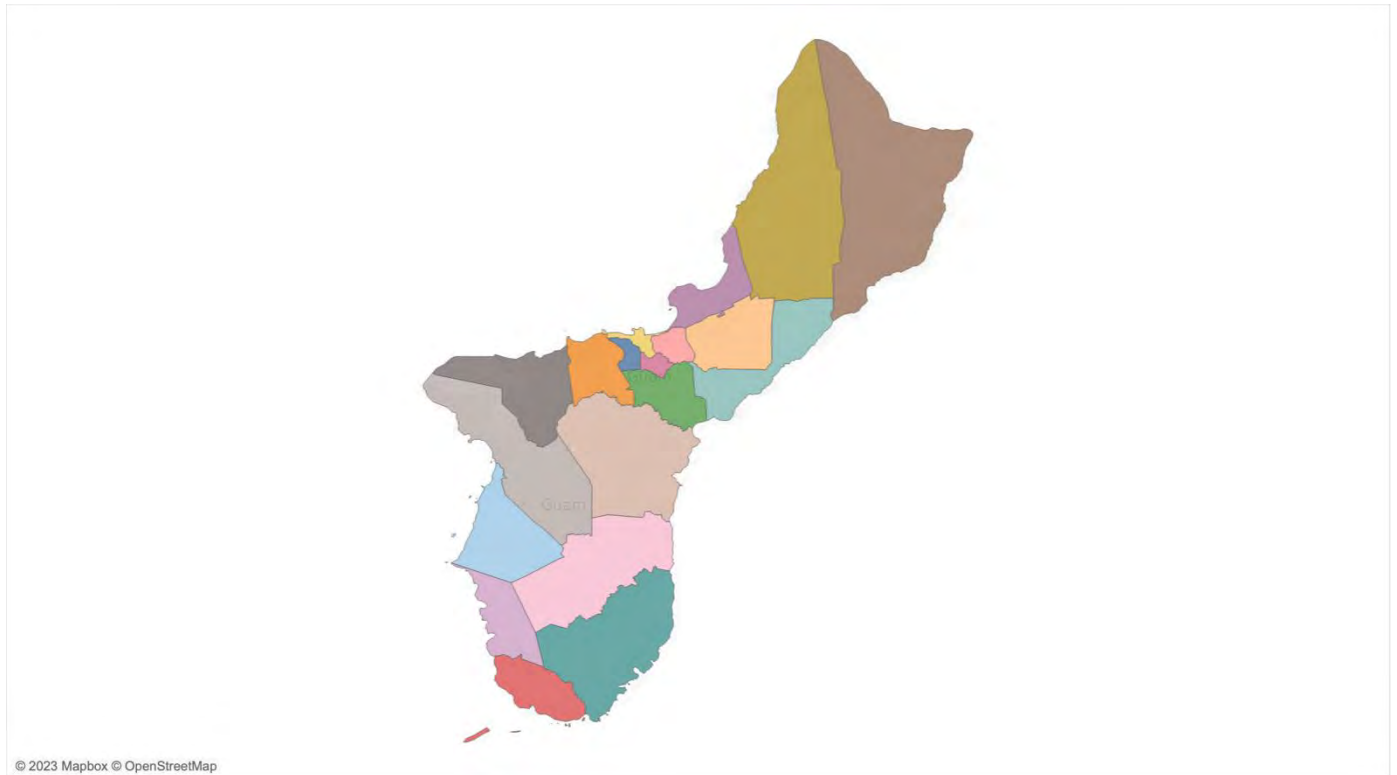# *Excess Deaths on Guam due to the SARS-CoV-2/COVID-19 pandemic*

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May 31, 2023

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Background/Preface

The 2020 U.S. Census has established the Territory of Guam's population at 153,836 people. The majority of the population is Pacific Islanders and Asians including indigenous Chamorros and other Micronesians (48.6%), Filipinos and other Asians (37.5%) with another 10.1% multiple ethnic groups. Assessing health disparities and the social determinants of health and socio-economic status is an important aspect of public health: compared to the U.S., Guam has a younger population, more foreign-born persons, more people using English as a second language, higher unemployment, lower educational attainment, higher average household size, lower median household income, and higher proportions below the poverty line.

This project was undertaken to examine excess mortality due to the SARS-CoV-2/COVID-19 pandemic in the U.S. Territory of Guam overall, and specifically to examine excess mortality in detail by age, sex, and ethnicity and co-morbid conditions. This is due to the disproportionate mortality observed during the SARS-CoV-2/COVID-19 pandemic. From March 12, 2020, to May 31, 2023, there were 61,907 cases of COVID-19 on Guam and 413 deaths. Guam's two largest ethnic groups, indigenous Chamorros and Filipinos, have the highest case numbers and deaths, but this is proportionate to their numbers in the overall population. However, Chuukese (from the Federated States of Micronesia) residing on Guam have lower case numbers, with the highest disproportionate mortality observed during the pandemic.

This report on the detailed examination of excess mortality provides a more precise picture of what happened on Guam during the pandemic.

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Note-All Appendixes cited are available upon request from the DPHSS-OER.

Executive Summary

A review of death certificates from 2015 to 2022 was conducted to determine the number of excess deaths caused by the COVID-19 pandemic. Excess deaths are typically defined as the difference between the observed numbers of deaths in specific time periods and expected numbers of deaths in the same time periods.[1] Calculations to determine the average number of deaths per year for the 2015 – 2019 period, and the expected number of deaths for the 2020 – 2022 period, were performed. The lowest estimate of the number of excess deaths for the period was 412; the highest estimate, the summary of all age-related excess deaths above the average of the previous five years, was 1,068. Most estimates ranged between 400 to 900 deaths considered as excess. Excess deaths were higher for (1) males, (2) those aged 75 years and above, (3) among indigenous Chamorros (by numbers), (4) Filipinos, (5) Chuukese and other ethnicities from the Freely Associated States of Micronesia (FAS) (numbers and percent of all deaths), and (6) for those dying from heart disease, cancer, stroke, renal failure, sepsis, and all other respiratory and circulatory illnesses combined (exclusive of chronic lower respiratory disease). In addition to the 321 deaths coded as from COVID-19, there were 90 deaths from other causes where current or recent COVID-19 infection was listed as a contributory factor on the death certificate.

Methods and Materials

Death certificate files, keyed by various temporary and permanent staff of the Office of Vital Statistics (OVS) and the Division of Public Health of the Department of Public Health and Social Services, were obtained for this project. The files were keyed in from the death certificates received by and housed in OVS.

The Excel death files contained text keyed from the death certificates listing causes of death. Using the death certificate registration numbers, the cause of death files produced by the National Vital Statistics System (NVSS) of the National Centers of Health Statistics, a division of the Centers for Disease Control and Prevention were downloaded. Files produced prior to 2019 had been downloaded sporadically to assist the Registrar of Vital Statistics in producing the top ten causes of death lists, and several years were incomplete. Thus, the public use mortality data files for the Territories for the years 2015, 2016, 2017, and 2019 were also downloaded.

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[1] Centers for Disease Control and Prevention, "Excess Deaths Associated with COVID-19," https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm

These files have no identifying record numbers and need to be matched individually to the death records, and this was accomplished by using the month of death, and the age, sex, and ethnicity of the deceased, as well as the textual causes of death.

The underlying cause of death is defined by the World Health Organization (WHO) as "the disease or injury which initiated the train of events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury." [2] Underlying cause of death is selected from the conditions entered by the physician on the cause of death section of the death certificate. When more than one cause or condition is entered by the physician, the underlying cause is determined by the sequence of conditions on the certificate, provisions of the ICD, and associated selection rules and modifications. Tables produced by the National Center for Health Statistics, CDC, which rank the top causes of death use the underlying cause of death. Thus, this was the cause of choice used for this report.

Once the death files had the underlying cause of death codes added, data cleaning was done. Detailed steps are described in Appendix I.

Week of death information was added to each record, to allow for comparison of totals by week over time, and the computation of the average number of deaths per week for the pre-Covid and Covid eras was conducted. The first and fifty-third week of each year were almost always partial weeks and have much smaller numbers of deaths; this is obvious when the graphs of deaths by week are seen.

The methodology described by CDC for computing excess deaths was followed: "Estimates of excess deaths can be calculated in a variety of ways and will vary depending on the methodology and assumptions about how many deaths are expected to occur. A range of estimates for the number of excess deaths was calculated as the difference between the observed count and one of two thresholds (either the average expected count or the upper bound threshold), by week and jurisdiction. Negative values, where the observed count fell below the threshold, were set to zero.[3]" The average number of deaths for the preceding five-year period (2015 – 2019) was computed, followed by the 5% and 95% confidence intervals for that average. This gave a high-low range for deaths occurring pre-pandemic, and allowed for small increases in deaths which may have occurred naturally if the pandemic had not occurred. Deaths beyond the 95% CI are deemed excess and are presented as the low estimate of excess deaths. Deaths above the five-year average of the pre-pandemic period constitute the high estimate of excess deaths. The

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[2] National Center for Health Statistics. Health, United States, 2020 – 2021: Annual Perspectives, Definitions. Hyattsville, MD. 2023.

[3] Centers for Disease Control and Prevention, "Excess Deaths Associated with COVID-19," https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm

website VitalStrategies.org[4] (https://preventepidemics.org/covid19/resources/excess-mortality/) had a very useful spreadsheet following this methodology, for populations with a high level of death registration, which Guam has. Using the spreadsheet automated the numerous calculations involved to produce estimates based on the overall deaths, and deaths by sex, age, ethnicity, and cause of death.

