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The Massachusetts Cancer Control Evaluation Project demonstrates how data from diverse sources can be integrated and analyzed geographically to assess cancer screening efficacy and to design effective interventions.

Year 1 project activities focused on examining the distribution of breast cancer in Massachusetts and throughout the US, analyzing census demographic data, and compiling data sources in preparation for statistical modeling.

Year 2 activities have focused upon completion of the statistical model. In addition to the socioeconomic variables created from our measurement modeling of the census tract measures, other known covariates were analyzed in Year 2. Spatial scan statistical techniques were utilized to examine the distribution of stage at diagnosis of breast cancer cases, and identify areas of the state with clusters of late-stage diagnoses. Data sets analyzed were incorporated into a mapping software package, allowing the user to view geographic representations of data distributions. This technique can be used to identify localities in need of cancer screening services, assess the sociodemographic characteristics of the localities' residents, and assist public health officials in tailoring interventions for these populations.

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INTRODUCTION:

Purpose

This study describes a system to assess the efficacy of breast cancer screening. Since direct measures of screening are not available, this project uses proxy measures based on diagnostic staging. The information provided by this system can be used by public health officials not only to identify geographic regions where screening is inadequate, but also to identify and characterize the educational, economic, and racial/ethnic background of citizens residing in these regions and to tailor interventions to fit the characteristics of the local population. The system for conducting such an assessment would also provide concomitant information about the location of mammography units, display data geographically on maps, and allow for querying of the displayed data so as to obtain information on any location.

Background

Breast cancer is the leading cancer among Massachusetts females and has accounted for 30.9% of all newly diagnosed cancer cases between 1982 and 1992. Further, there has been an alarming rate of increase in diagnosed cases, prompting state government officials in May 1992 to declare the disease an epidemic. Between 1982 and 1992, the age-adjusted incidence rate has increased 30.3%, from 90.0 cases per 100,000 females to 117.3 cases per 100,000 females.

Since there is no effective primary prevention strategy for breast cancer, secondary prevention, through mammography screening and early detection, remains the only way of controlling breast cancer and improving survival. Screening has been shown to reduce breast cancer mortality 30 to 40% among women aged 50 and older (Collette, 1992; Shapiro, 1982; Habbema, 1986; Chu, 1988). A large scale randomized controlled trial in Sweden reported a 30% reduction in breast cancer mortality for women aged 40 or older attributable to mammography (Tabar, 1985 and 1992).

Researchers from the University of Massachusetts Medical Center conducted an assessment of the effectiveness of a multicomponent intervention in two communities to increase utilization of breast cancer screening by women over 50 years of age (Zapka, 1993). They found dramatic improvement in both intervention and control groups and concluded that participation in screening was a rapidly rising secular trend. Our efforts were directed at monitoring screening efficacy across the entire state of Massachusetts.

Our surveillance system builds upon those of Kerner (1984) and Andrews (1994). Kerner and his colleagues examined geographic variation in disease incidence and mortality in relation to census variables in an attempt to target screening programs, while Andrews and his colleagues combined mortality and census data to target cancer screening programs on a geographic basis. Our system integrated data from a cancer registry with data from the census, along with other health information such as location of mammography screening sites, into a single geographical information system (GIS). Dangermond (1990) defined a geographical information system as "an organized collection of computer hardware, software, geographic data

and personnel to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced information". Maguire (1991) argues that "it is the ability to organize and integrate apparently disparate data sets together by geography which make GIS so powerful. The spatial searching and overlay operations are a key functional feature of GIS." Some elements of the GIS used in this study are diagrammed in Figure 1 and described below.

Previous Work

Year 1 activities focused on examining the distribution of breast cancer in Massachusetts and throughout the US. Using data from Massachusetts, Connecticut, California and the National Cancer Institute's Surveillance, Epidemiology and End Results program, we explored trends in cancer incidence, staging, mortality and mammography screening, and began integration of these data sources. Project staff also analyzed census data, prepared population data for multiple geographic units of analysis and time periods, and examined correlations between various socioeconomic factors. Additionally, we compiled a master file of data sources in preparation for developmental modeling, and began the statistical modeling.

BODY:

Methods

Since January 1, 1982 all new cases of cancer diagnosed in Massachusetts residents have been reported to the Massachusetts Cancer Registry (MCR), a Division of the Massachusetts Department of Public Health. Each report to the registry is recorded on a standardized form to obtain comparable information from case to case about the type, histology and stage of the disease. Forms also include demographic information, including the patient's age, race, occupation, smoking status, and address at the time of the diagnosis. For this study, breast cancer cases diagnosed between 1982 and 1992 were aggregated by census tract and integrated with geographical information, such as the location of 1177 census tracts, the location of 351 minor civil divisions (MCDs)[1], the location of 296 mammography machines at 218 sites, and the boundary files for each of 27 Community Health Network Areas (CHNAs)[2]. Breast cancer data were aggregated into two five-year periods, 1982-1986 and 1987-1992. While data from the first period was used to demonstrate the system and to identify areas of high or low screening efficacy, substantive findings and the consistency of those findings over time can be cross-validated with data from the second period. As diagrammed in Figure 1, data were also

[1] MCDs are equivalent to the 351 incorporated cities and towns in Massachusetts. Although the data in this paper have been aggregated at the level of the census tract, it is possible to disaggregate further to the block group level, or aggregate to the MCD level.

[2] CHNAs are a Massachusetts Department of Public Health designation for aggregations of cities and towns. CHNAs are used to develop health networks consisting of consortia of health care providers, human service agencies, schools, churches, advocacy groups and members of the public of all ages. These networks identify and assess health needs in their communities, and evaluate responses to these needs. The major foci of the networks are increasing access to care, efficiency of health services, and communication and collaboration among health care and human services providers in the area.

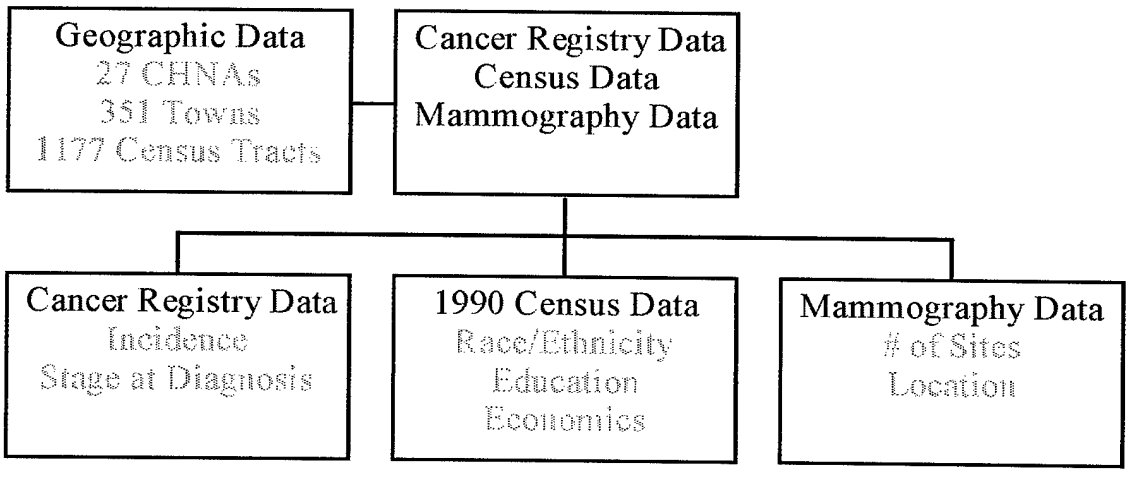
extracted from the 1990 Census so that tracts could be characterized according to a variety of social, economic, and demographic indicators, such as educational attainment, race/ethnicity, per capita income, employment levels, and the distribution of occupational categories.

Measures

Accurate measures of mammography screening are not generally available. A Wisconsin study compared levels of mammography screening using data from the Behavioral Risk Factor Surveillance System (BRFSS) to data from records of mammography sites. The two data sources showed similar trends, but large and consistent discrepancies in terms of the actual number of mammograms performed (Lantz, 1995). Estimates of screening from BRFSS data consistently overestimated rates of screening by about 20% as compared to data obtained from the mammography sites.

Since direct measures of screening are generally not available, this project uses proxy measures. One proxy measure suggested by Roffers and Austin (1993) is based upon the proportion of cases diagnosed at an *in situ* or localized stage. Boss and Suarez (1990) also suggested using the ratio of *in situ* diagnoses to all invasive cases as a measure to evaluate screening programs. Roffers and Austin maintain that if at least 5% and up to 15 or 20% of newly diagnosed cases are *in situ* for a community, mammography screening can be judged as satisfactory. The MCR began collecting data on cases diagnosed at the *in situ* stage in 1992 (previously, only invasive cancers were required to be reported). Stages used in analysis are: Stage 1 (localized disease), Stage 2 (regional spread of disease), or Stage 3 (remote or metastatic disease).

Figure 1. Elements of a Geographic Information System (GIS) for Breast Cancer Control Evaluation.



We chose to aggregate cases and data at the census tract level because use of higher levels, such as towns or CHNAs, would mask the broad variation found within towns and within CHNAs. We computed the proportion of female breast cancer cases in each census tract in Massachusetts diagnosed at Stage 1, Stage 2, or Stage 3. Assuming that earlier diagnosis reflects better screening, tracts with higher proportions of Stage 1 cases (localized disease at diagnosis) were seen as having better screening than tracts with lower proportions of Stage 1 cases. Conversely, census tracts with higher proportions of Stage 3 cases (remote or metastatic disease at diagnosis) were seen as providing poorer levels of screening than tracts with lower proportions of Stage 3 cases.

Statistical Analysis

A variety of univariate statistical methods were used to describe the occurrence of cancer within a region or across the state of Massachusetts, and to describe social, economic and demographic variables. Bivariate relationships were analyzed using chi-square and Pearson correlations; we also used polychoric and polyserial correlations to study associations, but do not report those analyses here. The relationships between cancer data and sets of social, economic and demographic variables were examined in a variety of ways, including multiple regression analysis and discriminant function analysis. We utilized spatial scan statistics techniques (Kulldorf, 1994) to test whether certain geographical regions contained clusters or excess numbers of Stage 1 or Stage 3 cases. Spatial scan statistics determine whether the higher numbers of Stage 1 or Stage 3 cases occurring in some regions exceed the number of cases attributable to chance variation. Regions with statistically significant excesses of Stage 1 cases could be viewed as screening more effectively, and regions with statistically significant excesses of Stage 3 cases could be seen as deficient in their screening programs.

Software Development

Both technical and functional specifications for the software prototype have been outlined in Appendix A. Project staff determined that it would be important to incorporate a mapping capability into any application software, and evaluated mapping software packages such as Maptitude and MapInfo. The software prototype will produce files which can be imported into the above referenced mapping software. The files will provide information (such as incidence rates, staging distributions, age compositions, and racial/ethnic, education, and economic variable distributions) which will be displayed with the selected geographic areas.

Appendix B depicts software interfaces which have already been designed. Additional work that needs to be accomplished includes:

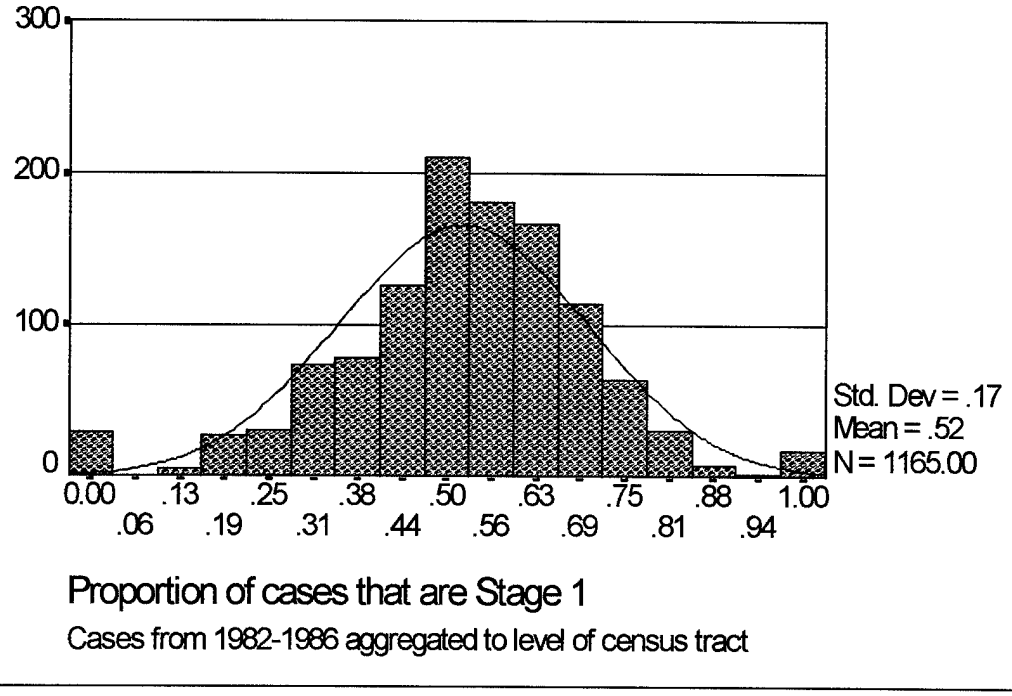
(1) complete porting of user interface;
(2) finish query definition modules;
(3) finish asynchronous query submission modules;
(4) complete implementation of basic statistics, such as rates and proportions;
(5) display the result sets on the screen in table format; and
(6) debug and test.

Results and Discussion

Figure 2 shows the distribution of the proportion of Stage 1 cases for the 1165 tracts reporting at least one case of breast cancer between 1982 and 1986. (Twelve of the 1177 census tracts had no cases during that period, leaving 1165 available for analysis.) The distribution of the proportion of Stage 1 cases ranges from zero for 29 tracts to a high of 1.0 for 17 tracts, with most tracts closer to the upper and lower sides of the mean proportion of .52 cases. While Figure 2 informs us that there is great variability among tracts with respect to the proportion of cases diagnosed at Stage 1, it conveys no information about geographic variability. Are some regions consistently higher or lower with respect to the proportion of Stage 1 cases diagnosed within those tracts?

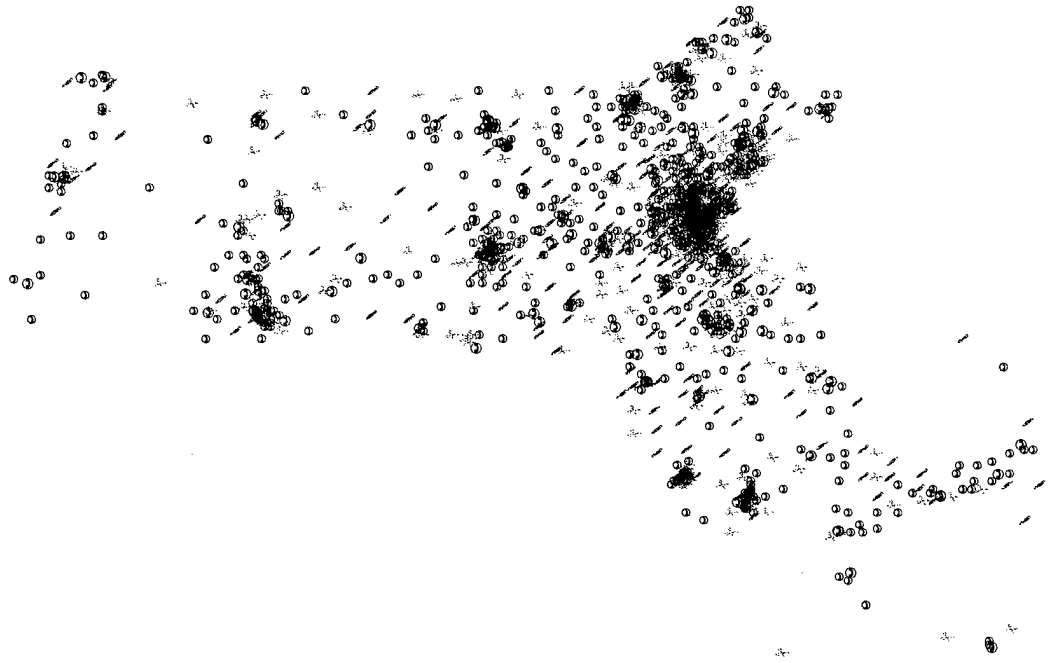
In order to view the data geographically in a way that would highlight the top 25% of tracts versus the bottom 25% of tracts, we grouped all tracts into one of three categories: 1) the lowest quartile - this included tracts where the proportion of Stage 1 cases was less than or equal to 0.4286; 2) the middle 50% - this included tracts where the proportion of Stage 1 cases was greater than 0.4286 but less than 0.6250, and 3) the highest quartile - this included tracts where the proportion of Stage 1 cases was equal to or greater than 0.6250. Figure 3 displays tracts from the lowest and highest quartiles, colors red and green respectively, and the middle 50% in black. It does appear that there are clusters of red tracts (lowest quartile of stage 1 diagnoses), which might suggest that those tracts are doing a poorer job of screening, especially in

Figure 2. Distribution: Proportion of Stage 1 Cases for 1165 Census Tracts.



comparison to what appear to be clusters of green tracts (highest quartile of stage 1 diagnoses). The black tracts represent the middle 50% and might be seen as about average. It would be a mistake to draw firm conclusions at this point however, because it is known that there may be relatively few cases in some tracts. Therefore, confident characterization of any given tract, even any given cluster of tracts, requires that such instability be taken into account.

Figure 3. Tracts in the Highest Quartile for Proportion of Stage 1 Cancers (Green) and Tracts in the Lowest Quartile for Proportion of Stage 1 Cancers (Red).



Note: The mapping software used to produce these figures makes use of color to distinguish data categories. In this figure, the scissor symbols are green, the pencil symbols are red, and the circled symbol is black.

We used spatial statistics to adjust and account for the variability and instability introduced by tracts with small numbers of cases. Kulldorff's spatial scan statistic was applied to determine whether there are clusters of tracts with excess numbers of Stage 1 cases (above the numbers that might be expected due to normal statistical variation). For each tract, the actual number of Stage 1 cases for that tract and neighboring tracts was compared to what might be expected given the number and distribution of Stage 1 cases for the entire state. The definition of neighboring tracts is continually enlarged in multiple statistical trials to include up to 10% of the total population of Stage 1 cases. The spatial scan statistic revealed no statistically significant clusters of tracts with excess numbers of Stage 1 cases. Thus, looking again at Figure 3, if there appear to be clusters of green tracts, those clusters are only apparent and can be attributed to normal variation.

Another question suggested by Figure 3 deals with the relationship between the educational, racial/ethnic, and economic variables and the proportion of Stage 1 cases. The data reveal low, but statistically significant ($p<.01$) correlations. There are negative correlations between the proportion of Stage 1 cases and several census variables: the proportion Black (-.17), Hispanic (-.13), unemployed (-.15), and the proportion with less than a ninth grade education (-.09). The correlations are positive between the proportion of Stage 1 diagnoses and the proportion of college graduates (.11), as well as per capita income (.11).

