2020 CENSUS-BASED NATIONAL POPULATION PROJECTIONS TECHNICAL NOTES

List of Abbreviations and Notations

Abbreviations

ASFR	Age-Specific Fertility Rate
BI	Bureau of Immigration
BPE	Base Population Estimation
CBPP	Census-Based Population Projections
CFO	Commission on Filipinos Overseas
CPD	Commission on Population and Development
CPH	Census of Population and Housing
CRVS	Civil Registration and Vital Statistics
DAPPS	Demographic Analysis and Population Projection System
NDHS	National Demographic and Health Survey
PAS	Population Analysis System
POPCEN	Census of Population
TFR	Total Fertility Rate
USCB	US Census Bureau

Notations

nMx	Age-specific death rate from age x and x+n
nDx	Number of deaths from age x and x+n
nQx	Probability of dying from age x to x+n
e_0	Life-expectancy at birth

Overview

Population projections are pivotal in planning for the future, whether on a national or local level scale. Program planners and managers need to know how many individuals in the future will require resources, services, and many other necessities for equitable development and improved quality of life.

As with the previous population projections, the 2020 Census-Based Population Projections (CBPP) uses the Cohort-Component Method. This method considers the three demographic processes of fertility, mortality, and migration in projecting the population. The Demographic Analysis and Population Projections System (DAPPS) Version 3.3 software was used as a tool, along with the Population Analysis System (PAS) workbooks, both of which were developed by the United States Census Bureau (USCB). DAPPS is a program designed to aid users in performing demographic analysis and population projections at the national and subnational levels (US Census Bureau, 2021), while the PAS is a set of Microsoft Excel workbooks that computes frequently used procedures and methods in basic demographic analysis (US Census Bureau, 2014).

Base Population

For the 2020 CBPP round, the input for the base population is the latest census counts from the 2020 Census of Population and Housing (CPH), which was conducted beginning in September 2020 with 01 May 2020 as the reference date.

As an initial step, various indices were used to evaluate the quality of the 2020 population census age-sex distribution. The assessment was done to check if there was evidence of age-heaping (Whipple and Myers Indices) and digit preference by age (UN Age-Sex Accuracy Index). The results indicated that there was no age heaping and digit preference in age in the 2020 CPH (see Table 1).

Table 1. Indices to Evaluate Age-Sex Data

2010			2015			2020		
Whipple	Myers	UN	Whipple	Myers	UN	Whipple	Myers	UN
108.5	1.6	17.9	106.8	1.3	17.9	103.3	1.0	19.5

A cohort analysis of the 2010, 2015, and 2020 census was also conducted. The result showed that contrary to expectation, the population in age group 0-4 years in 2010 who would be aged 5-9 years in 2015 and 10-14 years in 2020, increased. The same pattern was observed for age groups 5-9 years and 10-14 years: the number increased between 2010 and 2015, but declined in 2020 (See Table 2).

Table 2. Cohort Analysis from Three Rounds of Censuses

Age group	**2010 CPH**	**2015 POPCEN**	**2020 CPH**
0-4	10,233,784	10,818,931	11,069,479
5-9	10,321,543	10,842,920	11,270,637
10-14	10,179,610	10,493,942	11,091,362
15-19	9,705,354	10,191,185	10,482,815
20-24	8,408,656	9,467,494	10,024,753

The previous rounds of censuses recorded persistent discrepancy in children aged 0-4 years. In 2020 CPH, there were about 11 million enumerated children aged 0-4 years. An assessment was conducted to check the accuracy of the expected under-five population. Based on the Age-Specific Fertility Rate (ASFR) from various data sources, a total of eight (8) methods were explored to evaluate the 2020 CPH under-five (5) counts (Table 3). The results show a discrepancy in the expected under-five (5) counts and the 2020 CPH count for 0-4 years. Similarly, the resulting analysis from the Base Population Estimation (BPE) spreadsheet[1], a PAS workbook, validates the observation of such discrepancy for the age 0-4 count (Figure 1).

