# APPLICATION OF THE P/F RATIO METHOD IN ESTIMATING FERTILITY LEVELS IN LESOTHO

By

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# DECLARATION

I, Thandie Hlabana, do hereby declare that this is my own work supervised by Professor Akim Mturi, and all other people's work has been fully acknowledged. This work has not previously been submitted for an award of any degree.

Signed:...........................

**Thandie Keromamang Hlabana**

Date:...............................

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# Acronyms

| | |
|---|---|
| AIDS | Acquired Immune Deficiency Syndrome |
| ASFR | Age Specific Fertility Rate |
| BOS | Bureau of Statistics |
| CBR | Crude Birth Rate |
| CDR | Crude Death Rate |
| CEB | Children Ever Born |
| CPR | Contraceptive Prevalence Rate |
| DSS | Demographic Supplementary Survey |
| GNP | Gross National Product |
| ICPD | International Conference on Population and Development |
| IMR | Infant Mortality Rate |
| LHDA | Lesotho Highlands Development Authority |
| LRHS | Lesotho Reproductive Health Survey |
| TFR | Total Fertility Rate |
| UNAIDS | Joint United Nations Programme on HIV/AIDS |
| UNDP | United Nations Development Programme |
| UNFPA | United Nations Population Fund |

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# ABSTRACT

Inadequate demographic data in Lesotho inhibits demographic research. Nonetheless, indirect demographic techniques have proven to be useful tools in the developing world, as their application to census and survey data has greatly expanded knowledge of the demographic situation in data deficient countries (Brass, 1996). The different techniques are based on specific assumptions and robustness of available data, thus deserves caution in application. Failure to adhere to these methodological specifications results in generation of more errors (Feeney, 1996).

The impetus of this research was to assess the applicability of the P/F ratio method in estimating recent fertility levels in Lesotho. In particular, the data was evaluated to verify the following P/F ratio assumptions; (1) constant fertility; (2) accurate reporting of fertility by younger women; and (3) correct age pattern of fertility. In order to obtain optimal fertility estimates, the research undertook extensive data assessment, and corrections where possible, of individual variables employed in the P/F ratio method. In line with previous studies, the magnitude and pattern of the P/F ratios represented strong evidence of fertility decline in Lesotho. This evidence rendered the Brass P/F ratio method inappropriate for estimation of recent fertility levels in the country. Therefore, this research presents the Relational Gompertz model faring better in indirectly estimating fertility levels in Lesotho. Not undermining the Bureau of Statistics, the current study challenges the Bureau's estimates, and declares own estimates as more likely precise estimates of recent fertility levels in Lesotho when using the P/F ratio method. This assertion is grounded on the basis that compared to the Bureau, the study undertook and presented detailed data evaluation and adjustments, as well as adhering to the P/F ratio methodological assumptions. Nonetheless, the research also concludes that indirect techniques do not necessarily provide an utopia to demographic estimation in poor data countries. Even when the robust measures were employed, the quality of the 1996 data yielded implausible estimates as the method could not account for the degree of unreported births. This calls for caution during data collection and processing in order to minimise the reporting errors.

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Lesotho is among the poorest countries in the world and the quality of its demographic data is no different either. Data that is meagre and defective limits understanding of population dynamics in the country. The controversy arising from fertility estimates in many developing countries is mainly due to the poor data quality. For instance, fertility decline in Zimbabwe has been tested and tried with different studies coming up with contradictory conclusions (Muhwava, 2002). Similar debates on fertility levels are going on in South Africa as well (see Moultrie and Timæus, 2003 and Udjo, 2003). Erroneous information also produces inaccurate population development forecasts and planning as decisions based on the results could be compromised. As a result, indirect estimation of demographic parameters has proven to be very useful in the developing world, as its application to census and survey data has greatly expanded knowledge of the demographic situation in these often data deficient countries (Brass, 1996).

William Brass first initiated these techniques in the 1960s, with the aim of employing more reliable features of poor demographic data, so as to provide robust measures (Brass, 1964). Indirect estimation takes into account the most probable sources of errors and minimise their influence. This is done through use of demographic models or by making assumptions that translate into clear mathematical relationships. In addition, indirect estimation is a divergent from collection of data of uncertain quality, towards the use of information that is indirectly related to the demographic parameters, and which could be collected more reliably (Zlotnik and Hill, 1981). The techniques have been referred to as 'disaster rescue' for data deficient countries as they are relatively cheap to apply, and yet produce more reliable results (Brass, 1996: 451). However, the different techniques are based on specific assumptions and the robustness of the available data, thus deserves caution in application.

This dissertation looks at the indirect estimation of fertility applying the often-used P/F ratio method in Lesotho. Fertility is an important demographic variable that is inextricably linked to socio-economic development, and affects the health and well being of a population. Thus it is imperative to accurately estimate levels and trends of fertility. It is therefore in the interest of this study to assess the applicability of the P/F ratio method by ascertaining usability of the fertility data, as well as appropriately adhering to the underlying assumptions of the method so as to get optimal fertility estimates.

