INDONESIAN DEMOGRAPHIC DATA
Challenges and Opportunities in Analyzing Adult Mortality[1]

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Abstract: In Indonesia and in other Asian countries, demographic data collection has improved considerably over time. Nowadays, population censuses and national coverage demographic surveys have been conducted in a regular time. However, insufficient resources or priority has been given to analysis. An especially important issue is the lack of available data suitable for estimating the adult mortality indicators. This paper explores the development of Indonesian data collection on mortality. For empirical analysis, it focuses on adult mortality data derived from different data sources including the 2000 Census, the 2005 Inter-censal Survey (Supas), and the 1998 National Social and Economic Survey (Susenas). The study investigates how well these data collections capture the national and sub-regional Indonesian mortality experience. Life table and data adjustment methods have been applied. Results show that improvement in data quality and timeliness of adult mortality measurements should be possible by fully using existing datasets and applying standard analytical strategic.

Key words: demographic data, Indonesia, adult mortality, census and survey.

1. Introduction

Recent development in demographic data collection has shown that both demand and supply sides have significantly increased and will continue to increase in the near future. Demographic databases have played a significant role as the backbone of many important studies in investigating the complex interactions between population-related dimensions and other aspects (i.e. climate changes, environmental sustainability, politic, poverty and other socioeconomic factors). In many developing countries, this development is especially high due to a growing interest among different users in using demographic data as a standard practice for concrete evidence to justify their plans, policies or interventions. As a result, it certainly places greater demand on demographic data.

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In the context of Indonesia, recent policies in decentralization and democratization have expanded the role that demographic data plays in informing policies and assessing program results. For example, the population census has been utilized to guide government decisions in terms of regional budgetary allocation and political representation. The latest General Elections of 2009 employed the census data for estimating the population base of voters at each administrative level (i.e. national, regional and sub-regional/village) based on the number of population aged 17 years old and over or those who have ever married. The data sets on population-related features have also been utilized to determine the number of person eligible for some benefits based on their age and socioeconomic conditions. The benefit programs among others are the Social Security (e.g. Direct Cash Assistance and Housing Assistance) and Medicare (e.g. Health Insurance for the Poor-ASKESKIN). At the same time, the demographic data have facilitated the government in assessing theirs programs and policies by evaluating its ability to reach goals that have evidence-based indicators. For example, demographic trends and factors on the reduction of infant, child and maternal mortality are used as the evidence of the progress in achieving the goals and objectives of the ICPD and Millennium Development Goals (MDG). In terms of data sources, however, census and survey are primarily utilized since the issues of under reported and unperfected quality are still common in Indonesian registration data.

The availability of numerous demographic data these days indicates the high progress in demographic data collection methods. With the focus on data analysis, however, the progress has not been as advanced as the progress on data collection methods. The analysis of mortality in many developing countries, for example, has traditionally focused on the estimation of infant mortality. Other than some countries with good registration data, studies of adult mortality have received marginal attention in the regions where registration is lacking. The main available data sources such as census and surveys have routinely asked simple questions of children ever born and their survival as well as detailed birth histories. It certainly leads to improvement in the information on levels and trends in child mortality in the developing country. It is saddening to note that the same cannot be said about levels and trends in adult mortality. Despite the growing importance of disease and injury burden among adults in those countries, there still remains vast uncertainty about levels of adult mortality. Gakidou *et al*. (2004) reported that the adult mortality levels in many developing countries are derived heavily from the estimates of child mortality by assuming age patterns of mortality contained in 'model' life tables. In this case, Indonesia is one of those countries where adult mortality life tables are not available.

This paper presents an attempt to the adult mortality analysis. It focuses on Indonesian demographic data to examine the challenges and opportunities in adult mortality analysis, specifically by using census and surveys data. The paper begins with a review of mortality data in Indonesia. The second part of the paper provides empirical examples of adult mortality by using three data sources, namely the 2000 Census, the 2005 Intercensal Survey and the 1998 Social and Economic Survey. The limitations of the mortality variables found in the database are explicitly addressed. The third part presents the discussions and conclusions. The discussion follows some of the challenges and opportunities in exploring the mortality analysis in Indonesia.

2. Indonesian Demographic Data

The national population census has traditionally been utilized as the main data source in Indonesia for estimating demographic indicators, i.e. population size, total fertility rates, infant mortality rates and number of migrants. The census, however, does not always provide required information on a number of essential characteristics of the population. As a result, sample surveys have also been used as data sources. Recently, the number of surveys that covers large, medium, and small samples has increased as more funds have been provided by international and governmental sources in each country. Among those large surveys are the Demographic and Health Survey (IDHS), Indonesia Family Life Survey (IFLS), and the National Social and Economic Survey (SUSENAS). Another data source, such as the registration system, is still deficient and seldom used as main data sources to measure Indonesian demographic parameters. Considering the sample size and its quality, those data sources have indeed the potential to facilitate the drawing up of demographic dynamic in Indonesia. They are basically different from but complementary to one another. Each is best suited to satisfy the need for data on specific types or aspects of population phenomena.

Analysis of demographic variables is much easier when specific questions on births, deaths and migration are asked in the data sources. This section focuses on the link between understanding and utilizing available demographic data sources in Indonesia to estimate demographic parameters, with special attention to three data sources: the census, the intercensal survey (SUPAS) and the social and economic survey (Susenas).

2.1. Demographic Variables in Census and Intercensal Survey

In May 2010, Indonesia is going to carry out the 6th national population census since independence. Before the most recent census in 2000, population enumeration was regularly done in two processes, namely complete (100%) and sample enumeration (i.e. 5%). The complete enumeration gathers basic information such as individual's name, sex, age, and relationship to the head of household by using a short form. On the other hand, more detailed information such as citizenship, religion, socioeconomic characteristics, number of children ever born, information on housing conditions, current and previous places of residence, were obtained from the long form of household questionnaire and collected in sample enumeration.

Since 2000, the complete enumeration has been applied to cover the entire population of Indonesia for both individual and household. The main objective is to be able to provide demographic data down to the smallest administrative areas. Nevertheless, the number of questions addressed in this complete enumeration (i.e. by using the short form of questionnaire) is smaller than that usually covered in the sample enumeration in previous censuses. As a result, Indonesian BPS-Statistics conducted the Population Module Survey as part of the 2000 Census activities. Using the long form of questionnaire, this survey was done to fulfill the need for detailed demographic data which cannot be obtained from the 2000 Census. It was conducted in the whole of Indonesia with a sample of 203,008 households and was integrated with the 2000 National Social and Economic Survey (SUSENAS).

Another data source that is similar to the population census is the Intercensal Population Survey or known as Survai Penduduk Antar Sensus (SUPAS). It is designed to provide demographic data complementary to the census and to fill gaps in population information between two censuses. In Indonesia, SUPAS has been organized four times after the second modern census in 1971. These were conducted in 1976, 1985, 1995, and the last one in 2005. Compared to the census, the sample size in SUPAS is relatively small. For example, the 1985 SUPAS covered about 125,400 households and or 0.35 percent sample (Alatas, 1995) and about 216,945 households in the 1995 SUPAS. Meanwhile, the 1990 census covered about 2,000,000 households or 5 percent sample (Mamas, 1992). It is no wonder therefore some demographic variables (i.e. fertility, mortality, and migration) that are estimated from the SUPAS data are often incomparable with the variables estimated using the census data (Muhidin, 2002). In a study on migration data, for example, Alatas (1995) found that the number of recent migrants in 1980-1985 was smaller compared to the recent migrants derived from two censuses (i.e. the 1980 and 1990 censuses).