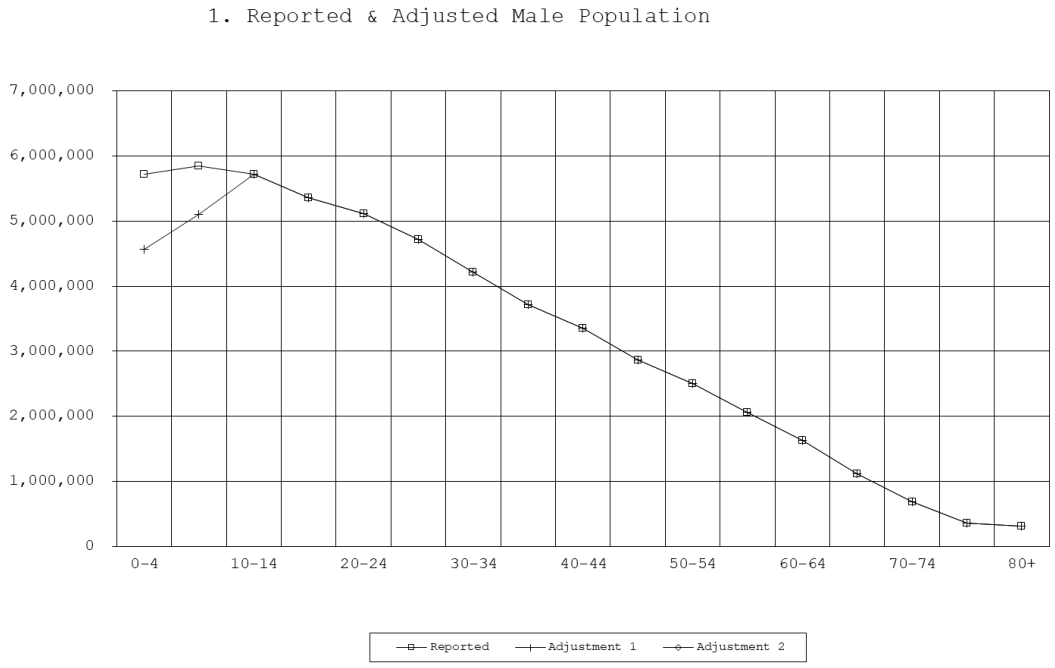
[1] *BPE is a spreadsheet that helps assess and adjust for the undercount of children.*

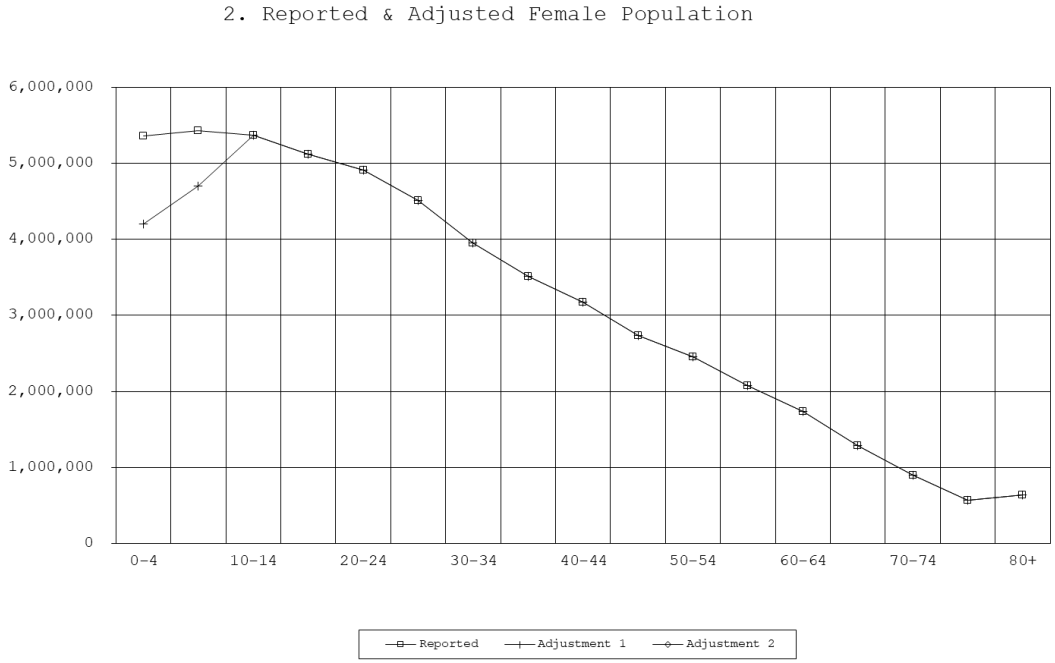
Table 3. Evaluation of Accuracy of the Expected Age Group 0-4 Years Population in 2020