Another way of examining the nature of the relationship between the socioeconomic and demographic variables and the proportion of Stage 1 cases was to perform a discriminant function analysis. In this analysis we divided the tracts into the three aforementioned categories - the highest quartile, middle 50%, and the lowest quartile of Stage 1 diagnoses. The analysis consists of a multivariate test whereby all of the above socioeconomic and racial/ethnic variables are taken together, adjusting for the known correlations and dependencies between pairs of variables, to determine whether there are consistent differences among the three groups on these variables. Table 1 shows the means for each of the census variables for each of the Stage 1 categories. The tracts in the lowest quartile were the referent group, with comparisons being made between this and the middle and high quartiles. All comparisons were statistically significant ($p<.0001$) and in the expected direction. Tracts with the lowest proportion of Stage 1 cases were higher in the percent of those with less than nine years of education, lower in the percent of college graduates, higher in the percent of blacks and Hispanics, higher in the percent unemployed, and lower in per capita income when compared to either of the other two categories. Clearly socioeconomic variables can discriminate between tracts with high and low, and between tracts with medium and low proportions of Stage 1 groups. We did not test the difference between medium and high because only two statistical comparisons are permissible, but a casual comparison would suggest little difference between the middle and high group on socioeconomic and racial/ethnic variables. Socioeconomic and racial/ethnic variables are important correlates of screening utilization.

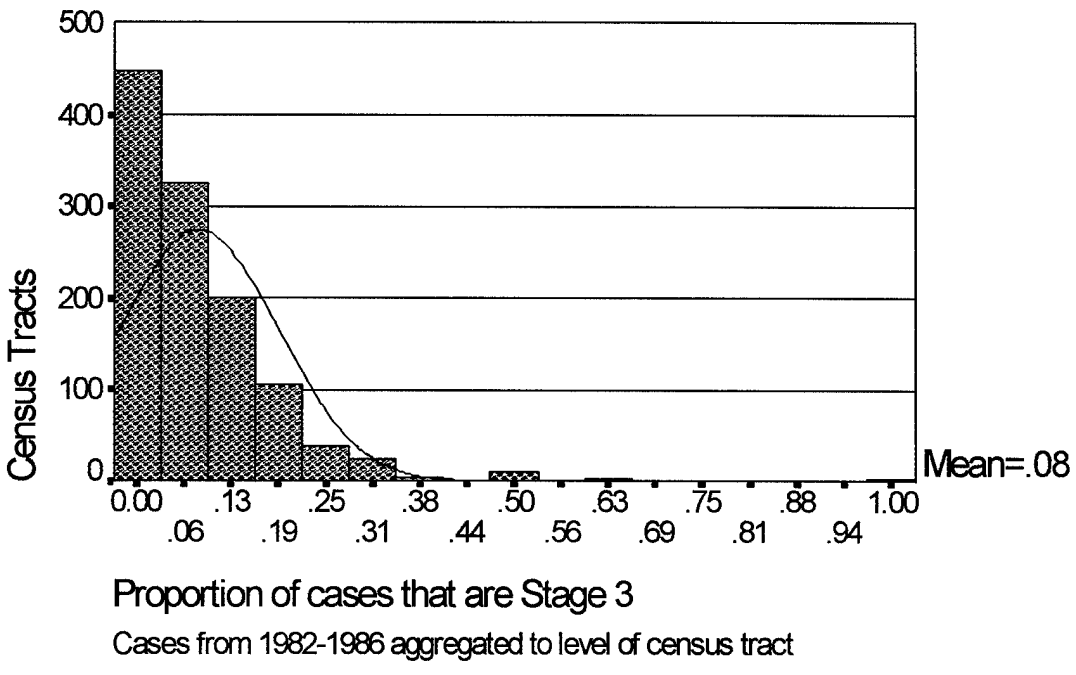
Table 1. Proportion of Stage 1 Tracts by Selected Sociodemographic Variables from the 1990 Census, Massachusetts

Proportion Stage 1	< 9 yrs ed	College Grads	Black	Hispanic	Unemployed	Per capita Income
Lowest 25%	12.05%	22.39%	11.08%	8.53%	8.83%	$14969.26
Middle 50%	8.50%	27.40%	4.79%	5.00%	7.06%	$17609.83
Highest 25%	9.35%	27.73%	5.63%	5.32%	7.10%	$17144.12

While an examination of census tracts according to the proportion of Stage 1 cases diagnosed provides some insights into whether tracts are doing well or poorly with respect to detecting cases early, an examination of tracts according to the proportion of Stage 3 cases may reveal whether tracts are high or low with respect to the proportion of cases diagnosed at a distant stage. Figure 4 shows the distribution of tracts according to the proportion of Stage 3 cases diagnosed in residents of each tract. The distribution is quite skewed, with most tracts showing a low proportion of Stage 3 cases. Nevertheless there is variability and a long tail, with some tracts showing a relatively high proportion of Stage 3 cases. As noted earlier, 12 tracts had no breast cancer cases, leaving 1165 census tracts available for analysis.

As with the proportion of Stage 1 cases, tracts were divided into three categories: 1) the lowest quartile - tracts with no cases diagnosed as Stage 3, 2) the middle 50% - tracts where there was at least one case diagnosed at Stage 3, but where the proportion was less than 0.125, and 3) the highest quartile - tracts where the proportion of cases diagnosed at Stage 3 was 0.125 or more.

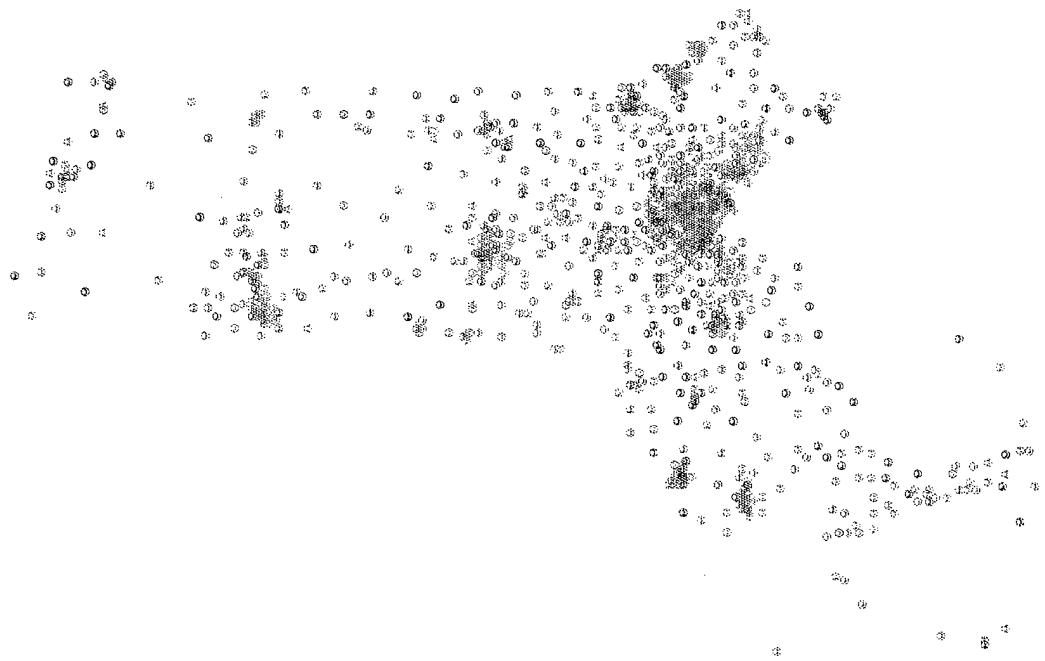
Figure 4. Distribution: Proportion of Stage 3 Cases for Each of 1165 Census Tracts.



Besides the aggregated view of late stage at diagnosis (Figure 4), we can view the data geographically (Figure 5). While Figure 4 shows that most cases are not diagnosed at Stage 3, it provides no information about the location of tracts where the proportion of Stage 3 diagnoses is relatively high, and no information on whether there are clusters of tracts with high proportions of Stage 3 diagnoses.

In Figure 5, the green tracts are in the lowest quartile with respect to the proportion of Stage 3 cases, while the red tracts are in the highest quartile, indicating a high proportion of Stage 3 cases. This may indicate areas of poor screening. Are there regions of the state where there are excessive numbers of Stage 3 cases relative to the total number of Stage 3 cases? We again applied Kulldorff's spatial scan statistic, comparing the number of Stage 3 cases in each tract to the number of cases expected if only chance variation were operating (e.g., the proportion of Stage 3 cases expected across similar groups of tracts). In this instance, there were 1433 cases diagnosed at Stage 3 out of a total of 18,627 cases for the five-year period (1982-1986). The spatial scan statistical analysis revealed four overlapping clusters with excessive numbers of Stage 3 cases. Of the four clusters identified, one is displayed in Figure 6.

Figure 5. Display of Tracts that are High (Red) and Low (Green) in Proportion of Stage 3 Cases.



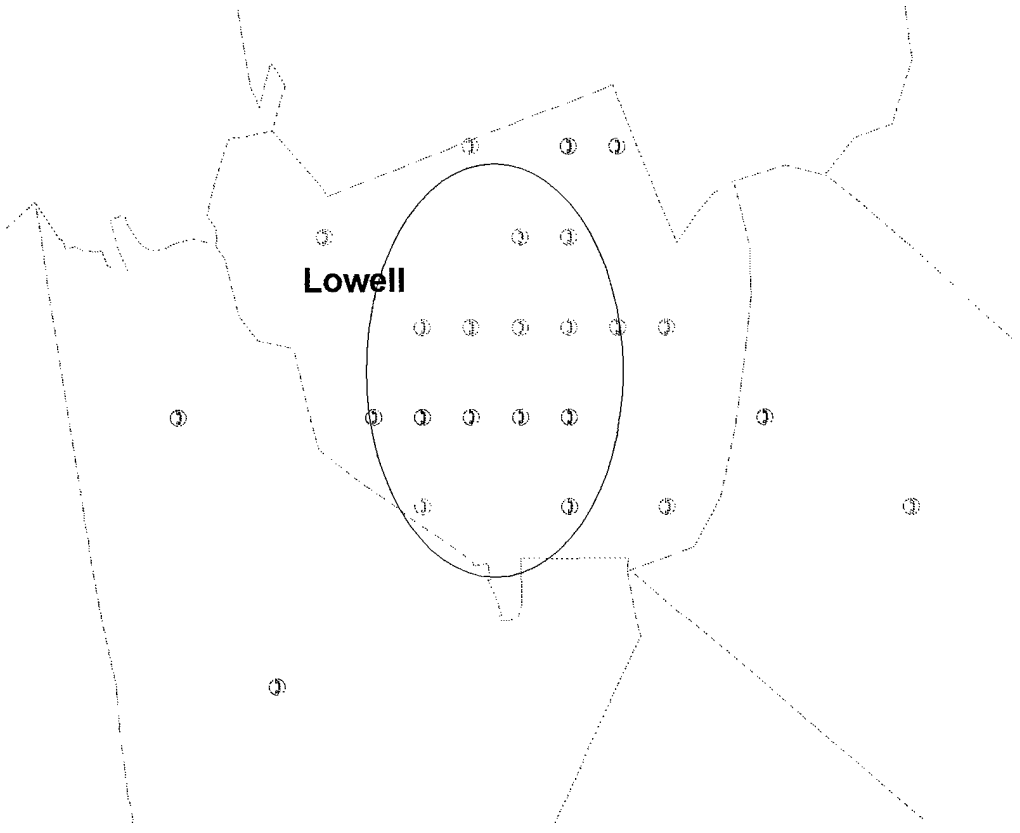
Note: The mapping software used to produce these figures makes use of color to distinguish data categories. In this figure, the green and red symbols have both reproduced as black.

For the tracts within the cluster circled in Figure 6, there were a total of 23 breast cancer cases of which 10 were diagnosed at Stage 3. To determine the degree of excess, we first calculate the expected number of cases for that area as the product of the number of cases for that region multiplied by the expected proportion of Stage 3 cases (the total number of Stage 3 cases divided by the total number of cases diagnosed statewide):

$$23*(1433/18627)=1.77$$

The excess is then 10/1.77=5.65; that is, there were 5.65 times as many cases as expected, which is 465% above what we would expect if only chance were operating.[3] There are three additional clusters with excesses of Stage 3 cases varying from 49% to 600%. Since these clusters overlap, Dr. Kulldorf recommends that we report only one cluster, the most likely, and points out that "it is a good illustration ... of the fact that we cannot determine the exact location and shape of any detected cluster, but only the general location."[4]

Figure 6. Most Likely Cluster of Tracts with Excesses of Stage 3 Cases.



Note: The mapping software used to produce these figures makes use of color to distinguish data categories. In this figure, the green and red symbols have both reproduced as black.

[3] Thanks to Dr. Martin Kulldorf from the National Cancer Institute for these calculations and the use of his statistical software.

[4] Kulldorf, personal communications, May 1996.

Having identified the most likely cluster of tracts with excesses of Stage 3 cases, the system can be queried for additional information such as the location of mammography sites, or the economic, racial/ethnic, educational, or occupational characteristics of the people living in these tracts. As an example, Figure 7 shows the educational characteristics of those living in the Lowell, MA area, previously identified as a cluster of tracts with an excess of Stage 3 cases. (Each pie chart represents one census tract.) The table inset within Figure 7 shows the correlations between selected census variables and the proportion of Stage 3 cases within the region where the clusters were identified. There are statistically significant ($p<.05$) correlations between selected census variables and the proportion of Stage 3 cases within the Lowell region. The correlations are positive for the proportion with less than nine years of education (.32), the proportion who are black (.33), the proportion who are Hispanic (.46), and the proportion who are unemployed (.33); the correlations are negative between the proportion of stage 3 cases and the proportion with four years of college (-.33) and per capita income (-.28). All correlations are statistically significant at $p<.05$, except the correlation between proportion of Stage 3 cases and the proportion Hispanic, which is significant at $p<0.01$, and per capita income, which does not reach significance at $p<.05$.

While Figure 7 illustrates how each of these census measures, such as educational level, can be displayed geographically, we can also perform the more traditional discriminant function analysis to determine how well the socioeconomic and racial/ethnic measures separate the lowest quartile and the middle 50% of tracts from the tracts in the highest quartile of Stage 3 cases.

We grouped tracts into three categories based upon the distribution of the proportion of Stage 3 cases. Since there were 441 tracts with zero Stage 3 cases, the bottom category contained 37.5% of the tracts, the middle category contained the next 36.6%, and the highest category contained 25.6% of the tracts. Table 2 displays the means for the census variables, and shows that the tracts with the highest proportion of Stage 3 cases have the highest percentage of people with a ninth grade education or less, the lowest percentage of college graduates, the highest percentage of blacks and Hispanics, the highest unemployment rate, and the lowest per capita income. All differences between the lowest and highest groups are statistically significant ($p<.02$) except the proportion of blacks in these tracts. All of the differences between the middle tracts and the highest reach univariate statistical significance for all variables ($p<.00005$).

Table 2. Proportion of Stage 3 Tracts by Selected Sociodemographic Variables from the 1990 Census, Massachusetts						
Proportion of Stage 3	< 9 yrs ed	College Grads	Black	Hispanic	Unemployed	Per capita Income
Lowest 25%	9.76%	26.75%	8.18%	6.47%	7.62%	$16765.96
Middle 50%	7.31%	28.89%	3.67%	3.74%	6.52%	$18233.26
Highest 25%	12.28%	21.57%	8.43%	8.43%	8.79%	$14892.95

Figure 8 shows the geographical distribution of mammography sites in the Lowell area. It would appear that the mammography sites are somewhat remote from the primary cluster of high Stage 3 census tracts. The geographical information system data base also includes roads and railroads, and provides a basis for determining how accessible these sites are to residents of the high Stage 3 census tracts. It may be that a combination of site location and access to public transportation deter participation in screening programs for certain residents.

Figure 7. Educational Characteristics by Census Tracts & Table Correlating Census Variables with the Proportion of Stage 3 Cases.

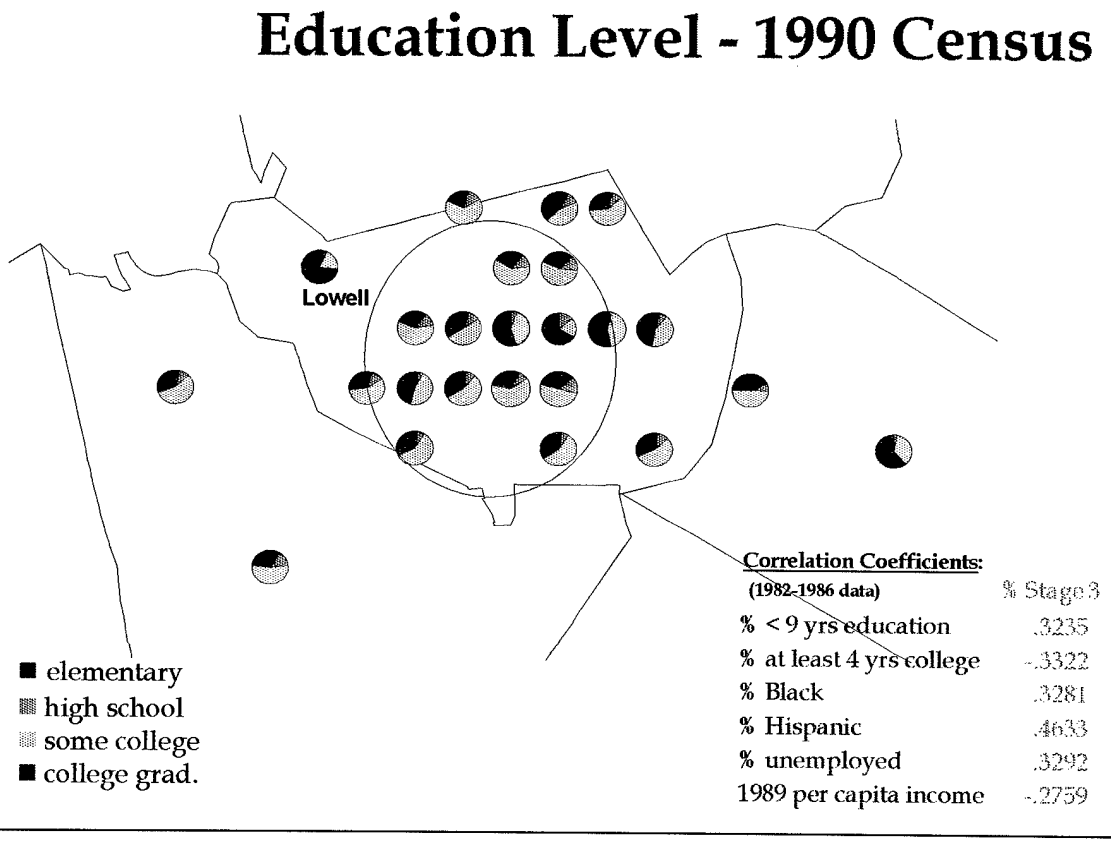
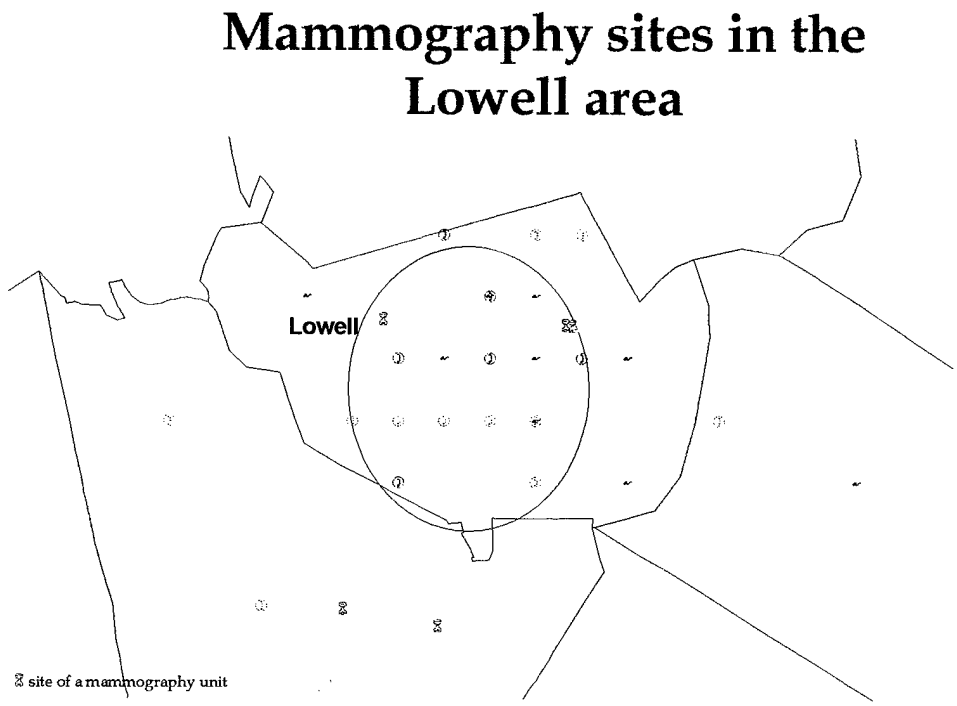


Figure 8. Mammography Sites in the Lowell, Massachusetts Area.



