"Missing" Persons in East Timor during the Indonesian Occupation, 1975 - 1999

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Abstract: Indonesia's occupation of East Timor from 1975 to 1999 caused an unknown number of deaths due to violence and starvation. In the first few years alone casualty estimates range from 60,000 (Houk 1978) to over 300,000 (Defert 1992). Recent statistical work done for the *Commission for Reception, Truth and Reconciliation in East Timor (CAVR)* concludes that there were at least 102,800 (± 12,000) conflict-related deaths during the 24-year period (Silva and Ball 2006). This paper applies standard demographic methods of indirect estimation to census data from before, during, and after the Indonesian occupation to obtain a systematic estimate of the number of "missing" persons in East Timor during the 24-year period. These missing persons did not necessarily die during the Indonesian occupation—they could have emigrated, been overlooked by a later census, or, in the case of children, not been born. Great care is taken to ensure that these sources of error are minimized as much as possible. My results suggest that the CAVR mortality estimates are a conservative lower-bound. I find that were a substantial number of missing persons (130,000) after the first five years of Indonesian occupation, and a smaller amount (50,000 or fewer) during each of the two subsequent decades. Even under the most conservative assumptions, the total number of excess deaths in East Timor during the entire period of Indonesian occupation likely ranges from 150,000 to 220,000.

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[1] This paper stems from analysis originally done for the *Human Rights Data Analysis Group* (HRDAG) at the Benetech Initiative in Palo Alto, California, as background to their report to the *Commission for Reception, Truth and Reconciliation in East Timor* (CAVR). However its conclusions differ from those reached by HRDAG and those published in CAVR's final report. See http://www.hrdag.org/timor for HRDAG's official results. Romesh Silva, Patrick Ball, and Kristen Cibelli of HRDAG were the initial impetus for my work on this topic and provided some historical data. Members of the 2005 Demography 296 Seminar at UC-Berkeley, attendees at the 2005 Social Science History Association session on "The Historical Demography of the Legacy of Colonialism," and attendees of a brown bag presented at the International Peace Research Institute in Oslo provided invaluable feedback on previous drafts. All remaining errors are mine. Research conducted with the support of a National Science Foundation Graduate Research Fellowship.

East Timor, a nation barely larger than the state of Connecticut, captured world attention in 1999 during its historic United Nations-sponsored referendum on independence. The lead-up to the vote was marred by violence for several months, as pro-Indonesian militia killed, threatened, and intimidated the East Timorese population in an effort to keep them from voting for independence. On August 30th of that year, the East Timorese electorate overwhelmingly voted in favor of independence from Indonesia. The vote ended 24 years of Indonesian annexation. Following the elections, in an apparent act of revenge, pro-Indonesian militias killed an estimated 1,000 supporters of independence. One-quarter of a million East Timorese fled to West Timor (Gunn 2000). Looting and ransacking were widespread, and the Indonesian "scorched earth" policy destroyed more than 70 percent of the housing stock in East Timor (Dolan, Large, and Obi 2004). The events of 1999 were perhaps best described as a "brutal finale" to 24 years of Indonesian occupation (Nixon 2004).

Although much has been written about East Timor since 1999, little is known about the full impact of Indonesian occupation, which began in 1975, following more than 400 years of Portuguese colonial rule. Currently, in the wake of East Timorese independence and the establishment of the *Commission for Reception, Truth and Reconciliation in East Timor* (CAVR), there is an interest in determining the extent of human rights abuses during the Indonesian occupation. This paper focuses on population-level estimates of excess mortality from 1975 to 1999. For the purpose of this paper, *excess mortality* is the number of deaths above and beyond those that would have been expected under "normal" circumstances. Estimates of excess mortality cannot, of course, tell the entire story: by definition such figures obscure the richness of individual histories and events. Yet mortality figures are an important way to summarize the experiences of a population, particularly when so many victims and their stories will forever remain unknown. The fact that each person has equal weight in such counts could also be thought of as a "democratic counterbalance" to *ex post* efforts to steer historical attention toward one particular version of events.

Wars and occupations tend to cause indirect mortality in the population above and beyond battlefield deaths (cf. Li and Wen 2005, Ghobarah, Huth, and Russett 2003), particularly if medical systems break down, internal migration causes poor living and sanitary conditions, and food becomes scarce. Excess mortality is difficult to pin down, however, because "missing" persons (who are absent even above and beyond the expected number of deaths) may in fact have

emigrated, gone into hiding and been missed by later censuses, or died due to disease or natural causes that would have occurred even in the absence of an armed invasion. Similarly, a large portion of the post-occupation population may well have arrived from outside East Timor—for example, via Indonesia's transmigration program—and thus disguise high levels of wartime mortality among the native population.[2]

Despite these challenges, indirect estimation of mortality is still a critical task for truth commissions, historians, and politicians. The casualties of war are certainly a subset of the number of "missing" persons. When combined with survivor testimonies and other historical evidence of military incursions, consistently high levels of "missing" people are strongly suggestive that Indonesian aggression in East Timor was responsible for a large number of deaths in the population.

In this particular case, robust statistical evidence gathered by the Human Rights Data Group (HRDAG) on behalf of the Commission for Reception, Truth, and Reconciliation in East Timor (Silva and Ball 2006) has estimated that at least 102,800 (± 12,000) East Timorese died of causes related to the Indonesian occupation. This result was based on years of careful analysis using a retrospective mortality survey, a graveyard census, and narrative testimonies. Given this well-documented finding, why use indirect estimation at all? First, this project was started prior to HRDAG reaching its final estimate, and hence provides a useful "sanity check" on their results. Second, it is important to develop indirect methods for cases where retrospective surveys, graveyard censuses, and narrative testimonies cannot be used. Such efforts are important but extremely expensive, time consuming, and—in the case of historical wars—potentially impossible to collect. Third and most important, indirect estimation provides a useful "upper bound" on the total number of East Timorese who died during the Indonesian occupation. This upper bound is a useful complement to the multiple systems estimation method used by HRDAG which provides a "lower bound" of the total number of persons who died of causes related to the occupation.

Why do I claim that HRDAG's estimates are a lower bound? Well, each of the methods that were used by HRDAG—narrative testimonies by witnesses and survivors, a graveyard census, and a retrospective mortality survey—are, in and of themselves, likely to underestimate

[2] Fortunately post-occupation Censuses in East Timor have gathered data on the nativity of the head of household, which allows us to distinguish between native Timorese households and other immigrants. To the extent that there were mixed marriages among natives and immigrants, however, the census data may be misleading.

the actual number who died during the occupation. Relying on narrative testimonies is problematic because many cases massacres and deaths go unwitnessed or survivors refuse to testify about what happened.[3] Graveyard censuses omit deaths when victims are buried *en masse*, buried without a marker, or not buried at all – which is often the case during violent crises. Retrospective mortality surveys underestimate mortality when deaths are "clustered" in families and there are no survivors in the country to report what happened.[4] If estimates from these three methods were simply added up, there would of course be risk of overestimation – multiple counting of the same deaths among different sources. However, HRDAG took painstaking efforts to avoid double-counting across different methods of estimation by detecting and eliminating duplicates. Hence their final casualty count is extremely well-documented and robust to evidentiary challenges, yet also likely to be lower than the "true" total. Indirect estimation thus provides a useful complement to their estimation of excess mortality.

East Timor, a very small country, is also an important case study of excess mortality. If the most commonly cited figure of 200,000 casualties during the first five years of Indonesian occupation is reasonable, then the Indonesian invasion of East Timor will have produced one of the highest *proportionate* death tolls of any war or mass murder in recent history. According to Kiernan (2003), the proportion of initial population who died in East Timor from 1975-1980 is on par with, if not slightly above the proportion of the original population killed during the Khmer Rouge regime in Cambodia (21 to 26 percent). Chomsky (1999) has claimed that a death toll of 200,000 would make it the highest proportionate death toll of any war since the Holocaust. Yet critics estimate the casualty count to be as "low" as 60,000, or less than 10 percent of the original population (Hull 2004), thus it is important to consider the issue carefully.

The availability of Portuguese censuses prior to the Indonesian takeover gives us a unique estimate of the pre-invasion population, something largely unavailable in other historical cases of colonization. Timor's isolation as an island means that out-migration was necessarily quite limited. By and large refugees displaced by the Indonesian invasion fled into East Timor's vast forests and mountains.[5] Crossing the border into West Timor or fleeing by boat to a nearby island generally meant arriving in Indonesian territory, not an enticing prospect. Australia was

[3] The opposite bias is also possible: that many survivors will report the same incident and thus lead to an overcount of the number who died, but HRDAG takes painstaking efforts to eliminate such duplicate reporting.
[4] Here again, the opposite is possible: multiple surviving family members could report the same death. However HRDAG has taken measures to guard against such overcounting.
[5] Less than 5% of East Timor's land area is arable (CIA 2005).

close enough to receive some refugees, but these arrivals are well-documented. Hence, East Timor offers a unique perspective on the demographic impact of political annexation.[6]

Quantitative representations of human rights violations, such as death counts, are inherently controversial, because perpetrators often desire to discount the importance of the event while advocates may be tempted to overestimate what happened in order to draw public attention. Scientific evaluations of the evidence thus provide an appealing alternative to political debate. This paper is one of only a handful of serious efforts to estimate excess mortality in East Timor during the period of Indonesian occupation. Most efforts have focused only on the first five years of occupation, when it is believed population losses were the most dramatic (cf. Kiernan 2003; Cribb 2001). The general literature on East Timor cites a near-ubiquitous figure of 200,000 casualties (cf. Amnesty International 1997; Pilger 1994a; Chomsky 1999), though the derivation of this number has not been well-documented.

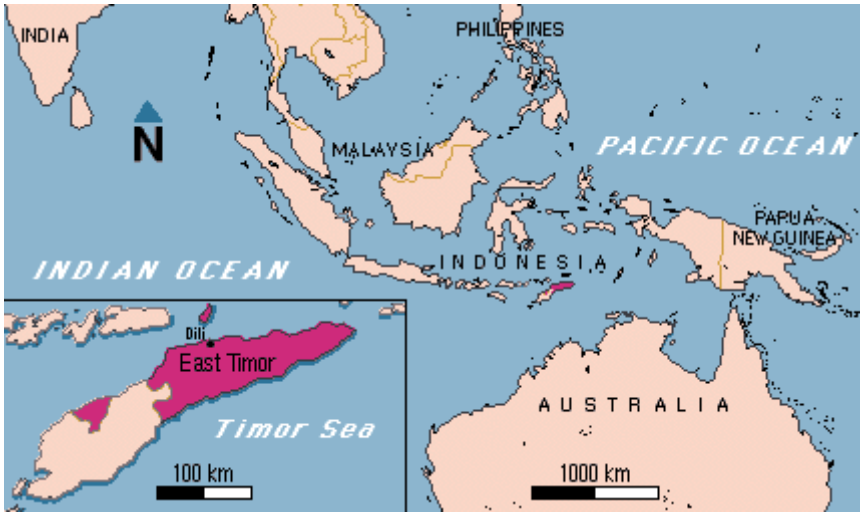
The remainder of the paper proceeds as follows. First, I lay out the salient features of East Timor's history to provide some background to the study. Second, I provide crude estimates of excess mortality based on population growth rates. The third section estimates excess mortality using age-specific death rates and all available information about migration.