Methods	TFR	Estimated	Difference from 2020 Population Count*
Method 1 (using interpolated ASFRs of the 2017 NDHS and 2022 NDHS)	2.4	10,135,148	-934,331
Method 2 (using ASFR of the 2022 NDHS)	2.0	8,159,472	-2,910,007
Method 3 (using interpolated ASFRs of the 2017 NDHS and 2022 NDHS at midyear 01 July 2020)	2.0	8,379,593	-2,689,886
Method 4 (using ASFRs of the 2020 CPH from P/F ratio)	2.3	8,943,755	-2,125,724
Method 5 (using interpolated ASFRs of the 2022 NDHS and 2020 CPH from P/F ratio)	2.9	10,505,892	-563,587
Method 6 (using average ASFRs of the 2017 NDHS and 2022 NDHS)	2.3	9,724,676	-1,344,803
Method 7 (using interpolated ASFRs of the 2017 NDHS and 2020 CPH from P/F ratio)	2.5	10,193,080	-876,399
Method 8 (using interpolated ASFRs of the 2010 CPH and 2020 CPH from P/F ratio)	2.7	10,922,103	-147,376

* 2020 CPH Count for age 0-5 years is **11,069,479**

Figure 1: Reported and Adjusted Male (top) and Female (bottom) Population based on the BPE Spreadsheet





The Philippines' population is expected to grow despite a continuous decline in total fertility rate (TFR). Even if TFR dropped lower than the replacement level of 2.1[2], the high proportion of females in their childbearing years paves the way for more individuals being born, thus, more addition to the population. This phenomenon is called population momentum. Prior to the drop in TFR to 1.9 in 2022, there is a large base in the country's age-sex population pyramid. When these individuals reach the reproductive age and have children of their own, this leads to an increase in births but on a smaller scale, resulting in an echo effect.

Using births and deaths from the Civil Registration and Vital Statistics, it is also possible to estimate the expected population in 2020, or the natural increase. But as shown in Table 4, there is a big discrepancy between the estimated population and actual population counts from the censuses.

Table 4. Estimated Midyear Population Using Natural Increase

Year	Estimated Midyear Population
Using 2010 CPH	
2010	92,598,289
2011	94,041,503
2012	95,534,253
2013	96,971,020
2014	98,319,404
2015	99,686,306
Using 2015 POPCEN	
2015	100,840,945
2016	102,210,509
2017	103,494,933
2018	104,787,502
2019	106,042,787
2020	107,209,099

[2] *Replacement level varies across countries. It is assumed that the replacement level for the Philippines is 2.1.*

The official census counts as of 01 May 2020 were adjusted to midyear, 01 July 2020, using the PopAgeMove analysis function[3] of DAPPS resulting in a total population of 109,216,772 where 55,399,887 were males, while 53,816,885 were females.

Despite the discrepancies found and due to the absence of evidence that supports the need to adjust the age-sex distribution from the 2020 CPH, no further adjustments in the 2020 CPH counts were done.

Fertility

Several data inputs were explored in analyzing the fertility component needed for the population projections: 2020 CPH, the National Demographic and Health Survey (NDHS), and the birth registration from the Civil Registration and Vital Statistics (CRVS). The series of NDHS from 1973 shows a continuous decline in the national TFR, with the latest data from the 2022 NDHS indicating that the TFR at 1.9 children is now below replacement level. In addition, the number of registered births from the CRVS for the years 2017 to 2022 were used to derive the TFRs for these years, which were also adjusted for under registration.

The adjustment factor of 90.6 was based on the percent birth registration of those below age one (1) year old (Age 0) from the 2020 CPH. Births from 10-14 years have been increasing, but not substantial enough to be treated as a separate age group. These births were added to the age group 15-19 years. Births from women above the age of 50 years were added to women 45-49 years, while births with no known age of mothers were proportionally distributed across the various age groups. Results show that the adjusted TFR estimates from the CRVS range from 2.3 children in 2017 to 1.8 children in 2022. From the 2020 CPH, the number of children born alive in the past was used to derive the TFR by using the Brass P/F ratio formula.