CONCLUSIONS:

This study demonstrates how data from diverse sources can be integrated and analyzed geographically to assess screening efficacy. This system can be used by public health officials to monitor breast cancer screening in particular areas, and could be easily adapted to monitor other kinds of cancers and cancer screening activities. In our demonstration we identified a specific geographical area with a higher proportion of late-stage breast cancer diagnoses than the rest of the state. Assuming that the same pattern is found with data from 1987 through 1992, those responsible for conducting screening programs within that area might be alerted as to the need for more effective screening. Furthermore, concomitant information about the region from the census could be helpful in designing effective interventions.

The socioeconomic and racial/ethnic associations with early and late stages of diagnosis are not new (Farley, 1989); what is new is being able to single out a particular geographical region with statistically significant excesses and immediately access the related socioeconomic and racial/ethnic characteristics of that region and put that information into the hands of intervention planners. It is known that interventions work better if they take target population characteristics into account.

It should be noted that in this study only proxy measures were available for mammography. Roffers and Austin (1993) suggest that the measure "percent *in situ* of all cases" can reflect frequency of mammography screening and the measure "percent localized of all invasive cases of known stage" may reflect frequency of manual screening. It is entirely possible to incorporate actual mammography utilization data as it becomes available. Use of such data would allow for a better assessment of the relationships between sociodemographic characteristics, utilization of mammography, and stage at diagnosis.

While analyses in this study were conducted at the level of the census tract, it is also possible to aggregate at lower levels, for example, at the census block group level as Krieger demonstrated in her San Francisco study (1992). Such finer analyses may be needed in urban areas, while analysis at higher levels of aggregation, such as towns (MCDs), or even CHNAs might be appropriate for certain kinds of studies.

It should be recognized that cases are assigned to census tracts on the basis of the patient's address recorded at the time of diagnosis. Problems in the address fields may occur when the patient provides a business, mailing, temporary or care/of address rather than usual residence address. Such address problems introduce errors in assigning correct census tracts. In addition, the geocoding process itself introduces tracting errors through mistakes in the reference GIS data. Examples would include inexact alignment of street-level data overlain on census tract boundaries, misnumbered buildings, misnamed streets, inverted block numbering, and missing building numbers and street names. Such errors in the reference GIS data may also lead to misassigned census tracts.

Another caution entails the assignment of socioeconomic variables based on tracts to aggregated cases within those tracts. Patients within a tract may not be typical of other residents within those tracts. Krieger (1992), however, has found that the use of socioeconomic data, at least at the level of the tract and block group, is generally not misleading, and consistent with the findings of others, and probably underestimates the effects that would have been observed were individual-level data available.

Future Work

In the process of integrating these diverse data sources and methods of analysis, we deliberately focused on breast cancer data from the years 1982 through 1986, using data from that period to test the system. In this way, substantive findings could then be cross-validated with data from 1987 through 1992 and beyond. While we were conducting these analyses, we found errors in geocoding that need to be addressed and corrected. We have almost completed making these corrections on the 1982-1986 data. In addition, we have found problems with the 1987 to 1992 data, and are correcting these problems as well. During the extension period, we will first need to reproduce the analyses on the corrected 1982 through 1986 data and ensure that our substantive findings are correct. We will next cross-validate our work using the 1987 to 1992 breast cancer data to determine whether substantive findings from the earlier period are stable across time periods or whether findings vary from location to location.

The above work has been conducted at the level of the census tract. Other work within the Massachusetts Department of Public Health aggregates to the town level. We will want to address the issue of level and compare findings from tract level to findings at town level. For some geographical areas, especially urban centers, we hope to explore the use of block group level units of analysis.

As noted previously, the MCR only began to collect data on *in situ* cases in 1992. We plan to conduct studies using *in situ* data from 1992 to examine surveillance efficacy. Data from 1993 and 1994 will also be available during the extension period, and it may be necessary to combine *in situ* data from these three years in order to conduct spatial scans. Throughout the extension period, we shall continue to analyze concomitantly census data, mammography site data, and other relevant data as they become available.

During Year 3, we plan to consult with Dr. Nancy Krieger at the Harvard School of Public Health, an expert on using socioeconomic data from the census. We also plan to maintain close contact with professional geographers such as Gerard Rushton from the University of Iowa and Ellen Cromley from the University of Connecticut, and leading spatial statisticians such as Martin Kulldorf from the National Cancer Institute and Joseph Glaz from the University of Connecticut.

The GIS-based surveillance system being developed should provide useful information, based upon the integration of diverse data sets into a system capable of up-to-date spatial display and statistical analyses using both spatial and traditional statistical techniques. Sharing the system with potential users as we progress should also provide suggestions for practical improvement. This system should be able to evaluate the effectiveness of breast cancer screening programs, and help to target those areas that would benefit from additional screening.

REFERENCES

Andrews HF, Kerner JF, Zauber AG, Mandelblatt J, Pittman J and Struening E. Using census and mortality data to target small areas for breast, colorectal, and cervical cancer screening. *American Journal of Public Health.* 1994;84(1):56-61.

Boss LP and Suarez L. Uses of data to plan cancer prevention and control programs. *Public Health Reports.* 1990;105(4):354-360.

Chu K, Smart C and Tarone R. Analysis of breast cancer mortality and stage distribution by age for the Health Insurance Plan Clinical Trial. *Journal of the National Cancer Institute.* 1988;80(14):1125-32.

Collette HJ, de Waard F, Rombach JJ, Collette C and Day NE. Further evidence of benefits of a (non-randomized) breast cancer screening programme: the DOM Project. *Journal of Epidemiology & Community Health.* 1992; 46:382-386.

Dangermond J. How to cope with geographical information systems in your organization. In: Scholten HJ and Stilwell JC, editors. Geographic information systems for urban and regional planning. Dordrecht, Kluwer Academic Publication, 1990.

Farley TA and Flannery JT. Late-stage diagnosis of breast cancer in women of lower socioeconomic status: public health implications. *American Journal of Public Health.* 1989;79(11):1508-1512.

Habbema JD, van Oortmarssen GJ, van Putten DJ, Lubbe JT and van der Maas PJ. Age-specific reduction in breast cancer mortality by screening: an analysis of the results of the Health Insurance Plan of Greater New York Study. *Journal of the National Cancer Institute.* 1986;77(2):317-20.

Kerner JF, Struening E, Pittman J, Andrews H, Sampson N and Strickman N. Small area variation in cancer incidence and mortality: a methodology for targeting cancer control programs. In: *Advances in Cancer Control Epidemiology and Research.* New York: Alan R. Liss, 1984:225-234.

Krieger N. Overcoming the absence of socioeconomic data in medical records: validation and application of census-based methodology. *American Journal of Public Health.* 1992;82(5):703-710.

Kulldorff M. Spatial disease clusters: detection and inference. *Statistics in Medicine.* 1994;13:1-12.

Lantz P, Bunge M, Cautley E, Phillips JL and Remington PL. Mammography use -- Wisconsin, 1980-1983. *Morbidity and Mortality Weekly Report.* 1995 (October 13):754-756.

Maguire DH, Goodchild MF and Rhind DW, editors. Geographic information systems, two volumes. Harlow, England: Longman Scientific & Technical, 1991.

Roffers SD and Austin DF. Cancer registry data measures for breast and cervical cancer control: definitions, applications, and analyses. *The Abstract.* 1993 (April);13-15.

Shapiro S, Venet W, Strax P, Venet L and Roeser R. Ten- to fourteen-year effect of screening on breast cancer mortality. *Journal of the National Cancer Institute.* 1982;69:349-355.

Tabar L, Fagerberg G, Duffy SW, Day NE, Gad A, Grontoft O. Update of the Swedish two-county program of mammographic screening for breast cancer. *Radiologic Clinics of North America.* 1992;30(1):187-210.

Tabar L, Gad A, Holmberg LH, Ljungquist U, Eklund G, Pagerberg CJ, et al. Reduction in mortality from breast cancer after mass screening with mammography. *Lancet.* 1985;1:829-832.

Zapka JG, Costanza ME, Harris DR, Hosmer D, Stoddard A, Barth R et al. Impact of a breast cancer screening community intervention. *Preventive Medicine.* 1993;22(1):34-53.

APPENDIX A. TECHNICAL AND FUNCTIONAL SPECIFICATIONS FOR SOFTWARE PROTOTYPE

TECHNICAL SPECIFICATIONS

Software Developer Technical Requirements:

- Microsoft Windows 95 and Windows NT Workstation (v.3.51 and up) are the target operating systems
- Microsoft Windows Network based on Windows NT Server v.3.51
- Microsoft Visual Basic v.4.0 Enterprise Edition is the software development environment
- Microsoft SQL Server Relational Database is the database system utilized
- Microsoft SQL Server Workstation Edition is the database development environment
- SPSS Developers Kit for Windows provides the statistical libraries that will be embedded into the system
- SylanMaps\OCX for Windows provides the mapping libraries necessary for embedding into the system

Technical Specifications/Requirements/Features:

- 32-bit based software prototype
- Remote OLE Automation Server
- Export capability (exporting of query results)
- Creation of re-useable classes
- RDO will be the chief class based database API used to connect to MS SQL Server
- Windows 95 or Windows NT (v.3.51 and up)
- User interface will be Windows 95/NT v.4.0 compliant
- 16MB of RAM
- Color VGA monitor (640 x 480 minimum video resolution)
- Microsoft compatible mouse
- Maximum storage is estimated at 10MB of available of hard disk (for software program files)
- MS SQL based database will be resident on Windows NT Server v.3.51 (MCR's server)
- Modem (for remote users only) capable of 28.8 bps

Data to be incorporated into the database:

- Population denominators
- Socioeconomic variables
- Cancer incidence (aggregate)
- Cancer mortality (aggregate)
- Behavioral Risk Factor Surveillance System data
- Mammography sites

FUNCTIONAL SPECIFICATIONS

Since reliable methods for measuring breast cancer screening are not yet available, surrogate or proxy measures of screening might be useful until better measures are developed. Two such measures are: (1) the proportion of breast cancer cases in each census tract that are diagnosed as Stage 1, and (2) the proportion of breast cancer cases diagnosed as *in situ*. The software will incorporate these measures along with other relevant concomitant data such as the number and location of mammography sites, and the racial/ethnic, educational, economic and age compositions of each geographic area.

Data files:

File 1a:	Census tract data (1177 tracts) - 1990 Census data, which will include race/ethnicity, education and economic variables
File 1b:	City/town data (351 cities/towns) - 1990 Census data, which will include race/ethnicity, education and economic variables
File 2:	Massachusetts Cancer Registry data - breast cancer incidence for 1982-1992 by census tract, age and stage
File 3:	Population data - four-digit census tracts and their respective 1980 and 1990 populations for 18 five-year age groups, by sex
File 4:	Mammography site data - address, census tract and number of machines

Sample output:

- By census tracts, towns, CHNAs -- proportion of cases diagnosed in situ, Stage 1, Stage 2 and Stage 3
- Cutoffs for low, medium and high proportions
- Associations with SES variables

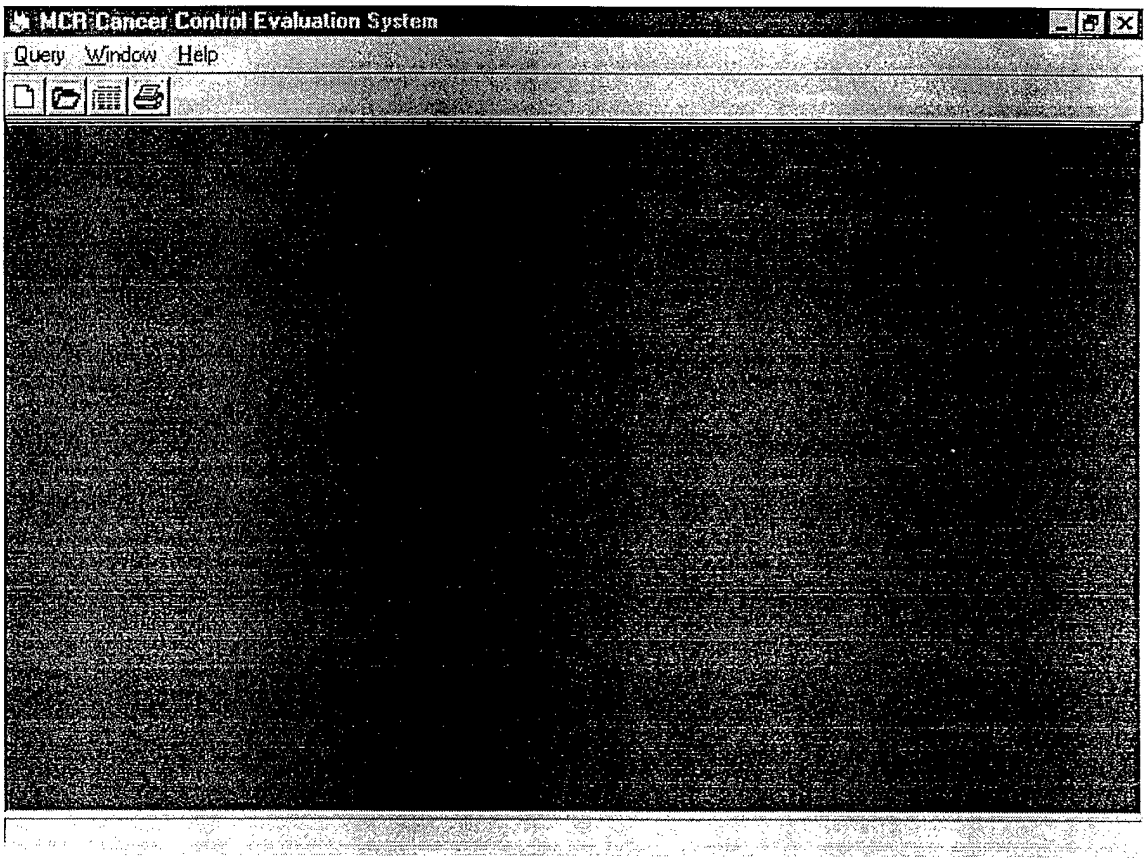
Graph:	Distribution of proportion of stage *in situ*, Stage 1 and Stage 3 cases for each census tract
Map:	Map low, medium, high proportion of Stage 1 and Stage 3. Highlight low/high proportions of *in situ* and Stage 1
Statistics:	Age-specific rates, age-adjusted rates, standardized incidence ratios