## 1.2 The Profile of Lesotho

### Geography

The Kingdom of Lesotho is located between 28° and 30° South, and between 27° and 30° East. It is small, about 30, 359 square kilometres, and enclave, mountainous country that is land locked along the borders of South Africa. The topography of the country presents a difficult terrain, with limited (9%) arable land for about 80% rural-based and agricultural dependent population (Bureau of Statistics, 1998). Furthermore, the country is divided into four ecological regions and ten districts, which vary in terms of accessibility hence differences in representation in the national statistics. Data collection from households located in remote and inaccessible mountainous areas is very difficult. As a result, enumerators tend to exclude such households (Makatjane, 1985). In addition, the climate is harsh with temperatures fluctuating from minus 7 degrees Celsius in winter to more than 30 degrees Celsius in summer. Thus, the terrain and climatic conditions compromise the efficient data collection in Lesotho.

### Economy

Economic prospects for Lesotho are also bleak. Based on poverty, human resource and economic indicators, Lesotho is classified under the poorest countries in the world (UNDP, 2004). In 2002 per capita GNP was estimated at M4, 196 (US$490)[1], with an annual inflation rate of 9.8% and unemployment rate of about 50% (Bureau of Statistics, 2003c). Sechaba Consultants (2000) have also indicated that about half of the population is below the poverty line. Amongst the many reasons for this poor economic performance is the poor natural resource base, where water is currently the

[1] This is based on the March 2003 estimates and therefore subject to currency fluctuations. M stands for Maluti, the currency of Lesotho that is equivalent to South African Rand.

major natural resource and export commodity developed through the Lesotho Highlands Development Authority (LHDA).

Again, the recent retrenchment of labour migrants from the South African mines has exacerbated the economic situation in Lesotho. For a very long time the South African mines have been the main source of employment and remittance for many Basotho. It has been estimated that in 1996 mine workers' remittances added about 33% to GDP compared to 67% in 1990 (Sechaba Consultants, 2000). Nonetheless, while the government is currently the main employer in Lesotho, the growing manufacturing sector has also offered a viable employment alternative to many households (ibid). Manufacturing depends largely on farm products, which support the milling, canning, leather and jute industries. In particular, the clothing industry is the main foreign exchange earner at the moment.

**Demography**

The population of Lesotho has been estimated at 1.96 million using the 1996 census, with an annual growth rate of 2.6%, and an average household size of 5.0 persons (Bureau of Statistics, 1998). This population has been projected to be 2.5 in 2005. With this current population growth rate, the population of Lesotho is likely to double every 33 years, adding considerable pressure to the country's limited natural resource base. About 55% of the population is below 20 years of age (ibid). This suggests high fertility rates. On average a women bears 4 children by the end of her reproductive period in Lesotho (Mturi and Hlabana, 1999; Bureau of Statistics, 2003a). Although, this fertility is low by sub-Saharan Africa standards, based on the Demographic Transition Theory, Lesotho has not yet featured in the fertility transition (Gaisie, 1996). This has been attributed to the low contraceptive prevalence rate (CPR). Mturi and Hlabana (1999) estimate CPR at 23.2% in 1991/92. However recent data from the 2002 Lesotho Demographic Survey (LDS) estimated an tremendous increase in CPR to 40.6% (Bureau of Statistics, 2003a). Although changes in the determinants of fertility do not immediately affect the level of fertility in a country, this CPR matches that of South Africa, which has an average of 3 children per women at the end of the reproductive period (Mostert et al., 1998). If this new CPR is correct, it is expected to mark the fertility transition in Lesotho.

Mortality rates are also changing in Lesotho. The 1996 population census estimated infant mortality rate (IMR) at 74 deaths relative to 84 deaths per 1000 live births in 1986 (Bureau of Statistics, 1998). Crude death rate (CDR) of 12.8 deaths per thousand population was estimated in 1996, and this presented an increase in deaths from 11.7 deaths per thousand population in 1986. In line with increasing mortality rates, life expectancy at birth has fallen from 60 years in 1996 to 45 years in 2001 (Ministry of Finance and Development Planning, 2002). There could be other socio-economic factors attributable to this fall, but the escalating prevalence of HIV/AIDS estimated at a quarter of the population cannot be downplayed. According to UNAIDS (2004), Lesotho is among the four most HIV/AIDS hard hit countries in the world, with more than 30% prevalence rate. This level was estimated from anti-natal clinics as voluntary testing is still very low.

Even though fertility and mortality levels in Lesotho are moderate by regional standards, the high population growth rate is a concern. Special emphasis has been made towards fertility decline as stipulated in the Lesotho National Population Policy 1994 (Ministry of Economic Planning, 1994). The government is also working towards curbing the impact of HIV/AIDS in order to reverse the increasing mortality levels (Ministry of Health and Social Welfare, 2001).

Compared to most African countries, Lesotho is said to be ethnically homogeneous society with one national language (Sesotho), and an almost similar culture as well as religion - 94% Christian population (Kimane et al., 1999). In addition, the country has one of the highest literacy rates in the region. Adult literacy is estimated at 82% (Bureau of Statistics, 2003a). Although women in Lesotho are more educated than men, Basotho still represent a patriarchal society. There is recognised male domination of ownership and control, which in turn maintains and operates a system of gender discrimination (Kimane et al., 1999). This system promotes male superiority and sole decision-makers within households and the society at large.