[3] *The PopAgeMove function moves the population age distribution to another date using a growth rate derived from values from deaths, ASFRs, and net migrants.*

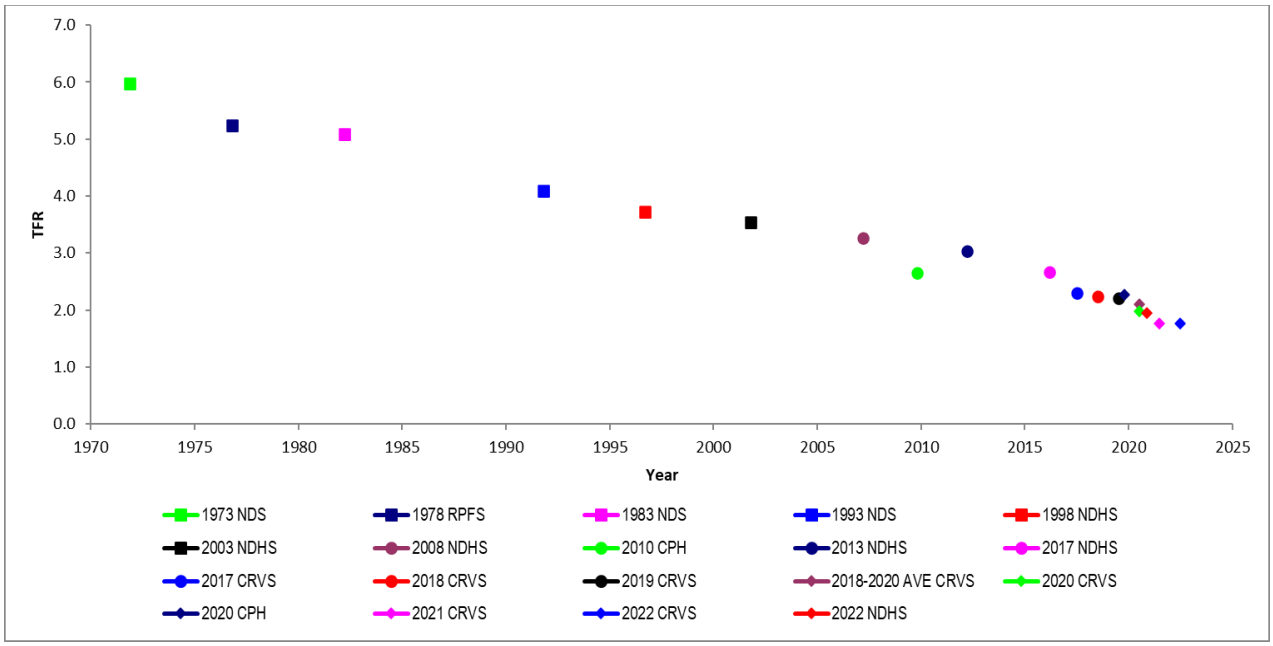
This resulted in a TFR of 2.3 children for 2020. The estimated TFRs and ASFRs are shown in Table 5 and Figure 2.