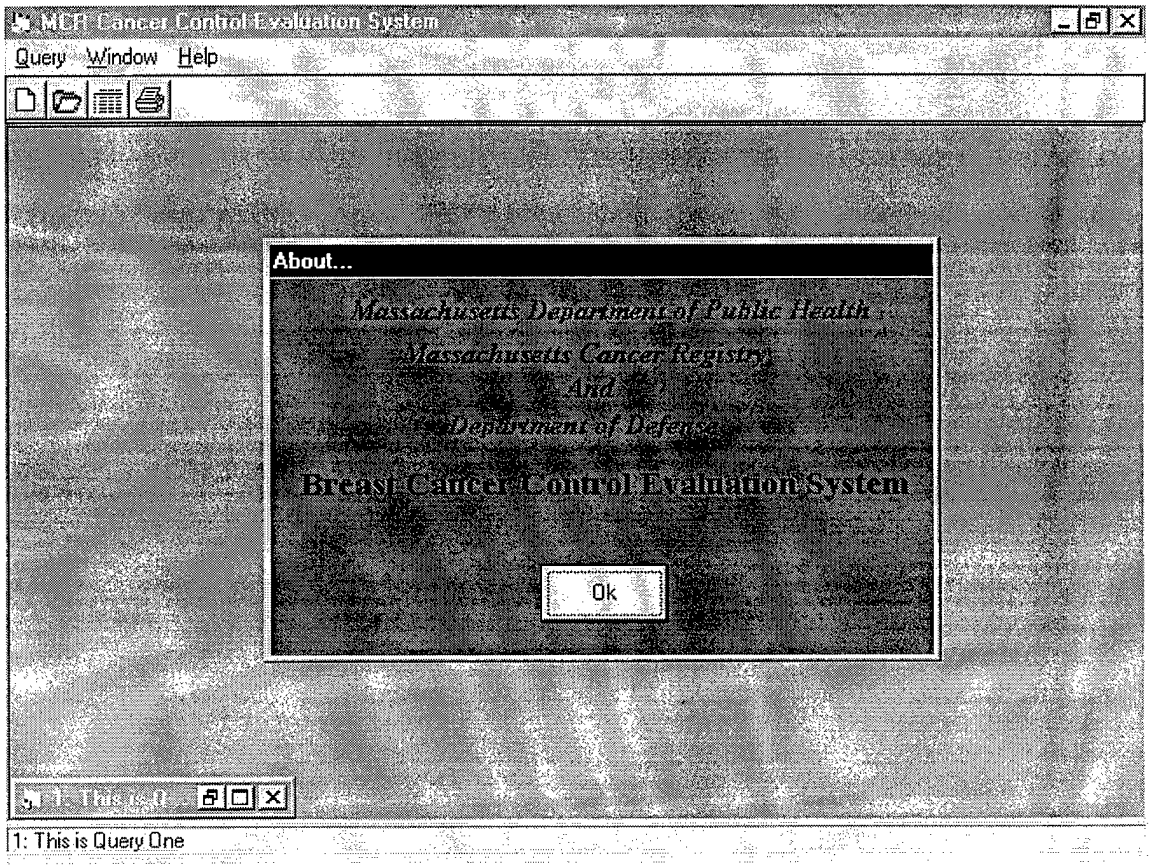
APPENDIX B. SOFTWARE PROTOTYPE SCREENS

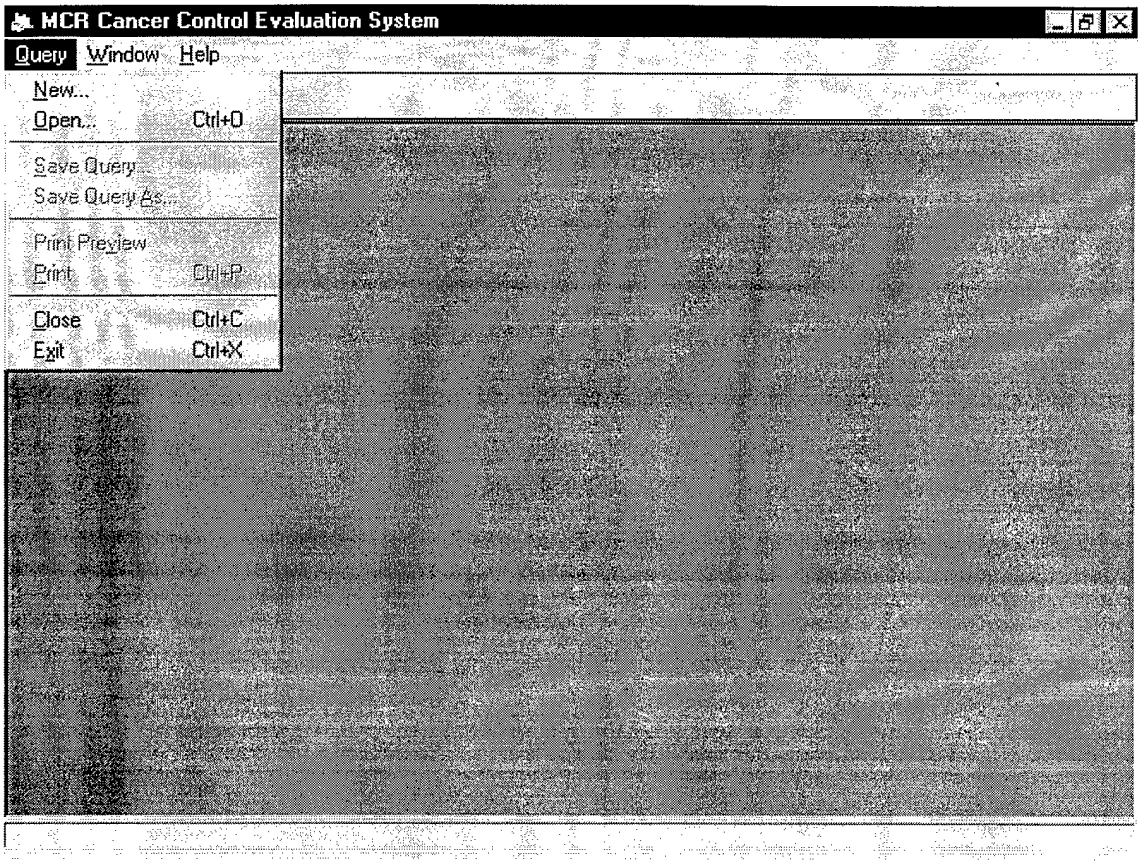
MCR/DOD BCCES Software Development

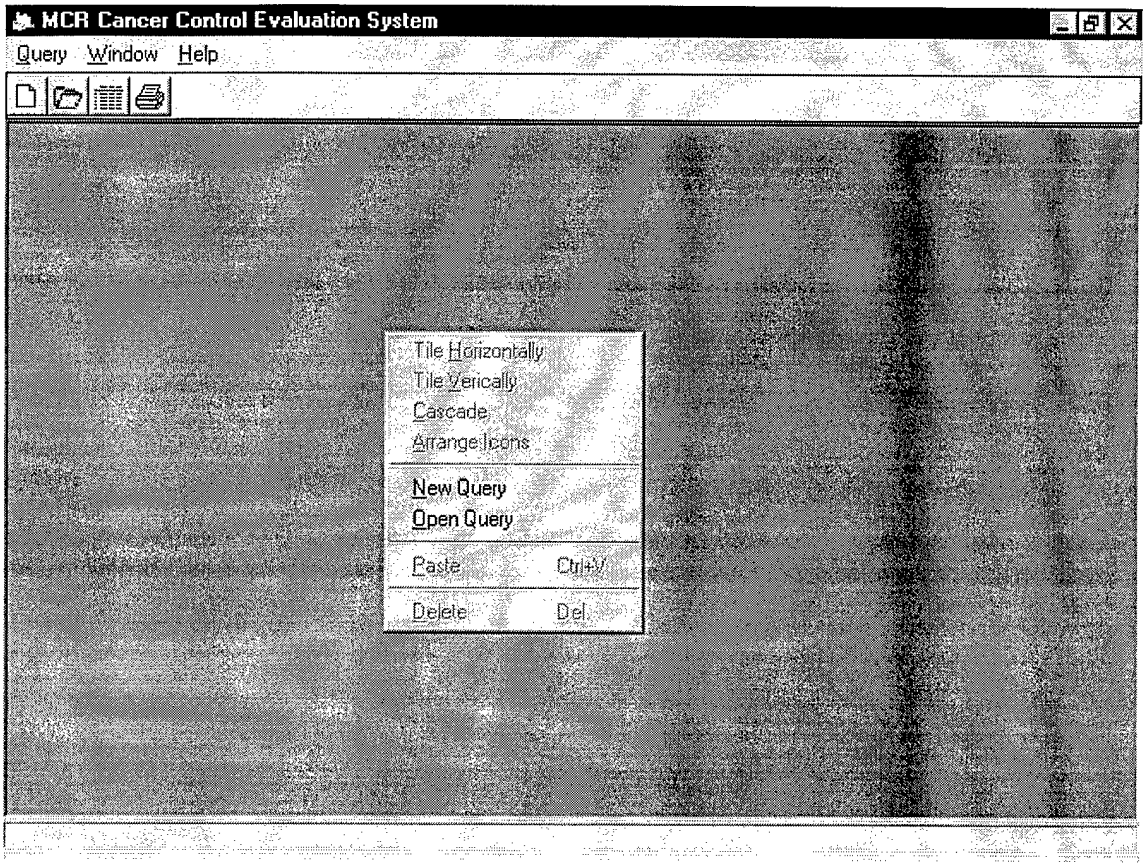
For Software Prototype

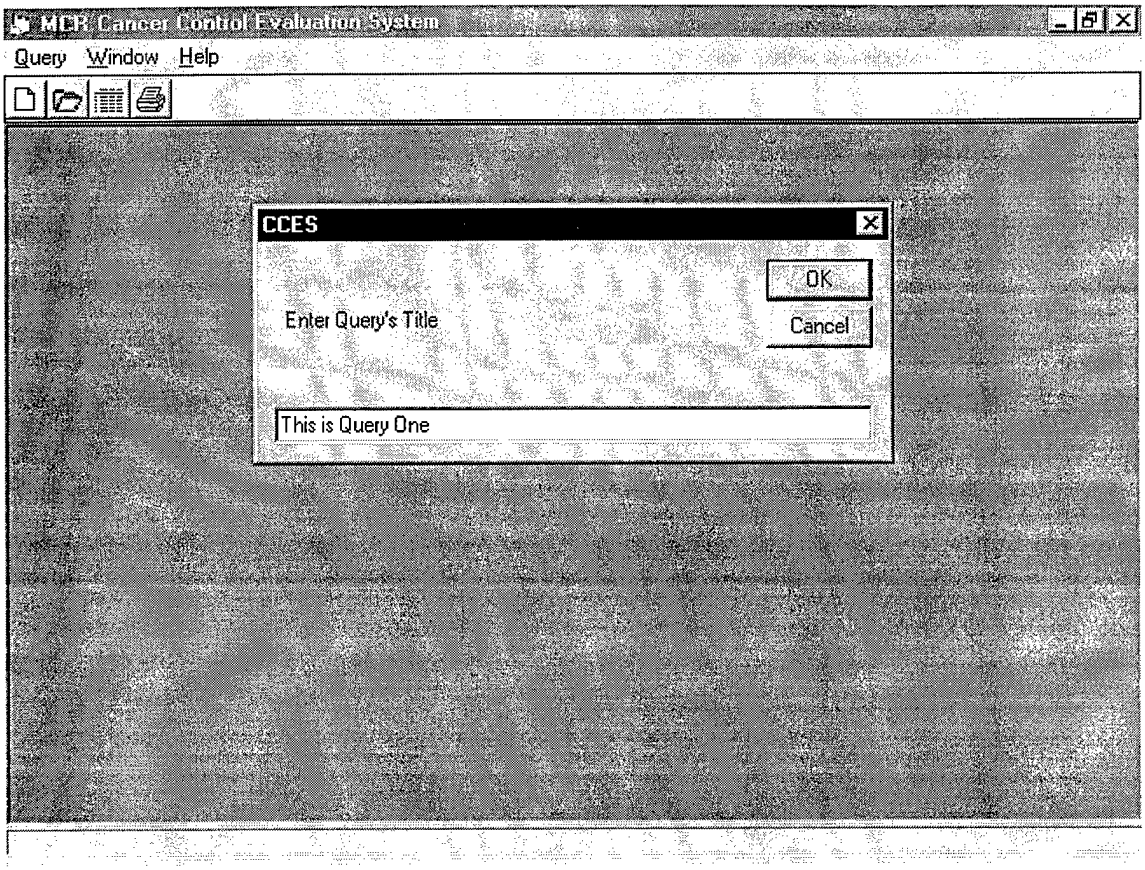
DoD BCCES Software Prototype Screens:

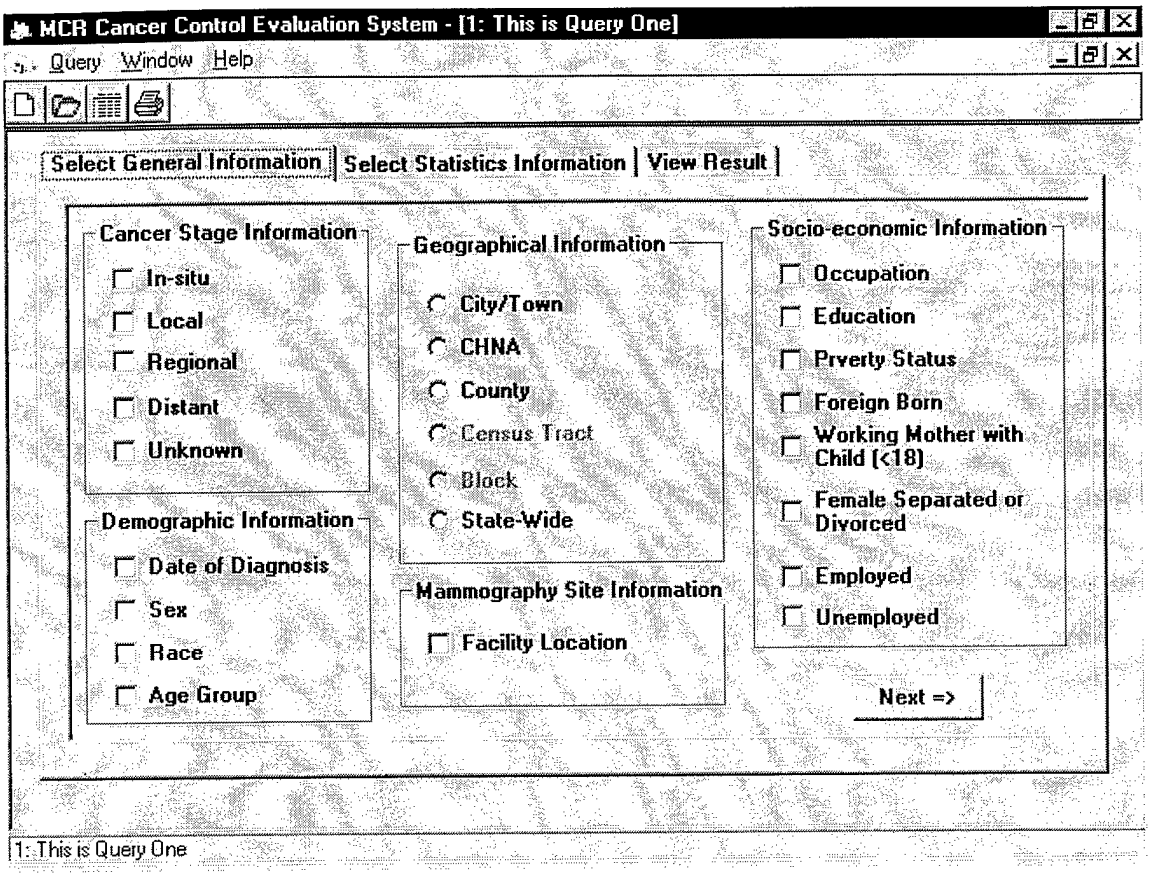


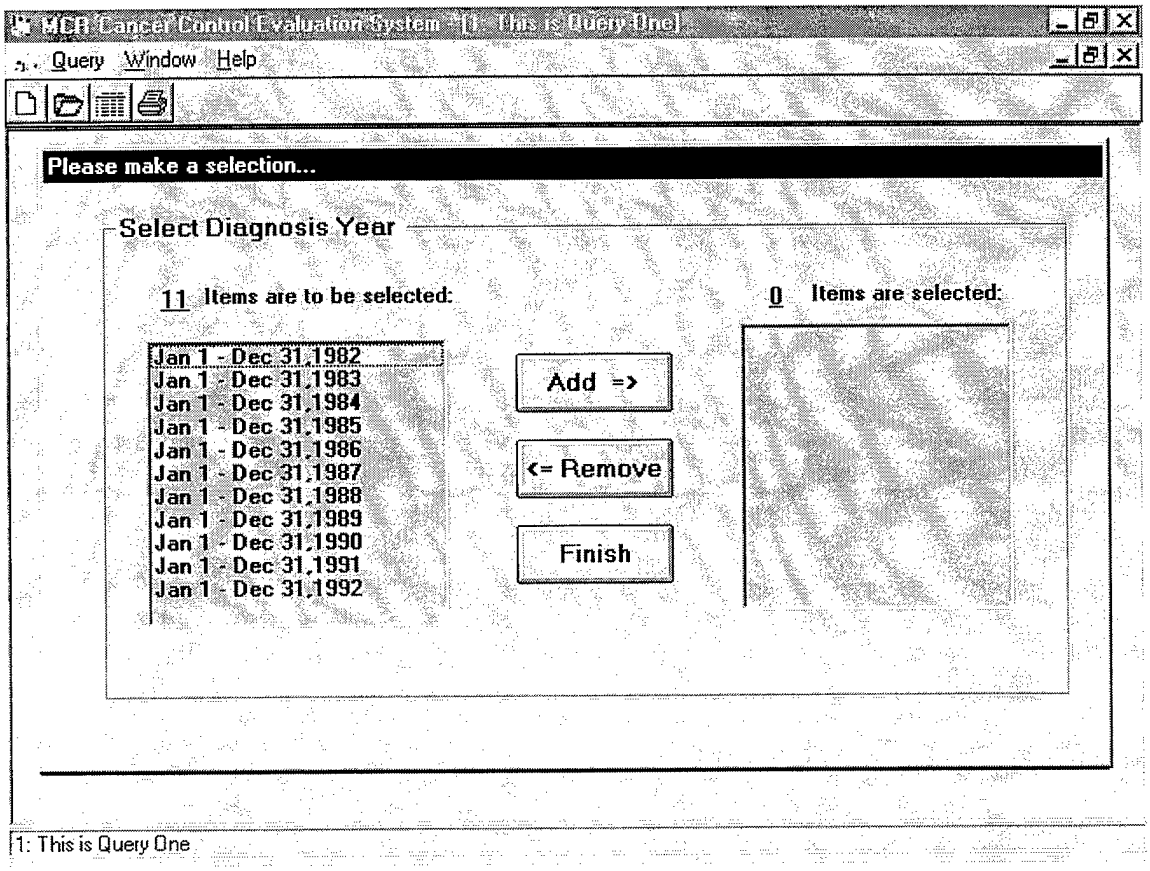

MCH Cancer Control Evaluation System
Query Window Help
About...
Massachusetts Department of Public Health
Massachusetts Cancer Registry
And
Department of Defense
Breast Cancer Control Evaluation System
Ok
1: This is Query One

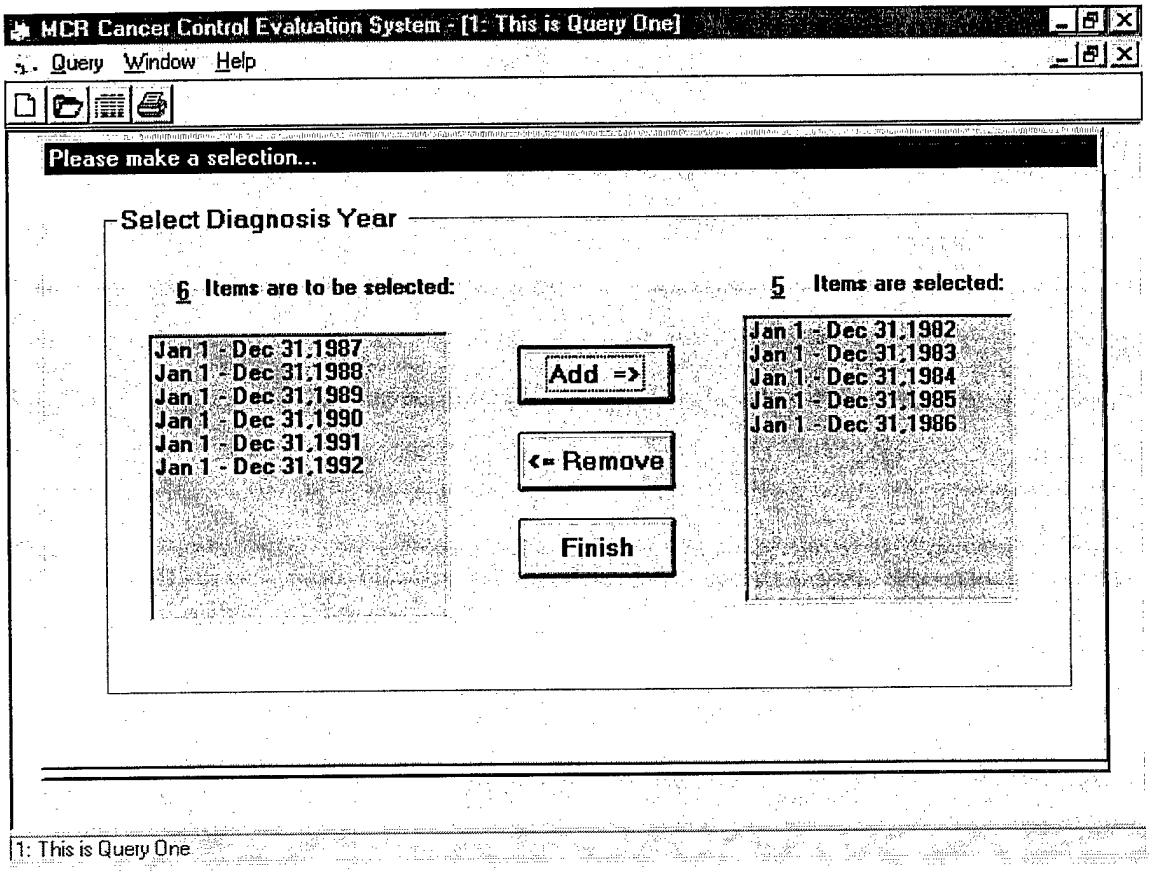

MCR Cancer Control Evaluation System
Query
Window
Help
New...
Open... Ctrl+O
Save Query
Save Query As...
Print Preview
Print Ctrl+P
Close Ctrl+C
Exit Ctrl+X