Study Limitations

None of the death certificates were keyed in fully verbatim, and early years (2015 and 2016 in particular) were missing important information, such as exact date of death. Staff at OVS were asked to fill in the missing information, and revised files were produced and used for this project. As stated earlier, the public use files for mortality for Guam had to be downloaded in order to obtain the cause of death codes for several years.

Results

Except for 2018, the annual number of deaths in Guam pre-pandemic (before March 2020) did not fluctuate more than two percent per year, either positively or negatively (Table 1); in 2018 it was nearly five percent higher than the previous year. The growth in the number of deaths appeared slow and steady, with only a few noteworthy incidents causing a sharp increase; for example, a house fire in 2016 that caused the death of all inhabitants. In 2020, the annual number of deaths jumped by over 15% from 2019, with another increase in 2021, but this seems to have been the peak year of deaths, as the number of deaths in 2022 declined 2.65% from 2021. Though declining, 2022 deaths were over 20% higher than the pre-COVID-19 deaths of 2019.

Table 1. Annual Change in Deaths: Guam, 2015 – 2022

	Pre-pandemic					COVID-19 pandemic		
Year	2015	2016	2017	2018	2019	2020	2021	2022
Deaths	1,009	1,021	1,007	1,056	1,035	1,193	1,281	1,247
Change		12	-14	49	-21	158	88	-34
Annual % Change		1.19	-1.37	4.87	-1.99	15.27	7.38	-2.65
% change 2019 - 2022	20.48							

Deaths per week for each of the pre-pandemic years were graphed and a linear trend line added. The slope and intercept are y= -0.0134x + 20.286 and the coefficient of determination or R^2 for this line is 0.0022; the fit is not tight, as the relationship between the week of the year and the

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[4] Vital Strategies, et al (2020). Excel mortality calculator. NY: Vital Strategies.

number of deaths is not strong. There appears little seasonality in Guam's deaths. The overall trend was toward a slight annual decrease in the number of deaths.

Figure 1. Deaths per Week: Guam, 2015 - 2019
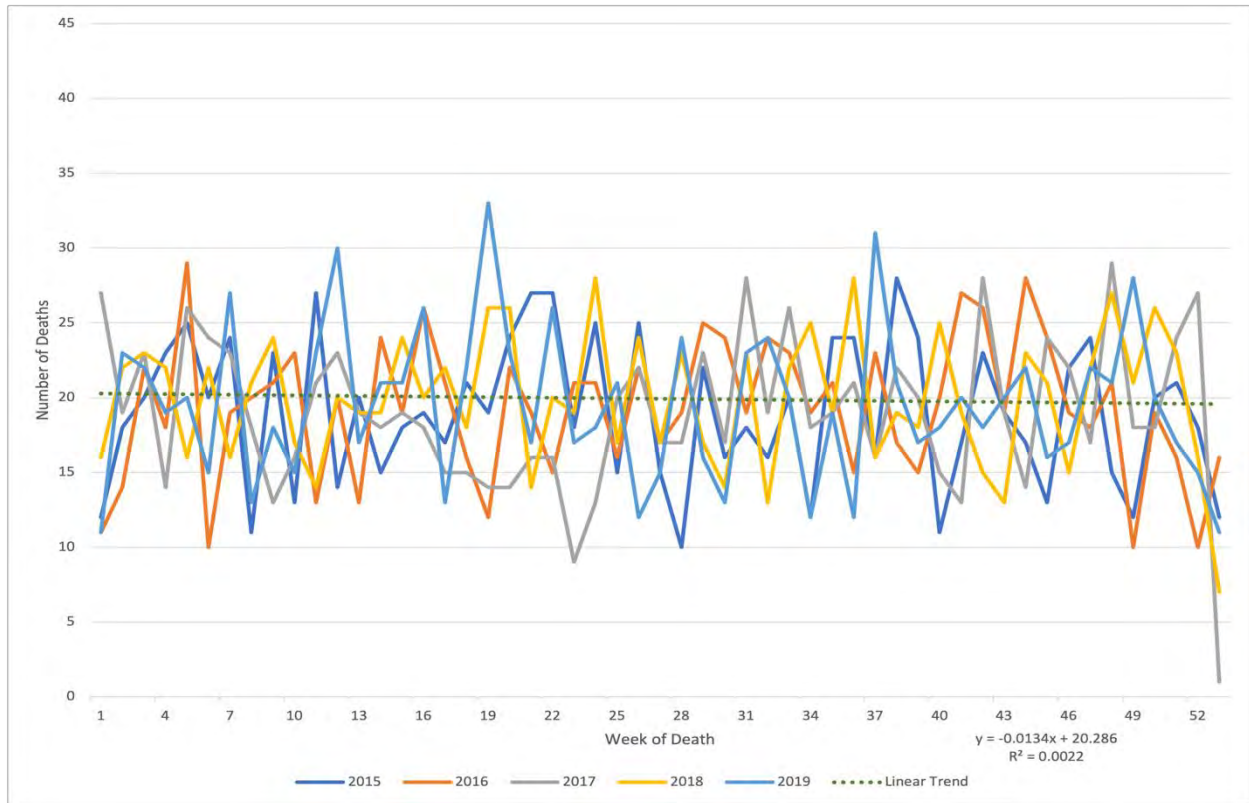
Low and high estimates for excess deaths were calculated using the average number of deaths per week for the pre-pandemic period and computing the 95% confidence interval (Table 2). Deaths above the 95% CI are the low estimates for excess deaths; deaths above the five-year average are the high estimates. Deaths from all causes from 2020 - 2022 and the 5% and 95% confidence intervals for expected deaths are shown in Figure 2.

The number of cases of COVID-19 and the number of deaths by month from 2020 – 2022 were also graphed (Figure 3), to visualize the impact of surges in the numbers of cases on the resulting deaths from all causes.

Figure 2. Deaths by Week, All Causes, 2020 – 2022
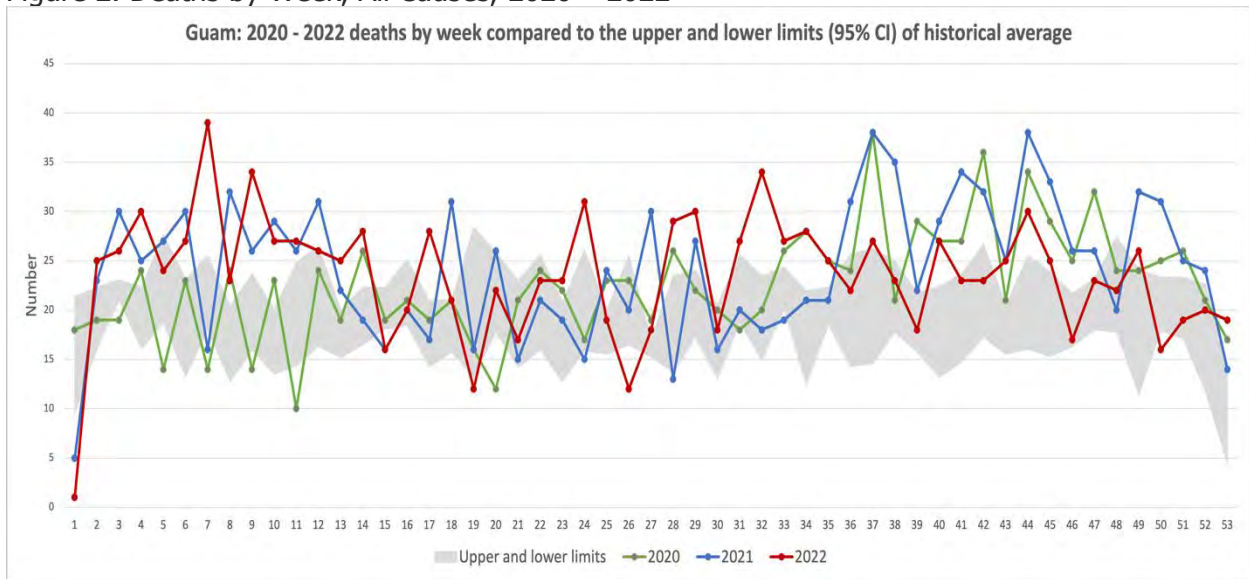
Note: "Historical Average" is average deaths per week from 2015 – 2019.