Table 5. TFR and ASFR from Various Data Sources, 1973 – 2022

Data Source	TFR	ASFR by Age Group						
		15 - 19	20 - 24	25 - 29	30 - 34	35 - 39	40 - 44	45 - 49
1973 NDS	5.970	0.05600	0.22800	0.30200	0.26800	0.21200	0.10000	0.02800
1978 RPFS	5.240	0.05000	0.21200	0.25100	0.24000	0.17900	0.08900	0.02700
1983 NDS	5.085	0.05500	0.22000	0.25800	0.22100	0.16500	0.07800	0.02000
1993 NDS	4.085	0.05000	0.19000	0.21700	0.18100	0.12000	0.05100	0.00800
1998 NDHS	3.730	0.04600	0.17700	0.21000	0.15500	0.11100	0.04000	0.00700
2003 NDHS	3.535	0.05300	0.17800	0.19100	0.14200	0.09500	0.04300	0.00500
2008 NDHS	3.265	0.05400	0.16300	0.17200	0.13600	0.08400	0.03800	0.00600
2010 CPH	2.655	0.03138	0.11575	0.13079	0.11137	0.07862	0.04311	0.02003
2013 NDHS	3.035	0.05700	0.14800	0.14700	0.12700	0.08400	0.03700	0.00700
2017 NDHS	2.665	0.04700	0.13100	0.13500	0.11400	0.07500	0.02900	0.00200
2017 CRVS	2.296	0.04498	0.11258	0.11501	0.09539	0.06495	0.02343	0.00278
2018 CRVS	2.232	0.04168	0.10748	0.11399	0.09471	0.06359	0.02249	0.00255
2019 CRVS	2.201	0.04017	0.10204	0.11397	0.09571	0.06326	0.02270	0.00241
2020 CPH	2.271	0.02319	0.07463	0.09617	0.09275	0.07566	0.05342	0.03838
2020 CRVS	1.971	0.03410	0.08857	0.10340	0.08886	0.05669	0.02044	0.00205
2020 CRVS*	2.099	0.03799	0.09768	0.10863	0.09157	0.06017	0.02152	0.00230
2021 CRVS	1.762	0.02950	0.07495	0.09364	0.08283	0.05092	0.01867	0.00181
2022 NDHS	1.946	0.02508	0.08364	0.10511	0.09462	0.05849	0.02079	0.00153
2022 CRVS	1.763	0.03037	0.07296	0.09395	0.08426	0.05105	0.01821	0.00175

Sources: PSA, 1973 - 2022 National Demographic and Health Survey,
2010 and 2020 Censuses of Population and Housing, and
2017 - 2022 Civil Registration Vital Statistics
** Based on the 2018 - 2020 average adjusted registered births from the CRVS*

Figure 2. TFR from Different Data Sources, 1973 – 2022



There was a reduction in the number of registered births between 2019 (1,697,903) and 2020 (1,541,057), and it continued in 2021 (1,395,584). This could be a possible effect of the pandemic. As observed, the adjusted TFR from the CRVS before the pandemic is about 2.2, a little lower than the 2020 CPH (2.3), but way above the 2022 NDHS figure (1.9).

The average adjusted TFR of 2.1 from 2018 to 2020 was adopted as the national baseline fertility estimate for the following reasons:

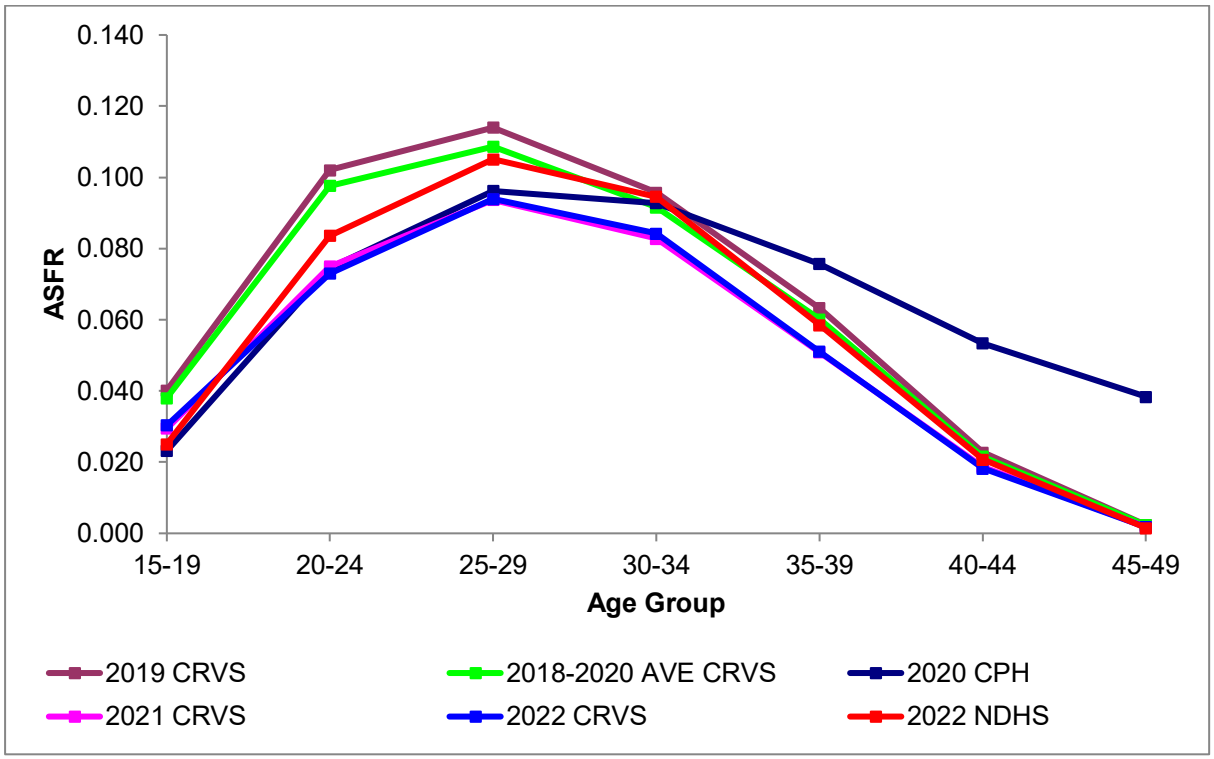
(1) the TFR derived from the CRVS exhibited a gradual decline that aligned with the fertility trend from NDHS, and the ASFRs exhibited a similar pattern to that of the 2022 NDHS;

