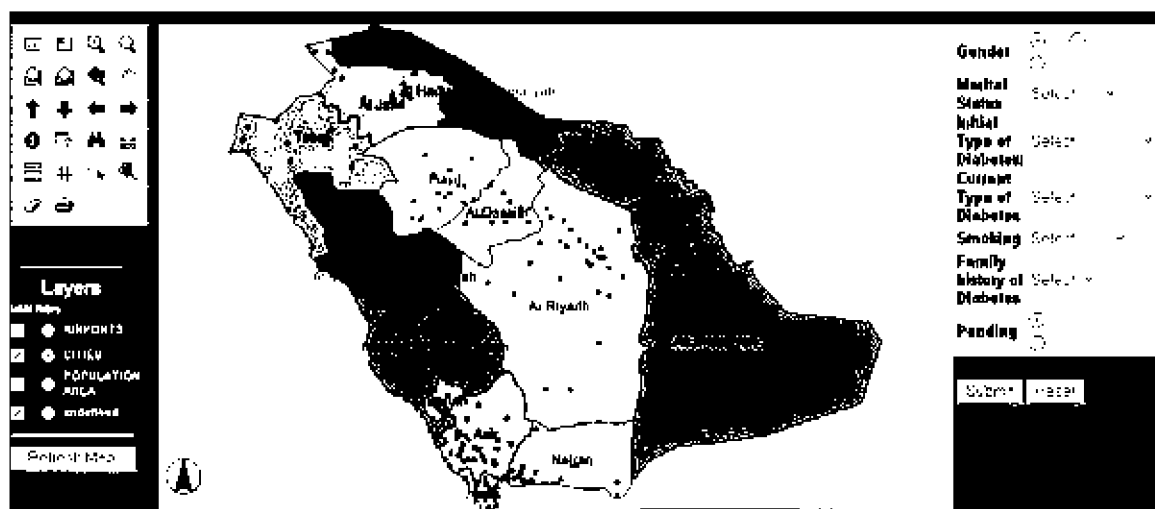


Figure 7: Map query tool

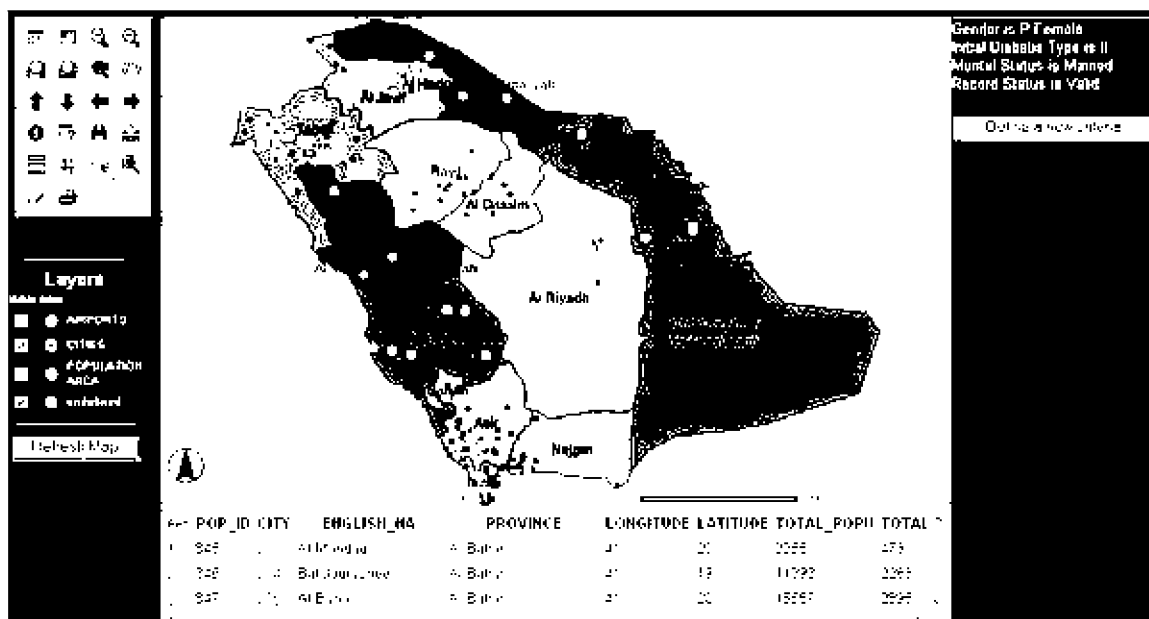


Figure 8: Map showing query results on city level

RESULTS: Found 2 records that match your criteria.

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National ID Number.	MRN	Serial #	Patient Name	Gender	DOB	Age	Age (Onset)	Initial Diabetes Type	Postal Code	Tel
1039545817	698407	1004393	Azza Abdulaziz Ali Ghamdi	Female	7/2/1924	83	61	2	999999	99-4315772
1050014107	694494	1004357	Azza Ahmad Abdulrahman Ghamdi	Female	21/11/1930	77	69	2	999999	99-4991924

Note: Data is not available for any purpose other than "View only"

Figure 9: Tabular results from the map

3. Discussion

As a very strong query tool, GIS is helpful in:

- Identifying, locating and grouping illnesses with people, places and activities.
- Developing a plan to improve the quality of care.
- Initiating control measures to halt the spread of disease.
- Increasing accessibility of service.
- Finding more cost-effective delivery modes.
- Preserving patient confidentiality while satisfying the needs of the research community for data accessibility.

The SNDR started at the end of the year 2000. Most of the new patient registration was done in 2001. More than 41,000 patients have been registered to

the centralized database with exact reflection of patient data along with geographical features thereby providing an interactive dynamic tool for the researchers and administrators to study the pattern of disease along with required resource allocation plans. Since SNDR is an on-going research project, collaboration from hospitals all over Saudi Arabia is progressing effectively.

4. Conclusions

The availability of data in a centralized form allows health researchers to analyze geographic, ethnic, occupational and other differences that provide clues, which point to the risk factors. The data also help to determine where early detection, educational or other intervention programs should be directed.