Figure 3. COVID-19 Cases and Deaths from All Causes: Guam, 2020 – 2022

There appeared to be minimal lag time between surges of cases and an increase in deaths from all causes, except for cases of the Omicron subtype beginning in January 2022. There was a small spike in deaths in January and March, then a drop in number of deaths to nearly a pre-pandemic level in April and May of 2022. Another spike of cases in June and Jul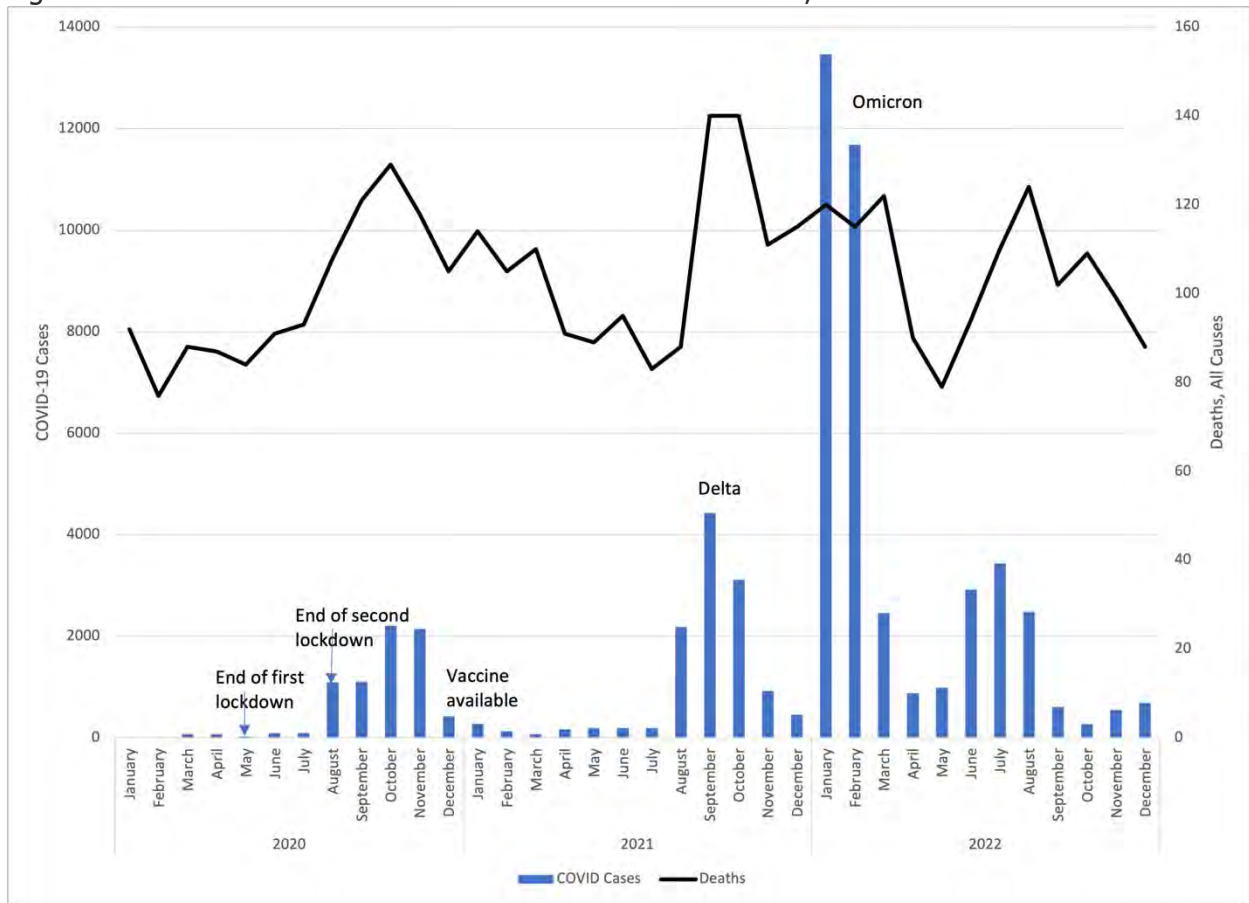y of 2022 was followed by another rise in deaths, but numbers had again dropped down by the end of the year. The overall low estimate of excess deaths during the COVID-19 period of January 2020 to December 2022 was 412 deaths. The high estimate was 808 deaths.

By sex, the low estimate for excess deaths of males was 272, and the high was 540.   The numbers were lower for females: the low estimate was 161 deaths and the high was 350. The totals of excess deaths by sex were close to the overall totals: 433 and 890.

Table 2. Estimates of Excess Deaths by Sex and Age Groups

Category	Deaths 2020 - 2022	Low Estimate Using >95% CI	Excess as % of all deaths	High Estimate From baseline average	Excess as % of all deaths
Overall	**3,721**	**412**	**11**	**808**	**22**
Males	2,227	272	12	540	24
Females	1,494	161	11	350	23
Total by Sex	**3,721**	**433**	**12**	**890**	**24**
Age 0 - 14	121	14	12	28	23
Age 15 - 29	113	11	10	19	17
Age 30 - 44	299	44	15	81	27
Age 45 - 59	840	133*	16	264*	31
$45 - 49^1$	175	25	14	47	27
$50 - 54^1$	298	60*	20	105*	35
$55 - 59$	367	67	18	121	33
Age 60 - 74	1,163	148	13	315	27
Age 75+	1,185	179	15	360	30
Total by Age	**3,721**	**529**	**14**	**1,068**	**29**
[1] Excess death numbers do not sum to category total					

Age

Age appears to be the variable where excess death has the most impact. The initial jump in excess deaths occurs in the age group 45 – 59, specifically in those 50 – 54. The age group most affected by excess deaths was among those 75 years and older. Not only were their numbers the highest, those numbers also represented a higher proportion of their age group than that of any other age group. Excess deaths in this age group were between three and six percent of the population over 75. Those 60 to 74 had the second highest percent of their 2020 population counted as excess deaths: between three-quarters of one percent to one and a half percent of the 2020 population 60 to 74 (Table 3).

Table 3. Estimated Excess Deaths as % of 2020 Census Population

Category	Low Estimate	% of 2020 pop	High Estimate	% of 2020 pop	2020 Census Counts
Overall	412	0.27	808	0.53	153,836
Males	272	0.35	540	0.69	78,271
Females	161	0.21	350	0.46	75,565
Age 0 - 14	14	0.04	28	0.08	34,297
Age 15 - 29	11	0.03	19	0.05	35,134
Age 30 - 44	44	0.15	81	0.28	28,684
Age 45 - 59	133	0.44	264	0.87	30,247
Age 60 - 74	148	0.75	315	1.59	19,855
Age 75+	179	**3.19**	360	**6.41**	5,619
All Chamorros*	143	0	332	0.53	63,035
All Chuukese	77	**1**	141	**1.37**	10,274
All Filipinos*	176	0	300	0.55	54,242
All White	25	0	44	0.42	10,491
All Other Ethnicities	60	0	124	0.49	25,243
* There is the potential for double counting in the Census populations used, as a person could be counted in either the "Chamorro Alone or in any Combination" and the "Filipino Alone or in any Combination" Census totals. Deaths were not double counted.					

Figure 4. Deaths in 45– 59 Years Age Group, 2020 – 2022

Guam: 2020 - 2022 deaths in people aged 45 - 59 by week compared to the upper and lower limits (95% CI) of the average of historical deaths
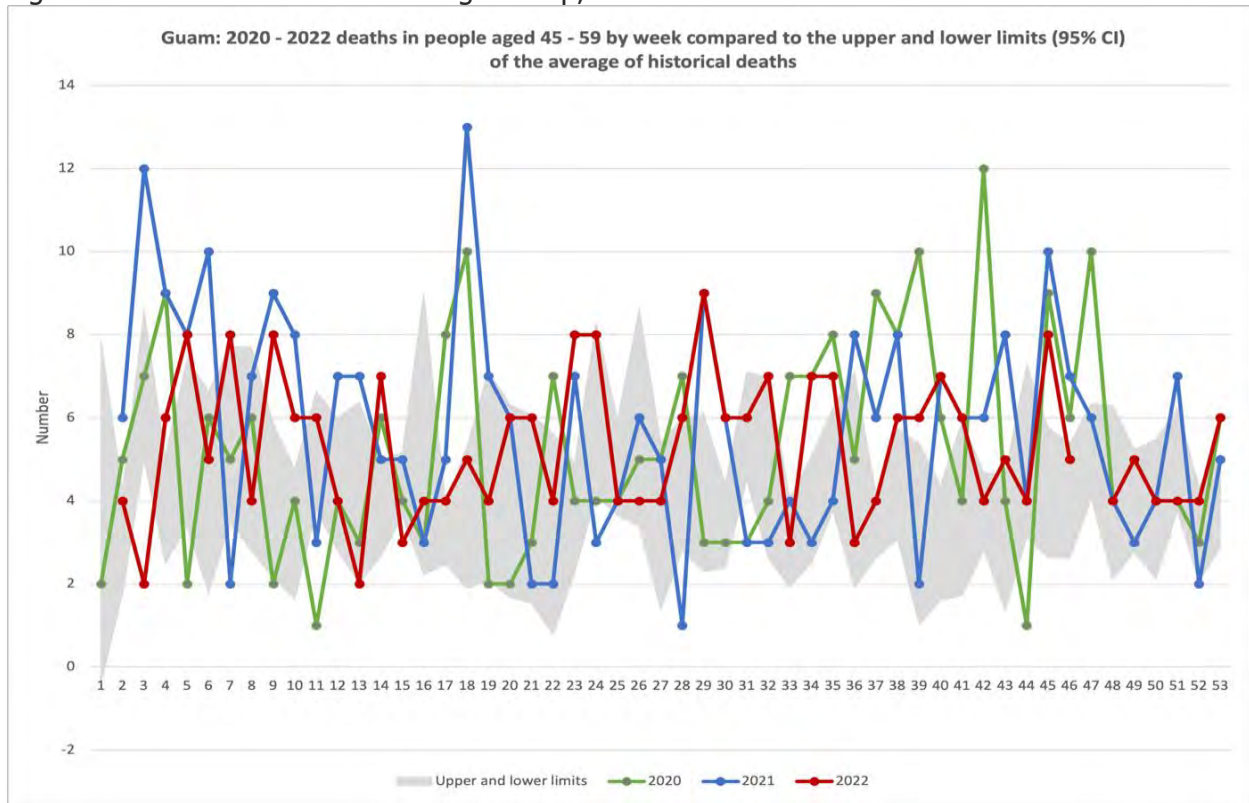
Figure 5. Deaths in 60– 74Years Age Group, 2020 – 2022