I. Background

East Timor lies on an island just north of Australia on the eastern edge of the Indonesian archipelago (Figure 1). Its population is a mixture of Melanesians, Malays, and Chinese. The Portuguese colonized East Timor in 1520. Over the following centuries, Spain, the Netherlands, Britain, and Japan attempted to wrest control of the country from Portugal, but only Japan was successful in occupying East Timor briefly during World War II. Portugal regained control of East Timor following World War II. After a 1974 coup in Lisbon, the newly-established Portuguese Junta de Salvação Nacional declared that Portugal would withdraw from its overseas territories. East Timorese independence appeared to be inevitable (Lawless 1976).

Figure 1 Map of East Timor in the Southeast Pacific Ocean

[6] Several authors have suggested that what happened in East Timor was a genocide (East Timorese being a national group whom the Indonesians attempted to exterminate), while others strongly contest this definition. This paper is not the correct forum for such a debate, and hence I simply refer to what happened in East Timor as "annexation" or "occupation." From a demographic standpoint, the importance of the occupation is that it involved a massive number of excess deaths, regardless of whether it meets the legal standards for "genocide" or not.



Even before the Indonesians invaded, the inevitability of independence was a contentious and ultimately violent issue inside East Timor (Huridocs 2003; Nichertlein 1977). *Fretilin* (Frente Revolucionaria Timor Lest Independente), a popular left-wing movement, wanted to declare full independence. A second group, *UDT* (Uniao Democratica Timorense) wanted to remain linked with Portugal. The least popular group, *Apodeti* (Associao Popular Democratica Timorense), wanted autonomous integration into Indonesia, though Indonesia made it clear that autonomous integration would not be possible (Lawless 1976; Houk 1978). Initially *UDT* and *Fretilin* were in alliance, but *UDT* later withdrew and the two groups clashed violently. On November 28, 1975, *Fretilin* unilaterally declared East Timorese independence. Nine days later Indonesian forces invaded.

On December 7, 1975, approximately 2,000 Indonesian paratroopers and marines and 20 warships began attacking Dili (the capital) and other coastal areas, causing at least 500 Timorese casualties (Lawless 1976). *Fretilin* is said to have put up a surprising amount of resistance given its technological inferiority, but Indonesians still conquered key strategic areas. The UN Security council called on Indonesia to withdraw from East Timor two weeks later, but to no avail. Indonesia only stepped up its continued incursions into rebel-held areas under the veil of anti-communism. A second invasion took place on December 25, 1975.

In 1976, Indonesia officially incorporated East Timor as its 27th province (CIA 2005). The United Nations vocally condemned the annexation of East Timor, but other superpowers – particularly the United States and Australia - were silent on the issue. The United States never formally recognized Indonesia's annexation of East Timor, but also never publicly objected to it.

Indonesia portrayed East Timor as an emerging communist nation, virtually guaranteeing U.S. support (Crossette 1994; Nichertlein 1977). The Indonesian invasion into East Timor began a mere 12 hours after President Ford left Jakarta, which is widely seen as evidence of American acceptance of Indonesia's conquest of East Timor (Pilger 1994a; Kohen 1981). The United States supplied the arms used by the Indonesian military and continued its military support long after the annexation of East Timor (Sidell 1981).

For Australia, Indonesia was a crucial trading partner and consideration to diplomatic relations was given more weight than ethical concerns (Walsh 1981). In 1977, Australia formally recognized Indonesia's annexation of East Timor on the grounds of "realpolitik." However, in the last decade of Timorese occupation there was significant pressure within Australia by human rights organizations to raise the Timor issue (Kiernan 2002).

Indonesia publicly claimed that what happened in East Timor was not a military takeover; rather volunteers from its military went to assist a pro-Indonesian Timorese political group in a war with a Marxist-controlled group, *Fretilin* (Sharkey 1977). It also maintained that the Timorese had willingly accepted Indonesian involvement. For example, a letter to the editor in the *New York Times* written by the U.S. counselor at the Indonesian embassy stated:

> Indonesia will not take over Portuguese Timor but will accept integration, should the people of the area democratically, and without terrorists' guns pointed at their heads, choose this course. (Abdullah 1976)

Yet the evidence that Indonesian rule in East Timor was anything but voluntary is overwhelming. In the *Sydney Morning Herald* on April 5, 1977, the Indonesian foreign minister was quoted as saying "Fifty thousand people or perhaps eighty thousand might have been killed during the war in East Timor... It was war... Then what is the big fuss?"[7] Two joint Congressional hearings documented testimony from dozens of experts on East Timor on the impact of Indonesian violence toward Timor (U.S. Congress 1999a, 1999b). Eyewitnesses and experts described extensive bombing in the mountains where many Timorese had gone to seek refuge following the 1975 attack. They also told of the killing of entire villages near where Fretilin guerillas were operating, and the killing of anyone suspected to have any association with Fretilin (Sharkey 1977). Survivors have corroborated in great detail the brutality of Indonesian occupation (Jardine 1994; Pilger 1994b).

[7] As cited in (Kohen and Taylor 1979).

Journalists and aid workers had only limited access to East Timor until 1989; hence knowledge of the extent of atrocities committed during the Indonesian annexation of East Timor is limited. Indirect estimation of excess mortality may be the best way to determine what happened in East Timor during Indonesian occupation. This paper first presents a crude growth-rate estimate of excess mortality to obtain a broad picture of what happened, and then presents more specific estimates by age and sex to determine excess mortality in East Timor during the Indonesian occupation.

II. Simplistic Estimates of Excess Mortality

In order to get a sense of excess mortality, it is useful to begin with a simplified model. We can express the actual[8] population of East Timor on December 31, 1999 as:

$$P_{Act1999} = P_{Act1975} + B_{interim} - D_{interim} \pm M_{interim}$$

where:

$P_{Act1999}$ is East Timor's population on December 31, 1999
$P_{Act1975}$ is East Timor's population on December 6, 1975
$B_{interim}$ is the number of live births during the period
$D_{interim}$ is the total number of deaths that occurred during the period
$M_{interim}$ is the net number of international migrants from 1975 to 1999

We can define two types of death during the period: *expected* and *excess*, where:

$D_{expected}$ is the number of deaths that would have been expected during the period if mortality rates held constant[9]
D_{excess} is the number of deaths that are not explained by the mortality rates in the starting year, a portion of which are presumably related to the Indonesian occupation

It follows that:

$$D_{interim} = D_{expected} + D_{excess}$$

Similarly, births and mortality totals are comprised of expected values and unexpected values. In the case of migration we take into account reported totals during the period in order to reduce the value of unexpected migration:

$$B_{interim} = B_{expected} \pm B_{unexpected}$$
$$M_{interim} = M_{expected} \pm M_{reported} \pm M_{unexpected}$$

Using a growth rate or another formula, we can derive an estimated 1999 population:

$$P_{Est1999} = P_{Act1975} + B_{expected} - D_{expected} \pm M_{expected} \pm M_{reported}$$

[8] For the sake of simplicity, I am equating actual population with the officially recorded population, even though they are not necessarily the same thing. I discuss problems with Census data in the next section.
[9] In fact, this is a conservative estimate, as most developing countries have experienced a "mortality transition" in the past half century, whereby mortality rates have been steadily decreasing.

If we then subtract the actual 1999 population from both sides of the equation above, we find that all terms on the right hand side cancel except the number of deaths:

$$P_{Est1999} - P_{Act1999} = \cancel{P_{Act1975}} - \cancel{P_{Act1975}} + (B_{expected} - B_{interim}) - (D_{expected} + D_{interim}) + (\pm M_{expected} \pm M_{reported} \pm -M_{interim})$$

$$P_{Est1999} - P_{Act1999} = D_{excess} + (B_{unexpected} \pm M_{unexpected})$$

As $(B_{unexpected} \pm M_{unexpected})$ approach 0:

$$\mathbf{P_{Est1999} - P_{Act1999} \approx D_{excess}}$$

In other words, since what we are really interested in is excess deaths, we will try our best to reduce the absolute value of unexpected births and unexpected migrants, so that the estimated minus actual population will primarily be comprised of excess deaths. If fertility or net migration were lower than expected, this would inflate our count of the excess deaths. Conversely, if fertility or net migration were higher than expected, or if "normal" mortality rates fell[10] over time, we would underestimate excess mortality.

We also face an additional problem: there are no official records for Timorese population on December 6, 1975, nor are there any for the population on December 31, 1999. Table 1 all of the population data sources that will be used in this paper. As it indicates, the last recorded population census prior to 1975 was Portugal's 1970 Census of its overseas territories. However, Portugal updated its Census count with records of births, deaths, and net migration in 1971 and 1972.[11] Most population data during the period of occupation comes from Indonesian sources. Some post-independence data are available, but detailed population counts from the 2004 census have not yet been released.

[10] It is nearly impossible to imagine that natural mortality rates would have risen during the period, as this would be contrary to the experience of peaceful and unoccupied developing countries during this period.

[11] Portugal also published a 1973 update, but it did not contain births and deaths for East Timor (Portugal Instituto Nacional De Estatistica 1971, 1972, 1973).

Table 1 Sources of Population Data for East Timor, 1960 - 2004

Applicable Year	Series Title	Done by:	Source Year	Notes:
1960	Anuario Estatistico Provincias Ultramarinas	Portugal Instituto Nacional de Estatistica	1961	Official Census; possible undercount due to poll tax
1970			1971	
1971			1972	Contains information on births and migration only.
1972			1973	
1972	Revista Do Centro de Estudos Demograficos	Portugal Instituto Nacional de Estatistica	1985	Estimates fertility and mortality rates from 1972.
1980	Sensus Penduduk: Rumahtangga Dan Penduduk, Timor Timur.	Bagian Statistik Demografi *[Indonesian Demographic Statistics Division]*	1981	Official Census; possible undercount (internally displaced persons in remote areas); but a political incentive to overcount.
1990			1991	
1991	Indonesia Demographic and Health Survey	Central Bureau of Statistics Indonesia *et al.*	1992	Contains 3-year retrospective age-specific fertility rates and 10-year retrospective infant and child mortality rates for East Timor
1994			1995	
1997			1998	
2000	International Data Base	U.S. Census Bureau	2004	Unclear how population totals account for refugees; used age structure only.
2001	Suco Survey	Asian Development Bank	2002	Population total
2004	2004 Census	Direccao Nacional de Estatistica de Timor-Leste	2005	At time of w riting, only population total had been released. Unknow n w hether total includes non-native Timor households.

Hence our "actual" population counts in 1975 and in 1999 will actually be estimates based on census data before and after the occupation, which adds another layer of potential error. Moreover, official counts done prior to the invasion are thought to be flawed. The Portuguese collected a "poll tax" on the East Timorese, so it's likely that their population numbers are an undercount (Cribb 2001). Yet Indonesian census-takers were unlikely to be warmly received by East Timorese during the occupation, so in a sense the rates of enumeration before and during the occupation may be fairly comparable.

When all the potential sources of error are considered, the cost of producing an estimated count of excess mortality may, to some, appear to outweigh the benefit of having a potentially flawed estimate. This opinion is perhaps understandable. We will never know the real number of East Timorese killed directly or indirectly by Indonesians, and it would be dishonest to claim otherwise. Yet if we are careful and responsible with our methods and consider the possible sources of error, we can produce a reasonable estimate of this figure.

