Using Age-Adjusted and Crude Rates for Assessing COVID-19 Cases

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Abstract

Purpose: To assess the difference in crude rates and age-adjusted rates in COVID-19 cases.

Methods: COVID-19 cases in Virginia were obtained from the publicly available dataset as of June 21, 2020. Crude rates of COVID -19 cases were calculated and estimates for the total population of Virginia were age-adjusted to the U.S. Census 2000 population using the direct method.

Results: There was a wide difference between the crude rate and the age-adjusted rate in the different age-groups. The crude rate was highest for the over 80 age group, 1063.93 per 100,000 population. However, the age-adjusted rate was highest in the 40-49 years age group, 147.72 per 100,000 followed by the 30-39 group and 20-29 group.

Conclusion: Comparing the crude rates and age-adjusted rates of COVID-19 cases takes into account the confounding effect of age due to differences in the distribution of a population. Given the risk and higher COVID-19 cases among certain age-groups, knowing the crude rates and the age-adjusted rates may help in population-based prevention and interventions and can be used for planning capabilities and targeted measures.

Key Words: Age-adjusted rate, COVID-19, Crude rate

Background

The World Health Organization (WHO) declared the novel Coronavirus (COVID-19) as a pandemic on March 11, 2020 (WHO, 2020). Many earlier estimates across different states in the United States have reported on cases and mortality rates, across different races and ethnicity (Centers for Disease Control (CDC), 2020). Co-morbidities of Covid-19 (e.g. diabetes, cardiovascular disease) increase with age, and underlying health conditions (Dowd et al., 2020; Shahid et al., 2020). The contribution of age distribution, when comparing cases across variables such as race, is relevant and will help in presenting a clearer picture of the spread of the coronavirus. This is especially relevant since for diseases in general and for COVID-19, a number of factors may have an impact, especially age as a confounding factor.

Generally, crude rates of cases or incidence of COVID-19 has been reported with a few exceptions, where age-adjusted rates have been described (CDC, 2020). Crude rates are useful when comparing different populations of varying sizes, such as comparing death rates for all causes over a particular time period (CDC, 2020). However, crude rates do not take into consideration the demographic makeup of a population. The reported crude rates of cases varies widely between different populations and the limitations of using crude rates has been addressed in other diseases like HIV and hypertension (Cosby et al., 2019; Hoyert et al., 2001; Ostchega et al., 2020; Zaba et al., 2007). Crude rates control for the population size, but assumes that all of the population are equally at risk, irrespective of the socioeconomic and demographic factors, like a younger population, and variation in age-structure (Klein & Schoenborn, 2001). Given the difference in health risks and outcomes across different age groups and races, understanding the effect of the age distribution of a population is essential. Information on age-adjusted rates while reporting cases serves as a measure of the demographic impact of the pandemic (Cosby et al., 2019; Hoyert et al., 2001; Ostchega et al., 2020; Zaba et al., 2007).

Using age-adjusted rates controls for age when comparing different populations with varying age-distributions (Curtin & Klein, 1995). In this manuscript, the extent to which age distribution of COVID-19 cases varies across different age groups and races within the Commonwealth of Virginia will be examined by comparing the crude rates with the age-adjusted rates at different locations across Virginia. There is a marked difference between the age-adjusted rates and crude rates for some population groups, which may be due to the difference in the population distribution of that particular group. For example, the Hispanic population has a much younger age distribution in the United States (U.S. Census Bureau, 2018). Thus, age standardization is necessary to prevent potential bias across different age groups (Curtin & Klein, 1995; Klein & Schoenborn, 2001).

Methods

Secondary datasets of COVID-19 cases containing age groups and races across the Commonwealth of Virginia were obtained from the publicly available database on June 21, 2020 (VDH, 2020). The population of Virginia was downloaded from the United States census website (U.S. Census Bureau, 2018). The total population in Virginia was 8,517,685 (US Census bureau, 2018). Twenty-five percent of the population was in the 0-19 years age-group, 13.7% in both 20-29 and 30-39 age-groups, 12.8% in the 40-49 age-group, 13.3% in the 50-59 age-group, 11.4% in the 60-69 years age-group, 6.7% in the 70-79 years age-group and 3.6% in the over 80 age-group (US Census bureau, 2018). The age groups for the study were extracted based on those reported in the publicly available dataset. Crude rates of COVID -19 cases were calculated and estimates for the total population of Virginia were age-adjusted to the U.S. Census 2000 population using the direct method and age-groups 0-9, 20-29, 30-39,40-49, 50-59, 60-69, 70-79 and over 80 years (Curtin & Klein, 1995). The direct standardization method for age-adjustment, used by the CDC's National center for Health Statistics (NCHS), is the application of observed age-specific rate to a standard age distribution that would eliminate the differences in crude rate, resulting from differences in the population age distribution (Hoyert et al., 2001; Klein & Schoenborn, 2001). Age-adjustment was done by multiplying the crude rates with the age-adjusted specific weights for each age group (Curtin & Klein, 1995). For example, for the age group 0-9 years, the crude rate of COVID-19 was 182.81 per 100,000. Multiplying the crude rate by the age group specific weight resulted in an age-adjusted rate, based on the U.S. Census 2000 population, of 0.141666. The direct method is particularly relevant in the United States as the White and Hispanic populations vary greatly in age-structure, and thus, using this method would then eliminate the difference due to one population being older than the other (Hoyert et al., 2001; US Census Bureau, 2018).