Tables 1 and 2 summarize the extent to which demographic questions are included in the census of 1961 to 2000 and in the SUPAS of 1976 to 2005. Both census and SUPAS generally collect similar information on demographic variables. The variables covered in the SUPAS, however, have particular features compared to the census. For example, information relating to fertility and mortality has been expanded. Ever-married women are asked about date of births and survival status of all children ever born as birth histories (instead of only last live birth as in the 1980 and 1990 censuses). In migration questions (i.e. place of residence 5 years ago), information about the main reasons of migration has also been asked. Furthermore, the unit geographical analysis is not only province, but also municipality and district. Such information can be potentially used to assess population mobility at a level lower than the province.

Tables 1 and 2 indicate that variables covered in Census and SUPAS are continually expanded. It has been in line with the greater inclusion of key demographic variables as recommended by UN Statistics Divisions into national censuses. These all have allowed standard fertility, (child) mortality, and migration estimation techniques to be applied. Based on these features and its wider national coverage, population census data are employed as the main data sources for demographic analysis in Indonesia.

Table 1. Variables concerning Demographic Variables: Indonesian census, 1961-2000

Demographic Variables in Census	Census Years				
	1961	1971	1980	1990	2000
Fertility (posed to ever married women)					
Children ever born	V	V	V	V	V
Child survival	V	V	V	V	V
Date of birth of last child born alive			V	V	V
Age, date or duration of first marriage			V	V	
Age of children			V	V	
Mortality					
Death in the past 5 years					V
Migration					
Place of current residence	V	V	V	V	V
Place of birth	V	V	V	V	V
Duration of residence		V	V	V	
Previous residence		V	V	V	
Previous residence at specific date			V	V	V

Sources: Summarized from Muhidin (2002) Table 4.2 and Questionnaires of Census various years.

Table 2. Variables concerning Demographic Variables: Indonesian SUPAS, 1976-2005

Demographic Variables in SUPAS	SUPAS Years			
	1976	1985	1995	2005
Fertility (posed to ever married women)				
Children ever born	V	V	V	V
Child survival	V	V	V	V
Birth histories of all children		V	V	V
Age, date or duration of first marriage	V	V	V	V
Mortality				
Death in the last n year (1 or 5 years)		V(1)		V(5)
Cause of deaths		V		V
Migration				
Place of current residence	V	V	V	V
Place of birth	V	V	V	V
Duration of residence		V	V	V
Previous residence		V	V	
Previous residence at specific date	V	V	V	V
Reason of recent migration	V	V	V	

Sources: Questionnaires of SUPAS various years.

Questions related to fertility and child mortality analyses have been addressed since 1961. Information on the number of children ever born and children surviving are collected. Information on number of marriages and age at first marriage, date of last live birth, and age of children are also collected in the census. Using this information, therefore, indirect estimation methods have been applied to measure the total fertility rates (i.e. the own-children and the last live birth methods) and infant mortality rates (i.e. the Brass and the Trussell methods). Nevertheless, questions about adult mortality remained a neglected topic. Interesting to note that the 1985 SUPAS had already posed a question related mortality in the last 12 months including the cause of deaths. Yet, it was stopped and only reappeared in the 2000 census and the 2005 Supas. It could be a reflection of international policy priorities that had encouraged concern about child survival to overshadow interest in the death rates of adults. Collecting such information allows indirect and direct estimation of adult mortality.

Questions related to migration have been collected since the 1961 census, which provide about place of current residence and place of birth were posed to the respondents. Therefore, lifetime migration could be examined from this information (e.g. see McNicoll, 1968; Withington, 1976; Hugo, 1978). In 1971, population census contained more personal data on the individual place of birth (province), place of previous residence, and the duration of residence in the previous place. Since 1980, question on the previous residence has been fixed for 5 years. Using this variable, recent migrant data can be derived from the census. Prior to the 2000 census, the geographical unit for place of residence was the province. In the 2000 census, province and district have been used as a geographical unit of analysis. Unfortunately, questions on the duration of residence in present province, i.e. to capture short-term migration, and the place of previous residence (i.e. province) have been omitted in the 2000 census. These demographic data collected in the census are certainly required for the application of estimation techniques.

2.2. National Social and Economic Survey (Susenas)

The National Social and Economic Survey [Survai Sosial Ekonomi Nasional, known as SUSENAS] is a large sample survey that has been conducted since the early 1960s. The survey is organized by Indonesian BPS-Statistics in order to answer the demand for Indonesian population statistics in general and socioeconomic statistics in particular. The census and SUPAS are indeed organized periodically in Indonesia. However, these are conducted once in 10 years. Meanwhile, demands for Indonesian statistics on planning and development process are more frequent. Therefore, other surveys (such as the SUSENAS) are organized more often than the census or SUPAS. Despite the Susenas has been conducted since 1963, the survey was organized irregularly prior to 1990 (Surbakti, 1995). Since 1990, the SUSENAS has been organized regularly once a year.

In general, data collected in this survey are classified into two groups: core and module data. The core questionnaire consists of a household roster listing the sex, age, marital status, and educational attainment of all household members. Module data on the other hand consist of certain information such as health care and nutrition, household income and expenditure, and labor force experience that are rotated over time in SUSENAS. Some questions used in the recent core data were used in the module data in the previous surveys.

Since 1992, additional information has been collected in the core data; these concern the original basic questions and the workforce, health of children under five, fertility, mortality, consumption, housing and settlement, and access to the mass media. For ever-married women aged less than 50 years old, the following questions are asked: age of first marriage, children ever born and still alive, and ever used and current contraceptive methods. Regarding mortality variables, the number of household members who have died within 12 months prior to survey is recorded. Information on name, age at death, sex, relationship to head of household, marital status, and criminal activity in which may have caused their death are also collected. The fact is that these additional variables have considerably contributed towards the provision of a data source for demographic estimation.

The SUSENAS was designed to cover all the regions of Indonesia. However, in the earlier rounds, regional coverage was restricted to Java and the sample size was small. Since 1982, the survey has been conducted in all Indonesian regions and broadened to cover a nationally representative sample, especially since 1993 with increased the sample size up to more than 200,000 household, from usually about 65,000 households before then. It is expected that from this large survey, socioeconomic parameters in smaller administrative units (i.e. municipality or regency instead of province) can also be obtained (Surbakti, 1995). The additional sample size, however, applied only to the core questionnaire, while for the module questionnaires (including health and housing module) the sample size is 65,000 households.

Since the SUSENAS data often provide demographic information, not only are economists interested in this survey but also demographers. For example, the SUSENAS data were used in Indonesian population projection. Indonesian BPS-Statistics used the 1967 SUSENAS data for estimating initial fertility and infant mortality levels. Iskandar (1976) used the 1964 SUSENAS data for estimating the distribution of fertility rates by age groups. Yet, no question related to migration is covered in Susenas data.

3. Mortality Analysis

In Indonesia, mortality analysis usually relates to the analysis of infant and child mortality. This is due to the fact that most information on mortality provided in demographic data sources has often been limited to infant and child mortality. As discussed in previous section, Indonesian census has mainly focused on information on the number of children ever born, children still alive, and infant deaths. Before the

2000 Population census, there was no detailed information on the occurrence of the event. Using this type of data, indirect estimation methods (i.e. the Brass method, 1975; Sullivan method, 1974; Trussell method, 1975; and Hill, 1987) have been used to estimate the infant mortality rate (IMR) from the census. Recently, infant and child mortality can be estimated directly using a full birth history data that have been recorded in the census and surveys. For each live birth the survival status of the child is noted. For children who died, the age at death was recorded.