## 1.3 Statement of the Problem

Like many developing countries, Lesotho suffers from data deficiency and defectiveness. Although the United Nations Principles and Recommendations for

Vital Statistics System Revision 2 urged governments "to establishing and maintaining reliable civil registration systems for legal documentation on events throughout the lifetime of individuals from birth, changes in marital status, and to death" (United Nations, 2003), vital registration system in Lesotho is poor. Despite the propagation by the Registration of Births and Deaths Act of 1973 (Government of Lesotho, 1973), more than 95% of the vital events are not registered (Bureau of Statistics, 2004). A total of 2 953, 2 873 and 2 793 births were registered in 2000, 2001 and 2002 respectively (Bureau of Statistics, 2004). This is in contrast with the crude birth rate of 30 births per thousand population a year, and about 75 000 live births which were estimated for similar periods (Bureau of Statistics, 2003a). In addition, it has only been recently that the Statistics Act 2001 binds individuals to report correct information during data collection or reporting (Government of Lesotho, 2001: 392). Thus, even the limited registered cases suffer from serious reporting errors due to people registering at their own individual convenience (Makatjane, 1985). This renders information from the vital registration system in the country unusable for estimating demographic parameters.

Consequently, the inefficient vital registration system leaves retrospective information from censuses and surveys as the main source of fertility data in Lesotho. Nonetheless, these data sources have not solved the problem of demographic estimation in the country as they also suffer from coverage and reporting errors (Bureau of Statistics, 2003a). This inefficiency is in line with the general observation that information on vital events collected through surveys in developing countries is subject to response errors, sometimes of a serious magnitude (Shryock and Segel, 1976, Smith, 1994; Brass 1996). Failure to report events increases with the duration of recall lapse where women might fail to report their children because they are not living with them, or they are too young to be recognised as individuals worth reporting on, or they have died (Potter, 1977). For instance, although the 1996 Population Census Analytical Report deemed the census data as satisfactory, it was also indicated that there was 5% under-enumeration of the de jure population (Bureau of Statistics, 1998: 15). The most affected group was children aged between 0 and 9 years (ibid). Under-reporting of children is likely to mislead estimation of fertility if proper adjustments are not employed.

Moreover, the accuracy of fertility measurement depends on the age structure of the women, the shape of the age-specific fertility curve and the age range of the women under consideration (Brass, 1964). It is highlighted that the main causes of errors in age data include ignorance of correct age; carelessness in reporting and recording, a tendency to prefer certain digits; a tendency to exaggerate length of life in advance ages; disliking certain numbers, as well as misstatement arising from various motives (Kpedekpo, 1982). Despite the increasing literacy rate, the 1996 Lesotho Census Analytical Report further indicates that more people were recorded in the "age not stated" category than in the previous censuses (Bureau of Statistics, 1998: 15). In particular, like in many African cultures, Basotho still use events as reference to the time of birth or age (Kimane et al., 1999). The conventional age referencing is a new practice, which is often ignored or not accurately known at all. If all these data problems are not taken into account, demographic estimation and analysis in the country is likely to be dubious.

The poor data quality warrants the use of indirect estimation of demographic parameters in Lesotho. Various demographic techniques for estimation of fertility have been developed to compensate incomplete and defective data. Nevertheless, these techniques do not provide an utopia for poor data populations. The models for converting the data are such that the reliability of the results depends on both the accuracy of the basic data collected, and the degree to which the assumptions of the models are met by a particular population. That being the case, serious prudence should be exercised when applying these models.

When looking at the fertility estimates in Lesotho, different researchers have come up with different estimates using the same data sets, and the same method of estimations. For instance, using the Relational Gompertz method, the Bureau of Statistics (1998) estimated TFR of 5.3 and 4.9 children per woman for the 1986 and 1996 population censuses respectively. Contrarily, using the same method, Mturi (1998) estimated TFR of 5.0 and 4.1 for the two censuses respectively. It is not clear from both studies why the estimates are different, which makes it difficult to make conclusions about which and why a particular estimate is more plausible than the other. It is likely that the disparity in the estimates is a result of original data adjustments employed, which are not published. This makes it difficult for readers to make their own personal judgement about the estimates presented.

In addition, using the Brass P/F ratio method, the Bureau of Statistics reported a TFR of 4.1 for both 1996 Population census and 2001 Demographic Survey (Bureau of Statistics 1998 and 2003a). This fertility estimate matches that derived by Mturi and Hlabana (1999) for the 1991/92 Lesotho Demographic and Health Survey - although they were using a different method. However, contraceptive prevalence rates (CPR) for these periods are different. As indicated earlier, in 1991/92 CPR was estimated at 23% (ibid). Later, Tuoane and colleagues (2003) reported an increase in CPR to 29% in 1995, while the 2001 Lesotho Demographic Survey estimated an even higher CPR of 40.6% (Bureau of Statistics, 2003a). Therefore, fertility levels in Lesotho would be expected to correspond with these changes in contraceptive use. While there are various determinants of fertility, Caldwell and Caldwell (2002) have indicated that the decreasing fertility levels in sub-Saharan Africa are a result of increasing levels of contraceptive use. For instance, a 23.4% CPR increase was coupled with a 15.9% decline in fertility between 1993 and 1998 in Kenya (African Population Policy Research Center, 1998: 13). Similar findings have been found in other sub-Saharan countries (Caldwell and Caldwell, 2002). Therefore, CPR increments in Lesotho are expected to yield at least some observable fertility decline. Contrary to this understanding, Frank (1987) also asserted that women in sub-Saharan Africa do not use contraceptives to reduce their fertility, rather to postpone their births. Nevertheless, if 40% changes in CPR do not correspond with changes in fertility levels, then there is a call for data and/or methodological evaluation or a more qualitative understanding of why Basotho women use contraceptives. This dissertation attempts to evaluate the former possibility – data and methodological flaws in fertility estimation in Lesotho.