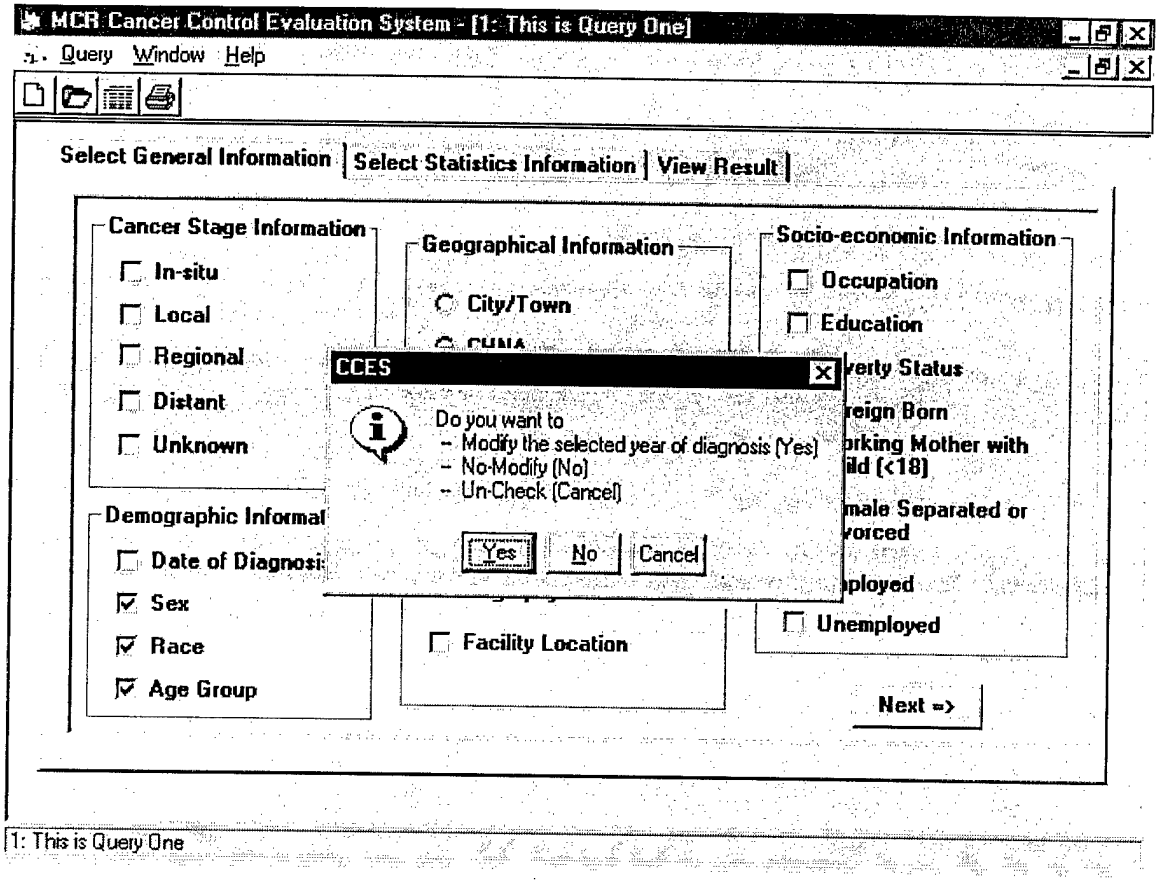

MCR Cancer Control Evaluation System
Query Window Help
Tile Horizontally
Tile Vertically
Cascade
Arrange Icons
New Query
Open Query
Paste Ctrl+V
Delete Del

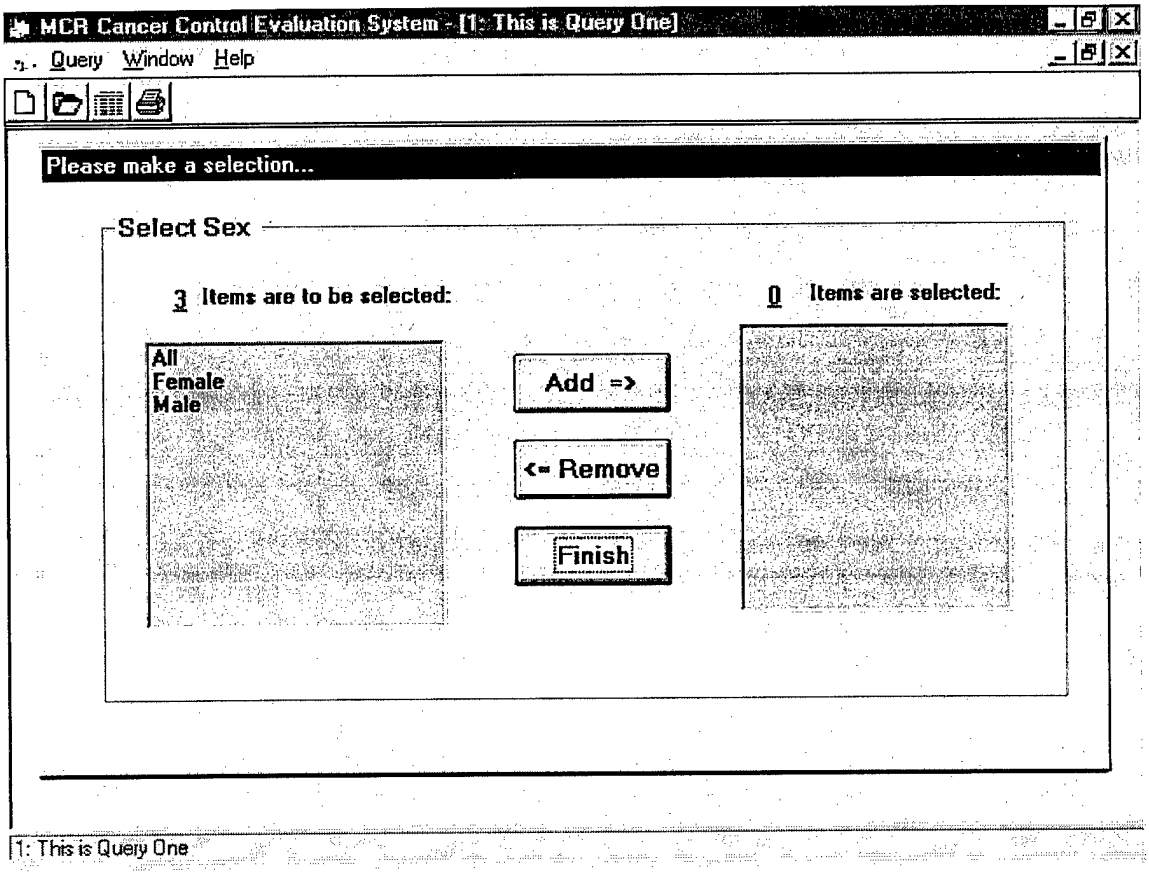

MCR Cancer Control Evaluation System
Query Window Help
CCES
OK
Enter Query's Title
Cancel
This is Query One

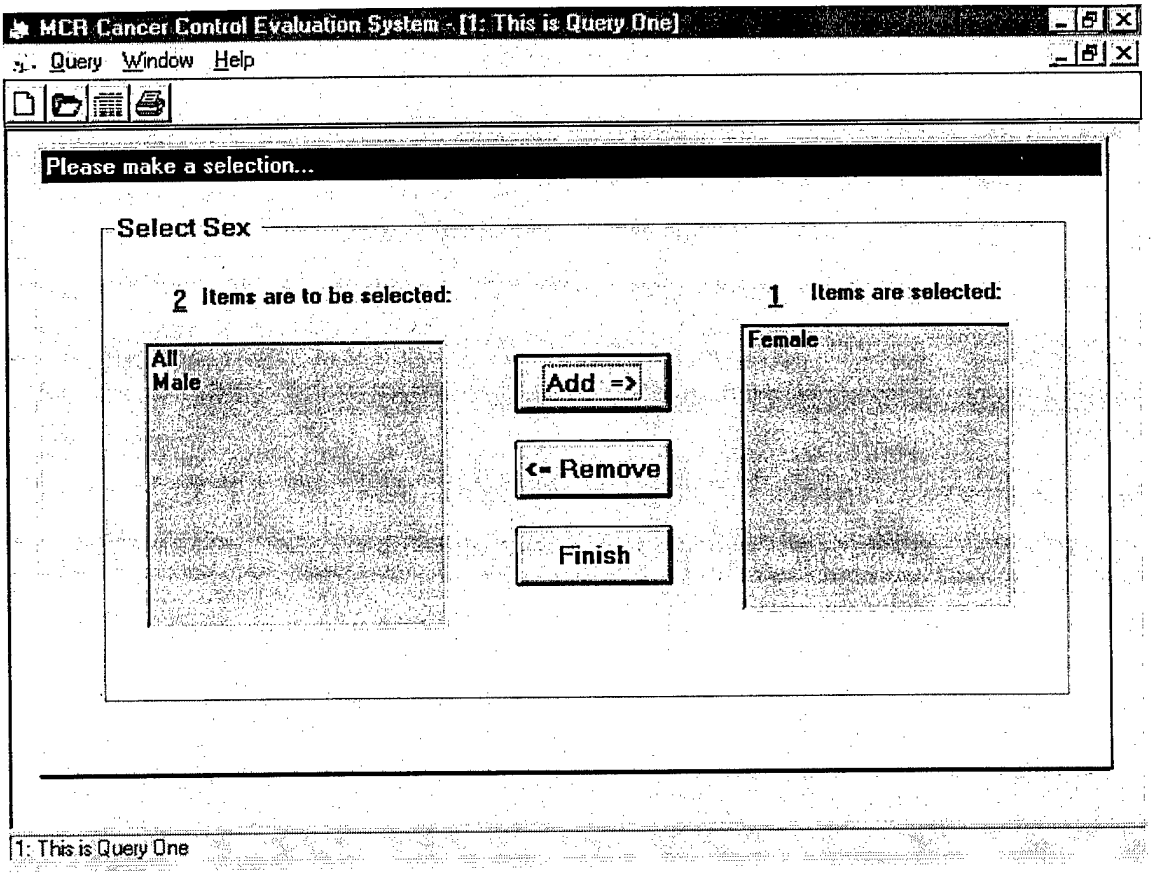

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Select General Information
Select Statistics Information
View Result
Cancer Stage Information
In-situ
Local
Regional
Distant
Unknown
Demographic Information
Date of Diagnosis
Sex
Race
Age Group
Geographical Information
City/Town
CHNA
County
Census Tract
Block
State-Wide
Mammography Site Information
Facility Location
Socio-economic Information
Occupation
Education
Prverty Status
Foreign Born
Working Mother with Child (<18)
Female Separated or Divorced
Employed
Unemployed
Next =>
1: This is Query One

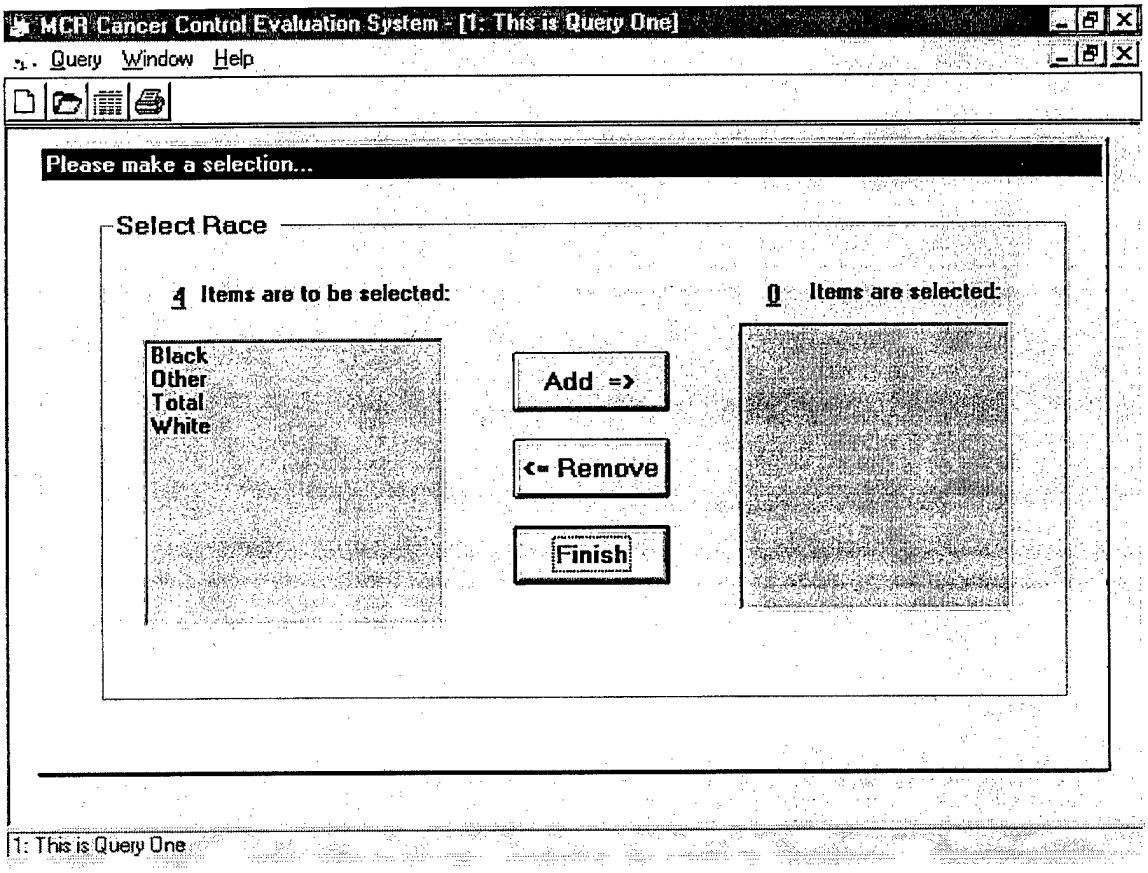

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Diagnosis Year
11 Items are to be selected:
Jan 1 - Dec 31,1982
Jan 1 - Dec 31,1983
Jan 1 - Dec 31,1984
Jan 1 - Dec 31,1985
Jan 1 - Dec 31,1986
Jan 1 - Dec 31,1987
Jan 1 - Dec 31,1988
Jan 1 - Dec 31,1989
Jan 1 - Dec 31,1990
Jan 1 - Dec 31,1991
Jan 1 - Dec 31,1992
Add =>
<= Remove
Finish
0 Items are selected:
1: This is Query One

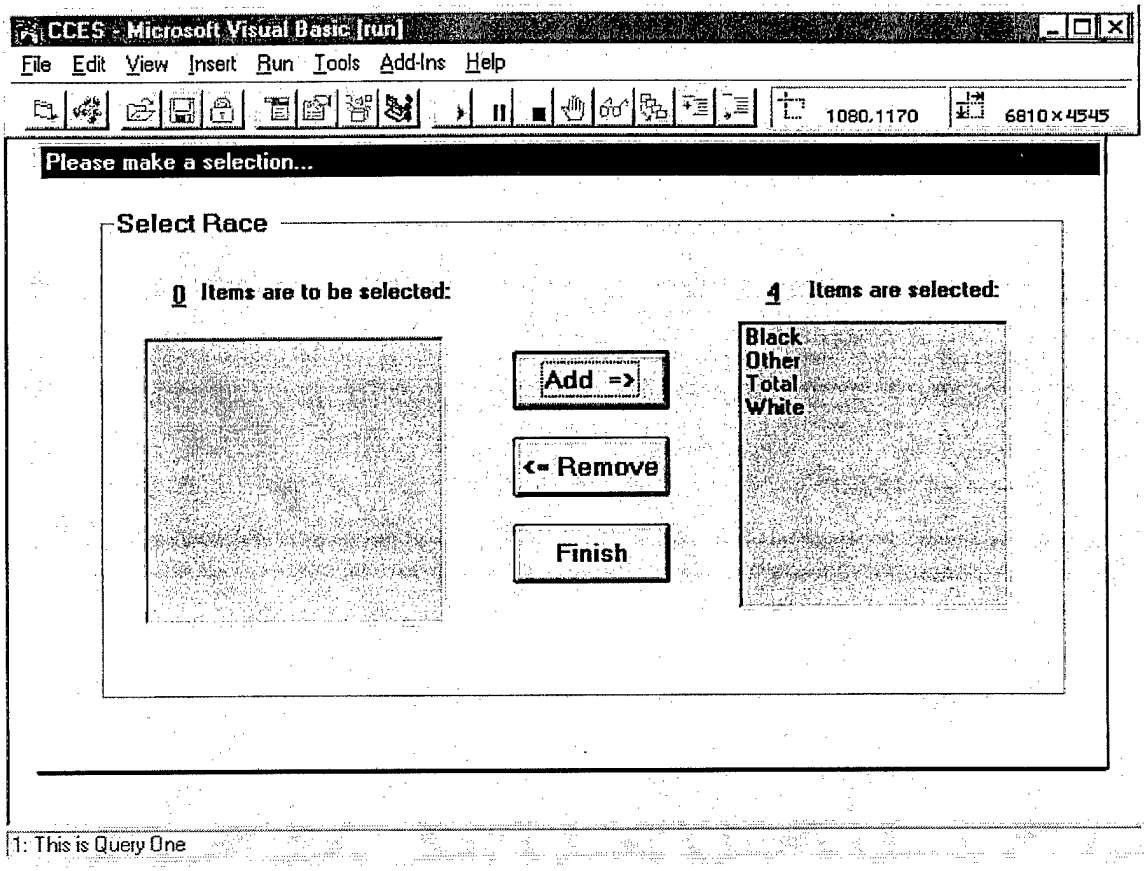

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Diagnosis Year
6 Items are to be selected:
Jan 1 - Dec 31,1987
Jan 1 - Dec 31,1988
Jan 1 - Dec 31,1989
Jan 1 - Dec 31,1990
Jan 1 - Dec 31,1991
Jan 1 - Dec 31,1992
Add =>
<= Remove
Finish
5 Items are selected:
Jan 1 - Dec 31,1982
Jan 1 - Dec 31,1983
Jan 1 - Dec 31,1984
Jan 1 - Dec 31,1985
Jan 1 - Dec 31,1986
1: This is Query One