On the other hand, there is relatively little knowledge about Indonesian adult mortality both at national and regional levels. Adult mortality has traditionally been estimated on the basis of infant and child mortality through a set of model life tables such as the regional life tables developed by Coale and Demeny (1966). Based on estimated child survivorship rate to age 5 years from census and survey data, mortality statistics regularly published by Indonesian BPS-Statistics have consistently relied on the West model. Nevertheless, the issue of appropriateness of the model life tables to estimate Indonesian mortality pattern is often a matter of debate.

In the past, some studies attempted to develop other ways to estimate the mortality rates apart from the West model. For example, Nitisastro (1970) used the United Nations (UN) life tables for population projections. Heligman (1975) constructed life tables for Indonesia based on survival ratio between the 1961 and 1971 censuses. Sinquefield and Kartoyo (1977) estimated Indonesian life tables for 1965-1970 by using the 1973 Fertility Mortality (FM) Survey. Instead of using West Model, Hull and Rohde (1978) used the South model to calculate mortality rates in Java in 1972. McDonald (1978) constructed Indonesian female life tables from the 1976 SUPAS data on the survival of mothers. Another study by Peter Gardiner (1978) examined the age-sex specific death rates from the results of the Indonesian Sample Vital Registration Project (SVRP) 1974-1977.

More recent studies on Indonesian life tables have also been done. A study by Agung et al. (1997) used the 1996 SUSENAS data to construct national life tables. Using the recent dataset of IFLS (Indonesian Family Life Survey), Hidayat et al. (2004) develop models of Indonesia's mortality schedules by applying hazard modeling in comparison to the life table models estimated from the 1996 Susenas and West Model. The study finds general similarities in the life table estimates between those three. While there is no gold standard for Indonesian mortality, Hidayat and colleagues claimed that observed mortality from the IFLS provides a stronger base for estimation of Indonesian mortality. A most recent study done by the Ministry of Health in 2007, assessing the dataset gathered in IMRSSP (Indonesian Mortality Registration System Strengthening Project) that has been operated in Solo and Pekalongan. With the data completeness score of 56%-74% in 2006 and 65%-81%, the study is able to develop a fairly accurate estimation of adult mortality in those studied regions (Soemantri, 2007).

The same phenomenon of facing the challenges in estimating adult mortality has happened at international level, especially in the countries where registration systems are not well function (Hill, 2000; Murray and Lopez, 1996). Based on this urgency, the UN Statistics Divisions have put efforts to address those challenges by focusing on model development and methodological refinements. As a result, several indirect methods for estimating levels of adult mortality have been proposed (Lopez *et al*. 2002; Preston *et al*. 1980; Hill, 1987). Indirect methods generally rely on census and survey data, and include, but are not limited to: deaths in the past 12 months, the widowhood method, the orphanhood method (Timaeus, 1986), and the sibling survivorship method (Hill and Trussell, 1977). Using sibling survivorship information, Stanton and colleagues (2000) compare DHS adult mortality estimates with UN general mortality indicators and DHS child mortality indicators. They find that the DHS adult estimates are somewhat lower on average than the UN estimates, and reasonably consistent with child mortality estimates. Stanton et al. conclude that the proportion of adult mortality affected by recall issues is much greater than with child mortality.

4. Data and Method

Adult mortality estimation in this paper is based on the 1998 Susenas, the 2000 Census, 2005 SUPAS data. The Susenas was carried out in January 1998 with a core sample size of 206,240 households and for the module questionnaires (including health and housing indicators) the sample size was 65,000 households. The Census – Population Module Survey was conducted in February 2000 integrated with the 2000 Susenas by covering a sample size of 203,008 households. Meanwhile, the 2005 SUPAS was conducted in August 2005 with a sample size of XX households.

Figure 1 presents the questions that are addressed in selected data sources about mortality variables. A relevant question asked in this survey was: “is there any household member who died since January 1997 (Census) or January 2002 (Supas) or during the previous 1 year (Susenas)?” If the answer was affirmative then personal information (i.e. age at death, sex, relation to the head of the household) was collected. The time of occurrence of the event, i.e. within 12 months prior to survey, was recorded in terms of completed years of age. In those selected data sources, however, death event is collected retrospectively. Only those household who were alive (survived) at the time of census or surveys are asked about their household member death experiences. The household who moved before the enumeration took place are also excluded from the observation (censoring case).

Figure 1. Wording of questions on household mortality in Census, SUPAS and Susenas

A. 2000 Census: Section IVB (Death Incident since January 1997)

IV.B. DEATH INCIDENT SINCE JANUARY 1997								
Serial no.	410. Name of household members who were passed away	411. Relationship with head household when he/she was alive (code)	412. Year of the incident since Jan 97	413. Sex *Male 1* *Female 2*	414. Passed away at the age… (if less than 2 year old, fill in month)	415. For women who passed away at the age of ≥ 10, were the death happened during		
						Pregnancy period *Yes 1* *No 2*	Child birth/ miscarriage *Yes 1* *No 2*	Parturition period**) *Yes 1* *No 2*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
01.					Year ○ Month ○			
02.					Year ○ Month ○			
03.					Year ○ Month ○			
04.					Year ○ Month ○			

CODE Column (3) BLOCK IVB.

1 = Head of HH	4 = Son/daughter in Law	7 = Other Relative
2 = Spouse	5 = Grandchild	8 = Housemaid
3 = Child	6 = Parent/Parent in Law	9 = Other

**) 42 days after childbirth/miscarriage

B. 2005 SUPAS: Section IVB (Death Incident since January 2002)

IV.B. DEATH INCIDENT SINCE JANUARY 2002									
Serial no.	409. Name of household members who were passed away	410. What year did (NAME) die?	411. Sex of (NAME) *Male 1* *Female 2*	412. How old was (NAME) when (NAME) died		413. Main cause of death	415. Women who passed away at the age of ≥ 10, did (NAME) die:		
				Less than 2 years (AGE IN MONTH)	More than 2 years (AGE IN YEAR)		During pregnancy?	During delivery/ miscarriage	During parturition period**)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
01.							Yes…… 1 No……. 2	Yes…… 1 No……. 2	Yes…… 1 No……. 2
02.							Yes…… 1 No……. 2	Yes…… 1 No……. 2	Yes…… 1 No……. 2
03.							Yes…… 1 No……. 2	Yes…… 1 No……. 2	Yes…… 1 No……. 2
04.							Yes…… 1 No……. 2	Yes…… 1 No……. 2	Yes…… 1 No……. 2

CODE Column (7) BLOCK IVB. Cause of death

1 = 4 = Son/daughter in Law 7 = Other Relative

**) 42 days after childbirth/miscarriage

C. 1998 SUSENAS: Household member who died during previous 1 year

IV.B. HOUSEHOLD MEMBER WHO DIED (INCLUDING STILLBORN) DURING PREVIOUS YEAR								
Serial no.	Name of household members	Relationship to the head household	Sex *Male 1* *Female 2*	Age (year)	Marital Status (code)	If column (6) coded 2 or 3, where is it recorded?	Only for HH member aged 5 years old	
							How long did you read holy book/religion article in the last week?	School attendance
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
01.								
02.								
03.								
04.								

CODE for Column (3): Relation to the head of household
1 = Head of HH
2 = Spouse
3 = Child
4 = Son/daughter in Law
5 = Grandchild
6 = Parent/Parent in Law
7 = Other Relative
8 = Housemaid
9 = Other

CODE for Column (7):
1 = KUA (Religion Office)
2 = Civil Registered Office
3 = State Court Office
4 = Others

CODE for Column (6): Marital Status
1 = Single, 2 = Married, 3 = Divorced, 4 = Widowed

CODE for Column (9): School Participation
1 = In school
2 = No longer in school

Figure 2 summarizes the procedure for estimating adult mortality in Indonesia. It starts with the construction of adult mortality patterns from the data sources. Some adjustments are made to the data estimated based on the assessment results. At the end, the mortality patterns constructed are utilized for constructing mortality base data at the national and regional levels.