Moreover, in accordance with the 1994 International Conference on Population and Development (ICPD), the first National Population Policy for Lesotho was adopted in 1994 and has been in operation for several years now. The policy aimed at regulating population growth by reducing fertility to replacement level (2.2 children per woman) by 2011 (Ministry of Finance and Development Planning, 1994). However, in 1999, the government of Lesotho proposed revision of this same policy due to some identified projection flaws, which rendered the policy deficient (Ministry of Development Planning, 2003). A sufficient population policy is informed by proper research; hence it is imperative to develop effective researches with accurate estimates.

The basic source of information for fertility analysis, including the present study, is the question on CEB and births in the 12 months prior to the survey. The Lesotho Bureau of Statistics is currently the main collector and analyser of fertility data in Lesotho. However, the Bureau tends to be reluctant to present the nature and magnitude of errors inherent in the data collected, particularly regarding individual variables. As Preston and colleagues (2001) argue, lack of knowledge regarding the data errors compromise the degree of confidence that can be placed in the estimates. Different techniques are based on specific assumptions and robustness of the available data, thus deserve caution in application.

## 1.4 Rationale of the Study

The controversies arising from fertility estimates of many developing countries are due to data quality. Considering the uncertainties inherent in the Lesotho demographic data, it is inevitable that indirect techniques are employed in order to obtain reliable estimates. Although the P/F ratio method has been employed in estimating fertility levels in Lesotho, there has never been any inference as to how much do the methods employed suit the demographic structure of Lesotho in terms of their underlying assumptions. In addition, algorithms employed in the data processing are often not published, making it impossible to assess the extent of imputation or modification of the data from the original to the final forms. Therefore, an independent judgement on any biases that could have been introduced by the cleaning is compromised.

This dissertation contends that it is necessary to ascertain data quality before embarking on analysis and interpretation of demographic data. It is also imperative to ascertain the usability of the demographic techniques so as to obtain plausible results. Against this background, this study is an attempt to improve on fertility documentation in Lesotho. Indeed, the usefulness and reliability of demographic parameters and estimates derived from the censuses and surveys depends on the quality of the data collected, as well as the method of estimation. The current study focuses on the raison d'etre and application of the P/F ratio method for fertility estimation in the Lesotho. It is in the interest of this research to use appropriately demographic techniques so as to optimise fertility estimation in country.

## 1.5 Aim and Objectives of the Study

The impetus of this study is to assess the application of the P/F ratio method in estimating fertility levels in Lesotho. In order to achieve this, the study will pursue the following specific objectives:

- To evaluate the quality of the fertility data in Lesotho.
- To assess the level of applicability of the P/F ratio method in estimating fertility levels in Lesotho.
- To estimate the levels of fertility.

## 1.6 Limitations of the study

The main shortfall of this dissertation is the fact that it uses secondary data, of which there was no control over the data collection and processing. As Preston and colleagues (2001: 211) put it,

> "It is useful to know something about the administrative structures producing a set of data…and the incentives to collect data accurately. Similarly it is useful to know what incentives people have to report themselves accurately".

The use of secondary data subjects the study to inherent coverage and content errors in the data sets. However, instead of using tables, the study uses raw data in order to evaluate the quality and reduce content errors where possible. In addition, as a former member of the steering and technical committees when conducting the 2001 Lesotho Demographic Survey, the author of this study claims a certain level of understanding of data collection and processing by the Bureau of Statistics.

## 1.7 Outline of the Dissertation

The first chapter offers background information on Lesotho, and the need for indirect estimation of fertility in the country as the motive behind this research. It sets out principal objectives and the procedures taken in order to achieve the research goal. The second chapter is a visit to literature regarding the rationale for indirect estimation of fertility, with particular focus on the use of the P/F ratio method. This includes demographic data collection methods in Africa and their deficiencies, as well as errors encountered in the fertility data.

Chapter three gives a comprehensive data and methodological outline of the Brass P/F ratio method along with the Relational Gompertz as its refinement. Data sources and required variables with their short falls, and detailed methodological analysis are included in this chapter. In addition, the chapter puts forth the confounding opinions of other researchers regarding the methodological strengths and weaknesses of these methods. Then chapter 5 and 6 are based on data quality evaluation and analysis of the 1996 Lesotho population census and the 2002 Lesotho Reproductive Health Survey, including the application of the P/F ratio techniques. The last chapter provides research summary, conclusions and recommendations.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Need for Indirect Demographic Estimation

Demographic analysis in developing countries is inhibited by lack of adequate and reliable data. Data barriers hamper the efforts of population and development planning in many countries. In the event that such pertinent information is imperfect, and whether the degree of imperfection is considered intolerable as a basis for analysis and interpretation, demographers tend to have two alternative strategies to improve analysis of vital events; either to go out to the field and collect new data or to use various kinds of statistical techniques to improve the given data (Adlakha et al., 1980). Sometimes both methods are combined, but the goal has typically been the same; to provide point estimates that are as close as possible to the real parameters. The former is quite expensive and often not a feasible alternative for many developing countries (ibid). Thus, the next best option for poor data countries has often been the latter, which is the adoption of adjustment techniques. As such the use of indirect estimation techniques for demographic parameters came to the fore.