Guam: 2020 - 2022 deaths in people aged 60 - 74 by week compared to the upper and lower limits (95% CI) of the average of historical deaths
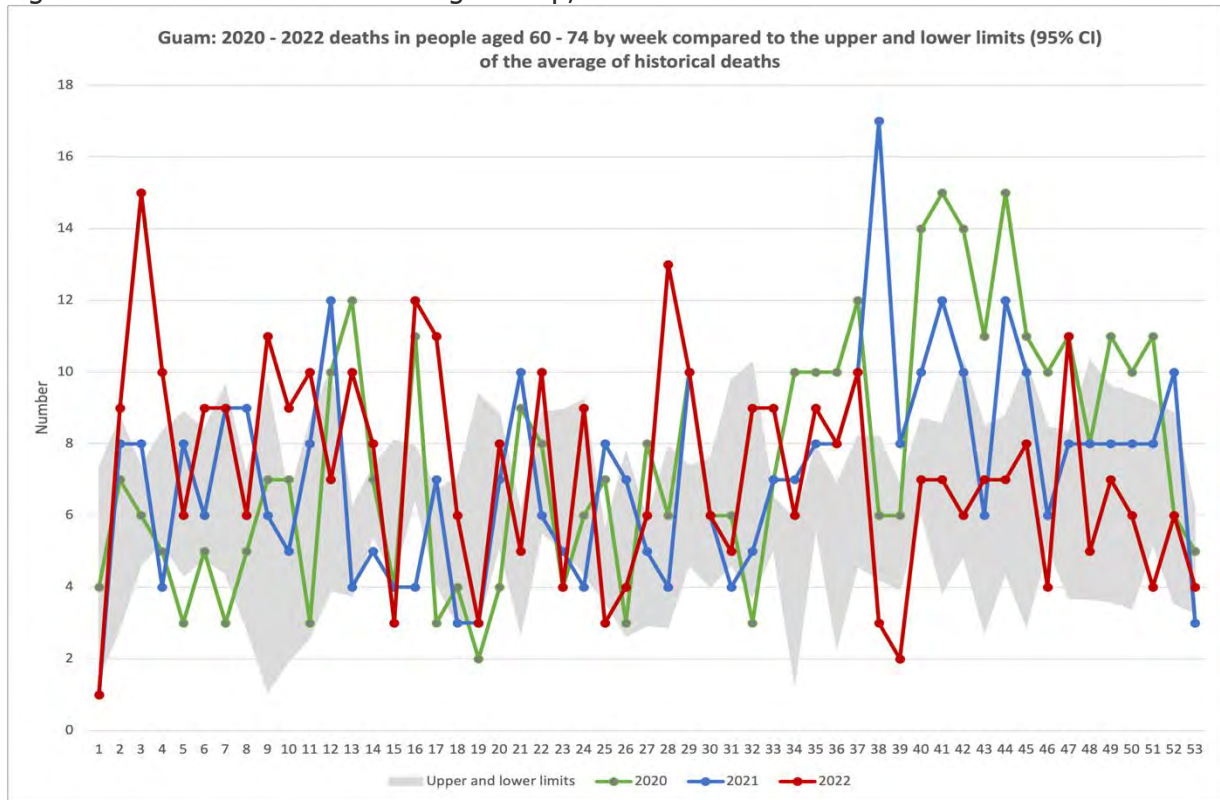
Figure 6. Deaths in 75+ Years Age Group, 2020 – 2022

Guam: 2020 - 2022 deaths in people aged 75 and over by week compared to the upper and lower limits (95% CI) of the average of historical deaths
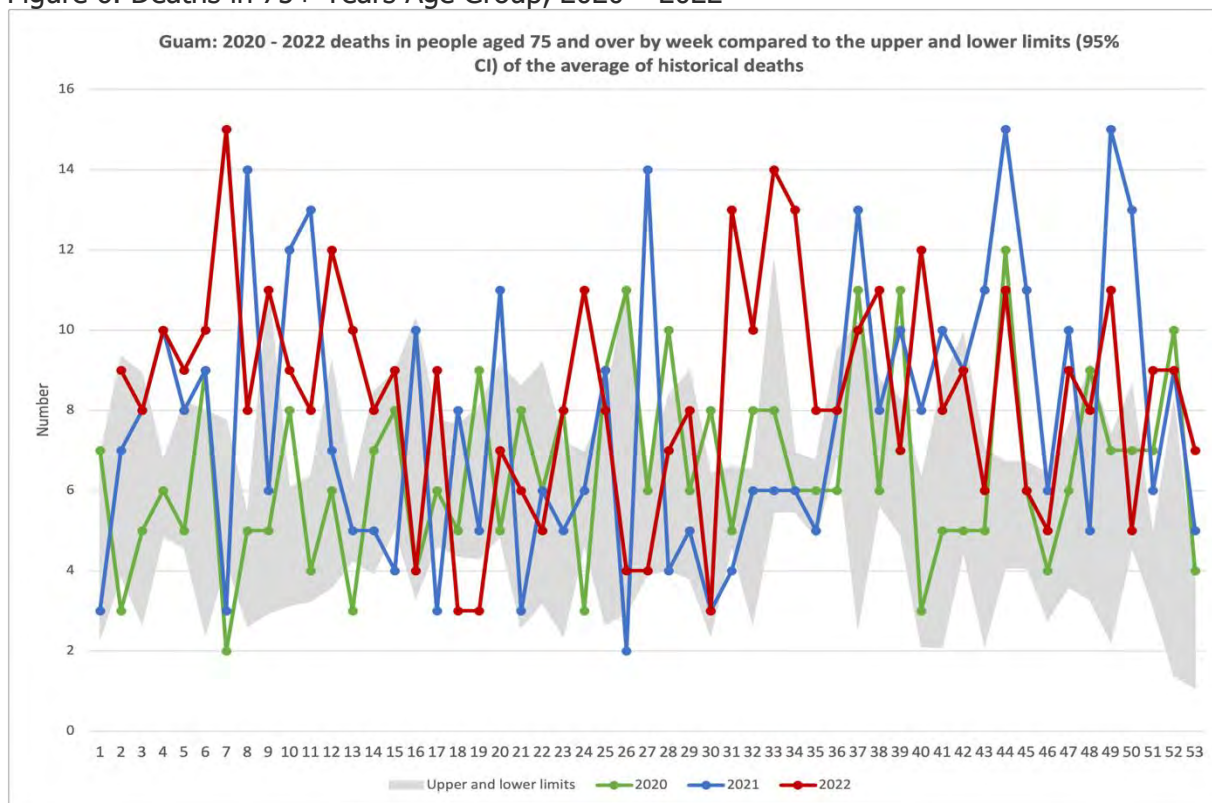
Ethnicity

Excess deaths by ethnicity were examined next (Table 4). No particular ethnic group seemed to have excess deaths out of proportion to their share of the overall population of Guam except Chuukese. While the numbers of Chamorros who died was the highest, those deaths represented approximately one-half of one percent of the Chamorro and part-Chamorro population counted in the 2020 Census (see Census counts in Table 3). Eight to nineteen percent of all Chamorro deaths in the COVID-19 era were excess. Filipino deaths were second in overall numbers, but also represented just over one-half of one percent of the Filipino and part-Filipino population. However, excess deaths made up between 21 to 36 percent of all deaths to Filipinos during 2020 to 2022. This was the highest proportion seen of all ethnic groups.

Chuukese deaths represented from one to nearly one and four-tenths percent of their 2020 population, making the impact of excess deaths due to the COVID-19 pandemic the greatest to this population. Excess deaths as a proportion of all deaths was the second highest for Chuukese, between 18 to 32 percent of all deaths.

Overall, excess deaths accounted for 13 to 25 percent of all deaths, when broken down by ethnicity, during this time.

