Nancy Condon
Project Title: City of Rockville Population Projections and Dashboard
Course Number: DATA 205 CRN 22017
Sponsoring Agency: City of Rockville Community Planning and Development Services

Introduction

City of Rockville Community Planning and Development Services internship involved creating a dashboard that displayed visualizations for demographic, economic, housing and population forecasts from U.S. Census Data. Secondly, estimate future city's population by age and sex in five-year increments as a tool to review future housing needs pertaining to volume and affordability.

A. Dashboard

The sponsors wanted to promote the 2020 Decennial Census, American Community Survey (ACS) 1-Year / 5-Year Estimates and Rockville City Planning data as a dashboard on a public facing website. The sponsor provided a sample dashboard for guidance and over a series of meetings actively participated in the development of visualizations in Power BI. Demographic information used was age, sex, race, and ethnicity. Highlights from the Economic page was represented by income, education attainment and labor force. Housing included type of housing, number of bedrooms and median rent prices (Figure 1). A page was developed for "other indicators" related to demographics, economic and housing. Finally, the last page was a table for the population, housing, employment forecasts from the City of Rockville Planning and Development Services.

For additional information, the user may hover over a visualization and a tool-tip box will appear with additional information. There are links embedded in the title box that takes the user to the Rockville Community Planning page and another link in the sources text box that takes the user to the U.S. Census Bureau home page.

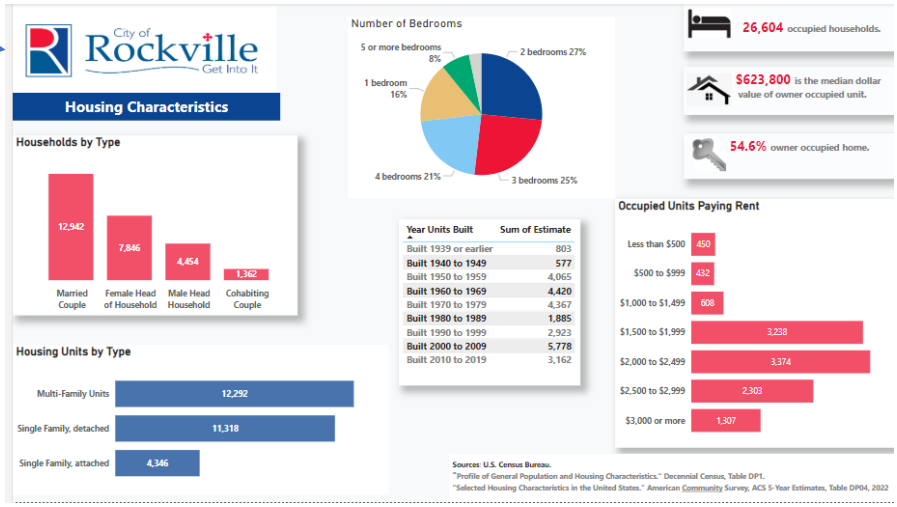


Figure 1

The excel files from the Census Bureau did not require any cleaning. The pre-processing methods used was filtering and subgrouping techniques for the visualizations. Additionally, data that required subgrouping, the margin of errors were pooled with the use of a online calculator

from https://www.datacenterresearch.org/data-resources/neighborhood-data/combining-data-points/ and subject matter expert review.

Basic statistics was not utilized on any dataset; visualizations were made from the existing data. As a resident of Rockville, I learned several interesting facts about the City of Rockville that became apparent from the visualizations. Asian race makes up about 22% of the population and only 56.5% of residents speak English at home. Over 57% of the population has a household income over $100,000 and 8.3% is determined to be below poverty level.

The dashboard is now available at Community Data & Trends | Rockville, MD - Official Website.

B. Population Estimates for Age and Sex Groups

The City of Rockville is concerned about future housing needs. The number, type (single, single attached, multi-family units, senior) and affordability of housing is of equal concern. Future population estimates that include age and sex cohorts at a city level is not readily available. This project entails projecting future population estimates to the year 2040 from the U.S. Decennial 2010 and 2020 Census' age and sex categories in five-year increments; and comparing future population estimates to future approved housing plan.