If the estimate produced here is carefully documented, scholars and critics can replicate the results, judge the integrity of the estimate, and improve the estimate if new historical information later appears. A future version of this paper will compare Census-based estimates of excess mortality with projections of retrospective mortality rates onto the original 1975 population using the results of a recent survey in East Timor done by the Human Rights Data Analysis Group (HRDAG).[12] After the *Commission for Reception, Truth, and Reconciliation in East Timor (CAVR)* releases its final report, there will be other additional analyses published separately by HRDAG with which to compare the present study. For now we are limited to an analysis based on Census data alone.

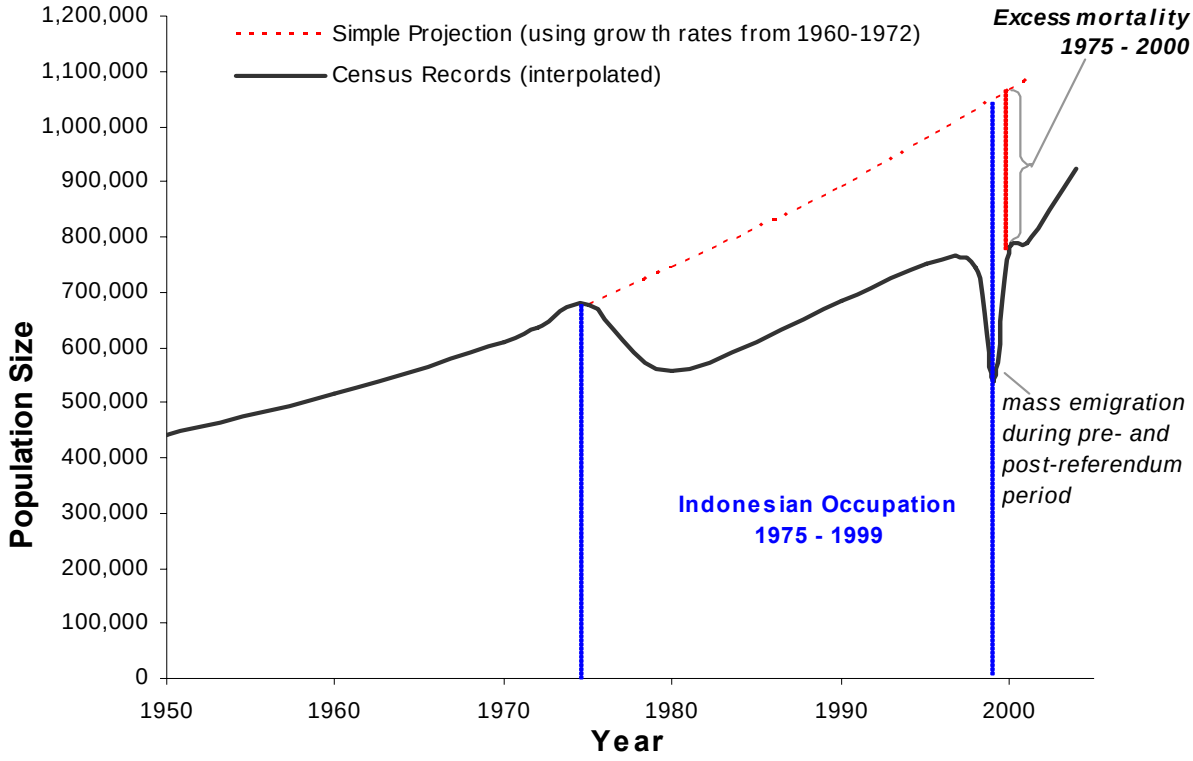
A simple way to estimate excess deaths is to apply East Timor's average annual growth rate from 1960 to 1972[13] to the period from 1972 to 1999. The "actual" 1999 total can be subtracted from this estimated 1999 total to obtain an estimate. The growth rate formula estimates East Timor's expected 1999 population at 1,065,531. We don't have a recorded total for 1999, but we know that the 2001 Suco survey counted 787,338 persons in East Timor (Asian Development Bank 2002). Projecting the average annual growth rate from 1972 to 2001 (0.72%)[14] back to 1999 implies a population of 781,684 in December of 1999. If we instead take the growth rate from 2001 Suco survey to the 2004 census (5.36%) and project backward, this would imply a 1999 population of 746,263. These figures imply an excess mortality of approximately 284,000 to 320,000 during the period. An illustration of the growth rate method is given in Figure 2. As the figure illustrates the dip in population from 1970 to the 1980 period and onward is quite dramatic.

[12] HRDAG (http://www.hrdag.org) is part of the Benetech Initiative in Palo Alto, California and directed by Dr. Patrick Ball. HRDAG has been hired to conduct data analysis for the *Commission for Reception, Truth and Reconciliation in East Timor (CAVR).* I have been volunteering as a statistical consultant on HRDAG's work for CAVR. Due to an agreement between CAVR and HRDAG, any and all results from the retrospective mortality survey and all other Timorese data collections (except for the present analysis, which is entirely based on publicly-available data) are embargoed until CAVR releases its final report.

[13] The average annual growth rate increased from the 1960-1970 period to the 1970-72 period. To err on the conservative side, I obtain an average annual growth rate from 1960-1972.

[14] The estimated growth rate is extraordinarily small because of the massive mortality and out-migration during the period; but using a smaller growth rate in a backward projection errs on the side of caution because it produces a larger estimate of the actual 1999 population.

Figure 2 Census Data Compared with Simplistic Population Projection: East Timor, 1950 - 2005



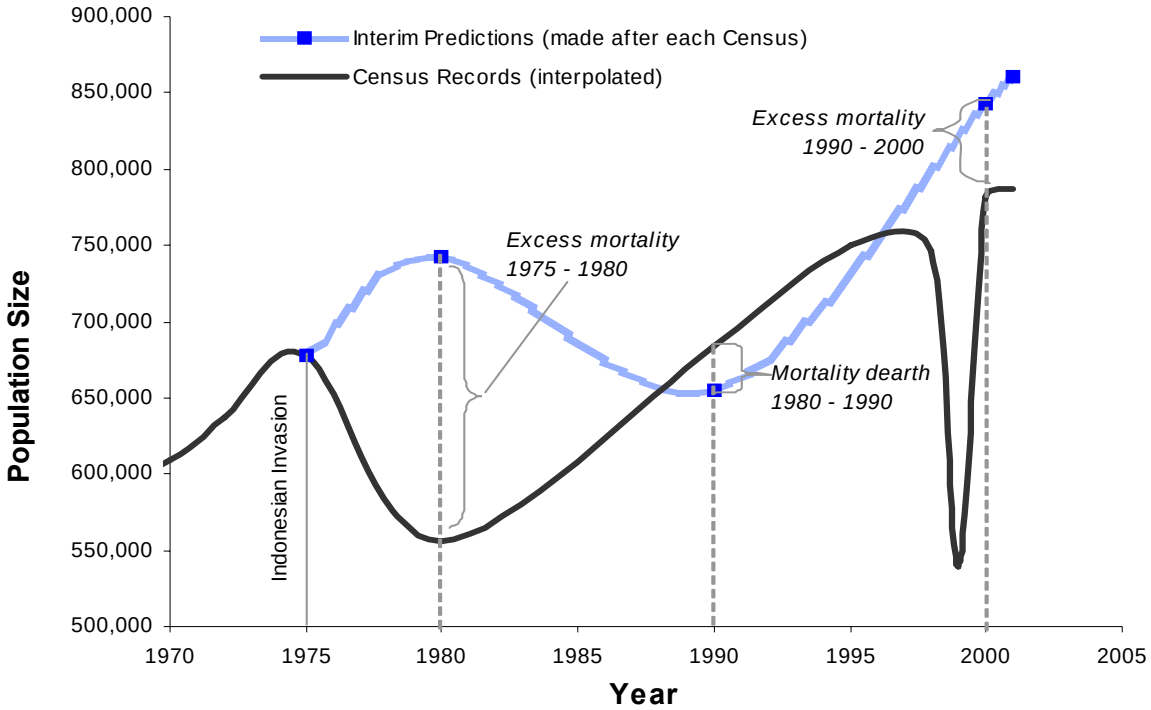
Sources: Census Data from Portugal Instituto Nacional De Estatistica 1970, 1972; Bagian Statistik Demografi 1980, 1985, 1990; Asian Development Bank 2002; and Author's calculations.

A growth-rate calculation done for the entire period is obviously problematic, however. During the past half-century, hardly any human population has experienced a period of 24 years with an unchanging annual rate of growth. Constant population growth requires a stable age structure, constant levels of in- and out-migration during the period, and constant age-specific fertility and mortality rates. East Timor fits none of these assumptions.

Given that there were Censuses in 1980 and in 1990, the above calculation can be improved upon by breaking down the 24-year period into smaller segments of time. Within each time segment, we can project the end population based on the recorded population at the beginning of the period and the growth rates of the previous period. In other words: given the recorded population in 1980 and the growth rate from 1975 to 1980, what population size would we expect to see in 1990? Figure 3 illustrates this method. At each dot, the difference between

the light blue line (projected) and the solid black line (recorded) gives the total excess mortality for the period. Summing the excess mortality from each period gives us a total estimate.

Figure 3 Census Data Compared with Interim Population Projections: East Timor, 1970 - 1999



Sources: Census Data from Portugal Instituto Nacional De Estatistica 1970, 1972; Bagian Statistik Demografi/ Indonesian Demographic Statistics Division 1980, 1985, 1990; Asian Development Bank 2002; Ministry of Health and National Statistics Office 2004; and Author's calculations.

According to Figure 3, the majority of excess deaths occurred from 1975 to 1980. In 1980 we would have expected 742,269 persons, about 187,000 more than were enumerated in the census. Interestingly, in 1990 our results are the opposite: we expected almost 30,000 *fewer* than were actually enumerated. This result could mean that there was a high fertility rate, additional in-migration,[15] lower mortality, or perhaps even that some population who fled to the forest, mountains, or out of the country between December 1975 and December 1980 returned to an area within East Timor that was enumerated during the 1990 Census. An equivalent difference between expected and actual population for 1999 ranges from 61,000 to 97,000, depending on the estimate of actual 1999 population used.

[15] Note, however, that this population total is only for people living in households headed by someone born in East Timor. Thus it factors out the vast majority of Indonesian trans-migration to East Timor during the decade.

Initial crude estimates based on growth rates from 1975 to 1999 suggested a maximum of 284,000 to 320,000 missing persons during the period. By breaking the period down into three smaller periods, growth rate estimates suggest that there were 219,000 to 254,000 missing persons from 1975 to 1999. These crude estimates based on growth rates provide a useful "upper bound" on excess mortality in East Timor during the Indonesian occupation. But they do not account for the changing age structure of the population nor do they allow us to examine the age and sex composition of the "missing" population.