Table 4. Estimates of Excess Deaths by Ethnicity

Category	Deaths 2020 - 2022	Low Estimate Using >95% CI	LE Excess as % of all deaths 2020 - 2022	High Estimate From baseline average	HE Excess as % of all deaths 2020 - 2022
All Chamorros	1,792	143	8	332	19
All Chuukese	435	77	**18**	141	**32**
All Filipinos	833	176	**21**	300	**36**
All White	171	25	15	44	26
All Other Ethnicities	490	60	12	124	25
All Other FAS[1]	221	30	14	59	27
All Other Asians[1]	169	20	12	35	21
All Blacks[1]	31	0	0	0	0
All Other NH&OPI[1]	36	0	1	2	6
All Others[1]	33	0	0	0	0
Total by Ethnicity	**3,721**	**472**	**13**	**912**	**25**
[1] Excess death numbers do not sum to category total					

Figure 7. Deaths in the Chamorro Population, 2020 – 2022

Guam: 2020 - 2022 deaths for Chamorros by week compared to the upper and lower limits (95% CI) of the average of historical deaths
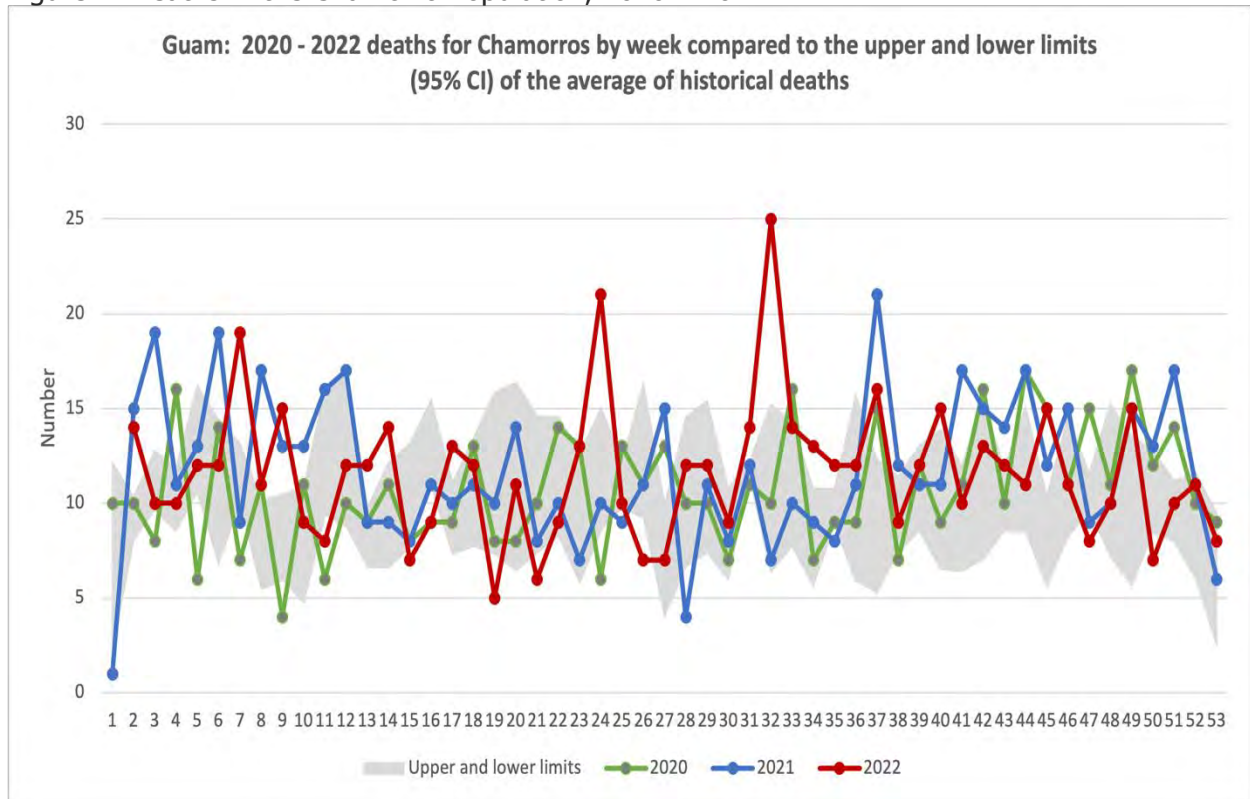
Figure 8. Deaths in the Filipino Population, 2020 – 2022

Guam: 2020 - 2022 deaths for Filipinos by week compared to the upper and lower limits (95% CI) of the average of historical deaths
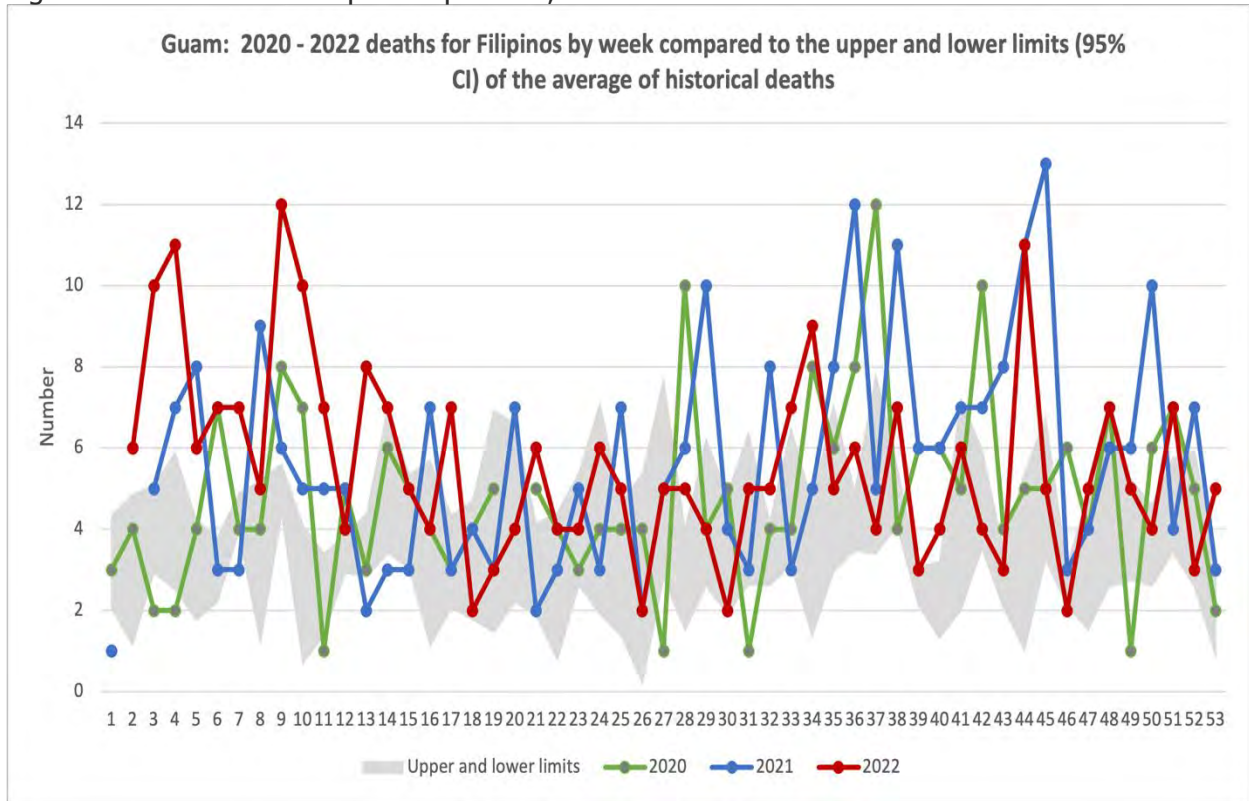
Figure 9. Deaths in the Chuukese Population, 2020 – 2022

Guam: 2020 - 2022 deaths for Chuukese by week compared to the upper and lower limits (95% CI) of the average of historical deaths
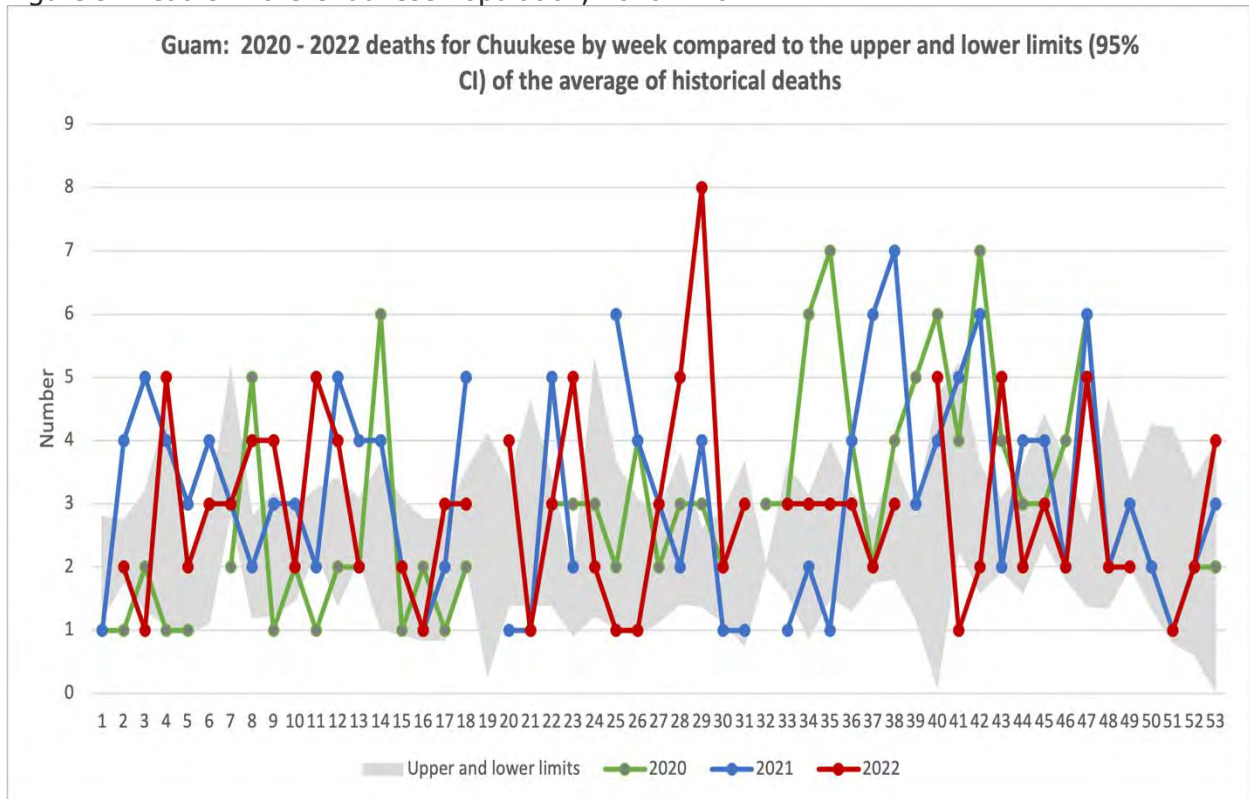
Figure 10. Deaths to All Other Ethnicities Combined*, 2020 – 2022