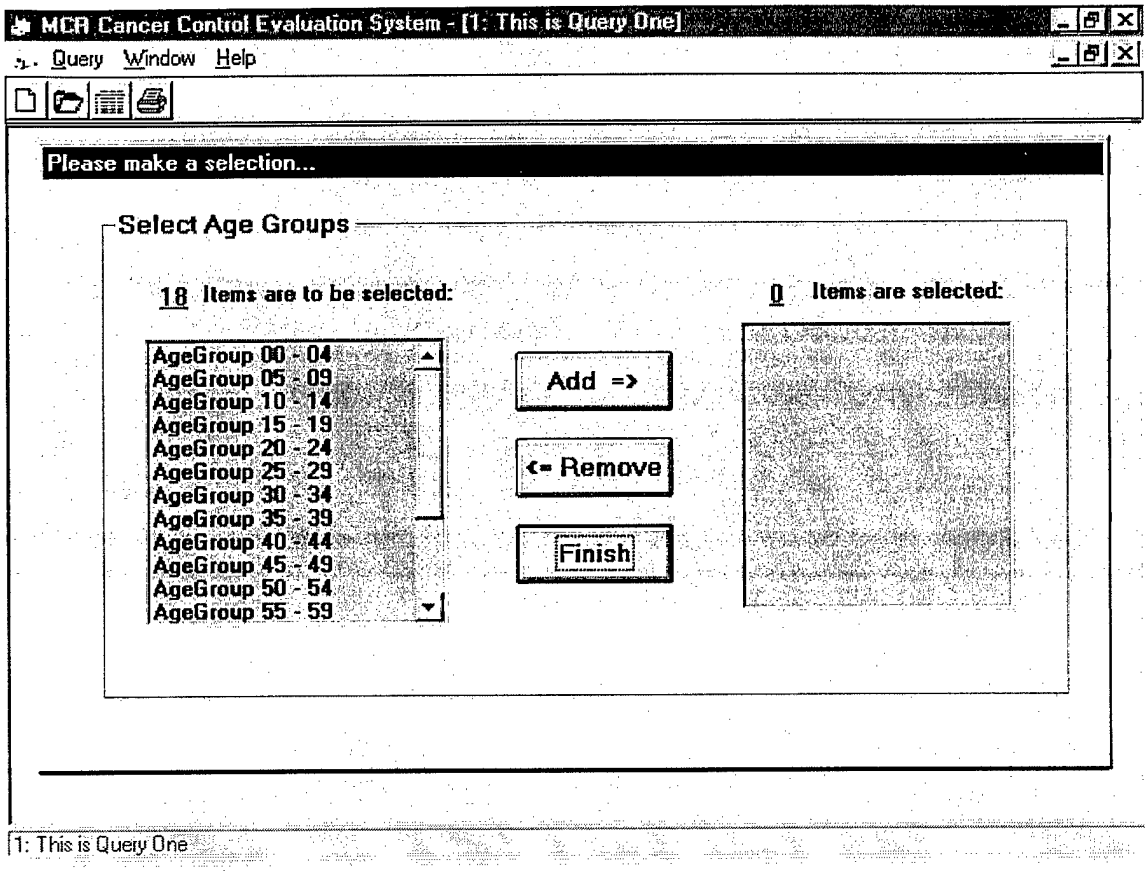

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Select General Information
Select Statistics Information
View Result
Cancer Stage Information
In-situ
Local
Regional
Distant
Unknown
Geographical Information
City/Town
Socio-economic Information
Occupation
Education
Demographic Informal
Date of Diagnosi
Sex
Race
Age Group
Facility Location
Unemployed
Next =>
CCES
Do you want to
- Modify the selected year of diagnosis (Yes)
- No-Modify (No)
- Un-Check (Cancel)
Yes
No
Cancel
1: This is Query One

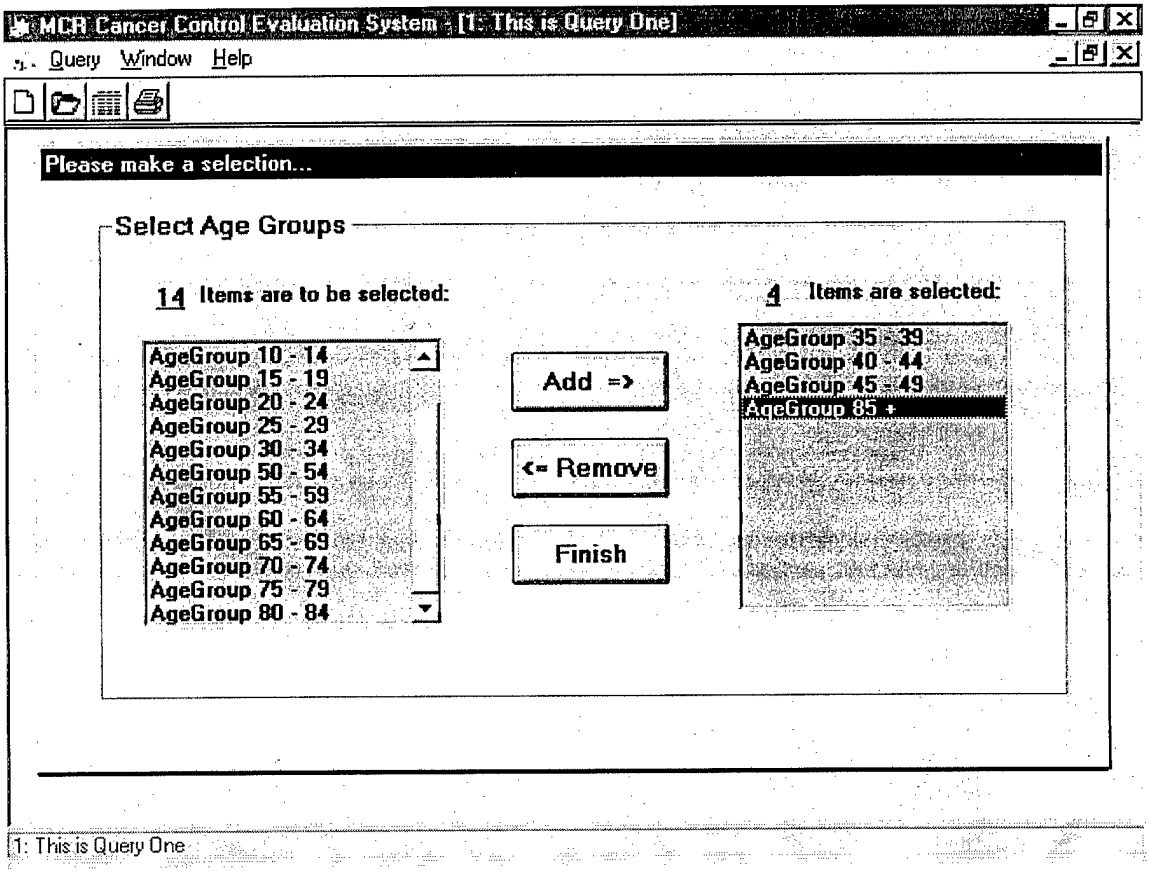

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Sex
3 Items are to be selected:
All
Female
Male
Add =>
<= Remove
Finish
0 Items are selected:
1: This is Query One

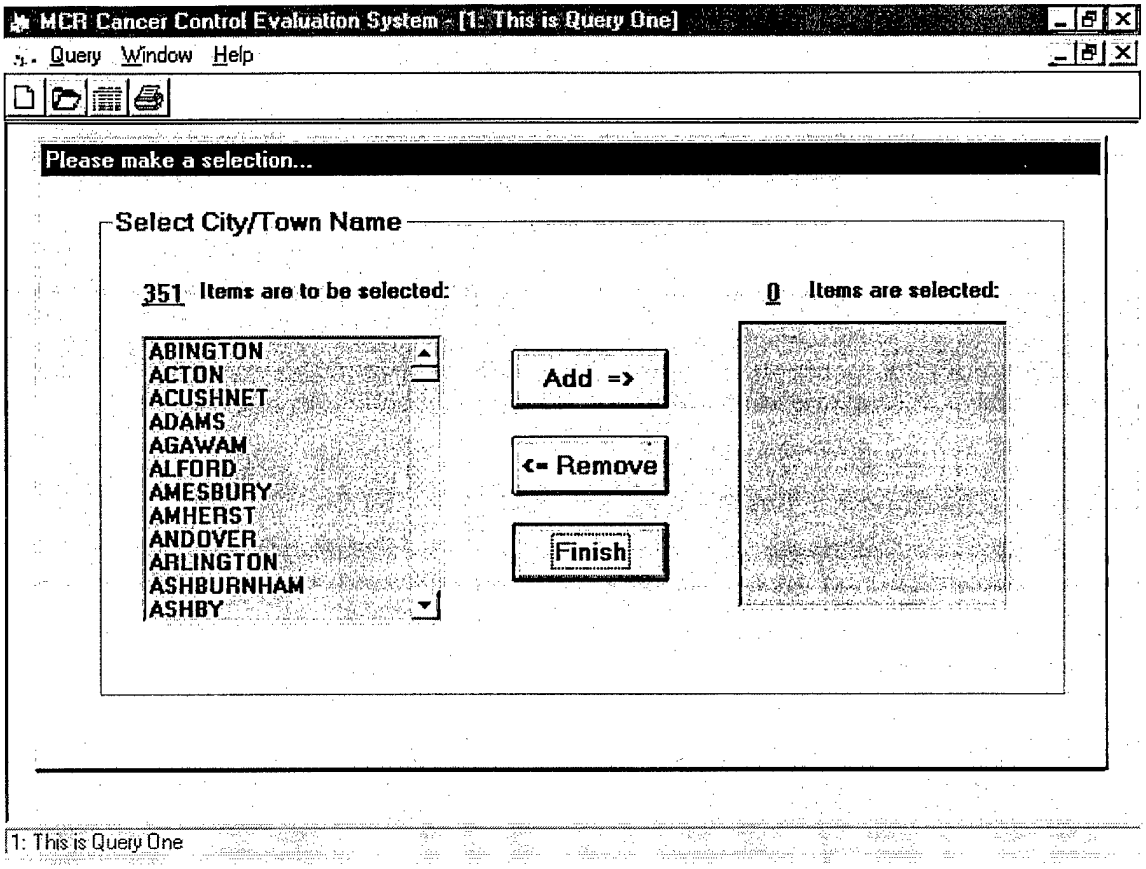

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Sex
2 Items are to be selected:
All
Male
Add =>
<= Remove
Finish
1 Items are selected:
Female
1: This is Query One

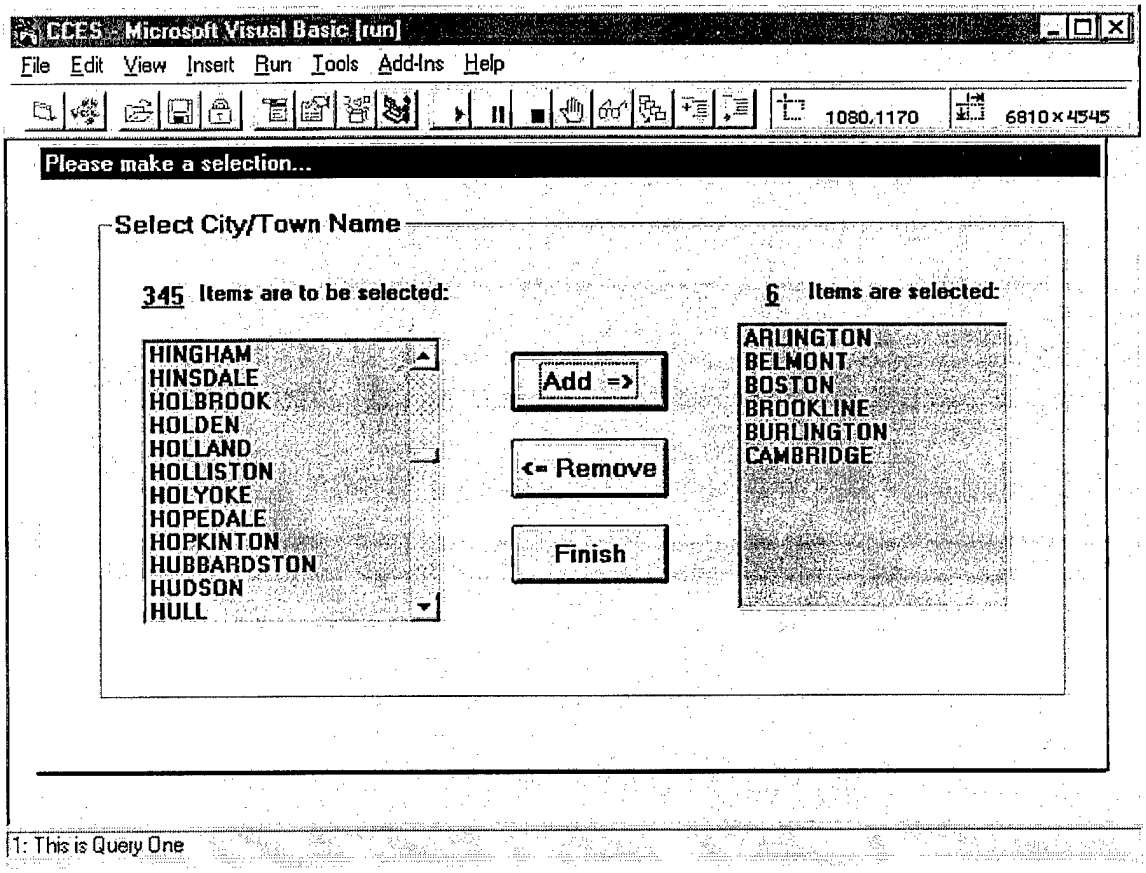

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Race
4 Items are to be selected:
Black
Other
Total
White
Add =>
<= Remove
Finish
0 Items are selected:
1: This is Query One

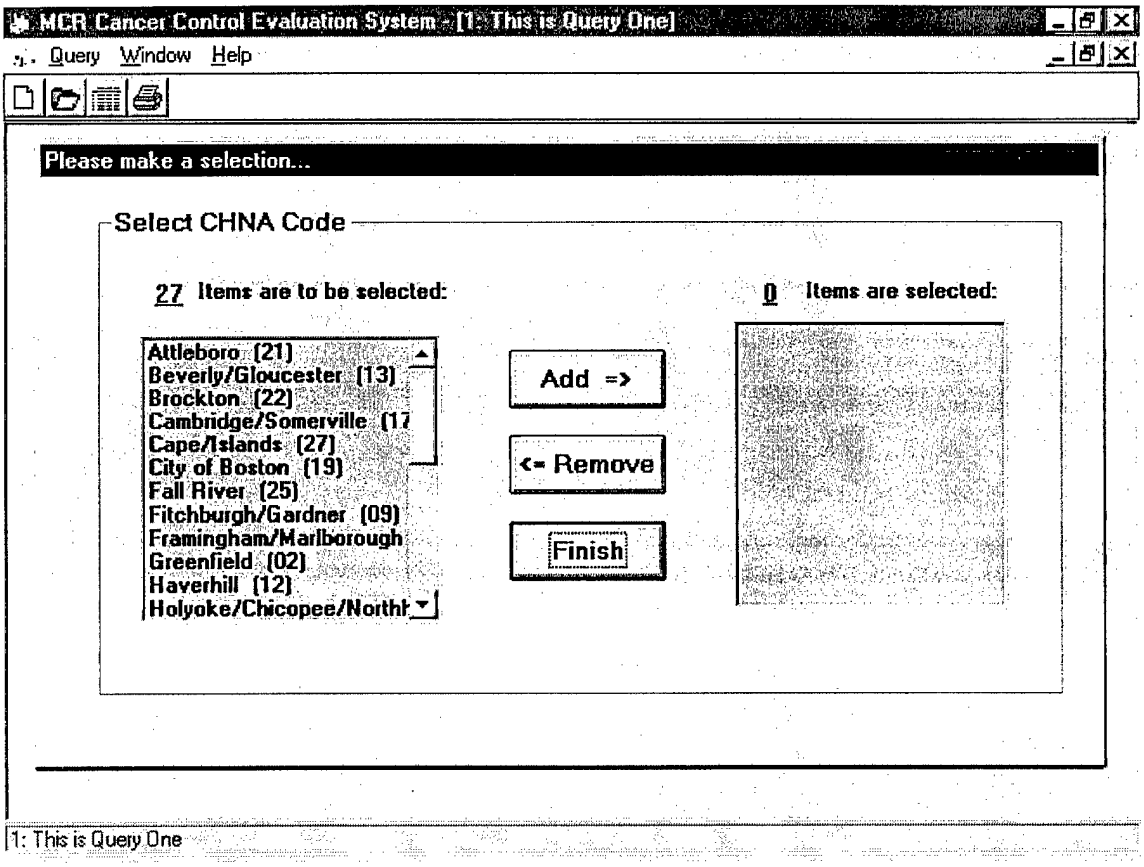

CCES - Microsoft Visual Basic [run]
File Edit View Insert Run Tools Add-Ins Help
1080,1170
6810 x 4545
Please make a selection...
Select Race
0 Items are to be selected:
Add =>
<= Remove
Finish
4 Items are selected:
Black
Other
Total
White
1: This is Query One

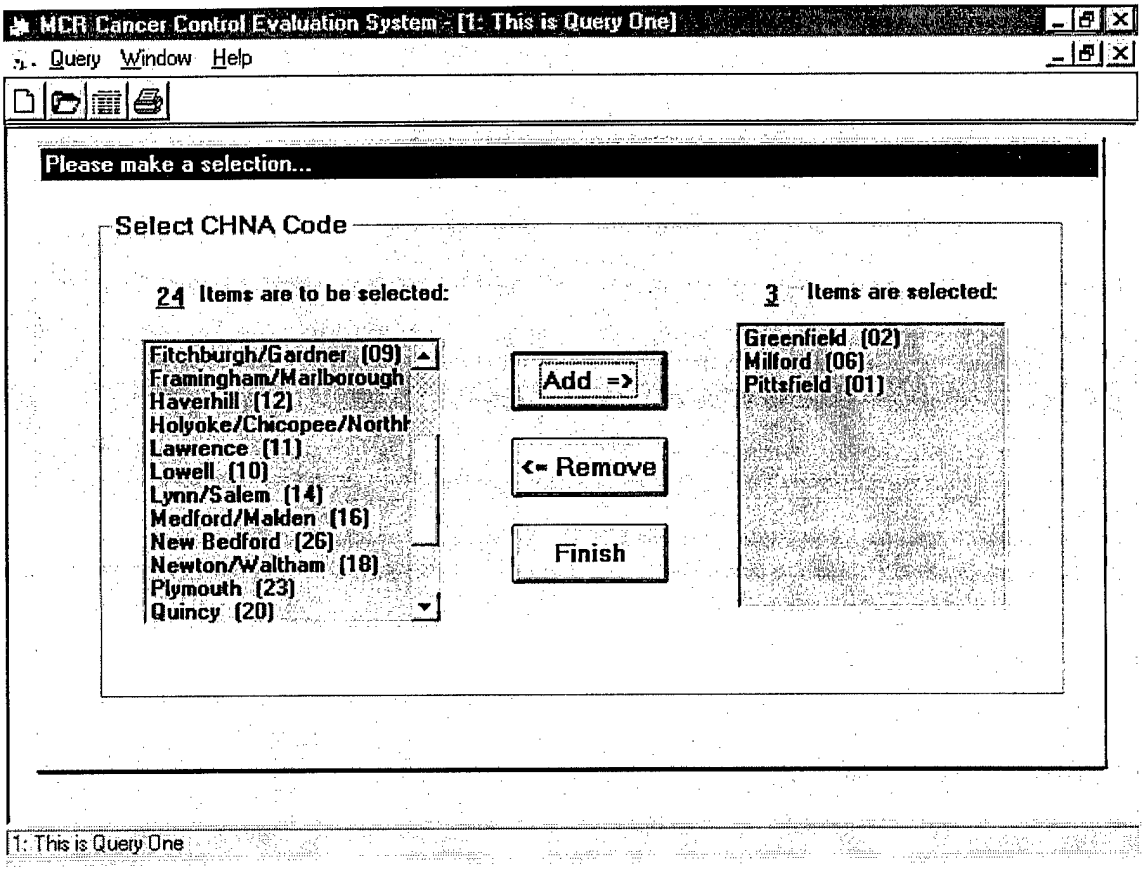

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Age Groups
18 Items are to be selected:
AgeGroup 00 - 04
AgeGroup 05 - 09
AgeGroup 10 - 14
AgeGroup 15 - 19
AgeGroup 20 - 24
AgeGroup 25 - 29
AgeGroup 30 - 34
AgeGroup 35 - 39
AgeGroup 40 - 44
AgeGroup 45 - 49
AgeGroup 50 - 54
AgeGroup 55 - 59
Add =>
<= Remove
Finish
0 Items are selected:
1: This is Query One