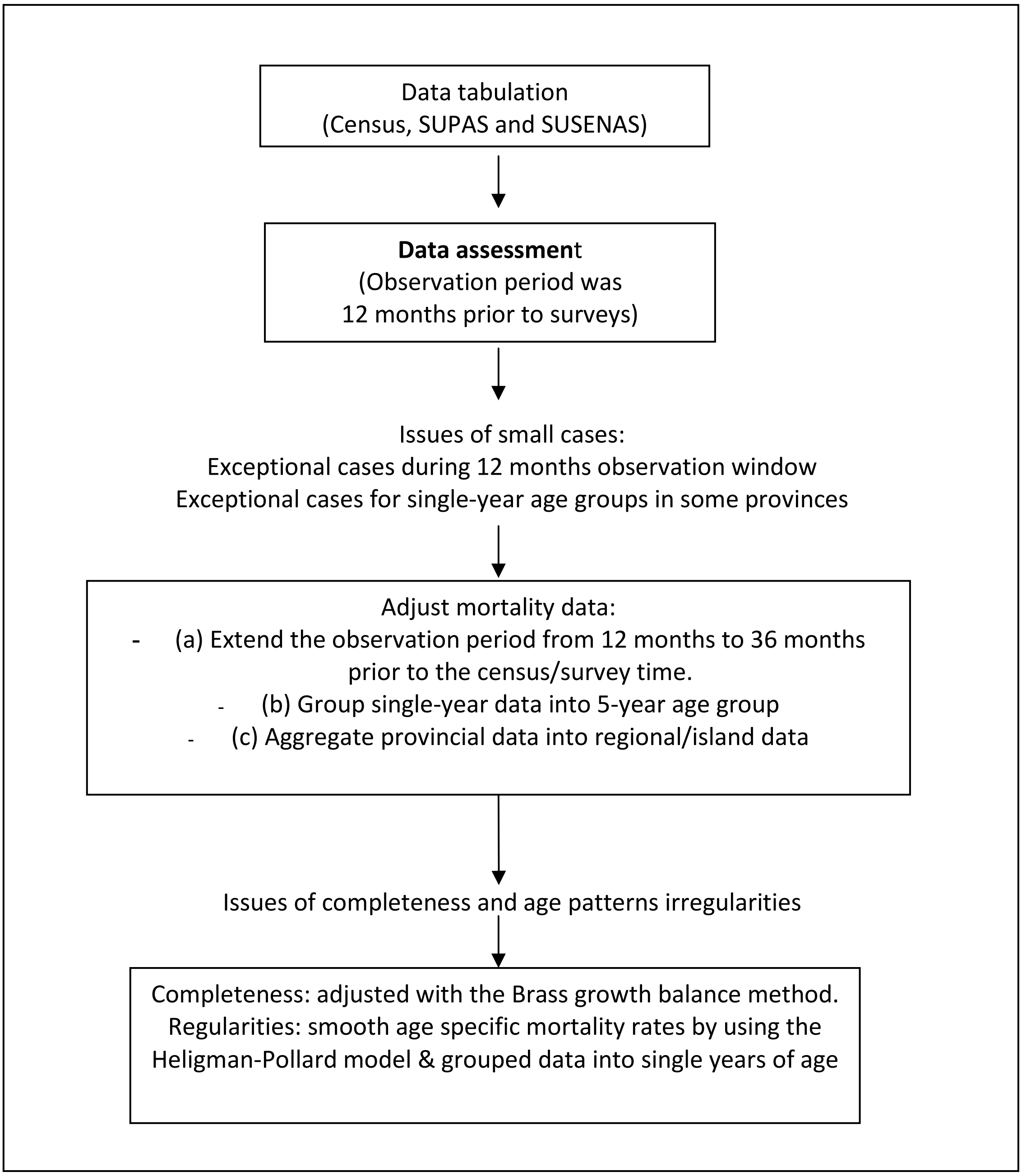
For analysis, this study considers data problems in the stage of data preparatory, such as incomplete and underestimated. Evidence from the data utilized show that Indonesian regional mortality has shown the regularity patterns. It is, therefore, possible to explain the regularities by mean of a mathematical model. The mortality schedule model proposed by Heligman-Pollard (1980) is chosen as the appropriate instruments for smoothing some distortions in age patterns and for constructing the age specific mortality rates in single-year or five-year age groups (see Appendix 1). Another feature of this paper is the introduction of regional dimension in the analysis. Life table indicators are presented for males and females at national level and regional levels (i.e. Provinces in Java and Bali). It aims to see if there are any differences in the patterns of adult mortality in Indonesia and its regions.

The adult mortality here is directly estimated by using life table analysis for Indonesian regions. The mortality rate of a person aged x who resides in region *i* [Mid(x)] is calculated as follows:

$$M_{id}(x) = \frac{Event}{Exposure} = \frac{Death(x)}{Midyear\_pop(x)} \tag{1}$$

Assuming that the demographic variables are characterized by regularities in age patterns, we confine our estimation by using the age model schedules of mortality. It is needed in order to smooth patterns of irregularities that are often found in observed data.

Figure 2. Summary of Indonesian adult mortality analysis



5. Empirical Results

5.1. Data Tabulation

Using the three data sources, we derived population data and mortality data which are then tabulated by age group and sex. With regard to age, it was prepared both in a single-year and five-year age groups. Not only males and females data are considered, but also total (males and females) data are provided. Table 3 shows the observed data for mid-year population and number of death during the periods considered in the 2000 Census. Death data are considered during the last 1 year (for the 1998 Susenas) and last three years (for the 2000 Census and the 2005 Supas). For the census, the mortality data could be grouped into three different periods, namely: 1997/1998, 1998/1999, and 1999/2000. In addition, the data for period 1997/2000 (three years period) could also be calculated. Similar situation are applied to the 2005 Supas data.

As the life table analysis is concerned, this present study used the period data (i.e. as the hypothetical cohort data). Detailed method for calculating the input data is elaborated in Appendix 2.

Table 3. Observed mid-year population and mortality data: the 2000 Census

	Mid-year population			*Number of death*		
Age	***99/2000***	***98/1999***	***97/1998***	***99/2000***	***98/1999***	***97/1998***
Male						
0-4	9,591,828	10,056,451	10,342,921	648,900	559,497	472,478
5-9	10,527,914	10,626,078	10,671,216	15,684	21,142	14,592
10-14	10,868,338	10,940,893	11,071,577	15,806	17,927	16,793
15-19	10,706,196	10,320,511	9,700,853	23,732	20,688	19,541
20-25	8,436,576	8,325,961	8,329,512	15,975	19,233	18,027
25-29	8,129,417	8,107,679	7,916,633	29,434	19,369	15,408
30-34	7,523,688	7,471,479	7,434,387	20,052	21,199	10,345
35-39	7,286,903	7,208,521	7,081,304	25,117	26,026	23,722
40-44	6,350,330	6,143,898	5,930,906	33,343	30,609	26,991
45-49	5,312,436	4,986,384	4,660,602	47,665	38,979	30,858
50-54	3,776,075	3,523,912	3,408,553	51,502	52,627	37,392
55-59	3,235,689	3,245,918	3,078,475	54,555	53,422	38,970
60-64	2,517,596	2,305,033	2,088,406	94,579	65,958	56,846
65-69	1,726,550	1,701,950	1,642,692	76,733	67,170	54,936
70-74	1,207,873	1,052,762	893,741	92,355	69,558	57,044
75-79	591,228	533,186	466,733	46,895	34,724	32,900
80-84	248,875	199,815	158,726	37,069	31,540	20,447
85+	169,643	171,778	147,265	62,066	49,536	49,841
Total (M)	98,207,155	96,922,209	95,024,502	1,391,462	1,199,204	997,131