Guam: 2020 - 2022 deaths for All Other Ethnicities by week compared to the upper and lower limits (95% CI) of the average of historical deaths
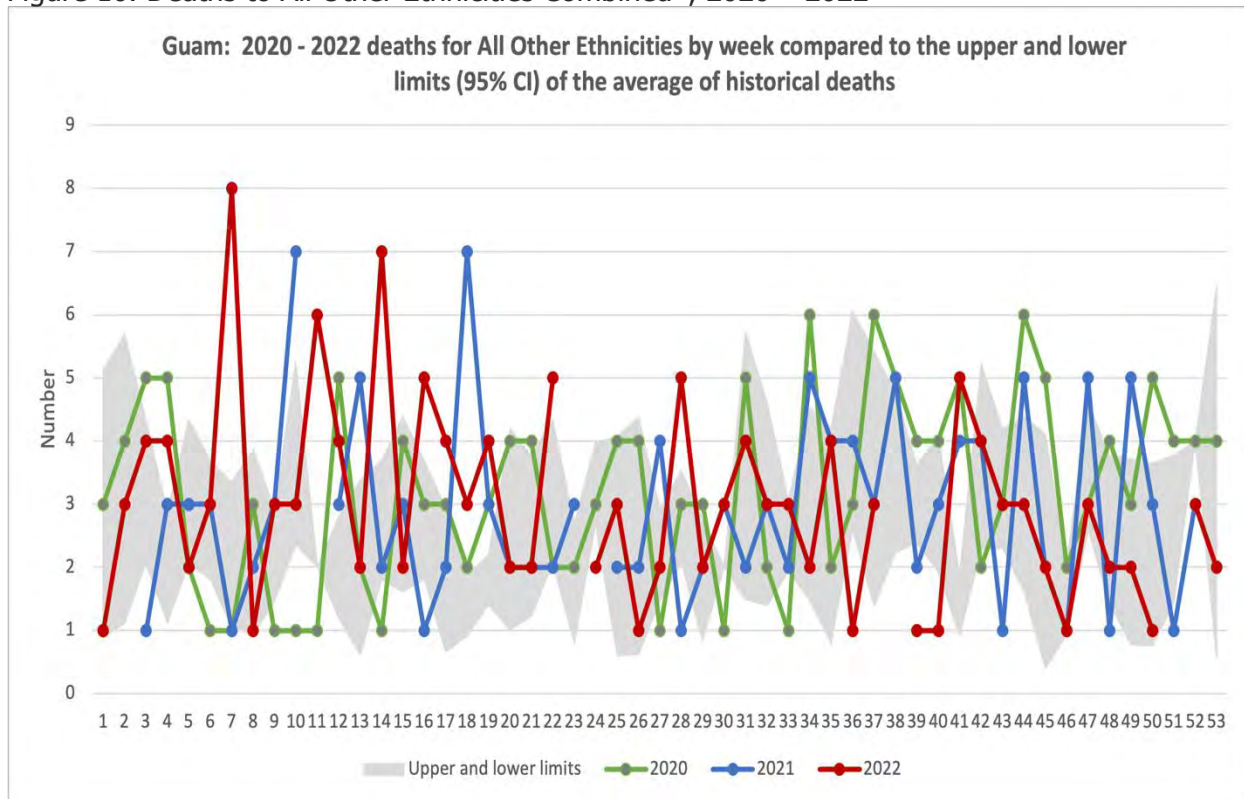
*Includes All Other Asians and All Other FAS populations

Guam's primary ethnic groups have had differing age structures for many years. Unfortunately, age and sex by ethnicity are not yet available for the 2020 Census. In the 2010 Census, the median age of the total population was 29.5 years, while the median ages of the Chamorro and Chuukese populations were 27.9 and 20.2 years, respectively. The median age of Filipinos in the 2010 Census was 37.7 years. The following population pyramids (Figures 11 – 14) give a visual view of the differing age structures of these populations, as well as the overall population counted in 2010.

Both the Chamorro and Chuukese populations have a higher proportion of their populations under the age of 19, as seen by the longer bars for those age groups. Such expansive pyramids denote younger populations, while those of older and aging populations tend to have constrictions in their appearance, as birth rates lower and the proportions of the populations at younger ages gets smaller[5]. The pyramids for both the total and Filipino populations show this type of constriction, the total population less so than the Filipinos.

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[5] Types and Significance of Population Pyramids, Dr. Jitender Saroha. World Wide Journal of Multidisciplinary Research and Development. WWJMRD 2018; 4(4): 59-69

Figure 11. Total Population by Age and Sex: Guam, 2010 Census
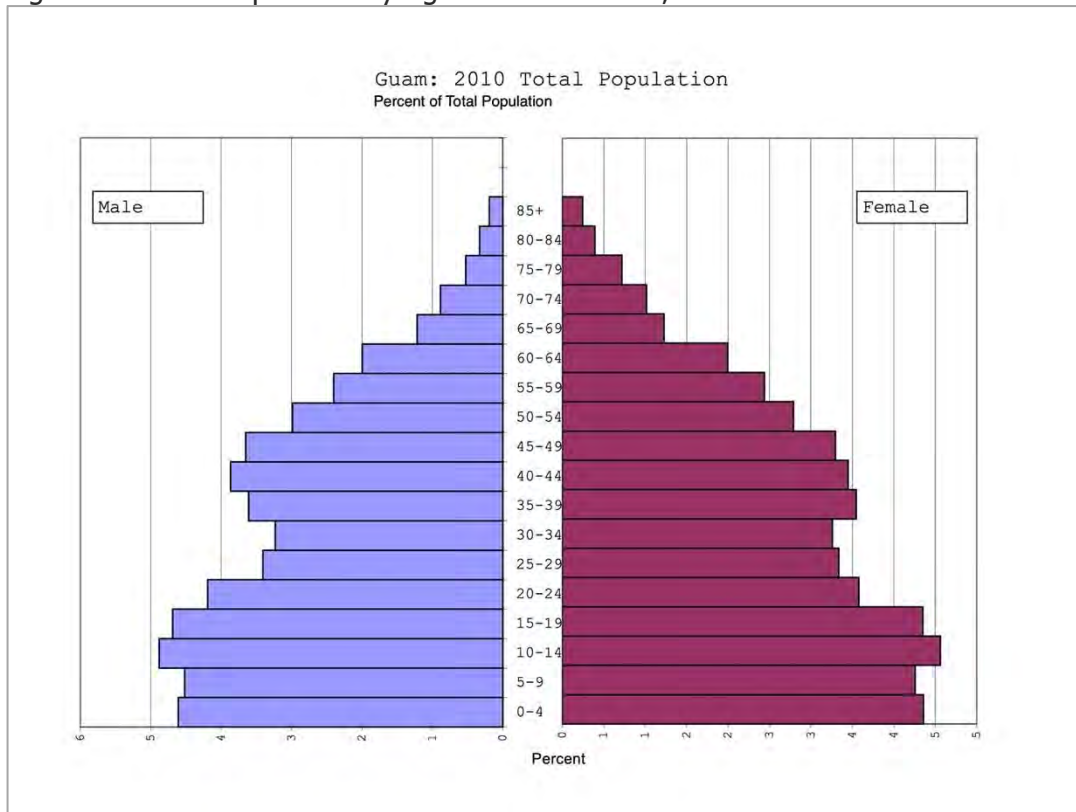