The standard method for projecting population estimates is the Cohort-Component population forecasting method. The basic Cohort-Component equation:

$$P_{t+n} = \text{population}_{t-1} + \text{births} - \text{deaths} + \text{net migrants}$$

This method requires additional data sources for births, deaths, net migration which are not readily available at the city (subcounty) level. For these reasons, the Hamilton-Perry Method, a variant of the Cohort-Component method was selected.

The Hamilton-Perry method is considered an acceptable method for use for subcounty areas. It only requires the use of two most recent U.S. Census periods. It utilizes cohort change ratios (CCR) which addresses deaths and net migration; and the Child Women Ratio (CWR) represents surviving births. Some key points are :

- It can be used to develop estimates by age, sex, race
- Applies a constant rate of growth for the individual cohort;
- Ratios >1 represent growth and <1 represents decline;
- It can lead to high projections in rapidly growing places and low projections in areas with population losses (Swanson et al. 2009).

The two most recent censuses used for this project was 2010 and 2020 Decennial Census Age and Sex cohort groups from the U.S. Census Bureau. The files were in EXCEL format and did not require any type of manipulation or preparation. All calculations were computed in EXCEL. Calculation example:

Closed age groups (50-54 Age group): $CCR = {}_{10}P_{50,2020} / {}_{10}P_{40,2010}$

Population Projection for 2030 : ${}_{10}P_{50,2030} = CCR * {}_{10}P_{40,2020}$

Child Women Ration (CWR):

0-5 Age group: $CWR = {}_5P_{0,2020} / {}_{30}FP_{15,2020}$

5-9 Age group: $CWR = {}_9P_{5,2020} / {}_{30}FP_{20,2020}$

Population Projection for 2030:

0-5 Age group: $CWR * {}_{30}FP_{15,2030}$

5-9 Age group: $CWR * {}_{30}FP_{20,2030}$

*FP = female population

85 + Age group:

$CCR_{75+} = P_{85+,2020} / P_{75+,2010}$

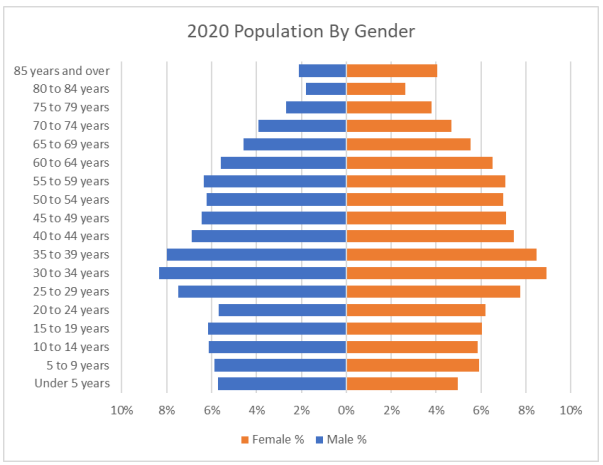
Population Projection for 2030:

$P_{85+,2030} = CCR_{75+} * P_{75+,2020}$

The 2010 -2040 population estimates, CCR and CWR are displayed in a table on page 4.

The 20-year growth rate (2020-2040) for the total population is estimated to be 20.5% with an annual rate at approximately 1.0%. For both males and females, ages 15 to 35 years had a CCR >1 projecting population growth or net migration. For ages 9 and under, had a ratio of 0.12, indicating a decline in fertility rates from 2010. From 2020 to 2040, the 65 years and older will grow by 8%.

Below is a comparison between male and female by population for 2020 and 2030 (Figure 3).



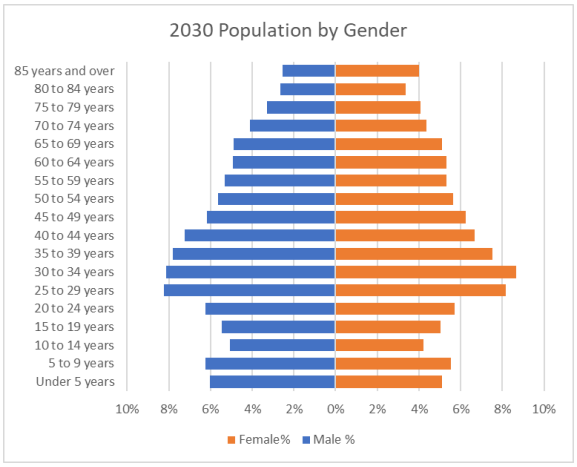


Figure 3. Population by age and sex for years 2020 and 2030.