(2) the average CRVS TFR is within the base year period of year 2020, which is the average from years 2018 to 2020. The TFR from the 2022 NDHS covers the years 2020 to 2022 which consists the pandemic years 2021 and 2022 where births declined, resulting in a lower TFR of 1.9;

(3) the 2020 CPH TFR based on the P/F ratio was not used because the input data for the adjusted TFR was children ever born alive from May 2019 to April 2020, and the 2020 CPH ASFR had a pattern of higher fertility among the older age groups (age groups 35-39 years to 45-49 years) as compared to the ASFR from the CRVS and NDHS.

The estimated ASFRs are shown in Table 6 and Figure 3.

Figure 3. National Level ASFRs by Data Source, 2019 – 2022



For projecting future fertility trends in the country, three scenarios were made based on the trends of fertility from various sources and in consultation with the Commission on Population and Development (CPD). The CPD's goal is to help couples achieve their desired family size. The baseline TFR for the year 2020 used the average TFR of the CRVS from 2018 to 2020 equivalent to 2.099 children which is about the replacement level fertility. For **Scenario 1**, the TFR for years 2021 and 2022 is estimated to be at 1.946 children based on the 2022 NDHS and assumed to rebound to a TFR of 2.100 children from 2025 until 2055. For **Scenario 2**, a slow decline from 2.099 children in 2020 to 1.946 children in 2021 and 2022, and a further decline to 1.900 children from 2025 until 2055 is expected. Finally, **Scenario 3** assumes a continuous decline such that by 2055, the TFR is at 1.700 children. The future TFRs were computed by fitting a logistic function given upper and lower asymptote values[4].

[4] *Specifically, the TFRLGSTNew spreadsheet was used using TFRs from various sources. This spreadsheet is used to interpolate and extrapolate TFRs by fitting a logistic function using 2 to 17 TFRs given upper and lower asymptote values.*

In the generation of population projections in the previous years, three fertility assumptions were generated, namely, high, medium, and low which were based when the replacement level be equal to 2.1 children. The medium assumption was always recommended for utilization and in the generation of subnational population projections such as region and province.

The current level of fertility rates in the Philippines shows that we are already at the below replacement fertility level of 2.1 children based on the average of 2018 to 2020 CRVS and the 2022 NDHS data. As such, the previous assumptions when a replacement level or Net Reproduction Rate = 1 is reached are no longer applicable in the 2020 CBPP since the said NRR target is already achieved. Hence, in the current CBPP, Scenario 2 will be endorsed as the recommended figures to be utilized for planning and programming purposes.

For the projected ASFR pattern, the 2021 CRVS was utilized because it has the same pattern as the 2022 NDHS. The projected TFRs under the three (3) scenarios are shown in Table 6.