III. Age-Specific Estimates of Excess Mortality

Fortunately we can achieve even more specific estimates of excess mortality by producing projections of population by age and sex. These age- and sex-specific projections have two major advantages over the simplistic total population estimates produced above. First, they take into account the ways in which changing age structure produces different composite fertility and mortality levels over the period, even when age-specific rates remain the same. Second, age- and sex-specific projections help us to distinguish between two types of excess mortality: deaths to the initial population alive on December 6, 1975 (who would be 25 years old or more if they survived to December 31st, 1999) and second, deaths to the arriving population during the period. The former estimates are generally more reliable than the latter, because we know that "missing" persons age 25 and above in 1999 either died, migrated outward, or were not enumerated in the second census. With the population of incoming births (those age 23 and below[16] in 1999), however, it is impossible to distinguish between child deaths and children not born (due to reduced fertility rates) from Census data alone.[17]

For these reasons, demographers prefer to use a *Leslie Matrix* to project populations. A Leslie Matrix employs age-specific mortality and fertility rates to provide a transition matrix that is more precise than a simple projection based on population growth rates (Wachter 2002). Appendix A provides detail about Leslie Matrix calculations. Estimates of the current population (expressed as vectors) can be multiplied by the matrix to produce new population vectors.

[16] Technically there is a small population of persons born between December 7, 1975 and December 31, 1975 who would also be 24 years old on December 31, 1999, but for simplicity we set an exact age cutpoint.

[17] The same would usually be true for immigrants as well: it would be difficult to distinguish whether they never arrived or whether they arrived and died before the census, except that in East Timor, the later surveys distinguish between household heads born in East Timor and those born elsewhere. This paper limits its mortality estimates to the native Timorese population wherever possible, so in-migrants are not a major concern.

To make use of all existing information, we break the calculation of excess deaths down into several time periods (as determined by the available data). Each time period can provide us with an estimate of excess deaths that we can sum to approximate the total excess deaths during the entire 1975 – 1999 period. First we explore the starting population. Then, using narrative historical information and Leslie matrices, we estimate excess mortality from December 7, 1975 to 1980; from 1981 to 1990; and from 1991 to December 31, 1999.

How big was the Population of East Timor on December 6, 1975?

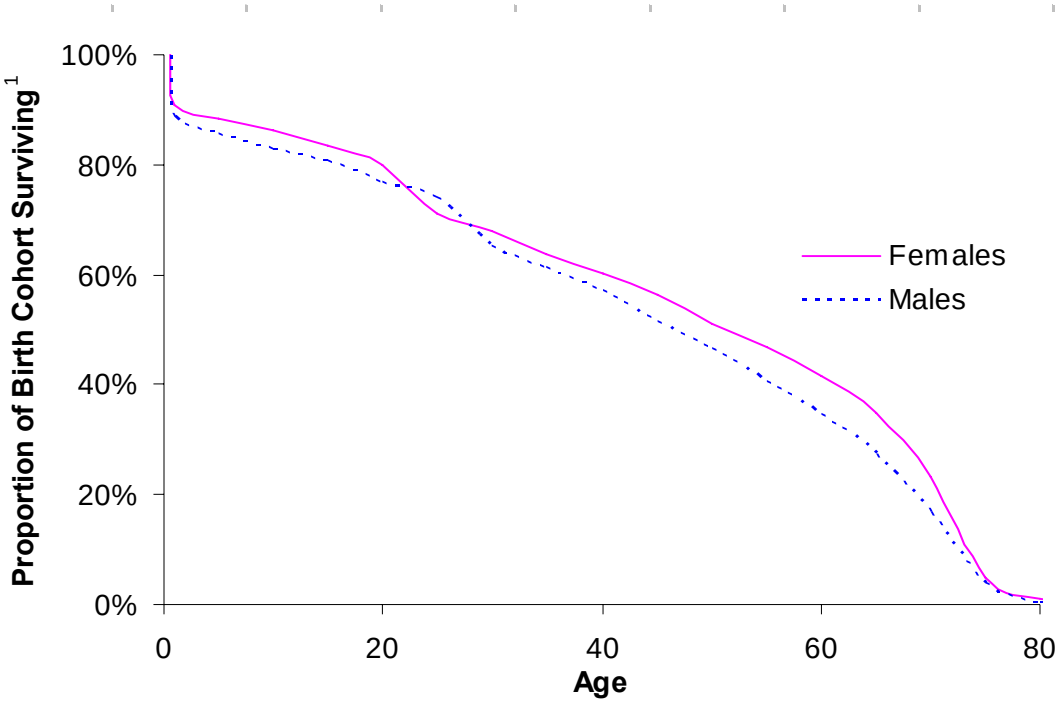
The population of East Timor on December 6, 1975, is one of the most important calculations in this estimation process. Error in the initial estimation will be further exacerbated over time by the application of population growth rates. Even though projecting the December 1970 population forward by 5 years seems relatively straightforward, there are questions about the reliability of the 1970 number. The Portuguese collected a poll tax during each census and hence all of their population counts were likely to have been understatements (Cribb 2001). What Cribb does not mention, however, is that undercounting the 1975 population will make excess mortality counts more *conservative* if later censuses are better-enumerated. Hence we rely on the Portuguese numbers.[18]

Projecting forward from the June 1972 estimate to a December 1975 with a Leslie matrix is problematic because Leslie matrices deal with whole years. Growth rates can easily be multiplied by fractions of a year, but it is not possible to multiply by fractions of a Leslie matrix. Therefore we produce a five-year Leslie Matrix from which to project the December 1970 population forward to December 1975. The December 1970 population counts are given in Appendix Table C-1.

The Portuguese Statistics institute provides age-specific mortality rates from 1972 (Portugal Instituto Nacional De Estatistica 1985). Age-specific mortality rates are displayed as survival probabilities in Figure 4. Equivalent life expectancies are 43.3 years for males and 46.7 years for females. Interestingly, the male survivorship probability rises above that for females in the early twenties, a phenomenon likely due to high rates of maternal mortality during that period.

[18] There was a survey done by the Catholic Church in 1974 and one done in 1978 by the Indonesian army, but these population counts are also thought to be flawed (Hull 2003).

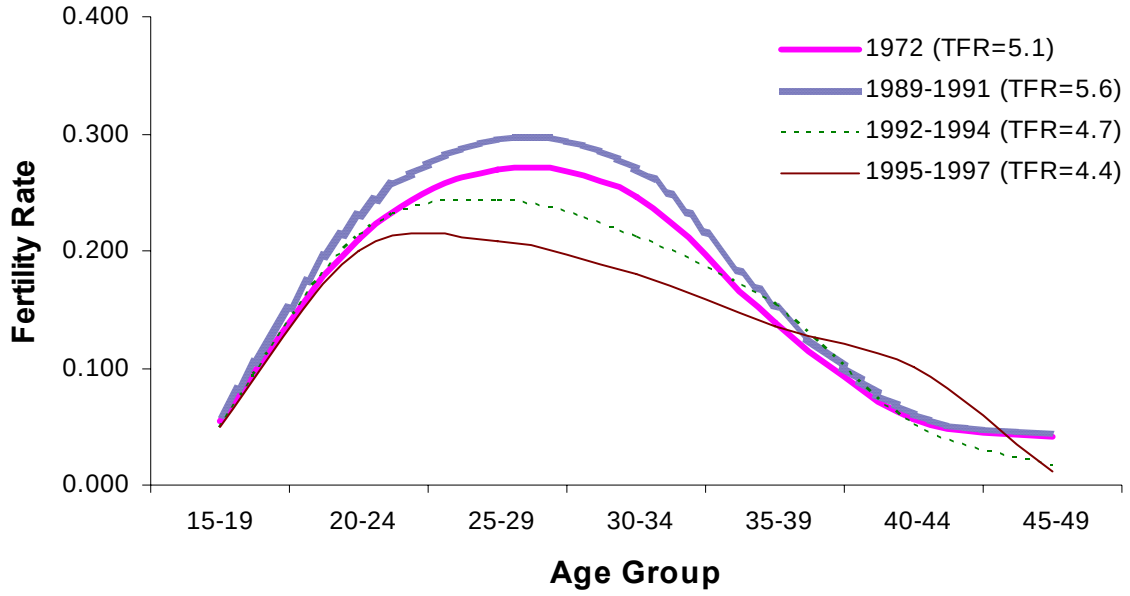
Figure 4 Cohort Survivorship, 1972



1. Proportion of birth cohort surviving *if* 1972 mortality rates held constant throughout the life course.
Source: *Portugal Instituto Nacional De Estatistica* , 1985.

The Portuguese Institute of Statistics estimates that in 1972 East Timor's total fertility rate (TFR) was 5.1 births per woman over her lifetime (1985). Unfortunately it does not provide any information on what the age-specific rates are. We relied on age-specific fertility rates from the East Timor sample of the 1991 Demographic and Health Survey (Central Bureau of Statistics Indonesia et al. 1992) to obtain a probable distribution of age-specific fertility rates in 1972. We obviously cannot be certain that the distribution was the same in the 1972, but the total fertility rates were quite close (5.1 in 1972 and 5.6 in the 1991 DHS), which suggests that there probably was *not* a dramatic shift in the age pattern of fertility from 1972 to 1991. Interestingly, these figures suggest that there was actually an *increase* in fertility during the period. It is not known whether this represents an actual increase or whether sampling, enumeration, and other methodological difference between the DHS and Portuguese statistics can explain the discrepancy. Nonetheless, the higher fertility rate from the 1991 DHS indicates that the 1972 fertility rate of 5.1 is likely a conservative estimate. Figure 5 shows age-specific fertility rates ($_nF_x$) for East Timor in 1972, as well as comparable DHS estimates from 1991, 1994 and 1997.

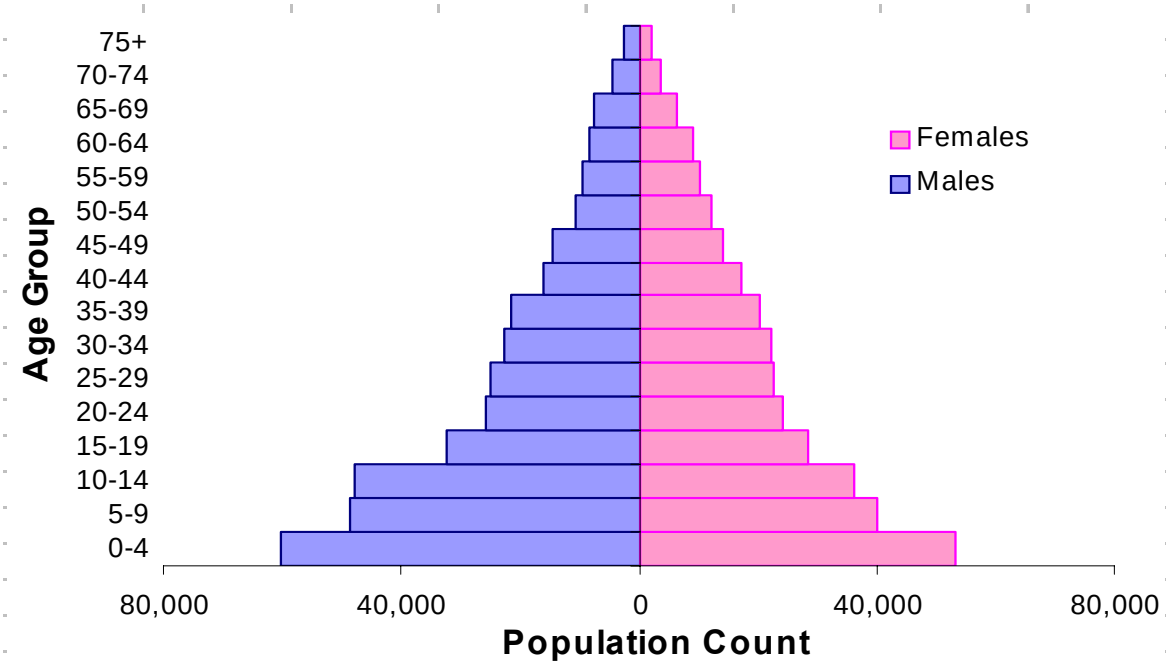
Figure 5 Age-Specific Fertility Rates, East Timor, 1972 - 1997



Source: Indonesia Demographic and Health Survey 1991, 1994, 1997; Portugal Instituto Nacional de Estatistica 1985
Note:1972 fertility rates were assumed to follow the same age pattern as fertility rates from 1989-91.