It took a long time before demographers established better ways of handling demographic data in developing countries. Despite the apparent poor quality of demographic data in these countries, demographic estimation was done the same way as in the developed countries where data is more reliable. It was only in the late 1940s and early 1950s that demographers recognised the imperative need to develop new approaches to demographic estimation (Brass, 1996: 451). As acknowledged by many demographers, the most important development in the measurement of vital rates during the post-war period has been the Brass's techniques (Coale and Demeny, 1968; Hobractf et.al, 1982). Tribute has been paid to William Brass in this regard and as he is referred to as the "intellectual father of indirect estimation" (Coale and Trussell, (1996: 472). He proposed numerous techniques for the estimation of demographic parameters, particularly mortality and fertility, which were first published in 1961, then later in collaboration with his colleagues, more developed methods were published (ibid). Brass' methods were designed to detect and adjust for reporting errors typically observed in the demographic data from less developed countries. As indirect techniques gained more recognition, more demographers developed, evaluated, modified and refined the techniques.

Indirect demographic estimation covers a wide variety of procedures, many of which solely utilise information obtained from single round surveys (SRS), (Brass and Coale, 1968; United Nations, 1983). It should be noted that data from registration systems has been proved to be too limited and defective for adjustment, however, there are direct adjustments of errors which are normally based on comparisons with censuses. Estimation from censuses and large surveys are best accomplished when errors of coverage are small and reporting of characteristics are adequate (Brass, 1996; 453). Therefore, the rational for indirect estimation is that in populations where reporting of events for a reference period is unreliable, other types of more accurate demographic data may be obtained, then transformed into desired vital rate estimates. The objective is to take into account the most probable sources of errors and minimize their influence on the estimated parameters. Based on the analysis of models and plausible hypotheses, indirect demographic techniques introduce some degree of order and consistency into what would have otherwise been an amalgam of errors (United Nations, 1983).

There are different types of indirect estimation procedures. There are those that transform the observed variables related to the parameter into the desired parameter. On the other hand, there are indirect techniques that compare the demographic parameter for consistency, and if necessary, adjustments with indirect indicators related to the parameter are employed. In both cases, transformation or comparison, "there is imposition of simplifications in order to reduce to manageable proportions of the potential variability of the real world" (Zlotnik and Hill, 1981: 103). These simplifications of variability by age or over time, represent the cost of being able to use related, but more easily observable variables in the estimation procedure. Therefore, indirect techniques rest on different methodological basis and assumptions about the demographic conditions in a population. Hence each technique is considered in terms of its data requirements, the assumptions of the model which it is based on, and its robustness when applied under conditions which deviate from those assumptions.

Most imperatively, it is worth highlighting that the indirect estimation models do not necessarily reflect true estimates and as thus can be sources of error themselves if the underlying assumptions are violated (Muhwava and Timæus, 1996). Other developments, which are an important integral of demographic estimation, though not the crux of this dissertation, are those robust to data capturing and recording errors. In order to comprehend the techniques themselves, it is imperative to understand the reasons for deficiency in the data collection systems in developing countries and some of the errors associated with demographic data in these countries.

## 2.2 Why Poor Data in Developing Countries?

It is clear that incomplete and/or inaccurate data on vital events is the primary reason for indirect demographic techniques. But the important question to ask is why developing countries suffer from poor data quality. An efficient registration system provides size, trends, patterns and causes of vital events, hence in the absence of such a system, indirect techniques are employed. It is reported that sub-Saharan Africa had 17 million unregistered births in 2000, representing 70% of births, while 3 million was estimated for middle east and north Africa (UNICEF, 2003). According to UNICEF, unregistered children are denied identity, privileges and protection granted to citizens since in legal terms they do not exist. These are mainly children from poor and remote households, who are not born in health institutions - where birth records are mainly taken (ibid). Their non-status subjects them to even more poverty and exclusion.

There are a number of different reasons, which are attributed to the deficiency of vital registration systems in developing countries. Among the many reasons in African countries, political instability, institutional disorganisation and lack of resource play a crucial role (United Nations, 2003; Cleland, 1996). Given the pressing needs and demands in many these countries, basic needs are prioritised over everything else, consequently the running of a registration system is often compromised.

> By default, systems have to be passive; the impetus and much of the cost of registering births and deaths must come from the individuals affected, but many will not co-operate unless they face legal sanctions for failure to comply, or see a positive need or advantage to themselves in registration (Cleland, 1996: 435).

This supports a similar allegation posited by Adlakha and colleagues (1980) that the general perception that individuals derive little or no benefit from the vital registration attributes to the nature of the registration systems in developing countries. Because of the levels of socio-economic and political deterioration in many of these countries, citizens seem to have lost hope in governments and other formal agencies, as a result there is lack of cooperation between these spheres. Although vital registration is a legal requirement in many countries, the limited access to registering institutions, as well as lack of law enforcement and/or positive incentives to register, renders the system very inadequate.

Moreover, while recording of vital events might be a foreign practice in many African countries, also posing as a problem is that the need to produce a certified record of a vital event often comes later in a person's life (United Nations, 2003). More often than not, people tend to report vital events when they are requested to produce certificates. Unlike death registrations, which are often requested by insurance agencies and local authorities for burial ground permits, birth registration is compromised because of lack of such demands. In many developing countries, children are mainly required to produce their birth certificates when they start school and when they request passports (Muhwava, 2002). If no request is made, individuals would go unrecorded in the official records. Therefore, populations with high none school attendance and low international migration are likely to have high unregistered births. Even those who register, sometimes tend to give wrong information, particularly age, either due to ignorance or to their own convenience (ibid). As a result, estimation of vital rates using national registers in African countries is problematic.