Table 6. Projected Total Fertility Rates for the National Population Projections Using Three (3) Scenarios

Year	Scenario 1	Scenario 2	Scenario 3
2020 (Baseline)	2.099	2.099	2.099
2021	1.946	1.946	1.946
2022	1.946	1.946	1.946
2025	2.100	1.913	1.744
2030	2.100	1.901	1.706
2035	2.100	1.900	1.701
2040	2.100	1.900	1.700
2045	2.100	1.900	1.700
2050	2.100	1.900	1.700
2055	2.100	1.900	1.700

Mortality

In the preparation of analysis of the mortality component, the following data were used: (1) CRVS death data from 2020-2022; (2) NDHS data on child mortality; and (3) 2015 POPCEN and 2020 CPH to compute for the midyear population. Deaths for 2022 used processed deaths until July 2023.

Data from the 2020-2022 CRVS were adjusted for levels of completeness of death registration (87.51% for males, 88.14% for females for 2020; and 95.08% for males and 94.95% for females for both 2021 and 2022) using the methodology performed by Kabamalan et al. (2023) with updated inputs. CRVS death data from 2020 to 2021 were also adjusted for late registration until the next calendar year.

Based on the assessment of mortality data from these sources, three assumptions were considered in preparing the data inputs for mortality as follows: 1) no adjustments in the 2020 CPH were made; 2) there was an under-registration on deaths reporting for ages below five; and 3) registered deaths from 2020 to 2022 were used to evaluate the effect of Coronavirus disease 2019 (COVID-19) on mortality levels.

Age-specific death rates (nMx) from years 2020 to 2022 were computed using direct estimation methods for both males and females. In the direct method, death rates were measured using census and death registration systems. For population data, the forward method of estimating years 2020, 2021, and 2022 population by age-group used the 2020 CPH population counts adjusted to midyear using the geometric population growth rate of 1.63 derived from the 2015 POPCEN and 2020 CPH. The nMx values (from age 0 to 85 years and above) were used to generate the life tables for males and females using MORTPAK, a software package for demographic measurement in developing countries, with special emphasis on mortality measurement.

The level of completeness of the CRVS death registration for children was evaluated by comparing the probability of dying between exact age x and x +n (nQx) generated from the life tables estimates of unadjusted ASDRs for infant and child

mortality ($_1Q_0$ and $_4Q_1$) and the latest results of the NDHS infant and child mortality estimates. Result showed pronounced under-registration in age groups 0 and 1-4 (see Table 7).

Table 7. Probability of dying (nQx) values and 2022 NDHS estimates by indicator, sex and selected years

	2020 LT nQx		**2021 LT nQx**		**2022 LT nQx**		**2022 NDHS**	
Indicator	Male	Female	Male	Female	Male	Female	Male	Female
Infant mortality (age 0)	0.010	0.008	0.010	0.008	0.010	0.008	0.025	0.019
Child mortality (age 1-4)	0.003	0.002	0.003	0.003	0.003	0.003	0.005	0.005

The nMx for ages 0 and 1-4 years were adjusted due to evidence of underestimation. The registered deaths for each age group were corrected using the nMx equivalent of the infant and child mortality rates from the 2022 NDHS[5]. The resulting nMx for ages 0 to 1-4 years are presented in Table 8.

Table 8. Adjusted nMx for ages 0 and 1-4 years, 2020-2022

Indicator	Male	Female
Infant mortality (age 0)	.026	.019
Child mortality (age 1-4)	.001	.001

Registered deaths (nDx) in the Philippines, as well as nMx, increased in 2021, presumably due to the COVID-19 pandemic, and returned to usual levels in 2022. The 2022 life expectancy at birth (e_0) estimates from the life table served as the baseline to project future life expectancies from the years 2023 to 2055. Projections of e0 were performed by fitting a logistic function to the life expectancy inputs using two asymptotes (upper and lower) and fixed slopes derived from a composite of cross-national data[6]. Projections of single year life expectancy at birth by sex up to

[5] *Particularly, this was performed via the USCB tool LTMXQXAD spreadsheet where estimates of infant and child mortality rates from the 2022 NDHS were converted to nMx.*

[6] *E0_Proj analysis function of DAPPS was used for the projection of life expectancies at birth.*

2055 were performed using the logistic curve and standard asymptotes. The lower asymptotes were assumed to be 25 years for both males and females; while the upper asymptotes (ultimate e_0) for males and females were assumed to be 82.56 years and 88.40 years, respectively. The ultimate e_0 values represent the summary of experience of low mortality countries based on the modeling by the USCB. Projecting the life expectancy at birth up to year 2055, the projected e_0 will reach 74.6 for males and 81.3 for females, with a quinquennial gain of about one year (see Table 9).