Based on the age-specific fertility and mortality rates in 1972, we calculate a five-year-wide Leslie Matrix (see Appendix B). The December 1970 population can be multiplied by our Leslie Matrix to produce an estimate of age-specific female population counts in December of 1975. But first we have to take into account the thousands of refugees who fled from East to West Timor in early 1975 due to fighting between *Fretilin* and *UDT*. It is estimated that as many as 3,000 persons (largely former *UDT* combatants and their families) fled to Indonesian Timor before the Indonesian invasion, and that an additional 2,500 emigrated to Australia (Lawless 1976). The literature suggests that at least 1,500 (Kiernan 2003) and at most 13,000 (Hull 2003) were killed during the conflicts between Fretilin and UDT. I approximate that from these sources the population lost an estimated 10,000 persons prior to the 1975 invasion. Thus my revised estimate of the 1975 population is 648,730. This estimate is near to Kiernan's suggested range of 652,250 to 707,500 persons alive immediately prior to the Indonesian invasion (2003). We don't have any information on the age or sex of pre-invasion refugees, so we reduce our counts of all population age and sex groups proportionately. The resulting population pyramid for 1975 is shown in Figure 6 (corresponding counts are given in Appendix Table C-2).

Figure 6 Age Pyramid of East Timor, December 1975

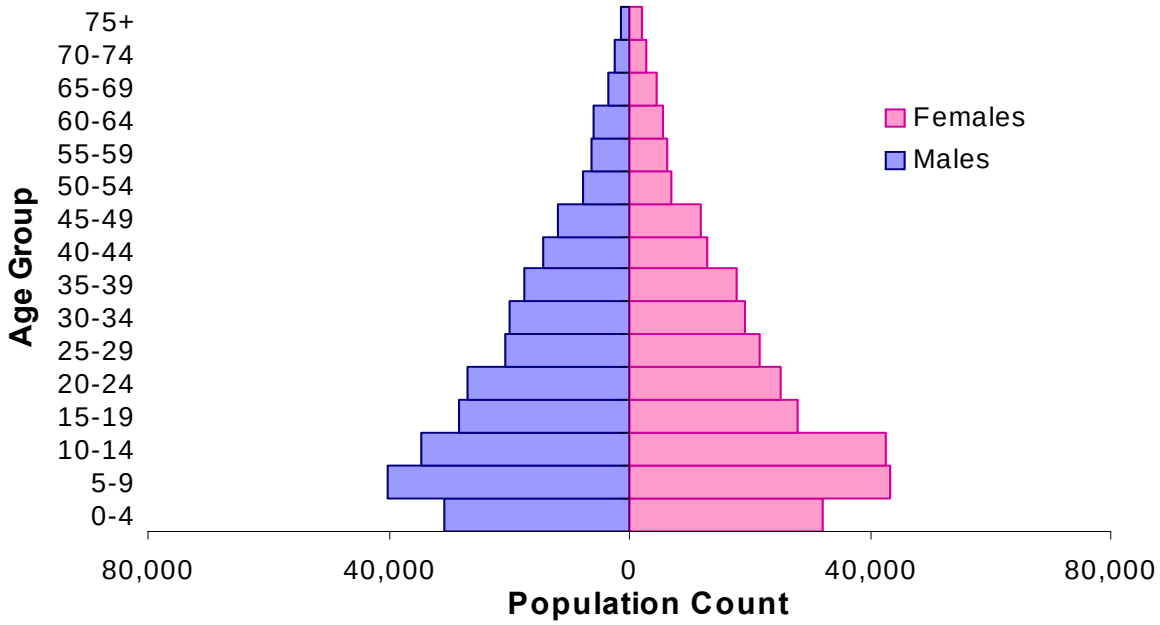


Source: Author's calculations.

The 1975 – 1980 period

In 1980, the Indonesians conducted a census of East Timor and counted 554,721 persons (age and sex breakdowns given in Appendix Table C-3). Given that this total is lower than the estimated 1975 population total, it is clear that there was substantial out-migration, severe under-enumeration, or excess mortality during the time period. However it is useful to produce an age-sex count estimate to see where the missing persons are concentrated. The age and sex structure of the recorded 1980 population is shown in Figure 7. In the absence of additional information about fertility and mortality during the 1975 to 1980 period, we can simply use our Leslie matrix from previous estimates to project the expected 1980 population. We multiply our 1975 population vector by the five-year Leslie Matrix shown in Appendix B. Assuming the sex ratio holds constant from 1970 to 1980, we estimate an expected 1980 population of 710,819 persons (see Appendix Table C-4 for expected population age and sex breakdowns). The estimate implies that excess mortality from 1975 to 1980 was circa 156,000 people, or 28% of the original 1975 population.

Figure 7 Age Pyramid of East Timor, December 1980



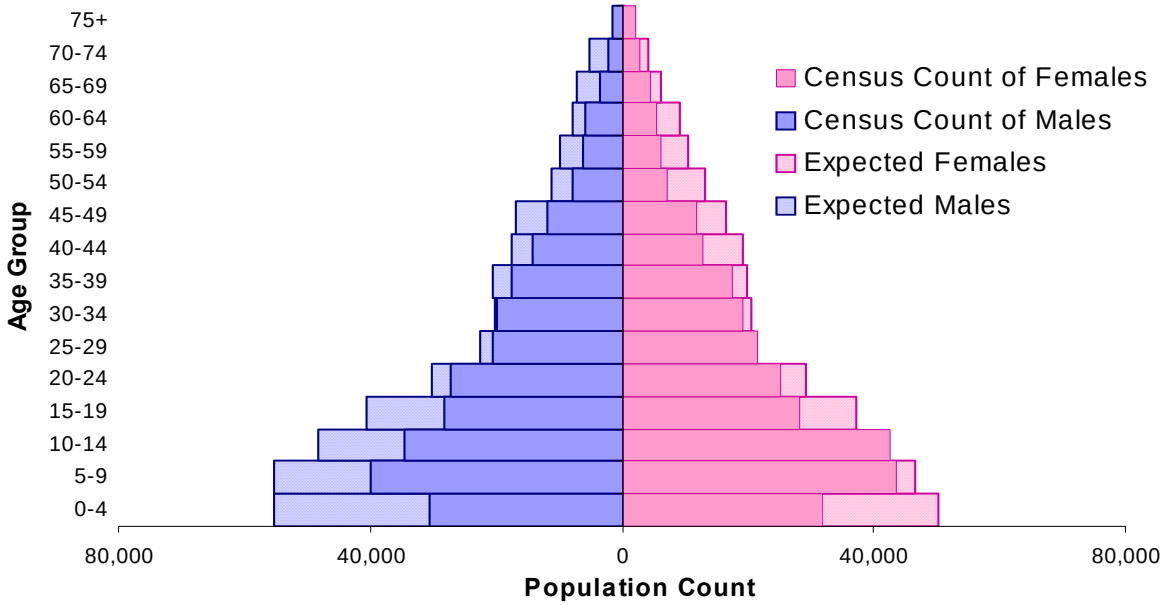
Source: Bagian Statistik Demographi [Indonesian Demographic Statistics Division], 1980.

How reliable is our estimate? Indonesian church sources reported 60 to 100 thousand deaths immediately following the invasion (Walsh 1981). Cribb (2001) claims at most 50,000 were killed by Indonesian forces and an additional 50,000 died of starvation or disease brought about by the occupation. Kiernan (2003) puts the death toll at 120,000 during this period. Others have claimed that 200,000 is more appropriate (Crossette 1994; Amnesty International 1997). Given the large rates of internal displacement, it is possible that thousands of survivors were not enumerated during the 1980 Census. Additionally, given the antagonistic relationship between East Timorese and Indonesians, many may have hid during Census counting. Under-enumeration would artificially inflate our estimate of excess mortality. Yet at the same time, Indonesia also had a major incentive to inflate its population count of East Timor in order to cover up the real number killed. Moreover, since the Portuguese estimates are also thought to be undercounts, the Indonesian undercount would have to be quite severe to inflate the count of excess mortality.

It is estimated that 30,000 people left the territory between the 1975 invasion and 1979 (Anon. 1979). But by 1979, the majority of internally displaced people who had fled into the mountains and jungles reappeared (Anon. 1979). Additionally, there was a massive famine in the late 1970s (Sherlock 1996). Kiernan (2003) and Cribb (2001) consider the 1980 Indonesian estimate carefully and determine it to be the most reliable available.

Because of our age- and sex-specific prediction of the 1980 population, we can analyze the groups most affected by excess mortality. Data for adults were grouped into ages 25 to 49, and age 50 plus. In order to examine 5-year age intervals, we interpolate the age distribution of adults (the resulting expected population counts for 1980 are given in Appendix Table C-3). Figure 8 shows the difference between the actual 1980 population in East Timor and the projected population.

Figure 8 Expected versus Reported Population, East Timor, 1980



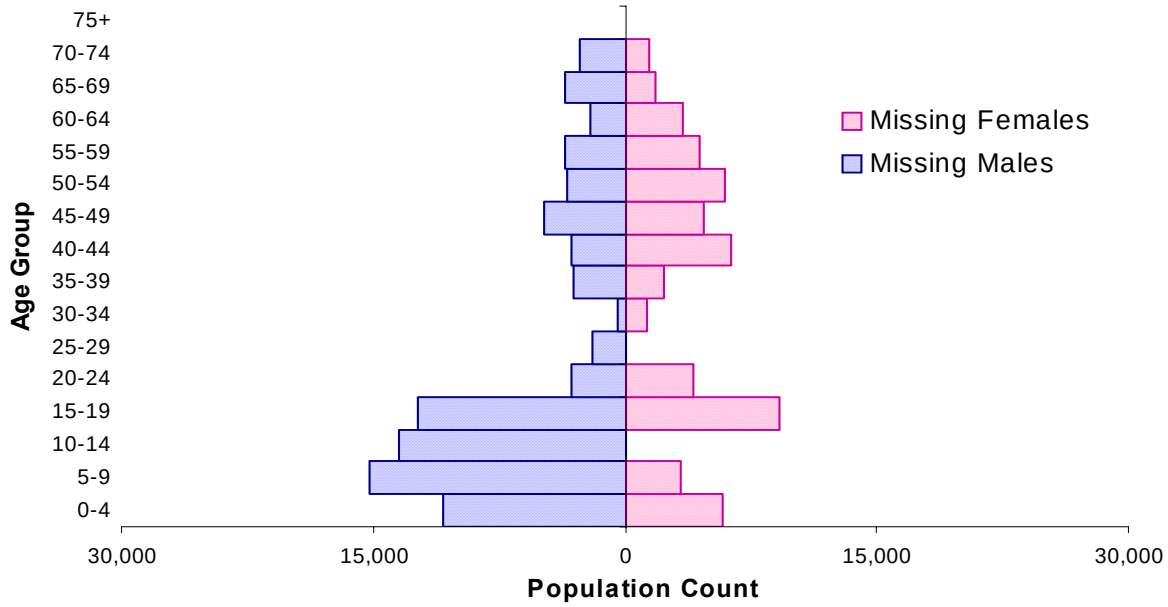
Note: Reflects original (unadjusted) fertility rate.
Source: Author's calculations.