On the other hand, censuses and surveys data do not necessarily provide a solution to recording of vital events as they also suffer similar defectiveness. The essential features of a population census are individual enumeration, universality, simultaneity and defined periodicity (Shryock and Segel, 1976:29). This definition makes censuses the next best option to vital registration, since they take an account of specific demographic characteristics of every individual within a given country. In particular, lack of financial and manpower resources compromise the quality of information gathered through censuses in many African countries (United Nations, 2003). These censuses suffer from coverage and content errors. For instances, they do not necessarily enumerate all persons resident in the country, and for those who are enumerated, some of the information collected is erroneous (ibid). Smith (1994) has also alluded to the evident sex and age differential coverage among young children, as well as differentials between urban and rural areas.

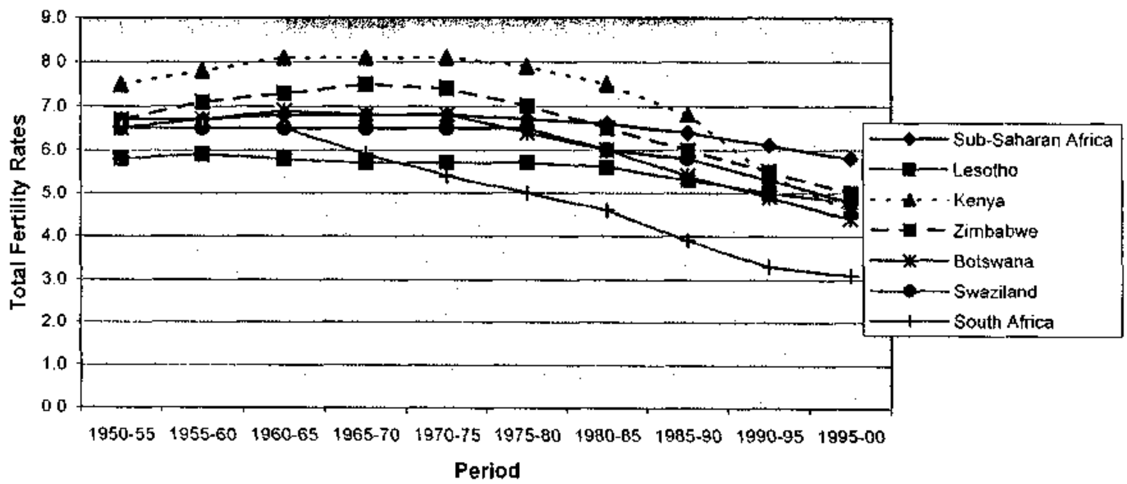
With reference to fertility estimation, census data in sub-Saharan African countries experiences poor age reporting across all ages. These age errors are caused by ignorance, lack of knowledge and misreporting of correct age, carelessness in recoding, a tendency to prefer or dislike certain digits, a tendency to overstate or understate age, and misstatements arising from other motives (Kpedekpo, 1982). Brass (1996: 453) also ascribes census weakness to lack of regular series of data collection. For instance in many sub-Saharan African countries, censuses are conducted after every ten years mainly due to lack of resources. Ten years is a long period in which many vital events can happen as well as change more than once to an individual. As a result, it is likely to be difficult for respondents - together with interviewers - to be able to trace and capture detail accounts of all events. Moreover, comparison of these events with previous censuses becomes dubious due to complex dynamics within populations. Epidemics and exodus can come and go within the intercensal period, and resultant population changes are likely not be captured (ibid).

From the above overview, central to data problems in developing countries is the search for the most cost-effective means to obtain data of reasonable quality. This has called for specific surveys to analyse demographic parameters (Cleland, 1996). In sub-Saharan Africa, the study of fertility came to the fore in the 1970s. In particular, the interest intensified after the 1980s when a region that has sustained the highest fertility levels, showed some signs of fertility decline. The Contraceptive Prevalence Surveys (CPS), World Fertility Surveys (WFS), and Demographic and Health Surveys (DHS) were endorsed in sub-Saharan Africa, and these have made a major contribution to the study of fertility in the region (ibid). Nonetheless, these did not escape data quality problems such as sampling coverage and content errors (Srinivasan and Muthiah, 1987). Similar to censuses, these surveys have experienced misreporting of age and births. Consequently, despite the growing fertility data collection, adjustments are still required to provide reasonable fertility estimates in the region.

## 2.3 Fertility Levels and Trends in Lesotho

Sub-Saharan Africa has the highest fertility levels in the world (Caldwell et al., 1992; Gaisie, 1996). As illustrated in figure 2.1 below, the region had an average TFR of 7 children per woman, with countries like Kenya ranging at 8.1 children, before the fertility transition occurred. However, many countries are now showing some signs of fertility decline. Although Lesotho does not feature among the sub-Saharan African fertility transition champions, it has an estimated TFR of 4.1 that matches some of these region champions (Mturi and Hlabana, 1999; Bureau of Statistics 2003b). It is clear from figure 2.1 that in the early 1950s the level of fertility in Lesotho was the lowest in Southern Africa. It has been posited that the low level of fertility is mainly due to spouse separation, where male labour migration in South Africa (Makatjane, 1994). However, the decline trajectory of TFR in the country was relatively very marginal. While South Africa experienced high and consistent declines by the late 1960s, Botswana and Zimbabwe followed the decline in the 1970s, and Kenya, Lesotho and Swaziland in the 1980s.