Female						
0-4	9,295,095	9,655,803	9,899,021	492,345	400,599	334,031
5-9	10,039,204	10,136,996	10,129,431	13,365	18,547	14,627
10-14	10,231,864	10,320,612	10,481,344	14,913	13,002	10,893
15-19	10,381,866	10,192,231	9,722,583	14,831	15,118	13,903
20-25	8,910,954	8,840,538	8,953,575	16,381	16,000	9,376
25-29	8,871,976	8,782,304	8,500,212	17,446	13,137	11,931
30-34	7,891,270	7,803,227	7,782,832	21,915	11,907	9,455
35-39	7,648,132	7,482,797	7,186,137	22,002	22,271	13,890
40-44	5,992,021	5,672,270	5,416,303	27,178	16,156	15,037
45-49	4,804,938	4,543,964	4,306,176	24,378	24,172	19,286
50-54	3,709,243	3,549,849	3,441,708	30,228	25,769	26,142
55-59	3,204,281	3,186,811	3,055,023	40,459	23,042	20,002
60-64	2,643,500	2,451,303	2,279,569	61,518	45,569	34,843
65-69	1,850,105	1,760,836	1,636,728	52,179	38,504	29,830
70-74	1,118,931	963,832	829,287	53,133	41,060	31,376
75-79	587,041	534,518	471,517	30,501	25,172	16,472
80-84	256,868	200,364	152,433	39,993	19,413	14,991
85+	191,194	186,910	159,003	63,421	45,388	39,594
Total (F)	97,628,483	96,265,165	94,402,882	1,036,186	814,826	665,679
Total M+F	195,835,638	193,187,374	189,427,384	2,427,648	2,014,030	1,662,810

The number of population and events (deaths) in the 2000 Census are weighted as the data here are part of module population sample survey. It shows 195.6 million people were alive at the census time, while 2.4 million people died during the past 12 months prior to census. From these calculations, the period mortality rates can be obtained. Total death rate in Indonesia for the period 1999-2000 was estimated at about 12 deaths per 1,000 population (2,427,648/195,835,638 = 0.01239).

5.2. Data Assessment

Examination of the estimated mortality rates, however, reveals two main problems: incompleteness and irregularities. Regarding the completeness of the data, it has to be kept in mind that the three data sources utilized in this study are sample enumerations and collected retrospectively. Demographic experiences such as deaths of household members were only recorded for a sub-cohort household. Some families may have been excluded from the observation due to migration or not present during the census date. In addition, information of the events (death) was solicited from the family or mother of the deceased. Hence, it has been argued that the number of deaths in this survey was under-reported and the resulting death rate was an underestimate. Therefore, an adjustment method is required for transforming the observed death rates into a better estimate of true mortality.

Manual X from the United Nations (1983) described two methods for assessing the completeness of death reporting in relation to population coverage. These are: (1) Preston-Coale method, and (2) Brass Growth Balance method. The Preston-Coale method uses the existing regional model of life table (i.e. the Coale-Demeny model) for adjusting the data, while the second method (Brass method) uses directly the observed data. Both methods assume that the population being studied is stable. In practice, the concept of a stable population, which assumes that fertility and mortality will remain constant for a sufficiently long time is not consistent with current Indonesian population. Considering this limitation and the fact that Indonesian mortality may be different from the existing regional model life tables, the second method appears to be better choice for assessing the completeness of Indonesian mortality data.

The Brass growth balance method is based on the following equation:

$$P(x)/P(x+) = r + D^*(x+)/P(x+) \quad (2)$$

where P(x) is the number of people aged x years, P(x+) is the number of people aged x years and over, D*(x) is the number of deaths occurring to persons aged x and above, and r is the growth rate. It is assumed that instead of the real death data D*(x+), the observed death data are only a proportion of the real data, i.e. D(x+), in which:

$$D(x+) = C(x)D^*(x+) \quad (3)$$

where C(x) is a factor representing the completeness of the observed death data at age x and over. Since the completeness of the death data is assumed to remain the same at all ages, at least over age 5 or 10 years, then C(x) can be replaced with a constant C. Using K=1/C and equation (3), equation (2) can be expressed as follows:

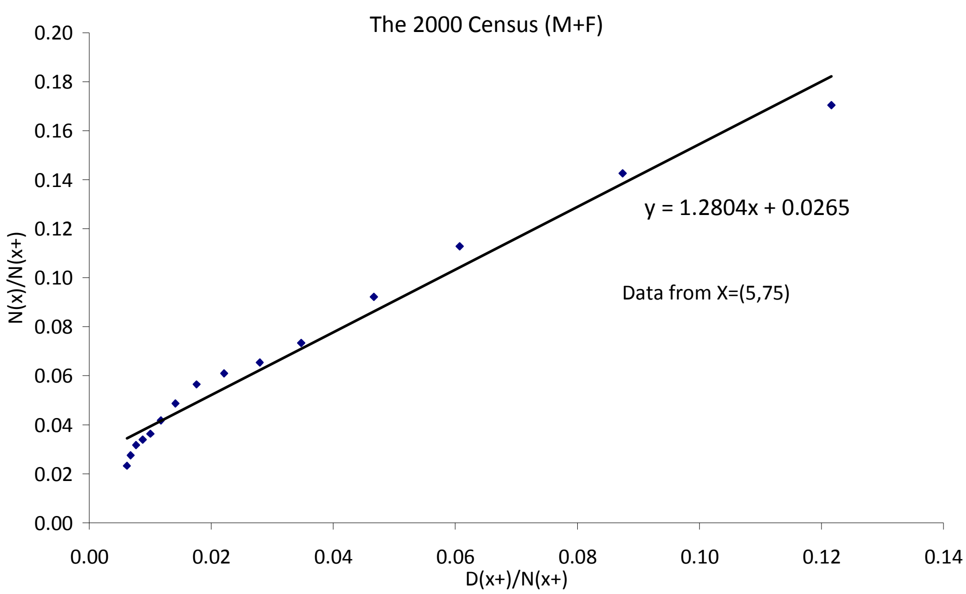
$$P(x)/P(x+) = r + K.D(x+)/P(x+)$$

By plotting a line which fits 15 points representing estimated data (5-year age groups, from age 5 to 75 years), Table 4 and Figure 3 show the completeness patterns of mortality data in the 1996 SUSENAS, the 2000 Census and the 2005 SUPAS. Evaluation to these data sources revealed that the completeness of data for males is generally higher than for females. Among these three data sources, the 2005 Supas has the lowest completeness values, which was about 25% on average. The 2000 Census has the highest completeness factors; it was 86 per cent for males, 87 per cent for females, and 77 per cent for both sexes for mortality data in the period 1997-1999. For the 1996 Susenas, it was 41 percent for males and 33 percent for females.