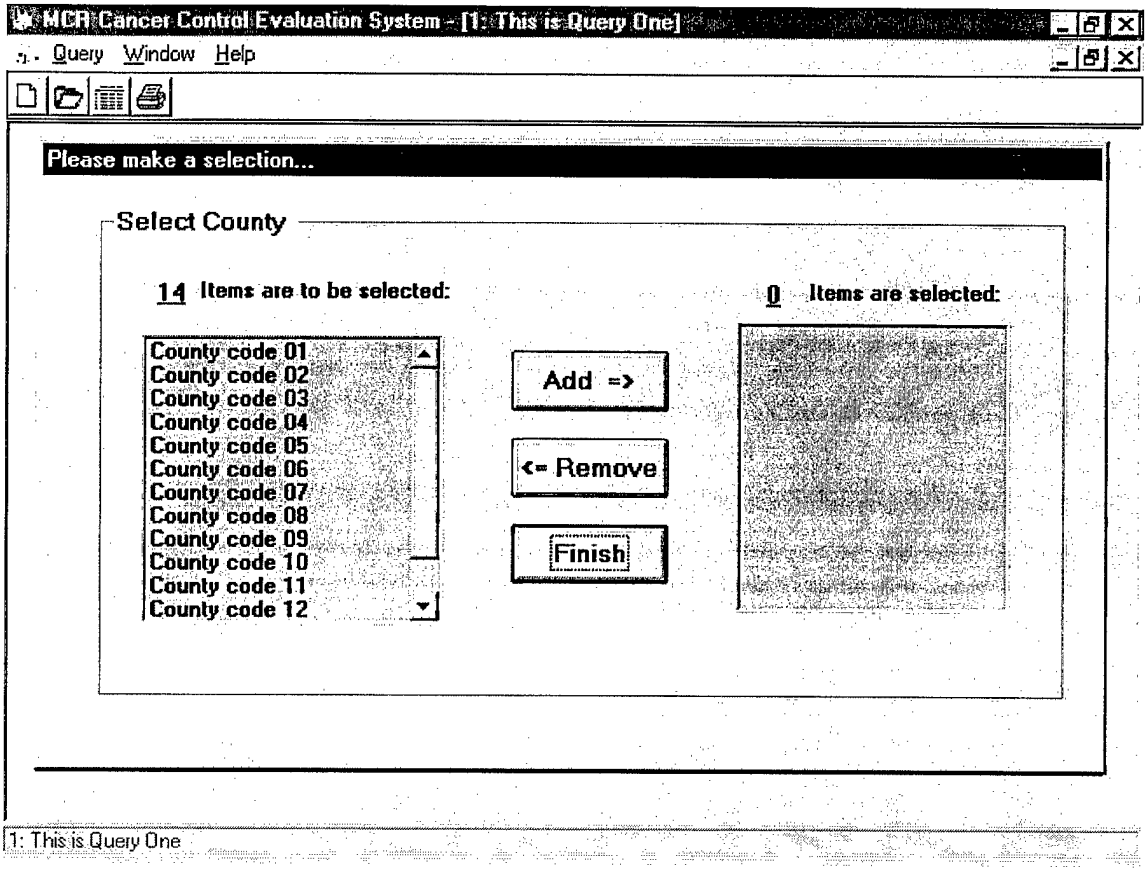

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Age Groups
14 Items are to be selected:
AgeGroup 10 - 14
AgeGroup 15 - 19
AgeGroup 20 - 24
AgeGroup 25 - 29
AgeGroup 30 - 34
AgeGroup 50 - 54
AgeGroup 55 - 59
AgeGroup 60 - 64
AgeGroup 65 - 69
AgeGroup 70 - 74
AgeGroup 75 - 79
AgeGroup 80 - 84
Add =>
<= Remove
Finish
4 Items are selected:
AgeGroup 35 - 39
AgeGroup 40 - 44
AgeGroup 45 - 49
AgeGroup 85 +
1: This is Query One

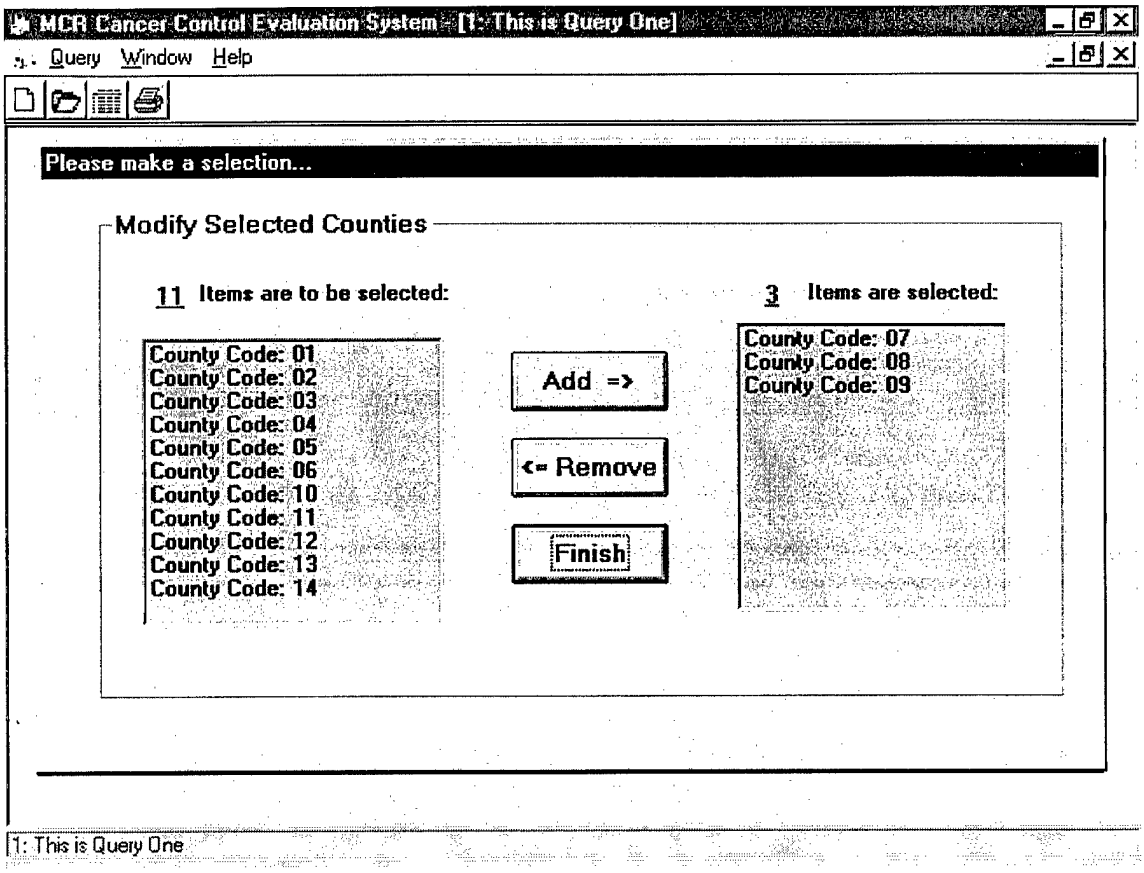

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select City/Town Name
351 Items are to be selected:
0 Items are selected:
ABINGTON
ACTON
ACUSHNET
ADAMS
AGAWAM
ALFORD
AMESBURY
AMHERST
ANDOVER
ARLINGTON
ASHBURNHAM
ASHBY
Add =>
<= Remove
Finish
1: This is Query One

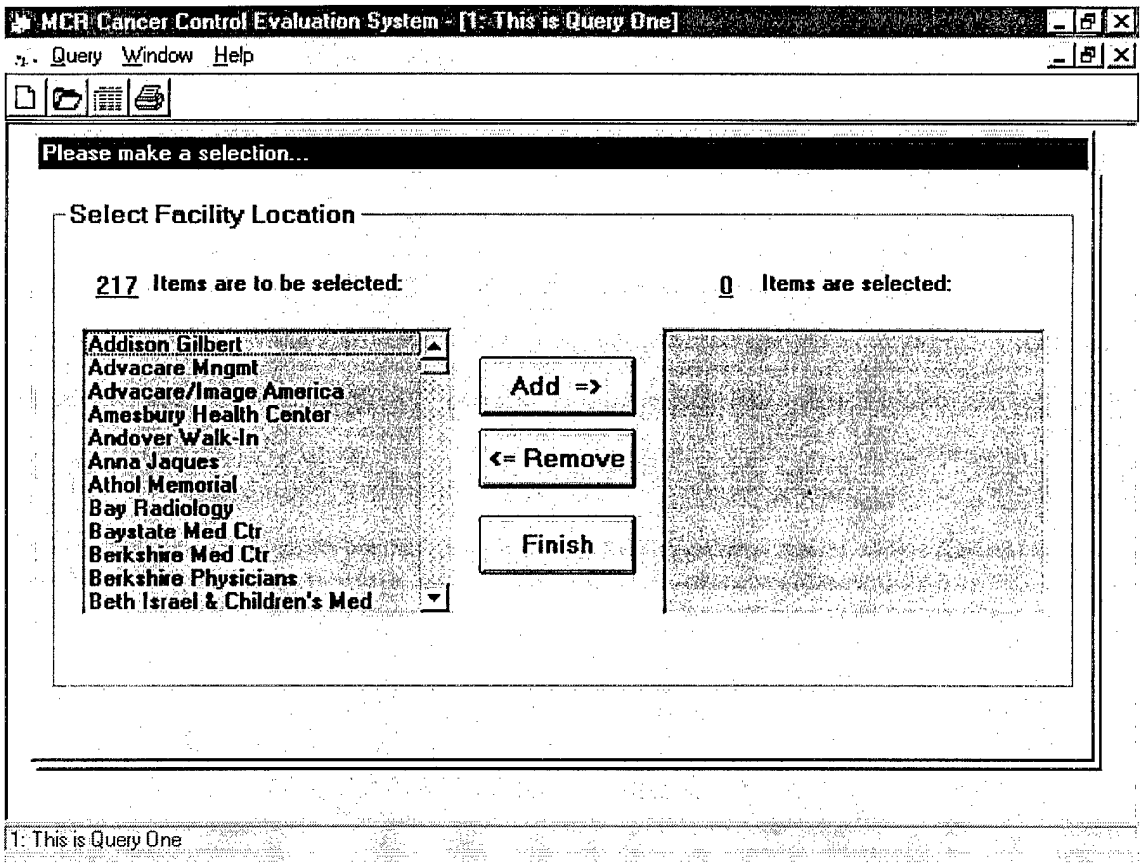

CCFS - Microsoft Visual Basic [run]
File Edit View Insert Run Tools Add-Ins Help
1080,1170
6810 x 4545
Please make a selection...
Select City/Town Name
345 Items are to be selected:
HINGHAM
HINSDALE
HOLBROOK
HOLDEN
HOLLAND
HOLLISTON
HOLYOKE
HOPEDALE
HOPKINTON
HUBBARDSTON
HUDSON
HULL
Add =>
<= Remove
Finish
6 Items are selected:
ARLINGTON
BELMONT
BOSTON
BROOKLINE
BURLINGTON
CAMBRIDGE
1: This is Query One

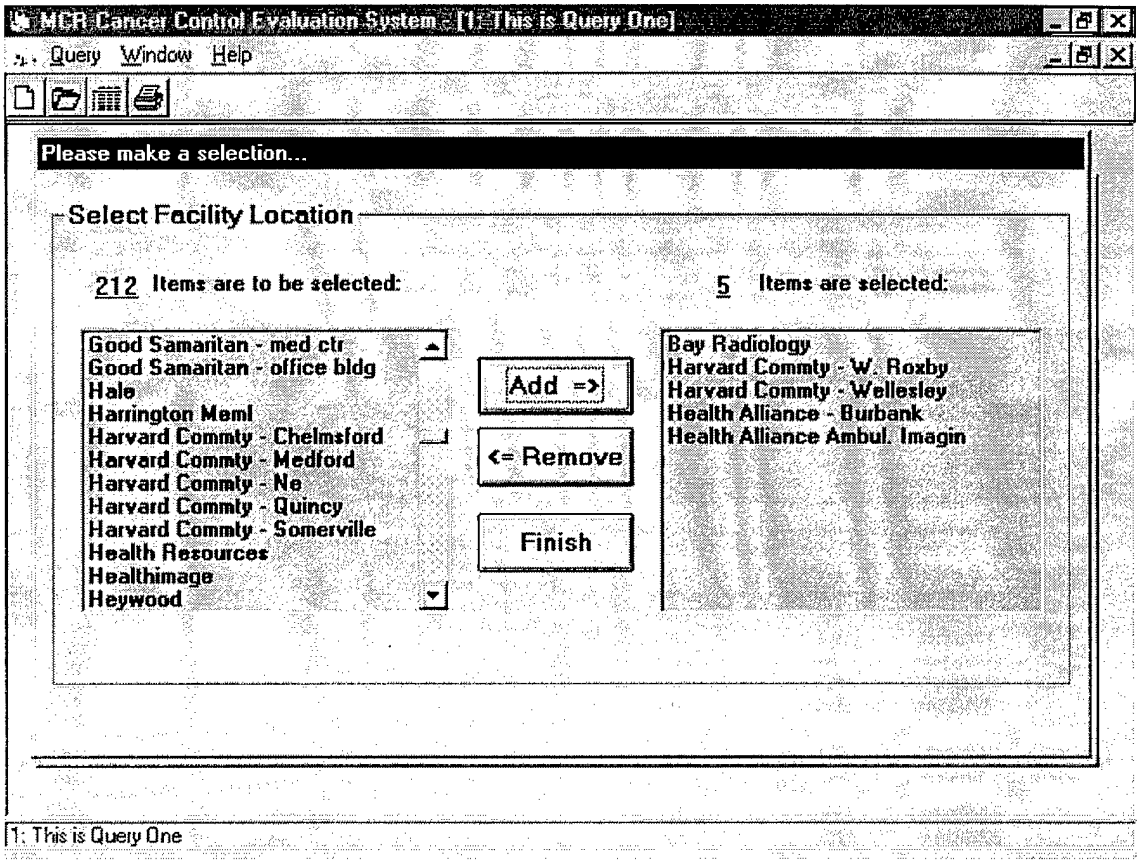

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select CHNA Code
27 Items are to be selected:
0 Items are selected:
Attleboro (21)
Beverly/Gloucester (13)
Brockton (22)
Cambridge/Somerville (17
Cape/Islands (27)
City of Boston (19)
Fall River (25)
Fitchburgh/Gardner (09)
Framingham/Marlborough
Greenfield (02)
Haverhill (12)
Holyoke/Chicopee/Northt
Add =>
<= Remove
Finish
1: This is Query One

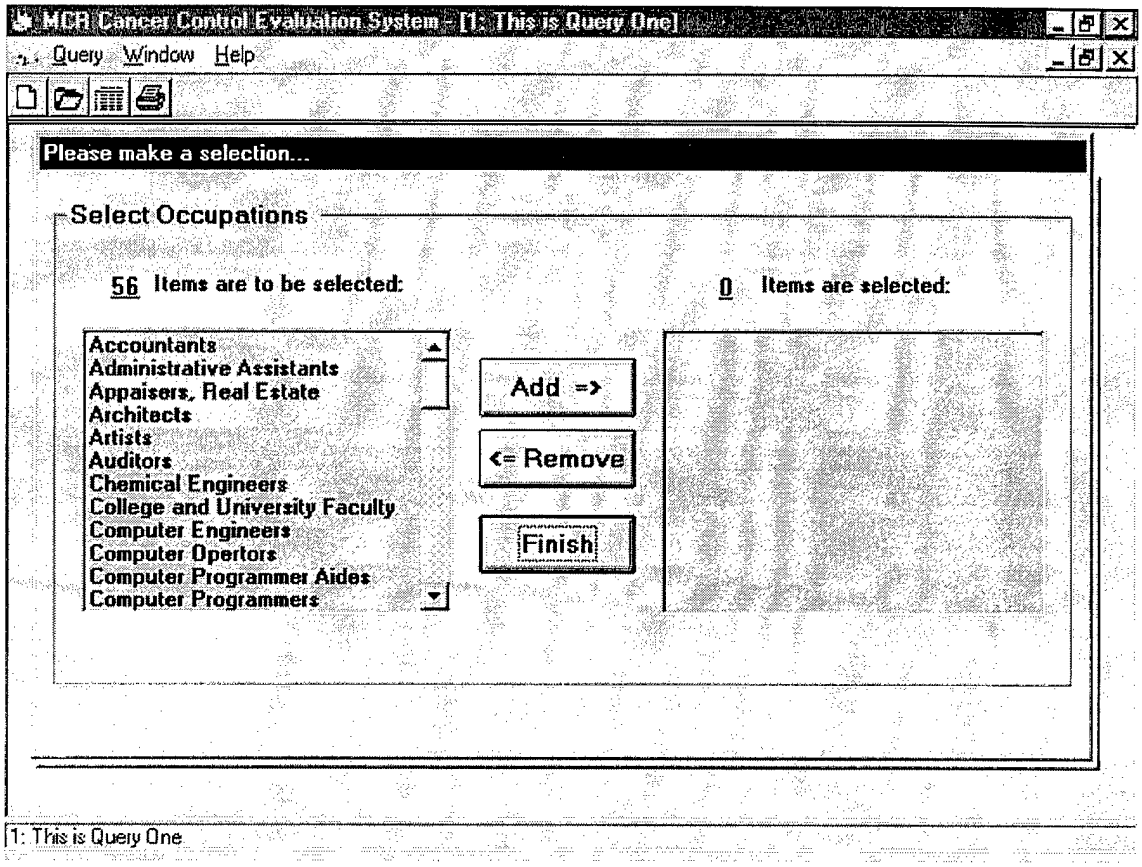

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select CHNA Code
24 Items are to be selected:
Fitchburgh/Gardner (09)
Framingham/Marlborough
Haverhill (12)
Holyoke/Chicopee/Northf
Lawrence (11)
Lowell (10)
Lynn/Salem (14)
Medford/Malden (16)
New Bedford (26)
Newton/Waltham (18)
Plymouth (23)
Quincy (20)
Add =>
<= Remove
Finish
3 Items are selected:
Greenfield (02)
Milford (06)
Pittsfield (01)
1: This is Query One