**Figure 2.1 Fertility Trends in Lesotho Compared with Other Sub-Saharan Countries, 1950-2000**




**Source**: United Nations (2001)

The apparent rate of declining fertility trends in the sub-Saharan Africa renders Lesotho lagging behind in the fertility transition (Gaisie, 1996; Caldwell and Caldwell, 2002). According to the Bureau of Statistics (2003b), fertility in Lesotho has declined from a TFR of around 5.4 in 1976 to 4.1 in 2001. This gives a 25%

fertility decline over a period of 25 years, which is a modest decline compared to the regional fertility transition champions. For instance, Botswana experienced a 23% decline in TFR from 6.5 to 5.0 children per women, in 1984 and 1988 respectively; while Zimbabwe experienced a 15% decline from 6.5 to 5.5 over the same period (Thomas and Muvandi, 1994). Udjo (2003) went further to indicate a 35% decline in TFR from 4.9 children in 1970 to 3.2 children in 1995 in South Africa. Lesotho presents an interesting demographic characteristic – from lowest fertility level and yet the least fertility decline among Southern African countries sharing some similar socio-economic characteristics. This trend needs to be validated and explored in detail.

The Lesotho Bureau of Statistics is the main collector of fertility data in Lesotho.[2] Based on the 1986 and 1996 population census, as well as the 2002 Lesotho Reproductive Health Survey, Table 2.1 presents TFR estimates in the country. First, the reported TFR, suggest irregular fertility levels in Lesotho where in 1986 women in Lesotho reported an average of 4.6 children per woman, followed by a sharp decline of 32.7% to 3.3 children per woman 10 years later. However, within a period of 6 years, the reported fertility increased by 28.3%. Cohen (1993) has mooted that observed erratic fertility trends are attributed to the poor data quality in most developing countries. Other fertility studies have suggested that fertility decline takes a while before it can stabilise, or rise again (Zopt, 1984; Gaisie, 1996; Kirk, 1996). Unlike mortality which experienced dramatic declines, changes in fertility are often found to be gradual unless there are serious socio-political, economic or biological changes to effect such huge changes (Kirk, 1996). Because of this understanding, and the evident inherent errors in the fertility data, reported fertility rates were disputed. At the same time the 1996 census estimates is even more questionable.

**Table 2.1 Total Fertility Rate Estimates in Lesotho**

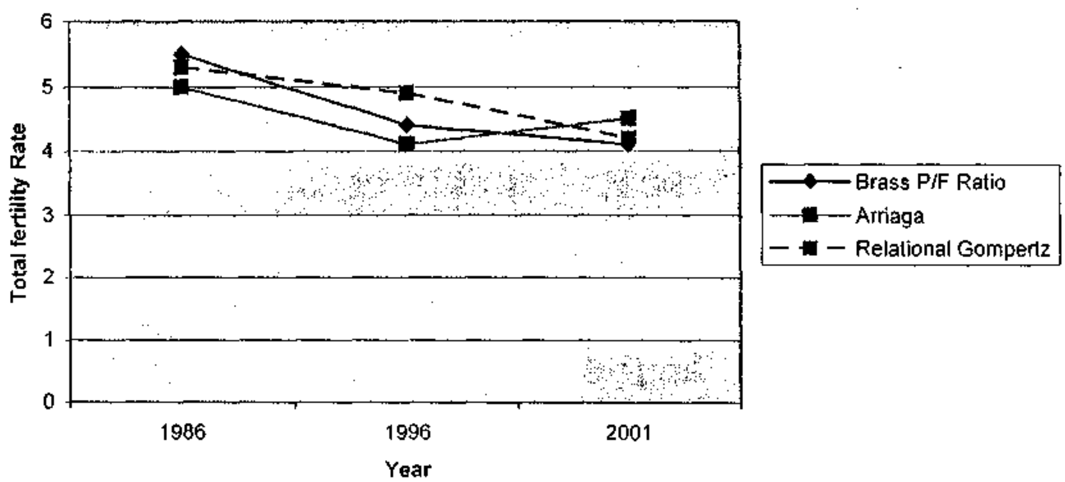
| Method | 1986 | 1996 | 2002 |
|---|---|---|---|
| Reported | 4.9 | 3.3 | 4.6 |
| Brass P/F Ratio | 5.5 | 4.4 | 4.1 |
| Arriaga | 5.0 | 4.1 | 4.5 |
| Relational Gompertz | 5.3 | 4.9 | 4.2 |

[2] The Bureau of Statistics is a government agency mandated to coordinate, monitor and supervise the national statistics system through collection, processing, analysing and disseminating national statistics, (Lesotho Bureau of Statistics, Act, 2001).

**Source**: Bureau of Statistics (2003a)

Indirect techniques - Brass P/F ratio, Arriaga and the Relational Gompertz models - were employed to improve fertility estimates in Lesotho. Despite the fact that the above methods use the same data on children ever born and births in the twelve months prior the survey dates, each method yielded different estimates and fertility patterns in Lesotho. This could be due to the different methodological assumptions. The P/F ratio uses an adjustment factor to match the cumulated age specific fertility rates with the reported average parities (Brass, 1964). The method suggests that Basotho women bore 5.5 children during their reproductive period based on the 1986 census, which was followed by a 20% and 6.8% declines in 1996 and 2002 respectively. The methodological details of this method will be discussed later, however, the most hooted flaw is the assumption of constant fertility. Contrary to this assumption, results from this same method suggest a fast declining fertility trend in Lesotho as depicted in figure 2.2. Violation of this basic assumption renders the Brass P/F estimates plausible. Other studies on fertility in Lesotho have suggested a moderate fertility decline in the country (Matabane, 1996; Mturi 1998; Mturi and Hlabana, 1999).