Guam: 2010 Total Population
Percent of Total Population

Figure 12. Chamorro Population by Age and Sex: Guam, 2010 Census

Guam: 2010 Chamorro Population
Percent of Total Population
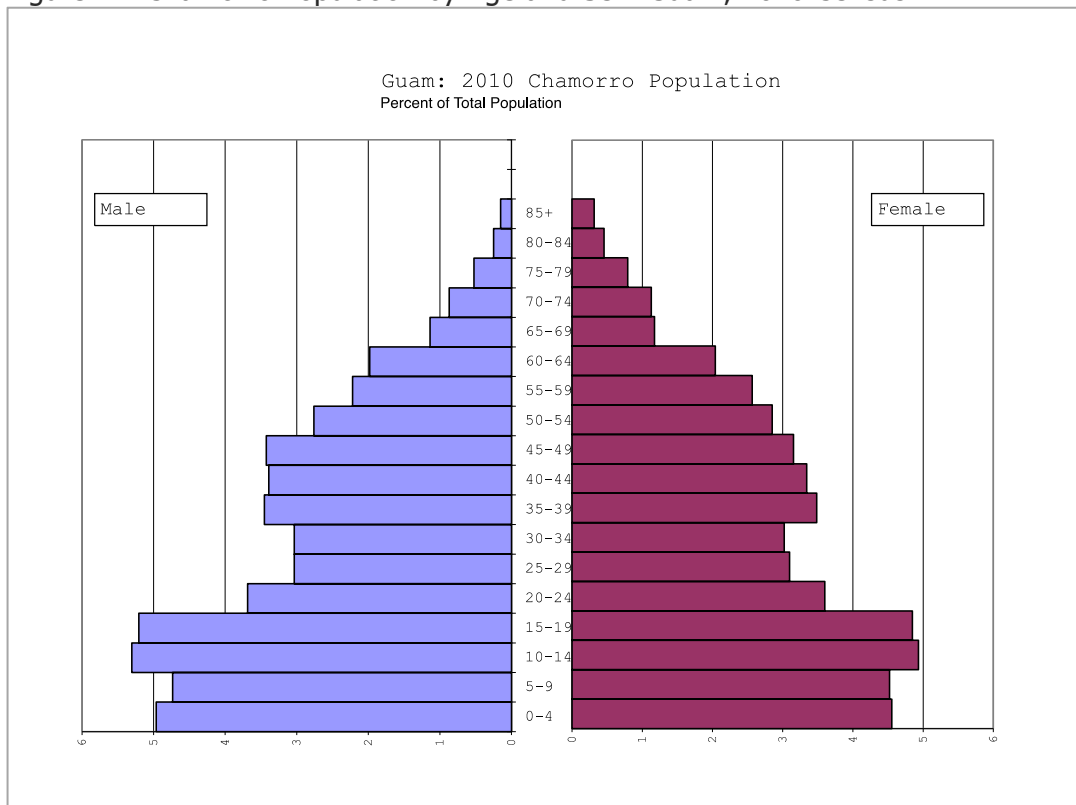
Figure 13. Chuukese Population by Age and Sex: Guam, 2010 Census

Guam: 2010 Chuukese Population
Percent of Total Population
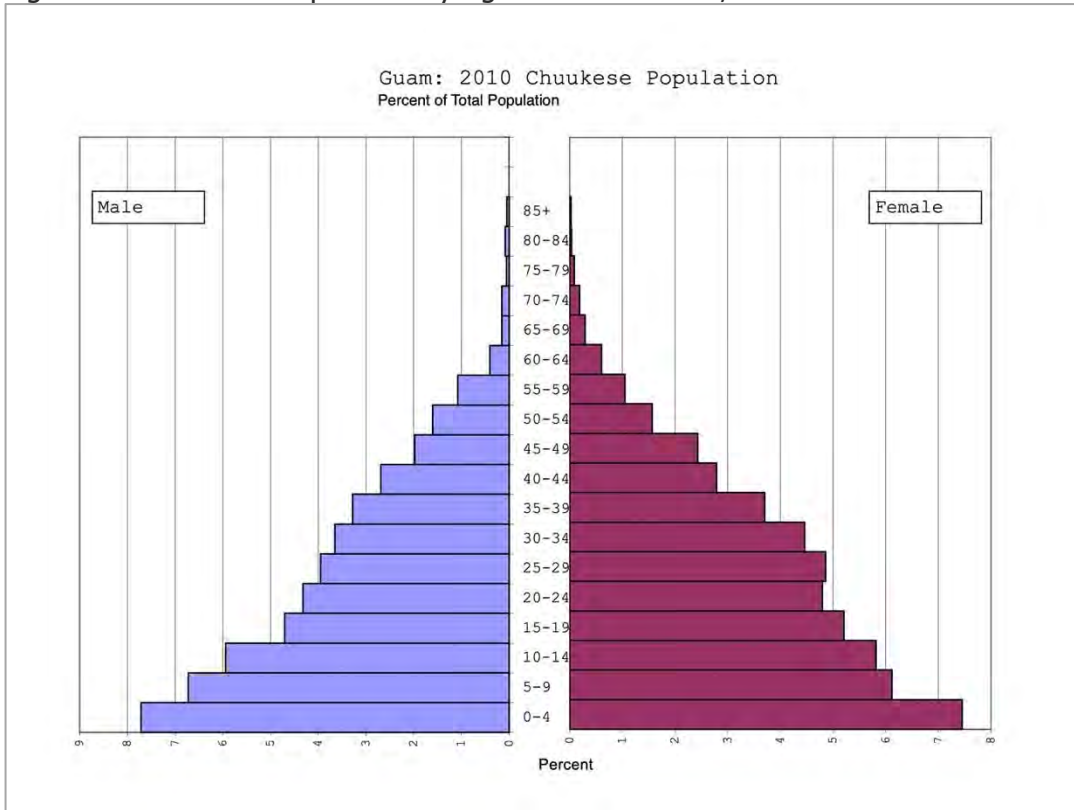
Figure 14. Filipino Population by Age and Sex: Guam, 2010 Census

Guam: 2010 Filipino Population
Percent of Total Population
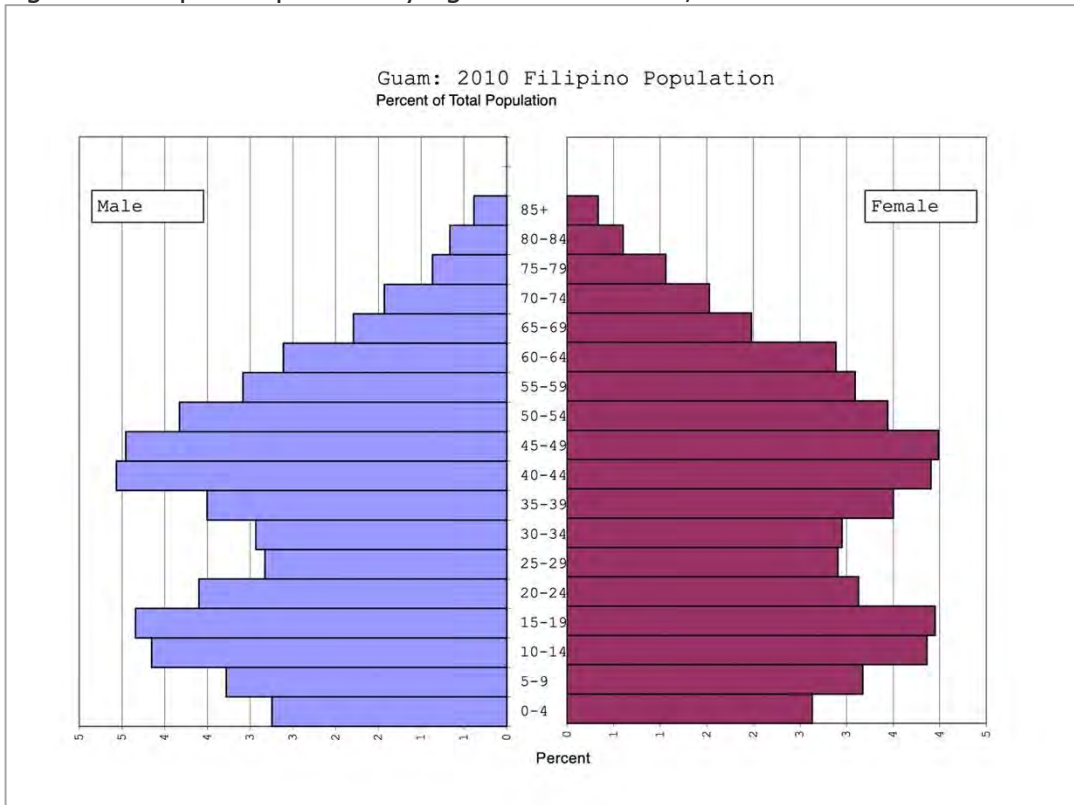
Cause of Death