Table 9. 2020 Baseline and 2055 projected life expectancy at birth, by sex

	2020		**2055**		**Gains**	
	Male	Female	Male	Female	Male	Female
Life expectancy at birth (e_0)	66.2	73.3	74.6	81.3	8.4	8.0

The mortality inputs used in DAPPS to generate the final projections were nMx for 2020, modelled nMx for 2100 from USCB, nDx for 2021 and 2022, and projected e_0 from 2023 to 2055.

Migration

In projecting net number of migrants, several data on migration from various local and international sources were examined: 2020 CPH, 2018 National Migration Survey, 2020 Annual Poverty Indicators Survey, 2020 Quarterly Labor Force Survey, 2020 Survey of Overseas Filipinos, and administrative records on migrants provided by the Commission on Overseas Filipinos (CFO) and the Bureau of Immigration (BI), including data from the United Nations.

After reviewing the assumptions and methodologies used by these sources, the use of local data for the analysis of international migration was preferred. Notably, data sourced from international agencies primarily originates locally and focus mainly on migration stocks rather than flows, at least in the case of the Philippines. Additionally, data gathered by other countries differ in operational definitions.

Combinations of data sources were iteratively evaluated prior to arriving at a final method for estimating the net number of migrants. Data from BI and CFO were selected for scenario-building for the following reasons: 1) BI and CFO have annual data on immigration and emigration, respectively, while the 2020 CPH has a single-time-point data with reference to migration five (5) years prior to the census day (i.e., May 2015 – May 2020), 2) the result of the indirect method for estimating net number of migrants based on 2010 and 2020 CPH is similar to the annual net migration from BI and CFO for 2020, 3) the 2019 age-sex structure of migration using the BI and CFO data is nearly identical with the 2010 CBPP migration structure using the 2010 CPH and CFO data, and 4) the Small Working Group on Migration is cognizant of the assumption that under-registration exists in both BI and CFO data. However, because of the lack of information on the levels of under-registration, no adjustments could be made.

To compute the net number of migrants, the year 2019 data on the number of emigrants based on registered Filipinos from CFO and the number of immigrants by age and sex based on the registration data from BI were used. Both registration data from CFO and BI are distributed by age and sex. The difference between the net number of migrants for 2018 and 2019 was used to estimate the net number of migrants for 2020 (-47,823) (see Table 10). A 10 percent increase, which was based on the average annual increase in net migration from BI and CFO, was added every five (5) years thereafter, i.e., projecting from 2025 to 2055.

Table 10. Baseline and projected net migration

Period	Net number of Migrants		
	Total	Male	Female
2018	-67,005	-22,603	-44,402
2019	-57,414	-19,368	-38,046
2020	-47,823	-16,133	-31,690
2025	-52,605	-17,746	-34,859
2030	-57,866	-19,520	-38,345
2035	-63,652	-21,472	-42,180
2040	-70,018	-23,620	-46,398
2045	-77,019	-25,982	-51,038
2050	-84,721	-28,580	-56,142
2055	-93,193	-31,438	-61,756

The difference between 2019 and 2018 is 9,591.

REFERENCES

United Nations Department of Social and Economic Affairs (n.d.). MORTPAK. Retrieved https://capacity.desa.un.org/tools/2020/mortpak

United States Census Bureau. (2014). *Population Analysis System (PAS) Software*. https://www.census.gov/data/software/pas.html

United States Census Bureau. (2021). *Demographic Analysis & Population Projection System (DAPPS) Software*. https://www.census.gov/data/software/dapps.html

Kabamalan, M.M.K., Reolalas, A. T., Villaver, M. B., Siwa, J. A. A., Tanalgo, K. P., & Mapa, C. D. S. (2023). Male-Female Disparities in Potential Years of Life Lost Due to Premature Mortality in the Philippines. Paper presented at the Asia-Pacific CRVS Research Forum, 3–4 April 2023 I Bangkok, Thailand.