Males have higher rates of excess mortality during the period, particularly those under the age of 20. Persons above age 50 have higher rates of excess mortality than middle-aged adults. Infants appear to be the most heavily affected group of all, accounting for nearly one-third of the estimated excess mortality from 1975 to 1980. Is this realistic? Infant mortality tends to be quite high during wartime (Urdinola 2004), so it's possible that this is a correct estimate of what actually happened. However as Cribb (2001) argues, the more likely scenario is that there was a drop in fertility from 1975 to 1980. It seems highly plausible that fertility would have declined during the 1975-1980 period, due to the high rates of internal displacement, the resulting breakup of families, food shortages, and lack of housing space. (Of course we could also imagine that during a time of war, family planning methods are haphazard, rape is more common, and hence

fertility rates are higher). Yet estimating that one-third of presumed deaths are due solely to infant mortality seems implausible. Therefore it seems wise to reduce the fertility rate used in our projections by 25%.[19]

When we reduce the fertility rate downward by 25% at all ages, our new prediction of the 1980 population is 684,415. Our prediction of all other age groups remains the same as before, only this time the projected infant population is 79,000 instead of 102,000. Now, the overall excess mortality is nearly 130,000 persons. This is more in line with the estimates of excess mortality during the period produced by other scholars. Although it is possible that this excess mortality estimate is high due to an under-enumeration in the 1980 census, it is unlikely that this was due to much higher migration than expected. The groups most impacted by mortality during the 1975 – 1980 period were the young and the old, the two groups least able to migrate on their own. These are also the two groups most vulnerable to disease and starvation. Figure 9 shows the final estimate of the age structure of East Timor's "missing" population in 1980.

Figure 9 Age Structure of "Missing" Population, 1980, East Timor



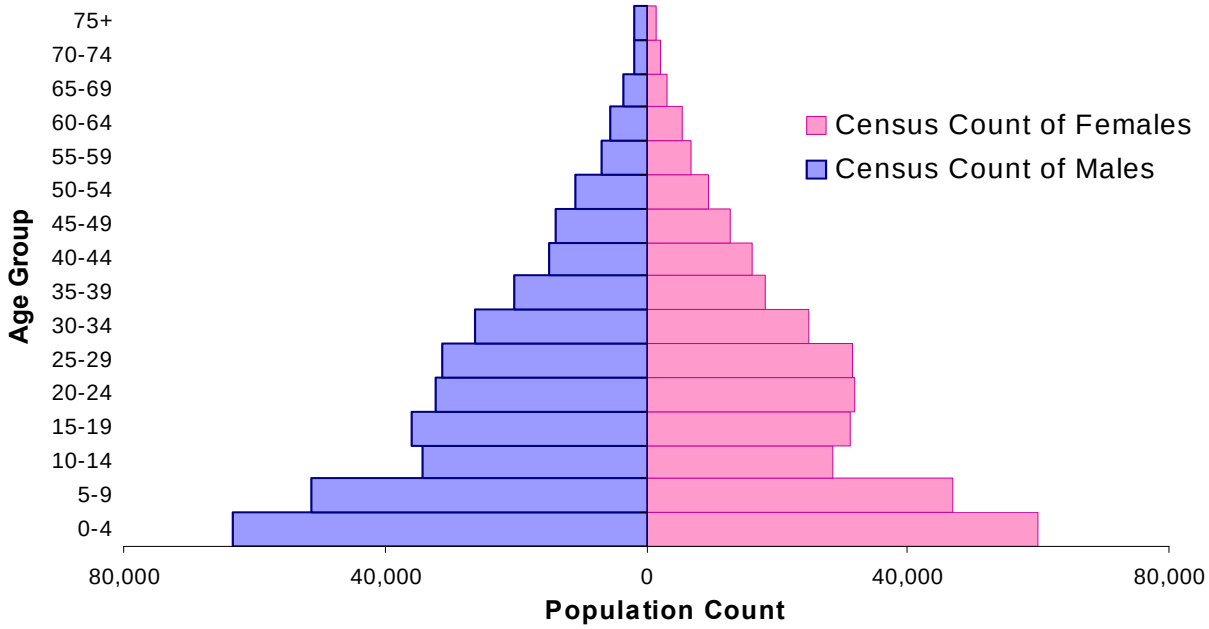
Note: Fertility at all ages reduced by 25% to reduce discrepancy betw een expected / actual 0-4 year olds.
Source: Author's calculations.

[19] This reduction is based on the patterns of excess mortality shown in the older population, and on the fact that a fertility decline could only really take effect 9 months after the invasion. Future versions of this paper will conduct a "sensitivity analysis" on various assumptions.

The 1981 – 1990 period

We can use similar techniques as above to estimate the excess mortality from 1981-1990. According to the Indonesian census, there were 684,202 persons living in households headed by a native of East Timor in 1990. An age pyramid of the recorded 1990 population is given in Figure 10 (census counts by age and sex are shown in Table C-5). As before, we have very little information about the reliability of these data, and there are good reasons to believe that East Timorese may have avoided Census enumerators, but also that Indonesians may have been tempted to overstate population totals in order to deflect attention to their annexation.

Figure 10 Age Pyramid of East Timor, December 1990

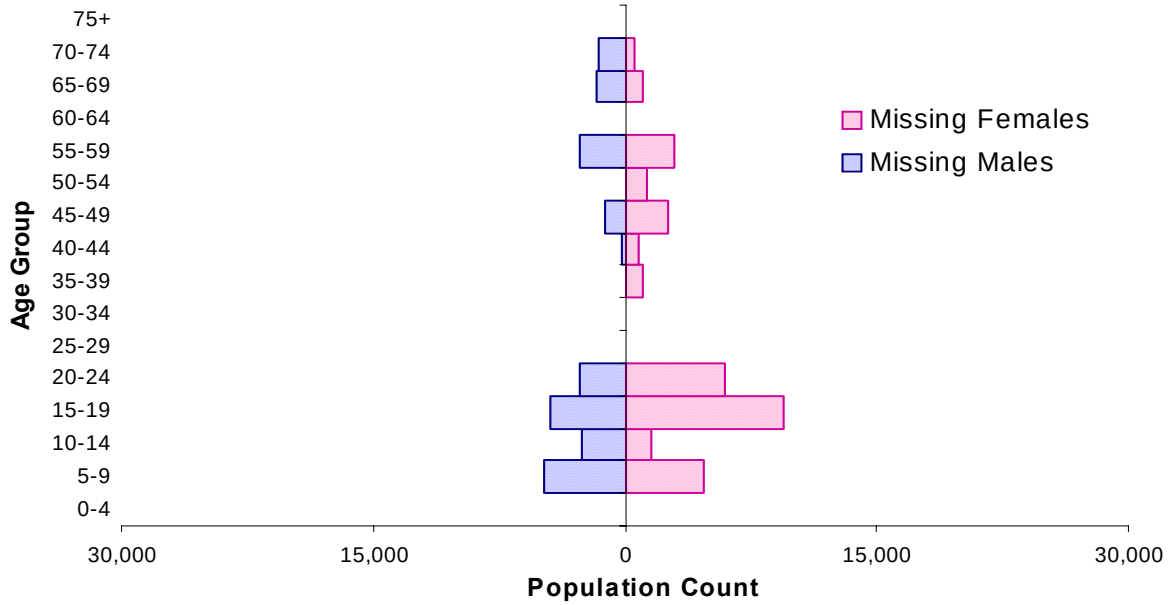


Source: Bagian Statistik Demografi [Indonesian Demographic Statistics Division], 1990.

There was no new publicly available information on mortality rates from 1981 to 1990, except DHS's publication of infant and child mortality rates in its 1991 survey (these are said to cover the previous ten years, so we use them for the entire decade from 1981 to 1990). Fertility data is also available from the 1991 DHS, but it is only for the three-year period prior to the survey. We therefore average the 1972 and the 1991 age specific fertility rates to produce an estimated 1990 population total (see Appendix Table C-6). Our projected 1990 population suggests an overall excess mortality of 27,499 for the entire decade. The age structure of "missing" persons in 1990 is shown in Figure 11. The missing population is concentrated among persons aged 5 to 24 and among persons aged 45 to 59. Interestingly, women were affected

more than men. There was a massive Indonesian Trans-migration program that brought thousands to East Timor, but this should not have had any substantial effect on the results shown above because we considered only persons in households headed by a native East Timorese.

Figure 11 Age Structure of "Missing" Population, 1990, East Timor



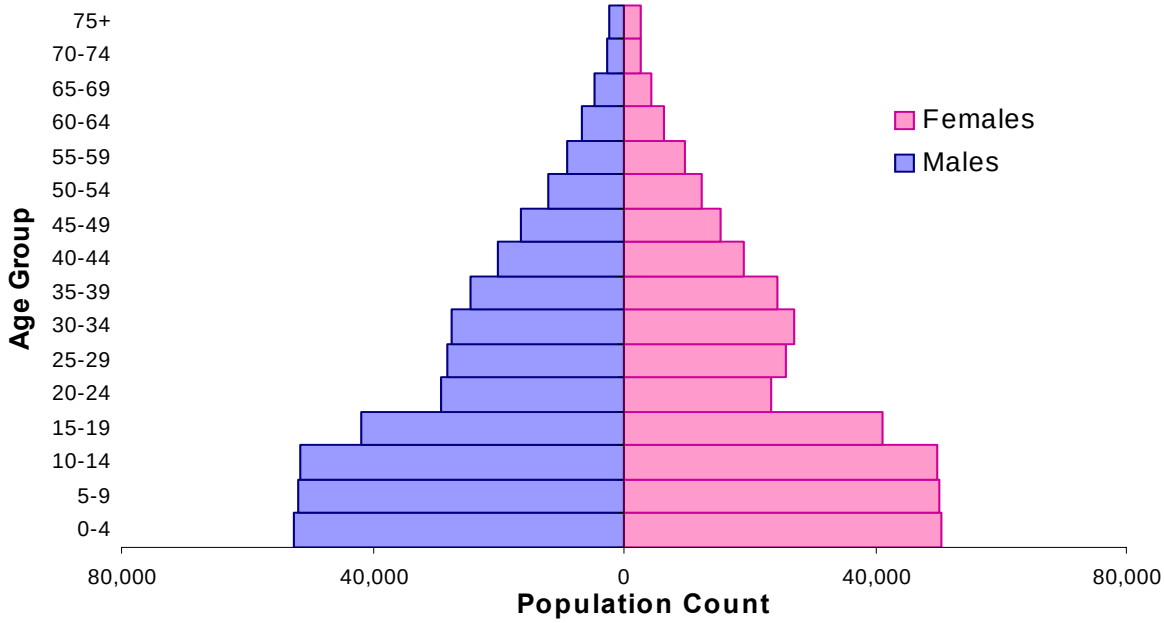
Source: Author's calculations.