Table 4. Completeness factors on Indonesian mortality data in selected data sources

Data Sources	**Period**	**Males (M)**	**Females (F)**	**Total (M+F)**
Census	1997	0.8269	0.5784	0.7038
(2000)	1998	0.8133	0.6445	0.7292
	1999	0.9316	0.8465	0.8864
	1997-1999	0.8614	0.8752	0.7756
SUPAS	2002	0.2943	0.1882	0.2400
(2005)	2003	0.3271	0.2260	0.2746
	2004	0.3076	0.2164	0.2608
	2002-2004	0.3101	0.2111	0.2593
Susenas	1996	0.4089	0.3263	0.3820
(1996 & 1998)	1998	0.3465	0.2582	0.3004

Figure 2
Plot of partial birth rates P(x)/P(x+), and death rates D(x+)/P(x+)
for females and males, Indonesia, 2000



The completeness of data = 1/slope = 1/ 1.2804 = 0.7756

5.3. Data Adjustment

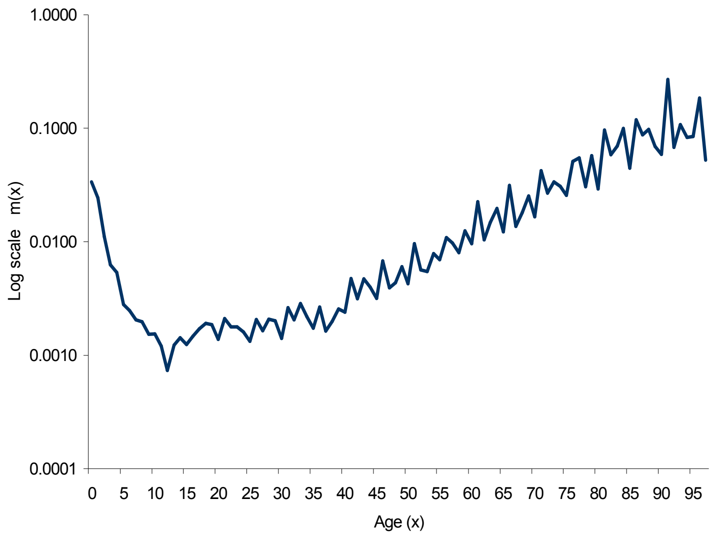
The completeness factors obtained are utilized to estimate the adjusted age-specific death rates. It is assumed that the completeness of reporting of deaths is the same at all ages. In this research, however, the child mortality data (aged 0-9 years) are not adjusted. Table 5 shows the mortality data before and after the adjustment has been done.

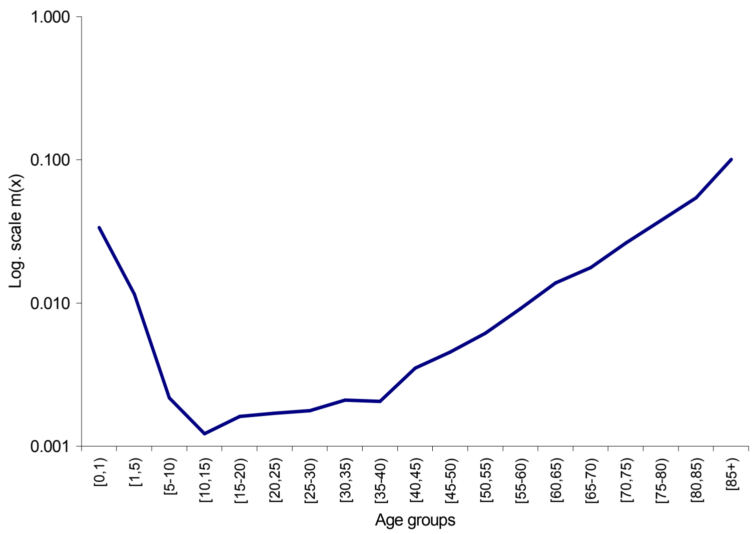
Table 5. Observed and adjusted age-specific death rates, Indonesia, 1996

	Observed ASDR			***Adjusted ASDR***		
Age	***Male***	***Female***	***Total***	***Male***	***Female***	***Total***
[0,1)	0.036005	0.031681	0.033897	0.036005	0.031681	0.033897
[1,5)	0.011108	0.010908	0.011010	0.011108	0.010908	0.011010
[5-10)	0.002530	0.002408	0.002470	0.002530	0.002408	0.002470
[10,15)	0.001280	0.001241	0.001261	0.002963	0.005149	0.003236
[15-20)	0.001776	0.001324	0.001554	0.004109	0.005493	0.003986
[20,25)	0.001986	0.001492	0.001718	0.004597	0.006191	0.004409
[25-30)	0.001860	0.001683	0.001765	0.004303	0.006983	0.004529
[30,35)	0.002036	0.002190	0.002117	0.004712	0.009087	0.005432
[35-40)	0.002082	0.002007	0.002044	0.004819	0.008328	0.005246
[40,45)	0.003954	0.002710	0.003358	0.009150	0.011245	0.008618
[45-50)	0.005865	0.003530	0.004714	0.013572	0.014649	0.012096
[50,55)	0.008204	0.004434	0.006305	0.018984	0.018400	0.016179
[55-60)	0.011068	0.006925	0.008972	0.025612	0.028736	0.023021
[60,65)	0.016988	0.009962	0.013417	0.039312	0.041339	0.034427
[65-70)	0.023774	0.012651	0.018139	0.055016	0.052494	0.046545
[70,75)	0.030039	0.020406	0.025172	0.069514	0.084674	0.064592
[75-80)	0.041718	0.036020	0.038854	0.096539	0.149464	0.099700
[80,85)	0.061290	0.046241	0.053039	0.141831	0.191875	0.136098
[85+)	0.126143	0.091713	0.106242	0.291909	0.380565	0.272617

With regard to the problem of irregularities, Figure 3 shows that the Indonesian mortality rates (in logarithmic scale) are subject to distortions, particularly for the single-year age groups. Therefore, using the mortality data for the five-year age groups, the model mortality schedule proposed by Heligman-Pollard (1980) is utilized for smoothing those distortions (see Appendix 2). The model is also applied to produce single-year age-specific death rates for Indonesia, both at the national and regional levels.

Figure 3. Observed age-specific death rates and death probabilities by single-year and five-year age groups, Indonesia 1998