In comparison to the year 2020, 2030 the population has changed. For both decades, females make up about 53% of the population. Birth rates appear stable and life expectancy is increasing with women living longer. A decrease of 1-1.5% in the 10- to 19-year-old group may indicate migration or morality or it is related to the 2020-year 0-5 age group aging.

	2010	2020	2030	2040	Cohort Change Ratio and Child Adult Ratios	2010-2020 Ratio Larger
Male						
Under 5 years	2,031	1,827	2,095	2,347	0.128	0
5 to 9 years	1,950	1,877	2,162	2,406	0.128	0
10 to 14 years	1,641	1,954	1,758	2,015	0.962	0
15 to 19 years	1,642	1,965	1,891	2,179	1.008	1
20 to 24 years	1,718	1,816	2,162	1,945	1.107	1
25 to 29 years	2,245	2,382	2,851	2,744	1.451	1
30 to 34 years	2,326	2,663	2,815	3,352	1.550	1
35 to 39 years	2,446	2,549	2,705	3,237	1.135	1
40 to 44 years	2,224	2,193	2,511	2,654	0.943	0
45 to 49 years	2,249	2,051	2,137	2,268	0.839	0
50 to 54 years	2,069	1,985	1,957	2,241	0.893	0
55 to 59 years	1,741	2,026	1,848	1,925	0.901	0
60 to 64 years	1,560	1,784	1,712	1,688	0.862	0
65 to 69 years	1,096	1,460	1,699	1,549	0.839	0
70 to 74 years	777	1,245	1,424	1,366	0.798	0
75 to 79 years	639	859	1,144	1,332	0.784	0
80 to 84 years	511	575	921	1,054	0.740	0
85 years and over	475	676	878	1,224	0.416	0
Female	**2010**	**2020**	**2030**	**2040**		
Under 5 years	1,971	1749	2,005	2,246	0.122	0
5 to 9 years	1,837	1884	2,170	2,415	0.129	0
10 to 14 years	1,642	1863	1,653	1,895	0.945	0
15 to 19 years	1,487	1926	1,975	2,275	1.048	1
20 to 24 years	1,653	1975	2,241	1,988	1.203	1
25 to 29 years	2,258	2473	3,203	3,285	1.663	1
30 to 34 years	2,587	2847	3,402	3,859	1.722	1
35 to 39 years	2,503	2699	2,956	3,829	1.195	1
40 to 44 years	2,403	2377	2,616	3,125	0.919	0
45 to 49 years	2,454	2265	2,442	2,675	0.905	0
50 to 54 years	2,227	2232	2,208	2,430	0.929	0
55 to 59 years	1,990	2260	2,086	2,249	0.921	0
60 to 64 years	1,813	2082	2,087	2,064	0.935	0
65 to 69 years	1,346	1762	2,001	1,847	0.885	0
70 to 74 years	951	1494	1,716	1,720	0.824	0
75 to 79 years	864	1216	1,592	1,808	0.903	0
80 to 84 years	743	836	1,313	1,508	0.879	0
85 years and over	1,140	1290	1,569	2,101	0.470	0
Total Population	61,209	67,117	73,905	80,846		

Figure 2 . Age and Sex Population Estimates, CCR, and CWR from 2010-2040.

Evaluating the accuracy of the projections for years 2030 to 2040 is problematic, as the data is not yet available. According to the literature (Baker, et al, 2020), the Hamilton-Perry average error rate for county projections ranges from 6% to 16%. Based on the City of Rockville's population of 67,000 and it is approximately at the 75th percentile for all U.S. counties, it is surmised that this error rate would apply.