The 1991 – 1999 period

Estimation of mortality during the 1991-1999 period is slightly more difficult due to the large-scale migrations which took place toward the end of the period. Following the August 1999 referendum and its subsequent violence, hundreds of thousands fled into West Timor (Stahn 2001). Many returned in a short amount of time after the United Nations stabilized the situation. The United Nations estimates that eventually, 90% of the 250,000 East Timorese who sought refuge in West Timor during 1999 were successfully repatriated into East Timor (Dolan, Large, and Obi 2004). By December of 2000, at least 200,000 persons, or 80% of the refugees, had been successfully repatriated into East Timor. Therefore we need to incorporate what we know about excess emigration during the period.

I computed "actual" and "expected" totals for 1999. The 2001 Suco survey estimated the total population as 787,338 persons.[20] Subtracting the additional 18,200 refugees who were repatriated in 2001, this means that for our purposes we should assume that there were 769,138 people in East Timor in December of 2001. Projecting this back to 1999 produced an estimate of 787,338 persons in East Timor on December 31, 1999.[21] I have not been able to obtain age and sex breakdowns from the 2001 survey. However, the U.S. Census' International Database contained Timor's population age structure in 2000.[22] Applying this age structure to the 1999 estimated population size of 746,263 persons produced the estimate shown in Figure 12 (see Appendix Table C-7 for detailed counts).

Figure 12 Age Pyramid of East Timor, December 1999



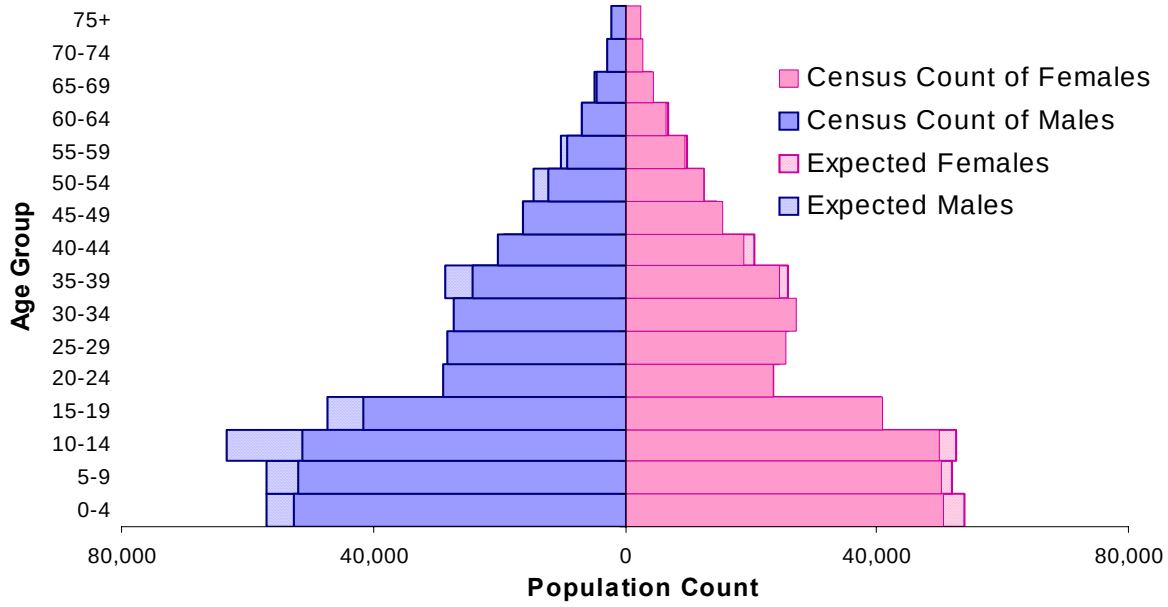
Source: Author's calculations.

Based on the recorded 1990 population and age-specific fertility rates, I calculated an expected population of 833,043 persons in 1999 (see Appendix Table C-8). From this we subtract approximately 50,000 out-migrants who had not yet returned. The final difference

[20] A total population count of 924,642 is also available from the 2004 East Timorese census (Direcção Nacional de Estatística de Timor-Leste 2005) – however it has not yet been released what percent of the population are non-native Timorese, nor what the age structure of the population is. Therefore I don't use it in this paper.
[21] As noted earlier, using the small population growth rate when projecting backwards will produce a more conservative estimate of excess mortality.
[22] I did not use the actual totals given by the U.S. Census Bureau, as they do not appear to have taken migration into account. (They may have included refugees living outside the country in their totals, but it is not clear.)

between the actual and expected population is 26,780 persons. A comparison of the 1999 expected population and the 1999 estimated population is shown in Figure 13

Figure 13 Expected versus Reported Population, East Timor, 1999



Source: Author's calculations.

IV. Conclusions

As would be expected, the age and sex specific projections in section III produced smaller estimates of excess mortality than did the growth rate projections in section II. Whereas growth-rate estimates calculated between 219,000 and 320,000 excess deaths during the 24-year period, the projections based on leslie matrices estimated 184,000. The leslie matrix projections are likely more accurate for four reasons. First, by using age-specific fertility and mortality rates, they account for the naturally-changing age structure during the period. Second, these fertility rates were adjusted to keep pace with the changes in births per woman during the period. Third, a substantial portion of persons who died in the early part of the Indonesian invasion were at or under childbearing age. Many of these victims would have produced offspring in the remaining years of Indonesian occupation. A growth rate calculation can double and triple count these "missing" persons by assuming their future offspring were born, when in fact these children were never conceived. Leslie matrices help reduce this error by applying age-specific fertility rates to the population alive at the beginning of each 5- or 10-year interval. Finally, the ability to tabulate "missing" persons by age and sex helped pinpoint likely sources of error in the aggregated

estimates. For example, it appeared that there were far too many infant deaths between 1975 and 1980 (one-third of the total), so I was able to lower the assumed fertility rate immediately following the invasion.

As Table 2 shows, excess mortality was primarily concentrated in the first five years of occupation. From 1975 to 1980, there were nearly 130,000 net "missing" persons, or 70% of the total for the entire 24-year period. The final decade of occupation seemed to produce the same number of net missing persons (27,000) as the previous decade, despite all of the reports of mass violence following the 1999 elections. Perhaps this indicates that violence was fairly consistent throughout the latter two decades of Indonesian occupation, or perhaps the 1999 estimates of excess mortality were decreased by the mass return of migrants and refugees after 1999 who had previously lived in exile.

Table 2 also indicates, however, that the figure of 184,000 missing persons is a net total. While most age groups in each projection showed excess mortality, there were also age groups which showed an unexpected population increase. These increases may be due to returning migrants, lower-than-expected death rates, over-enumeration and other factors. When we separate out groups where there were a net number of persons "missing" and groups where there was a net unexpected population increase, we can obtain a better upper-bound on the number of missing persons during the period. There may have been as many as 229,000 missing persons during the entire period if we count only age groups where there were fewer persons than expected. However, the unexpected "additional" 45,000 persons should not be dismissed entirely. The presence of additional persons may indicate that there was return migration during the period, that there are errors in the assumed mortality and fertility rates, or that some Indonesian settlers were counted among the native Timorese population.

It is useful to examine what percent of missing persons came from the original population that was enumerated during the previous census. Missing persons in age groups previously enumerated by a census are more certain to be excess deaths than missing persons among the population of assumed births during the period. For example, in 1990, age groups ten and older were enumerated in the 1980 census, so abnormal "disappearances" during the intercensal period are far more likely to be excess deaths than they are for children under the age of ten, who may have not even been born during the period. Table 2 shows that the percent of missing persons

from previously-enumerated populations range from 67% to 82% during the period. Thus only a small part of the estimated excess deaths could be driven by erroneous fertility rates.

My best estimate of excess mortality in East Timor during the Indonesian occupation is 184,000 persons (± 34,000), or 28% of the 1975 population[23] either due to direct violence or else indirectly, perhaps as a result of hardships encountered when they hid from or were forcibly displaced by the Indonesian army. 220,000 is likely a high estimate of deaths because the number of "missing" persons is likely to contain at least a small number of non-deaths (migrants, non-births, and persons not enumerated in later censuses). If we also take into account the net "excess" persons during the period, and assume that under-enumeration was larger than expected due to the massive numbers of people in hiding during the Indonesian occupation, then our estimate of excess deaths might be as low as 150,000 during the entire 24-year period.

Interestingly, Indonesian apologists who point to the massive financial investment Indonesia made in Timorese infrastructure and population (for example, Sherlock notes that Indonesians built far more schools during their 25 years of rule of East Timor than did the Portuguese during 400 years of colonialism) and the likely resulting decreases in "natural" mortality would actually have far more excess deaths to account for than others. This is because if Timorese mortality due to "normal" circumstances was in any way decreasing during the period, then projected population totals would have been much higher, along with the counts of missing persons.

The data available for calculating estimates during this historical period were not ideal, and we cannot be certain of their precision. However, we do believe this to be the best approximation of deaths possible from Census data alone. When combined with the robust statistical estimates from HRDAG (Silva and Ball 2006) which found that 102,800 (± 12,000) East Timorese died due to causes related to the Indonesian occupation, the evidence is simply overwhelming. It is likely that the figure of 102,800 (± 12,000) deaths is a lower-bound estimate, and 184,000 (± 34,000) is an upper bound estimate.

[23] This percentage is provided as a point of reference, even though the 184,000 excess deaths were not all to persons alive in 1975.

Table 2 Expected versus Reported Population, East Timor, 1975-1999

Period	Beginning (Recorded) Population	End (Recorded) Population	End Expected Population[1]	**Net Difference between Projected Population and Recorded Population**		"Missing" Persons[2]		Unexpected "Additional" Persons[3]	Percent of "Missing" from original period population[4]
1975-1980	648,730	554,721	684,415	**-129,694**	=	-132,112	+	2,418	73%
1981-1990	554,721	684,202	711,701	**-27,499**	=	-52,210	+	24,712	82%
1991-2000	684,202	746,263	773,043	**-26,780**	=	-44,540	+	17,761	67%
TOTAL				**-183,973**		**-228,863**		**44,891**	

Notes

1. Based on a projection done with recorded population at the beginning of the period and interpolated fertility and mortality rates.
2. Sum of age groups where expected population was less than actual population.
3. Sum of age groups where expected population was *more* than recorded population (unclear whether this was due to immigration, lower mortality rates, higher fertility rates, or census error)
4. For example, in 2000, what percent "missing persons" were age 10 and above? These are more certain to be excess deaths, because this population was enumerated in the 1990 census. "Missing" persons under age 10 in 2000 could be expected births that didn't happen.

Source: Authors' calculations from official censuses and fertility / mortality records.

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Appendix A: Leslie Matrices

A Leslie Matrix projects a population in steps that are equal to the width of its age intervals—for example, a population in five-year age groups can be projected five years ahead. We have five-year age groups and rates, but unfortunately because we want to project from 1972 to 1980 it will be necessary to convert our age groups and rates into age intervals that would allow us to project directly to 1980. In this analysis we employ five-year age intervals, which align perfectly with the dates of interest.