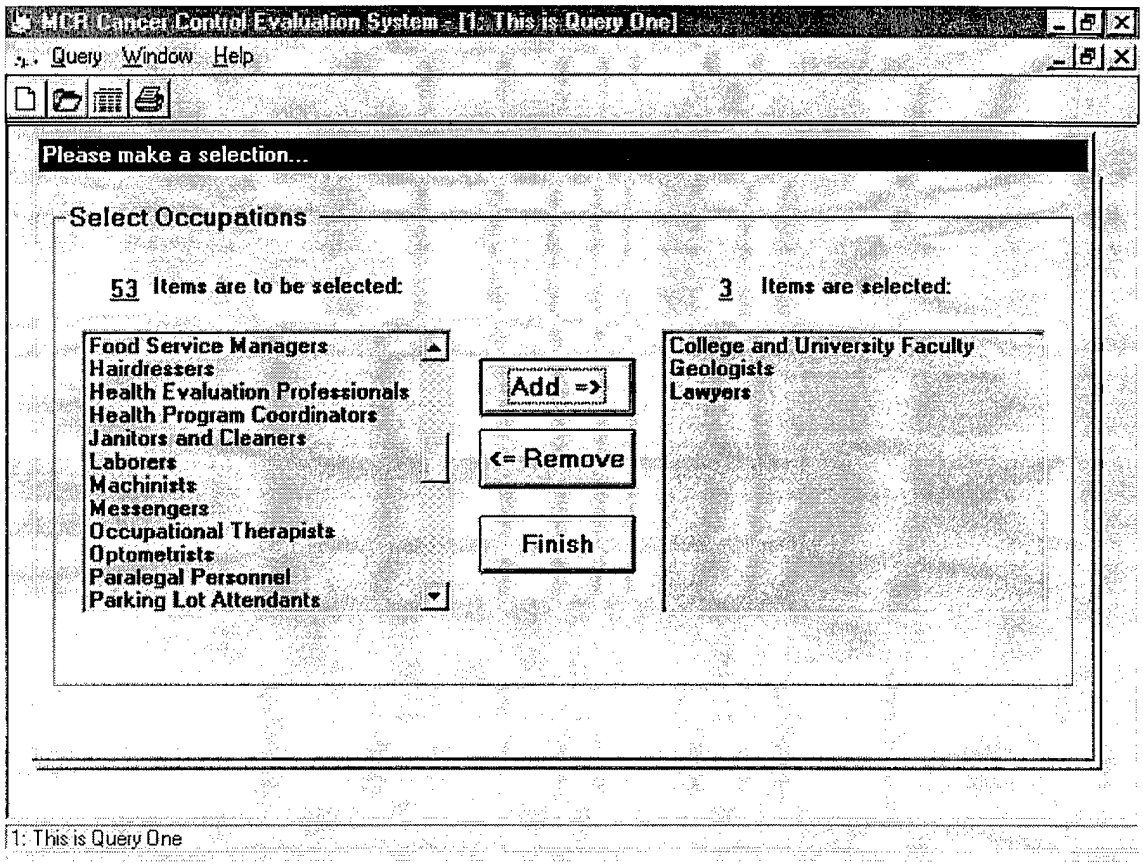

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select County
14 Items are to be selected:
0 Items are selected:
County code 01
County code 02
County code 03
County code 04
County code 05
County code 06
County code 07
County code 08
County code 09
County code 10
County code 11
County code 12
Add =>
<= Remove
Finish
1: This is Query One

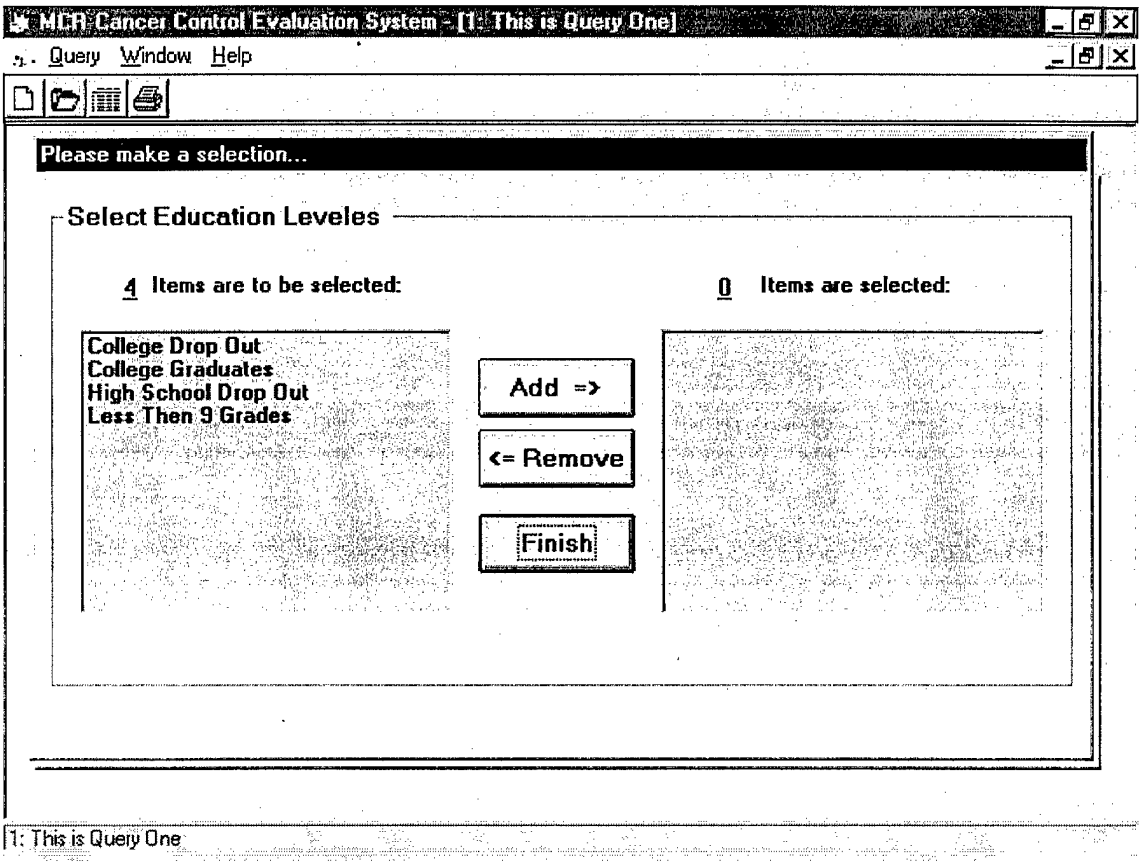

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Modify Selected Counties
11 Items are to be selected:
County Code: 01
County Code: 02
County Code: 03
County Code: 04
County Code: 05
County Code: 06
County Code: 10
County Code: 11
County Code: 12
County Code: 13
County Code: 14
Add =>
<= Remove
Finish
3 Items are selected:
County Code: 07
County Code: 08
County Code: 09
1: This is Query One

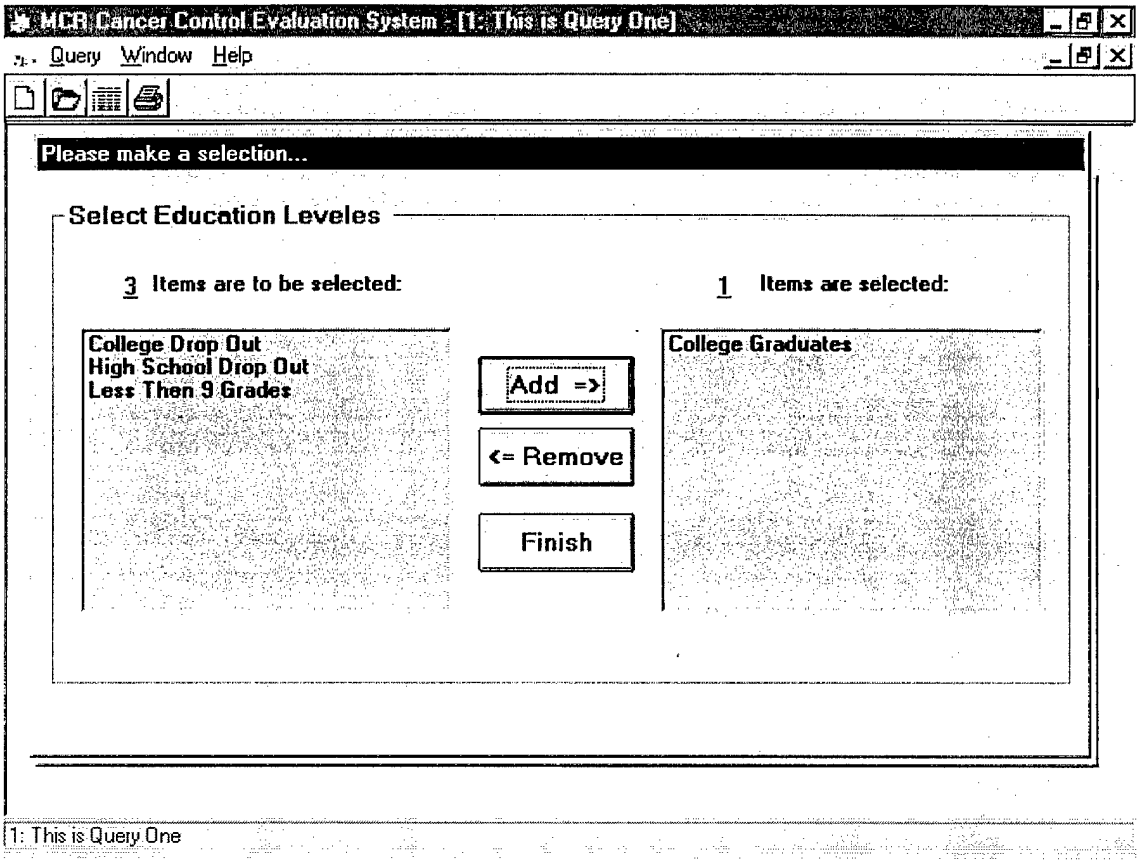

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Facility Location
217 Items are to be selected:
0 Items are selected:
Addison Gilbert
Advacare Mngmt
Advacare/Image America
Amesbury Health Center
Andover Walk-In
Anna Jaques
Athol Memorial
Bay Radiology
Baystate Med Ctr
Berkshire Med Ctr
Berkshire Physicians
Beth Israel & Children's Med
Add =>
<= Remove
Finish
1: This is Query One

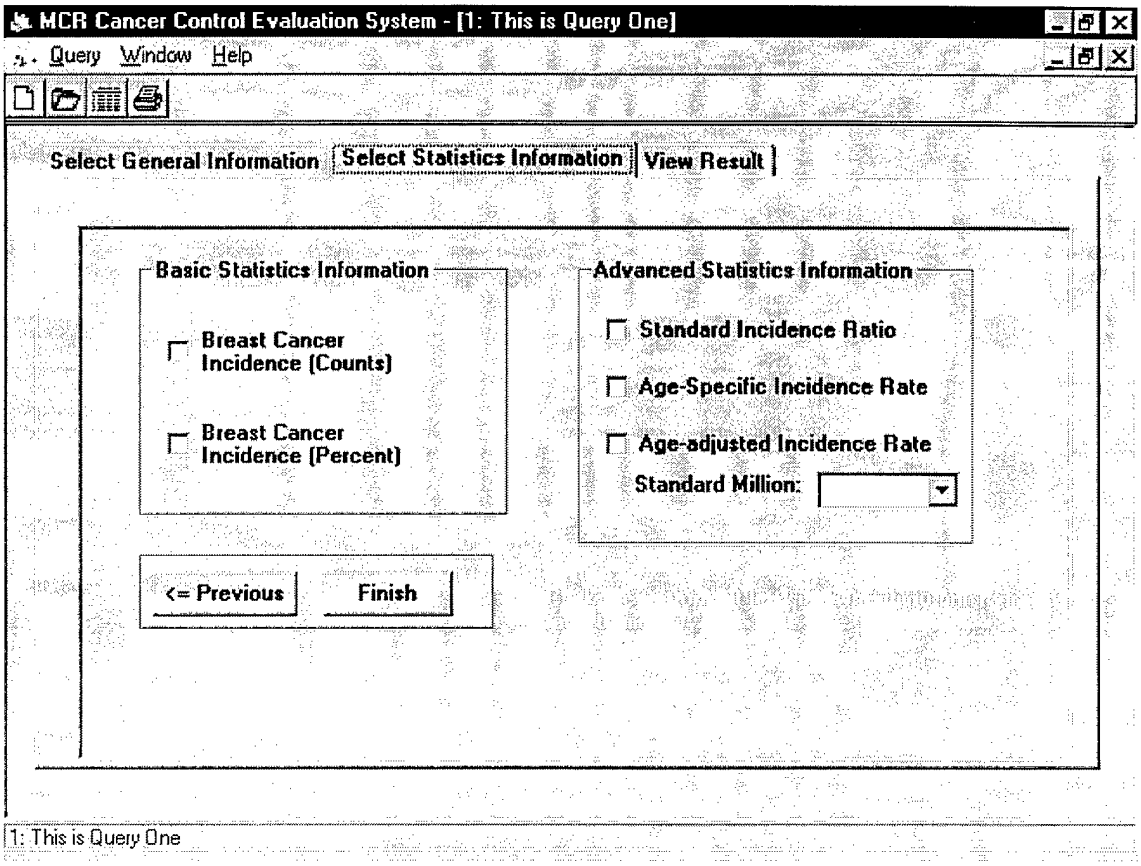

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Facility Location
212 Items are to be selected:
5 Items are selected:
Good Samaritan - med ctr
Good Samaritan - office bldg
Hale
Harrington Meml
Harvard Commty - Chelmsford
Harvard Commty - Medford
Harvard Commty - Ne
Harvard Commty - Quincy
Harvard Commty - Somerville
Health Resources
Healthimage
Heywood
Add =>
<= Remove
Finish
Bay Radiology
Harvard Commty - W. Roxby
Harvard Commty - Wellesley
Health Alliance - Burbank
Health Alliance Ambul. Imagin
1: This is Query One

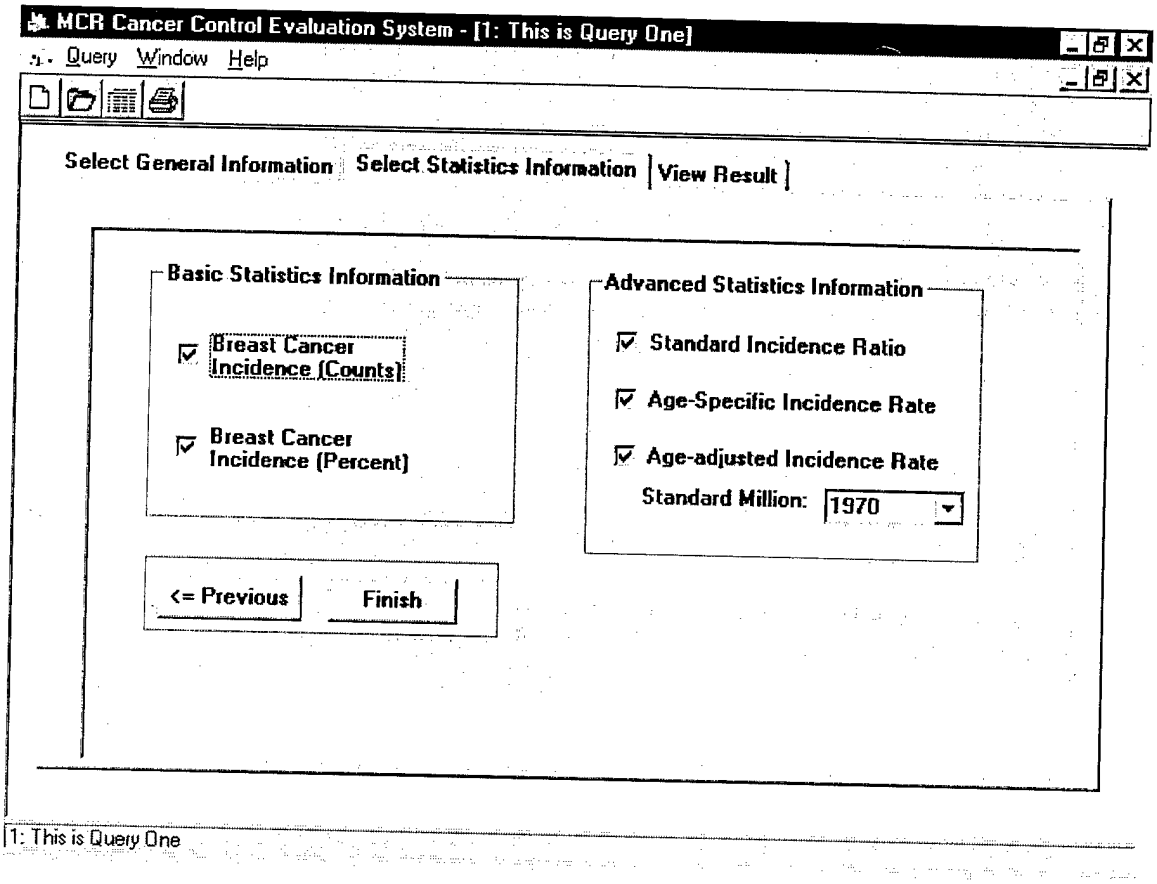

MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Occupations
56 Items are to be selected:
0 Items are selected:
Accountants
Administrative Assistants
Appaisers, Real Estate
Architects
Artists
Auditors
Chemical Engineers
College and University Faculty
Computer Engineers
Computer Operators
Computer Programmer Aides
Computer Programmers
Add =>
<= Remove
Finish
1: This is Query One


HCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Occupations
53 Items are to be selected:
3 Items are selected:
Food Service Managers
Hairdressers
Health Evaluation Professionals
Health Program Coordinators
Janitors and Cleaners
Laborers
Machinists
Messengers
Occupational Therapists
Optometrists
Paralegal Personnel
Parking Lot Attendants
Add =>
<= Remove
Finish
College and University Faculty
Geologists
Lawyers
1: This is Query One


MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Education Leveles
4 Items are to be selected:
0 Items are selected:
College Drop Out
College Graduates
High School Drop Out
Less Then 9 Grades
Add =>
<= Remove
Finish
1: This is Query One


MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Please make a selection...
Select Education Leveles
3 Items are to be selected:
1 Items are selected:
College Drop Out
High School Drop Out
Less Then 9 Grades
College Graduates
Add =>
<= Remove
Finish
1: This is Query One


MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Select General Information
Select Statistics Information
View Result
Basic Statistics Information
Breast Cancer Incidence (Counts)
Breast Cancer Incidence (Percent)
Advanced Statistics Information
Standard Incidence Ratio
Age-Specific Incidence Rate
Age-adjusted Incidence Rate
Standard Million:
<= Previous
Finish
1: This is Query One


MCR Cancer Control Evaluation System - [1: This is Query One]
Query Window Help
Select General Information
Select Statistics Information
View Result
Basic Statistics Information
Breast Cancer Incidence (Counts)
Breast Cancer Incidence (Percent)
Advanced Statistics Information
Standard Incidence Ratio
Age-Specific Incidence Rate
Age-adjusted Incidence Rate
Standard Million:
1970
<= Previous
Finish
1: This is Query One