The 2020 Decennial Census estimates the City of Rockville having 27,593 housing units for a population of 67,117. From 2020 to 2040 "approved applications for construction but not yet built" housing estimates, Rockville is estimated to add 6,6649 housing units. Using the 2020 population multiplier to each type of housing unit:

Type of House	Projected Number of units (2020-2040)	2020 Population Multiplier	Estimated Population Served
Single Family-Detached	30	2.99	90
Single Family-Attached	740	2.597	1923
Multi-Family	5,036	2.095	10,550
Senior	843	1.20	1,011
Total	6,649		13,573

From 2020-2040, there is projected to be an additional 13,729 people living in City of Rockville. The 'approved' housing estimate is short by about 75 units (156 people) Multi-Family units. However, there are over 6, 000 'projected' units waiting to be 'approved' between the years 2035 to 2040. In addition, the analysis did not include any possible zoning laws or policy changes that affect housing.

The word 'Seniors' usually is used with the age 65 and over. For this comparison the (80+) population was used and estimated from 2020 to 2040 to be 2,510 people. The future housing projections indicate that there will only be 843 units added to the inventory, housing only about of the population estimate. Furthermore, there are no additional housing units 'projected' for a future time.

The population estimates and housing analysis will be shared with the sponsors in the next two weeks for feedback.

Finally, to produce 5-year population projections by age and sex was computed using the Hamilton-Perry population estimates. The EXCEL FORECAST.Linear function was used to predict the future value based on all existing values versus the Linear Interpolation method, using only 2 known values. The 2020 – 2040 Population Projections is page 6.

	2010	2020	2030	2040	Cohort Change Ratio and Child Adult Ratios	2010-2020 Ratio Larger

Male						
Under 5 years	2,031	1,827	2,095	2,347	0.128	0
5 to 9 years	1,950	1,877	2,162	2,406	0.128	0
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85 years and over	1,140	1290	1,569	2,101	0.470	0

	2010	**2020**	**2030**	**2040**		

2020 - 2040 Population Projections					
	2020	**2025**	**2030**	**2035**	**2040**
Male					
Under 5 years	1827	2,086	2,095	2,230	2,347
5 to 9 years	1877	2,110	2,162	2,296	2,406
10 to 14 years	1954	1,860	1,758	1,990	2,015
15 to 19 years	1965	1,931	1,891	2,109	2,179
20 to 24 years	1816	1,917	2,162	2,032	1,945
25 to 29 years	2382	2,567	2,851	2,786	2,744
30 to 34 years	2663	2,731	2,815	2,938	3,352
35 to 39 years	2549	2,709	2,705	2,912	3,237
40 to 44 years	2193	2,432	2,511	2,665	2,654
45 to 49 years	2051	2,226	2,137	2,341	2,268
50 to 54 years	1985	2,081	1,957	2,167	2,241
55 to 59 years	2026	1,891	1,848	1,942	1,925
60 to 64 years	1784	1,703	1,712	1,768	1,688
65 to 69 years	1460	1,427	1,699	1,540	1,549
70 to 74 years	1245	1,169	1,424	1,295	1,366
75 to 79 years	859	956	1,144	1,119	1,332
80 to 84 years	575	740	921	888	1,054
85 years and over	676	821	878	1,081	1,224
Female	2020	2,025	2,030	2,035	2,040
Under 5 years	1749	2,005	2,005	2,138	2,246
5 to 9 years	1884	2,081	2,170	2,293	2,415
10 to 14 years	1863	1,786	1,653	1,885	1,895
15 to 19 years	1926	1,917	1,975	2,161	2,275
20 to 24 years	1975	1,964	2,241	2,091	1,988
25 to 29 years	2473	2,807	3,203	3,194	3,285
30 to 34 years	2847	3,090	3,402	3,358	3,859
35 to 39 years	2699	2,984	2,956	3,382	3,829
40 to 44 years	2377	2,662	2,616	2,965	3,125
45 to 49 years	2265	2,539	2,442	2,782	2,675
50 to 54 years	2232	2,322	2,208	2,477	2,430
55 to 59 years	2260	2,163	2,086	2,257	2,249
60 to 64 years	2082	2,019	2,087	2,108	2,064
65 to 69 years	1762	1,721	2,001	1,858	1,847
70 to 74 years	1494	1,430	1,716	1,602	1,720
75 to 79 years	1216	1,320	1,592	1,540	1,808
80 to 84 years	836	1,072	1,313	1,293	1,508
85 years and over	1290	1,548	1,569	1,910	2,101
Total Population	**67,117**	**72,812**	**73,905**	**77,392**	**80,846**

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