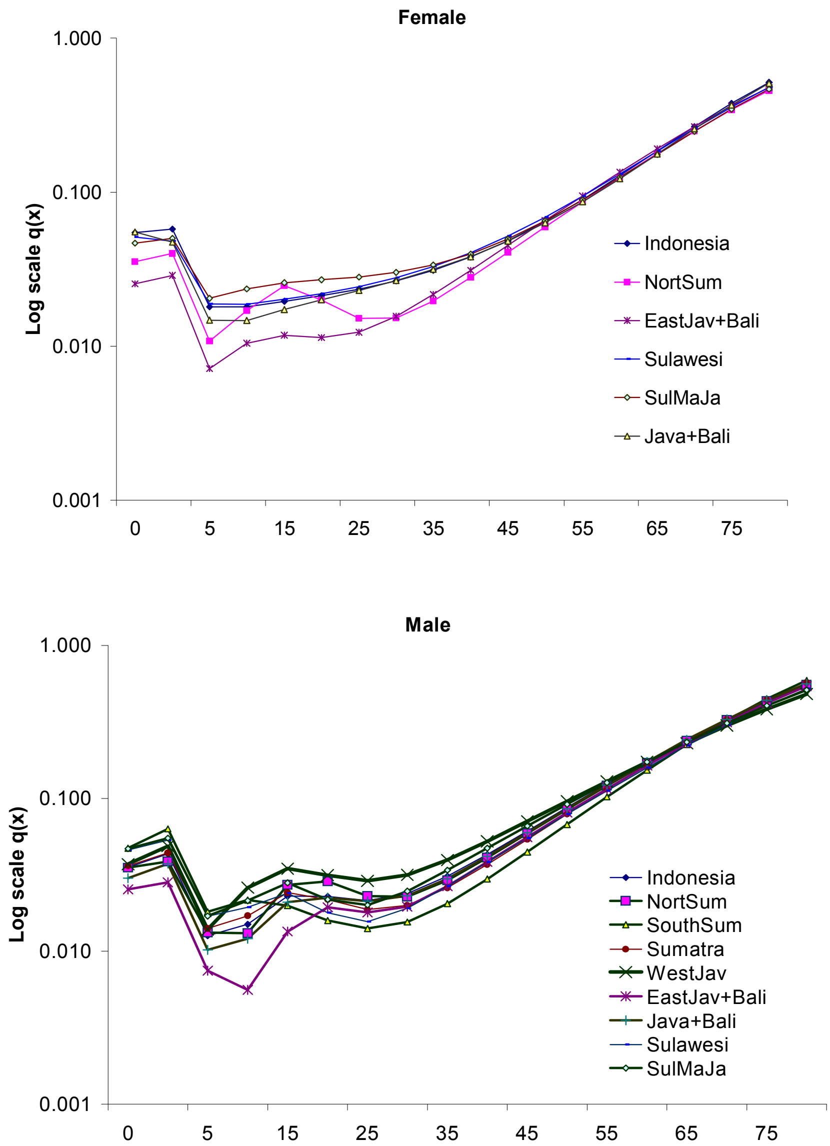




At the national level, there was no problem categorizing the mortality data by sex and age (i.e. single- or five-year age groups). At the regional level, however, some problems appeared. It was found that the number of events (deaths) classified by sex and age (even five-year age groups) was too small in some provinces to estimate age- specific death rates. This may be due to the small size of the sample covered in those provinces. Thus, we clustered the 27 provinces into groups of provinces. After clustering into 8 main regions and classifying by five-year age groups, the age patterns obtained were relatively good. The 8 regions clustered are: 1. Northern Sumatra (Aceh, North and West Sumatra, and Riau), 2. Southern Sumatra (Jambi, South Sumatra, Bengkulu and Lampung), 3. Western Java (Jakarta and West Java), 4. Eastern Java (Central and East Java, and Yogyakarta) and Bali, 5. Nusa Tenggara (West and East Nusa Tenggara, and East Timor), 6. Kalimantan, 7. Sulawesi, and 8. Maluku-Papua. These regions are grouped according to their geographical position.

Figure 4 shows the mortality patterns for the regional levels. Based on the values of goodness-of-fit, the models generally fit well for the Indonesian male and overall data, but less for the female data. In practice, the present research requires mortality data categorized by region and sex (male and female). Thus, in some cases, regional mortality patterns for both sexes (males+females) serve as the pattern for females or males. For example, the mortality patterns for females in Southern Sumatra, Nusa Tenggara and Kalimantan are derived from their total patterns. In addition, the mortality patterns of a wider group of regions may also be used to present the mortality patterns at the subregional level as in the case of Sulawesi and Maluku-Papua. The mortality patterns of these regions are derived from the mortality patterns of Sulawesi-Maluku-Papua.

Figure 4. Age-specific death probabilities of Indonesia by sex and region, 1998



5.4. Life Tables

Using adjusted data with and without smoothing, Indonesian life tables for males, females and total were generated. Table 6 presents the results for the 2000 Census data.

Data		*Adjusted and smoothed*			*Adjusted but not smoothed*		
Sources	***Period***	***Male***	***Female***	***Total***	***Male***	***Female***	***Total***
Census (2000)	1997	65.61	61.76	66.07	64.97	66.19	65.51
	1998	62.38	62.61	63.71	61.97	65.30	63.38
	1999	62.26	67.47	64.45	62.26	66.58	64.21
	1997-1999	63.38	64.12	64.74	63.02	66.31	64.45
SUPAS (2005)	2002						
	2003						
	2004						
	2002-2004						
SUSENAS	1996						
	1998						

6. Conclusions

Based on findings from this study, at least two main challenges can be addressed in analyzing adult mortality data in Indonesia. *First* is about quality data. The question on recent household member deaths has just been applied in the last decade to collect data on all ages (child and adult) mortality. Nationally and even globally, it has not been used as widely as questions on Children Ever Born (CEB) and Child Survival. As Indonesia still far away from having complete and accurate death registration data, such question is the only possible source of information on the age pattern of adult mortality as well as mortality of the entire age span. Nevertheless, the issues of complete and accurate have still to be solved. Therefore, the practice of collecting data on mortality for all age population should be further encouraged. It is expected to solve underreporting problems as discussed in this study when the analysis is done based on household surveys without large sample sizes.

Our empirical findings have shown that it is possible to get high quality responses to mortality questions in demographic data collection such as census (80%). The sample surveys such as Supas and Susenas, however, are still facing an issue of underreporting. In practical, reporting of death person is still less likely to be complete than reporting of registered population. It is no wonder therefore that calculated proportions of person died are likely to be too low/high, especially in some age groups (elderly and children age). Underreporting could also be resulted from recall dates of events accurately which leads to incomplete or inaccuracy the reported age at death. As a result, the problem of age heaping on multiples of 5 or 10 years was identified in this study.

Second challenge is about the regional dimension on mortality data. The variables provided from the data sources have been able to be used to estimate the trends and patterns of adult mortality for both females and males. It is due to the fact that the questions addressed are aimed to get information on the sex and age of each deceased person in the household sample. Yet, there is no information on place of death, which leads to assumption that the event of death occurred in the place where the household was registered at the census/survey time. Such limitation could hinder the better estimate for analyzing regional mortality.

In terms of opportunities, this study points out at least two aspects. *First* is on comparative analysis. Providing more demographic data collections available, especially those covered mortality variables; we have an opportunity to compare one study to another for better understanding about adult mortality in Indonesia. In this paper, for example, we do have an ideal situation which data on population base (exposure) and person death (event) are available from three different data collection, and at different points in time (the 2000 census, the 2005 SUPAS, and the 1998 SUSENAS). This certainly provides a powerful test of the quality of the estimates.

At international level, the opportunity to do a comparative analysis can also be done. Providing the UN Statistical Divisions has encouraged the standardized demographic parameters in the national population censuses around the world, therefore, cross-national analysis of adult mortality would be feasible. Application of new and existing methods to mortality data in different countries could force the understanding of adult mortality in different contexts. The similar idea has been adopted by Lopez et al. (2002) in their study on the development of life tables for 191 countries. Moreover, a most recent study from Bell and Muhidin (2009) adopts similar idea to the analysis of internal migration by using the national census data in 44 countries.

Second opportunity relates with the efforts from the government of Indonesia to improve the demographic data development. Some regulations have been endorsed in order to establish a better registration system. Recent Law No. 23/2006 on Civil Administration, for example, regulates about civil registrations (include Birth Registration and Death Registration). Regarding mortality statistics, the Law says that every resident should report important events, such as birth, death, still birth, marriage, divorce, child adoption, change of name, and change of citizenship. The report should be done to the Government within 30 days of the event. Any those events that occurred outside the territory of the Republic of Indonesia, should be reported within 7 days to the Indonesian Embassy or other representatives of Indonesian. If the regulation could be implemented, then a hope of having good registration system would be achieved.

In short, this study has pointed out the analysis of adult mortality in Indonesia has traditionally been problematic. Using careful and systematic assessment and adjustment methods to the observed data from the 2000 census, 2005 Supas and 1998 Susenas, the study has been able to compute reasonably accurate life tables for the mortality rates of Indonesian population as a whole. Nevertheless, it is still fairly approximate especially for the regional mortality data. Despite those issues, the study has also demonstrated that the release of the 2000 census and the 2005 Supas data provides an opportunity to update our estimates of Indonesian mortality, in particular measure of adult mortality. It would appear from the results that mortality in Indonesia fell overtime.