A Leslie Matrix is a transition matrix which is multiplied by a vector of single-sex population totals by age group to produce an age-disaggregated estimate of the single-sex population in the following period. The matrix uses single-sex mortality and fertility rates (usually for women) because fertility rates are very difficult to ascertain on a combined-sex basis. Using the ratio of women to men in the total population, this new estimate of the female population can be easily converted into a hypothetical total population estimate. The Leslie Matrix does not factor migration into account; it assumes a closed population. Migration rates can of course be added in later. According to the 1970, 1971, 1972, and 1973 Portuguese censuses, the migration in and out of East Timor were nearly equal. Hence, in the absence of additional information about migration, we assume that net migration was zero during the period.[24]

A Leslie Matrix has a top row which projects fertility and a sub-diagonal which projects survivorship (Wachter 2002). The rest of the entries in the matrix are "structural zeroes," since transitions between these groups during the time interval are impossible. Each column corresponds to an age group in the current population, while each row corresponds to an age group in the projected population, as shown in Figure A-1.

[24] All available information suggests that the vast majority of displaced persons stayed in East Timor and hid in the mountainous areas.

Figure A-1 Leslie Matrix

	0 to 1	2 to 3	4 to 5	6 to 7	…..
0 to 1	kids	kids	kids	kids	.....
2 to 3	survivors	0	0	0	
4 to 5	0	survivors	0	0	
6 to 7	0	0	survivors	0	
8 to 9	0	0	0	survivors	
…..	.....				

Note: The entries in the top row of a Leslie Matrix will be all zeroes until a column corresponding to a childbearing age group is reached. However for illustrative purposes we include "kids" in the top row above.

It is common to refer to $A_{i,j}$ as being the entry in the i^{th} row and j^{th} column of our Leslie Matrix. As shown above, all of the entries in the matrix will be structural zeros except for the first row and the subdiagonal. If we assume that ${}_nL_x$ is the female cohort person-years lived from age x to age x+n in a hypothetical life table computed using current period age-specific mortality rates and ${}_nF_x^{dau}$ is the female fertility rate from age x to x+n for daughters only,[25] then the formula for the j^{th} column of the first row is given by the following formula:

$$A_{1,j} = \frac{{}_nL_0}{2l_0} \cdot \left({}_nF_x^{dau} + {}_nF_{x+n}^{dau} \cdot \frac{{}_nL_{x+n}}{{}_nL_x} \right)$$

This formula allows for the fact that some women in the current age group of interest will not survive through the four-year period to bear children, and that the older women in the current age group of interest will spend most of their four-years exposed to the next age group's fertility rate. The formula also accounts for the fact that some births will not survive until the end of the four-year period.

The sub-diagonal of the Leslie matrix (an entry in $A_{j+1,j}$) is more straightforward. It simply represents survivorship among women in the current age group as they transition to the next age group. Its formula is given as:

$$A_{j+1,j} = \frac{{}_nL_{x+n}}{{}_nL_x}$$

[25] This is derived from the total female age-specific fertility rate multiplied by .4886, an internationally-used definition for the fraction of births which are female (Wachter, 2002).

Appendix B: Leslie Matrix used for Projections from 1970 to 1980

	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75+
0-4	0	0	0.059	0.276	0.509	0.561	0.419	0.212	0.104	0.045	0	0	0	0	0	0
5-9	0.96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-14	0	0.97	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-19	0	0	0.962	0	0	0	0	0	0	0	0	0	0	0	0	0
20-24	0	0	0	0.924	0	0	0	0	0	0	0	0	0	0	0	0
25-29	0	0	0	0	0.922	0	0	0	0	0	0	0	0	0	0	0
30-34	0	0	0	0	0	0.949	0	0	0	0	0	0	0	0	0	0
35-39	0	0	0	0	0	0	0.939	0	0	0	0	0	0	0	0	0
40-44	0	0	0	0	0	0	0	0.938	0	0	0	0	0	0	0	0
45-49	0	0	0	0	0	0	0	0	0.924	0	0	0	0	0	0	0
50-54	0	0	0	0	0	0	0	0	0	0.911	0	0	0	0	0	0
55-59	0	0	0	0	0	0	0	0	0	0	0.902	0	0	0	0	0
60-64	0	0	0	0	0	0	0	0	0	0	0	0.868	0	0	0	0
65-69	0	0	0	0	0	0	0	0	0	0	0	0	0.762	0	0	0
70-74	0	0	0	0	0	0	0	0	0	0	0	0	0	0.641	0	0
75+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.15	0

Appendix C: Detailed Population Figures

Table C-1: Reported Population by Five-Year Age Group, East Timor, 1970

Age group	Females	Males	Total
0-4	39,765	43,626	83,391
5-9	39,854	47,147	87,001
10-14	32,768	42,428	75,196
15-19	24,522	26,695	51,217
20-24	23,521	24,442	47,963
25-29	22,394	24,150	46,544
30-34	21,636	21,407	43,043
35-39	19,094	19,743	38,837
40-44	15,531	14,250	29,781
45-49	13,003	13,144	26,147
50-54	11,566	9,851	21,417
55-59	9,434	8,666	18,100
60-64	8,820	7,768	16,588
65-69	5,385	6,212	11,597
70-74	3,461	4,042	7,503
75+	2,278	2,873	5,151
TOTAL	**293,031**	**316,446**	**609,477**

Source: Portugal Instituto Nacional De Estatistica 1970

Table C-2: Estimated Population by Five-Year Age Group, East Timor, 1975

Age group	Females	Males	Total
0-4	47,833	52,478	100,311
5-9	37,676	44,571	82,247
10-14	38,182	49,438	87,620
15-19	31,054	33,805	64,859
20-24	22,309	23,183	45,492
25-29	21,349	23,023	44,372
30-34	20,926	20,704	41,630
35-39	20,011	20,692	40,703
40-44	17,638	16,183	33,822
45-49	14,128	14,281	28,409
50-54	11,668	9,938	21,606
55-59	10,275	9,438	19,713
60-64	8,066	7,104	15,170
65-69	6,619	7,636	14,255
70-74	3,397	3,968	7,365
75+	511	645	1,156
TOTAL	**311,904**	**336,827**	**648,730**

Source: Author's calculations

Table C-3: Reported Population by Five-Year Age Group, East Timor, 1980

Age group	Females	Males	Total
0-4	32,021	30,579	62,600
5-9	43,436	40,005	83,441
10-14	42,523	34,731	77,254
15-19	28,078	28,215	56,293
20-24	25,078	27,063	52,141
25-29	21,651	20,576	42,227
30-34	19,192	19,880	39,072
35-39	17,700	17,545	35,245
40-44	12,776	14,270	27,046
45-49	11,784	11,948	23,732
50-54	7,102	7,700	14,802
55-59	6,247	6,280	12,527
60-64	5,600	5,872	11,472
65-69	4,478	3,585	8,063
70-74	2,914	2,304	5,218
75+	2,071	1,517	3,588
TOTAL	**282,651**	**272,070**	**554,721**

Source: Bagian Statistik Demografi, 1980

Table C-4: Expected Population by Five-Year Age Group, East Timor, 1980

Age group	Females	Males	Total
0-4	50,419	55,315	105,734
5-9	46,729	55,280	102,008
10-14	37,217	48,188	85,405
15-19	37,308	40,614	77,923
20-24	29,129	30,270	59,399
25-29	20,878	22,516	43,394
30-34	20,569	20,352	40,921
35-39	19,956	20,634	40,590
40-44	19,060	17,488	36,548
45-49	16,543	16,723	33,266
50-54	13,071	11,133	24,204
55-59	10,687	9,817	20,505
60-64	9,058	7,978	17,036
65-69	6,242	7,200	13,442
70-74	4,306	5,029	9,334
75+	517	653	1,170
TOTAL	**341,690**	**369,188**	**710,879**

Source: Author's calculations

Table C-5: Reported Population by Five-Year Age Group, East Timor, 1990

Age group	Females	Males	Total
0-4	59,838	63,161	123,000
5-9	46,901	51,189	98,090
10-14	28,618	34,354	62,972
15-19	31,156	36,052	67,208
20-24	31,848	32,358	64,206
25-29	31,460	31,330	62,790
30-34	24,985	26,129	51,114
35-39	18,278	20,159	38,438
40-44	16,053	14,995	31,049
45-49	12,730	13,890	26,620
50-54	9,389	10,799	20,188
55-59	6,752	6,995	13,747
60-64	5,556	5,448	11,005
65-69	3,029	3,526	6,554
70-74	2,222	1,867	4,089
75+	1,403	1,730	3,133
TOTAL	**330,219**	**353,983**	**684,202**

Source: Bagian Statistik Demografi, 1990

Table C-6: Expected Population by Five-Year Age Group, East Timor, 1990

Age group	Females	Males	Total
0-4	59,732	62,549	122,282
5-9	51,618	56,045	107,664
10-14	30,127	36,886	67,014
15-19	40,662	40,464	81,126
20-24	37,801	35,028	72,829
25-29	23,906	25,155	49,061
30-34	21,931	21,172	43,103
35-39	19,294	19,464	38,758
40-44	16,907	15,137	32,044
45-49	15,335	15,125	30,460
50-54	10,752	9,917	20,670
55-59	9,685	9,635	19,320
60-64	5,562	5,304	10,866
65-69	4,133	5,163	9,296
70-74	2,734	3,458	6,191
75+	430	587	1,018
TOTAL	**350,611**	**361,090**	**711,701**

Source: Author's calculations

Table C-7: Estimated Population by Five-Year Age Group, East Timor, 1999

Age group	Females	Males	Total
0-4	50,710	52,463	103,173
5-9	50,267	51,943	102,211
10-14	49,901	51,405	101,305
15-19	41,007	41,751	82,758
20-24	23,403	29,004	52,407
25-29	25,707	28,283	53,990
30-34	27,085	27,294	54,380
35-39	24,413	24,303	48,716
40-44	19,010	20,154	39,164
45-49	15,540	16,352	31,891
50-54	12,489	12,164	24,652
55-59	9,550	9,204	18,754
60-64	6,495	6,737	13,232
65-69	4,425	4,627	9,052
70-74	2,835	2,768	5,603
75+	2,647	2,327	4,974
TOTAL	**365,483**	**380,780**	**746,263**

Source: Author's calculations.

Table C-8: Expected Population by Five-Year Age Group, East Timor, 1999

Age group	Females	Males	Total
0-4	54,101	57,106	111,208
5-9	52,094	56,857	108,951
10-14	52,720	63,287	116,007
15-19	40,743	47,145	87,888
20-24	23,608	23,986	47,593
25-29	24,616	24,514	49,131
30-34	25,845	27,030	52,875
35-39	26,015	28,692	54,708
40-44	20,425	19,078	39,503
45-49	14,696	16,035	30,731
50-54	12,538	14,421	26,959
55-59	9,710	10,060	19,769
60-64	6,823	6,691	13,514
65-69	4,145	4,826	8,971
70-74	2,517	2,115	4,632
75+	270	333	603
TOTAL	**370,867**	**402,175**	**773,043**

Source: Author's calculations