Underlying cause of death, as coded by the National Vital Statistics System, National Center for Health Statistics using the International Classification of Disease Codes Tenth Revision (ICD10), was the final variable examined. Not all the deaths occurring in 2022 were coded; at the time of this writing, 97 of the 1,247 deaths remained without codes.
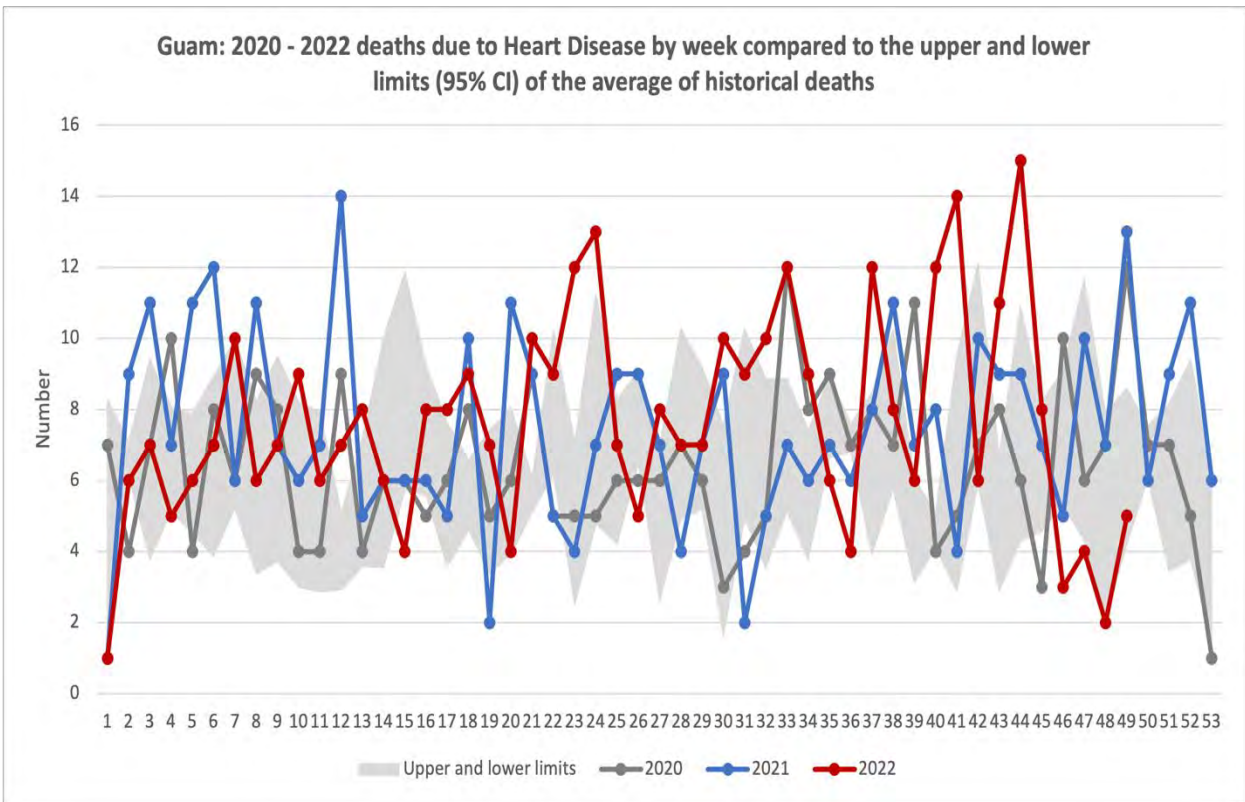
Of all the initial 46 cause categories examined, Heart disease had the highest number of excess deaths (Low Estimate 121 – High Estimate 253), followed by Cancer (80 – 156), Stroke (36 – 68), Renal Failure (25 – 36), and Sepsis (20 – 34) (Table 5). Diabetes, which played a large part as a risk for dying from COVID-19, had only 1 to 3 excess deaths, when diabetes was coded as the Underlying Cause of death. Diabetes was more likely to be coded as a contributory cause of death on death certificates The value of masking and social distancing can be seen in the low numbers of excess deaths from Influenza & Pneumonia and Chronic Lower Respiratory Disease. When all excess deaths by cause group were totaled, there were between 334 and 706 excess deaths. Natural deaths, not including COVID-19 as a cause, produced between 186 to 492 excess deaths, while external causes (accidents, suicide, assault, legal intervention) were responsible for between 32 and 65 excess deaths.

Table 5. Estimates of Excess Deaths by Cause of Death

Category	Deaths 2020 - 2022	Low Estimate Using >95% CI	Low Estimate Excess as % of all deaths from this cause	High Estimate From baseline average	High Estimate Excess as % of all deaths from this cause
Heart Disease	1,114	121	11	253	23
Cancer	603	80	13	156	26
Stroke	239	36	15	68	28
Diabetes	50	1	1	3	6
Accidents	128	8	6	21	16
Sepsis	141	20	14	34	24
Suicide	92	6	7	11	12
Renal Failure	130	25	19	36	27
Chronic Liver Disease and Cirrhosis	46	2	4	5	10

Chronic Lower Respiratory Disease	49	4	8	4	8
All Other respiratory and circulatory diseases	103	23	22	29	28
Pregnancy, perinatal conditions, and congenital anomalies	71	8	12	13	19
Influenza & Pneumonia	71	5	7	9	13
All Other causes	465	32	7	65	14
Total All Causes	3,721	334	9	706	19
*97 deaths remain without cause of death codes					
Natural (w/o C19)	3,051	186	6	492	16
External	252	32	13	65	26

Figure 15. Deaths due to Heart Disease, 2020 – 2022

Guam: 2020 - 2022 deaths due to Heart Disease by week compared to the upper and lower limits (95% CI) of the average of historical deaths

Heart disease had the highest number of excess deaths (Low Estimate 121 – High Estimate 253). The numbers of excess deaths were a lower percentage of all deaths from this cause because Heart disease caused the most deaths during this period, as it has for at least the last fifty years on Guam.

Figure 16. Deaths due to Cancer, 2020 – 2022

Guam: 2020 - 2022 deaths due to Cancer by week compared to the upper and lower limits (95% CI) of the average of historical deaths
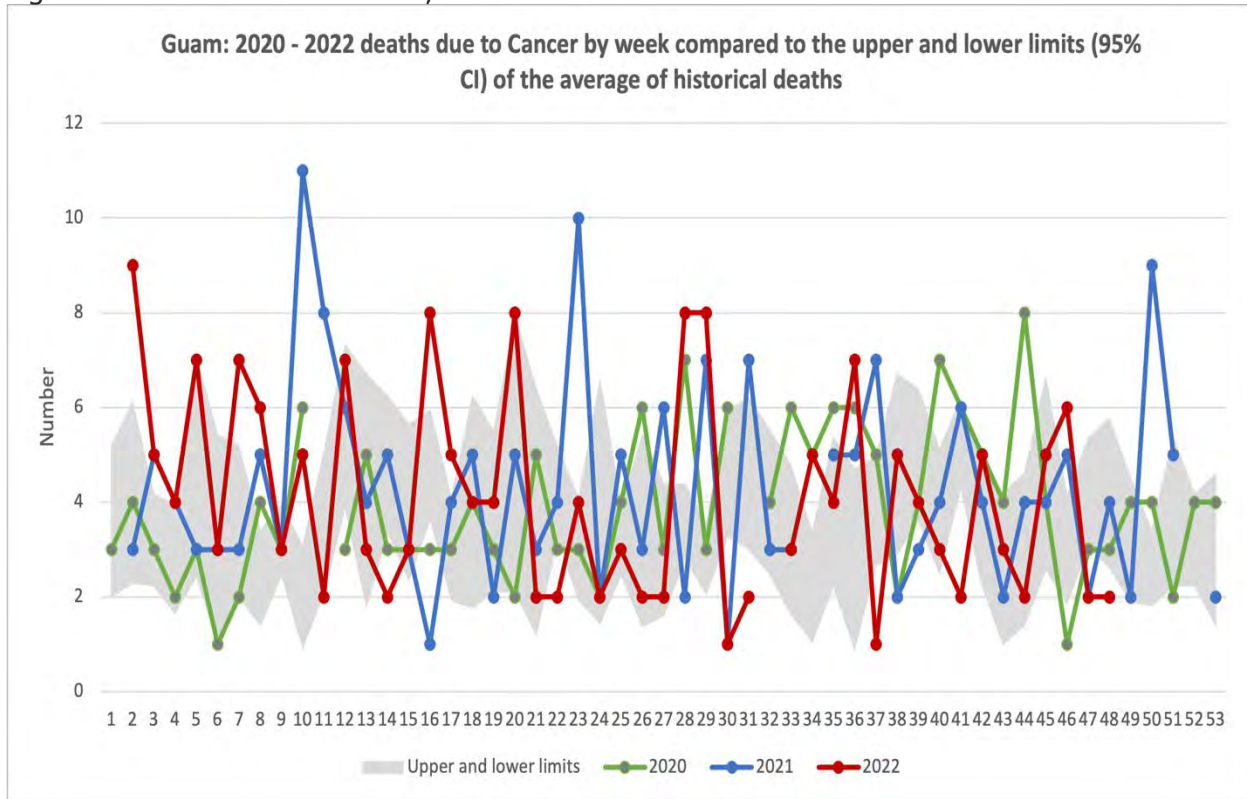
In addition to the 321 deaths where COVID-19 was coded as the Underlying cause of death (ICD10 code U07.1), there were an additional 90 deaths where COVID-19 was listed as a current or recent past infection on the death certificate. Table 6 shows the distribution of the Underlying causes coded for these persons, and the COVID-19-related deaths as a proportion of all deaths from that cause.

Table 6. Causes of Death with COVID-19 Infection Listed, 2020 - 2022

Cause	Deaths	%	% of all deaths from this cause 2020 - 2022
Heart Disease	32	35.56	2.87
Cancer	12	13.33	1.99
Renal Failure	6	6.67	4.62
Stroke	5	5.56	2.09
Accidents	5	5.56	3.91
Diabetes	4	4.44	8.00
Chronic Lower Respiratory Disease	4	4.44	8.16
All Other respiratory and circulatory diseases	4	4.44	3.88

Sepsis	3	3.33	2.13
Suicide	3	3.33	3.26
Influenza & Pneumonia	1	1.11	1.41
Pregnancy, perinatal conditions, and congenital anomalies	1	1.11	1.41
All Other causes	10	11.11	2.15
Total	90	100.00	2.76

Conclusion

As stated earlier in the Summary, COVID-19 caused between 412 to 1,068 excess deaths in Guam over the three-year period of 2020 to 2022. Most of these excess deaths were among males. The elderly over 75 years of age were especially vulnerable due to immune systems weakened by age and possibly chronic conditions. Those of Chuukese and other FAS ethnicities were also vulnerable, losing at least one percent of their 2020 population in excess deaths. The generally younger age of the FAS populations seems to have prevented these losses from being worse. The reverse may be true for the Filipino population, who had 21 to 36 percent of all their deaths as excess. This population is more settled and enjoys a higher socioeconomic status but is also older than the FAS population.

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https://wonder.cdc.gov/wonder/help/ucd.html#:~:text=The%20underlying%20cause%2Dof%2Ddeath,from%20the%20conditions%20entered%20by

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