Results

As of June 21, 2020, Virginia had recorded 57,994 cases of COVID-19 of which 4,195 (7.3%) were missing ages and therefore were excluded from the analysis. Among the 53,799 cases with known age, the age group distribution of cases included 3.4% of cases between 0-9 years, 17.7% between 20-29 years, 20% between 30-39 years, 19.5% between 40-49 years, 16.7% between 50-59 years, 11% between 60-69 years, 5.7% between 70-79 years and 6% over 80 years of age (Table 1). Table 1 also displays the crude rates and age-adjusted rates of COVID-19 for each age group. As seen, there was a wide difference between the crude rate and the age-adjusted rate in the different age groups. The crude rate was highest for the over 80 age group at 1063.93 per 100,000 population, followed by the 40-49 age group, and 50-59 age group, with crude rates of 959.41 and 792.65 per 100,000 population respectively. However, the age-adjusted rate of cases was highest in the 40-49 years age group at 147.72 per 100,000 followed by the 30-39 group and 20-29 group at 140.81 and 106.29 per 100,000, respectively. The age-adjusted rate for the over 80-age group was 35.48 per 100,000 population.

Table 1

Age-adjusted Rates of COVID-19 Cases in Virginia (Data as of June 21, 2020)

Age Groups	**Total COVID-19 (Age-reported) Cases in Virginia as of June 21, 2020* *N* (%)**	**Crude Rate Per 100,000**	**Age-Adjusted Rate Per 100,000**
0-9	1859 (3.4)	182.81	25.90
20-29	9519(17.7)	816.35	106.95
30-39	10785(20)	927.57	140.81
40-49	10476(19.5)	959.41	147.72
50-59	8987(16.7)	792.65	88.12
60-69	5908(11)	606.46	44.31
70-79	3044(5.7)	533.72	31.37
80+	3221(6)	1063.93	35.48
Total	53,799		

*Total cases *N*= 57,994, Age missing = 4,195 cases (7.25%)

Discussion

At first glance, the crude rate data indicates that in Virginia, the age group of over 80 years had a higher prevalence of COVID-19, relative to other age groups. However, the age-adjusted variation of cases demonstrated that the 40-49 and 30-39 age groups had the highest rates of COVID-19 cases. The study data shows that the disparities in the unadjusted crude rates of cases are confounded by differences in the age structure of the population (Curtin & Klein, 1995; Hoyert et al., 2001; VDH, 2020). The results of this study is consistent with the literature which has shown if age is a confounding factor, it can be identified by comparing crude and age-adjusted case rates (Shahid et al., 2020).

In Virginia, the age distribution in each population group varied, as the over 80 age-group represented about 4% of the total population, while the age-groups 20-29, and 30-39 represented 14% of population each, and those in the age groups 40-49 years and 50-59 years contributed 13% each (US Census Bureau, 2018). Thus, it was found that COVID-19 cases were higher among the age group between 30-49 compared to those 80 years and above when age was adjusted. These results demonstrate the pitfalls of comparing crude rates, which resonates with what has been documented in the extant literature, and the value added by age-adjusting when studying diseases related to age-groups or geography (Cosby et al., 2019; Dowd et al., 2020; Ostchega et al., 2020). Standardization removes the effect of age as a confounder given the effect of age and comorbidities on COVID-19 (Shahid et al., 2020).

Public Health Implications and Conclusion

Using age-adjusted rates reduces the probability of bias when comparing unadjusted rates of cases across age groups, as the confounding effect of age will be taken into account. Results from this study can be used for planning capabilities and targeted measures to raise awareness of COVID-19, given the risk and higher cases among certain age groups. Knowing the crude rates and the age-adjusted COVID-19 case rates can help in population-based prevention and interventions by assisting in identifying vulnerable populations for testing and providing education on public health measures, such as social distancing, that help to suppress the spread of COVID-19. Comparing the crude and age-adjusted rates of COVID-19 cases takes into account the confounding effect of age due to differences in the age distribution of a population. The prevalence of COVID-19 cases in the younger age groups may highlight the intersection of social determinants of health, such as access to healthcare (testing) as a contributing factor to the spread of COVID-19.

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