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Appendix 1: Model Mortality Schedule

A large number of demographic functions have been developed to capture regularities in mortality data. One of the commonly used models in mortality analysis is the Heligman-Pollard function. It has eight parameters of gradation, which are collapsed into three additive components: (1) early childhood ages, (2) adult ages, and (3) mortality at higher ages. The sum mortality curve, qi(x), is expressed below as:

$$q(x) = q(child) + q(adult) + q(elderly)$$
$$= A^{(x+B)^C} + D.e^{-E(\ln x - \ln F)^2} + \frac{GH^x}{1+GH^x} \qquad \text{(A.1)}$$

where: q(x) = probability of a person dying at age x
A, B, C, D, E, F, G, H = parameters
e = base of natural logarithm (2.718)

The fit of the model is tested using the period-cohort mortality data by 5-year age groups. For the analysis, we use the UNABR procedure provided in the MortPak package. The parameters of these models are estimated using non-linear least square by minimizing the sums of squared deviation between the observed and the estimated probabilities. In order to assess the goodness-of-fit of the model, we use the following function:

$$S^2 = \sum_{x=0}^{80} \left(\frac{q'(x)}{q(x)} - 1 \right)^2 \qquad \text{(A.2)}$$

where x is the 5-year age groups, q'(x) is the predicted mortality probability and q(x) is observed probability. Small values (i.e. close to zero) in S-squared indicate that the model does fit the data well. In other words, the ratio of estimated mortality probabilities must approximate the observed probabilities over the age groups.

McNown and Rogers (1989) used the Heligman-Pollard model for mortality projection. It was argued that although the model is complex and involves a large number of parameters, their flexibility is necessary to capture the full curvature of the mortality profile and the changes in this profile over time. Other model schedules, which nominally seem to employ fewer parameters, ignore some features of the age curve mortality or adopt a 'standard' which then is shaped to fit a particular application with the aid of a few parameters (e.g. Brass, 1971). In addition, Kostaki (1991) and Birg et al. (1998) showed how the Heligman-Pollard model could be used as a tool for expanding an abridged life table (i.e. 5-year age groups) into a complete life table (i.e. single-year age groups). Birg et al. (1998) applied this model for obtaining single year of age-specific Indonesian mortality from the Coale-Demeny life tables of the West model.

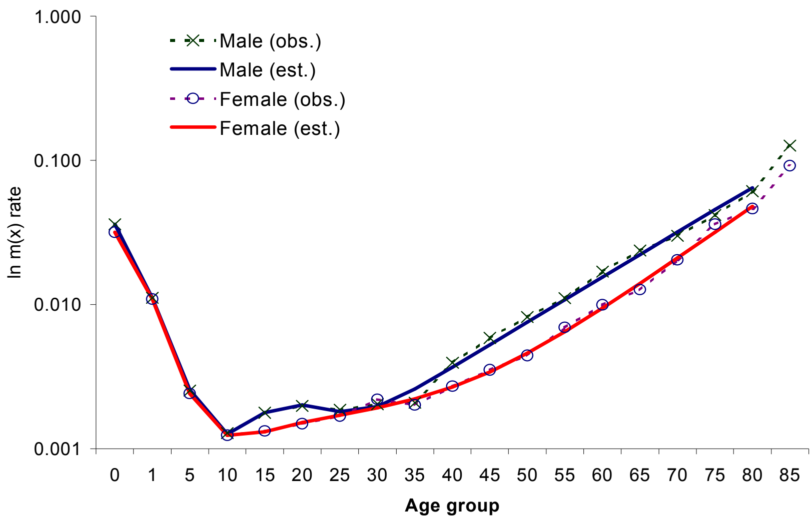
Table A.1 and Figure A.1 show the estimation of age-specific mortality patterns for Indonesian males, females and the total, derived from the 1996 SUSENAS data. These patterns have similar regularities as the general mortality rates and can be generated by the Heligman-Pollard model. The goodness-of-fit of the model, based on the S-squared values, shows that the model fits very well (i.e. close to zero) with the observed data. Therefore, the Heligman-Pollard model will be employed in our mortality estimation.

Table A.1 Parameters from the Heligman-Pollard model for Indonesian mortality

Sex	***Childhood***			***Adult stage***			***Elderly***		***Goodness -of-fit***
	A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	
Male	0.0710	1.8276	0.3901	0.0012	8.45	19.75	0.0002	1.0755	0.108
Female	0.1386	3.0875	0.4992	0.0013	0.97	28.38	0.0000	1.0896	0.058
Total (M+F)	0.0890	2.2386	0.4243	0.0010	4.51	20.33	0.0002	1.0748	0.045

Note: Goodness-of-fit values are derived from S-squared values.

Figure A.1. Observed and estimated Indonesian age-specific mortality, 1998



Source: calculated from the 1998 SUSENAS.

Appendix 2: Population and Mortality Base Data

In order to calculate the age-specific death rates (ASDR), the period-cohort data of event and exposure are needed. In fact, the events (deaths) provided by the data sources are categorized as period data. A relevant question asked in this survey was: "is there any household member who died in the last 12 months?" If the answer was affirmative then personal information (i.e. age at death, sex, relation to the head of the household) was collected. The time of occurrence of the event, i.e. within 12 months prior to survey, was recorded in terms of completed years of age. People who attained completed age x years in the interval period (t,t+1) may represent summation over two cohorts, i.e. cohort ct-x-1 and cohort ct-x. For example, people who died when they were 10 years old between January 1995 and January 1996 (i.e. 12 months prior to the survey time) might belong to two different cohorts (i.e. born within February 1984-January 1985 and February 1985-January 1986). Therefore, it is assumed that half of the events belong to the younger cohort, while the other half belongs to the older cohort. In other words, the events occurred in the middle of 12 months prior to survey time (i.e. in the 6th month). Using the estimated event data, the period-cohort data can be obtained.

For infant death, however, a different assumption is applied. Using the infant mortality data derived from the 1991, 1994 and 1997 IDHS, Muhidin (1999) reported that two-thirds (2/3) of the infant deaths occurred within 6 months after the children were born. From that study, it is assumed that two-thirds of the infant deaths belonged to the younger cohort and one-third to the older cohort. In general, the assumptions applied to the period-cohort data can be expressed as follows:

$$D_{PC}(t, c_{t-x-1}) = \lambda_1 D_p(x-1, t) + \lambda_2 D_p(x, t) \qquad \text{(A.3)}$$

where: DPC(x, ct-x-1) = period-cohort deaths of population from birth cohort (t-x-1) in interval period (t,t+1)

DP(x,t) = period deaths of population aged x in interval period (t,t+1)

λ1 and λ2 = 0 and 2/3 for the first age group (x = 0)

λ1 and λ2 = 1/3 and 1/2 for the second age group (x = 1)

λ1 and λ2 = 1/2 and 1/2 for the age group 1 < x ≤ z

λ1 and λ2 = 1/2 and 0 for the highest age group (x= z+)

With regard to the population exposed to the risk of death, the mid-year population is used as a point of reference. Since the mortality data are collected retrospectively, then the number of population by their cohort in every period must remain similar to the number of population at the survey time. The population exposed to the risk of death is estimated using the equation as follows:

$$L(t, c_{x-t-1}) = P(x) + 0.5 D_{PC}(t, c_{x-t-1}) \qquad \text{(A.4)}$$

where: L(t, ct-x-1) = population exposed to risk from birth cohort (t-x-1) in the interval period (t,t+1)

P(x) = population aged x at time t