**Figure 2.2 Total Fertility Rates by Method of Estimation in Lesotho**




**Source**: Bureau of Statistics, 2003a.

The Arriaga method, on the other hand, is one of the Brass P/F ratio refinement and modification. This method makes provision for changing fertility levels by using a linear interpolation of children ever born by age of the mother from two or more censuses (Arriaga, 1983). The method provides estimates of children ever born for one year prior to the census date. As indicated in figure 2.2, similar to the reported estimates, the estimates from the Arriaga method suggest inconsistent fertility levels in Lesotho. TFR declined by 18% between 1986 and 1996, then increased by 10% within a period of 6 years. This irregular fertility behaviour is also not accounted for nor the methodological implications highlighted in the Bureau of Statistics reports.

Another Brass P/F ratio refinement and modification is the Relational Gompertz model. The model is used as a diagnostic tool and estimation technique for the evaluation and adjustment of fertility estimates obtained from retrospective reports on period and recent fertility (Zaba, 1981). Like the Brass' P/F ratio method, the Relational Gompertz model indicated declining fertility trend in Lesotho (refer to figure 2.2). However, converse to the former, this latter method yielded lower TFR estimates for 1986 and 2002, and a higher estimate for 1996. Why these differences are observed, the Bureau of statistics makes no mention, but declares that

> … in terms of trends, the estimates based on the Relational Gompertz method fared better than those based on the Arriaga method. Consequently, the total fertility rate based on the Relational Gompertz method is recommended. (Bureau of Statistics, 2003: 125).

This statement is based on the fact that the two methods (Arriaga and Relational Gompertz) do not assume constant fertility. However, the recommendation of the Relational Gompertz over the Arriaga method is not clear. It is important to understand that these techniques are based on specific data requirements and methodological assumptions about the population, which if violated, compromises the estimated parameters. The Bureau of Statistics censuses and surveys reports provide only an outline on these methodological assumptions without making any inference as to how far the models employed suit the data. This raises concern about the plausibility of the estimates. Most notably, the differences between the reported and estimated rates indicate serious data defectiveness and hence the need to articulate such defects, as well as making sure that they do not infringe the use of particular indirect models as this will compromise the accuracy of the estimates.

Mturi (1998) also used the Relational Gompertz model to estimate fertility levels for the 1986 and 1996 Lesotho population censuses. It is interesting to note that using the same data sets and method, Mturi had different estimates from the Bureau of Statistics. Mturi estimated TFR of 5.0 and 4.1 for 1986 and 1996 respectively. It is not clear from the study whether there were any specific data adjustments employed before using the indirect technique. So the question is which estimates, and why, are more plausible between the two studies. Similarly, using reverse survival method, Matabane (1996: 6) estimated a TFR of 4.9 for the 1986 Lesotho population census. This estimate is still different from both the Bureau's and Mturi's estimates. The different estimates suggest that fertility is Lesotho ranged from 4.9 to 5.3 in 1986.

From the above analysis of fertility estimation in Lesotho, it is not clear which estimate, and with what level of certainty or plausibility, should be taken. At the same time, there is no inference to the data quality, as well as how far the data suits the methodological requirements used for the estimation. In order to optimise fertility estimation, it is the interest of this research to (i) evaluate individual variables used for estimation to establish the magnitude of the errors inherent in the data, and (ii) to establish how far the data meets the methodological requirements and assumptions of P/F ratio techniques.

# CHAPTER 3

# DATA AND METHODOLOGY

## 3.1 Data Sources

Traditionally, demographic parameters are based on vital registration systems and censuses; vital registration provides the numerators while census provides denominators of the rates. Censuses are defined as official and complete periodic counts of a population together with its basic socioeconomic and demographic characteristics. Accordingly, information gathered through censuses should provide the best snap-shots for fertility estimation. However, as indicated earlier, deficiencies regarding coverage and content errors threaten the plausibility of this important source of data. On the other hand, vital registration systems are defined as "the continuous, permanent and compulsory recording of occurrences and characteristics of vital events primarily for their value as legal documents as provided by law and secondarily for their usefulness as a source of statistics" (Pollard et al., 1983: 8). This information is gathered by means of issued official certificates. It is therefore imperative to indicate that vital registration is a good source of fertility data because it has a universal coverage supported by legislation, thus compulsory and free from sampling error. An efficient registration system provides size, trends, patterns and causes of vital events. Nonetheless, relative to censuses, this source of demographic data is very deficient in Lesotho with just 4% of births registered in 2002 (Bureau of Statistics, 2003b).

Given the deficiency in the vital registration system in Lesotho, population censuses and surveys have become the primary source of fertility data. Lesotho has been conducting censuses for more than a century, beginning as early 1875 as by the colonial British government (Bureau of statistics, 1998). However, direct fertility questions were first included in the questionnaire in 1976 census. With the censuses conducted every 10 years, fertility levels can be assessed for three periods thus far (1976, 1986 and 1996). This study will use the most recent Lesotho population census data of 1996.

There are also sample surveys from which fertility data can be analysed in Lesotho. For instance, as part of the 41 developing and 20 developed countries in which World Fertility Surveys (WFS) were conducted, Lesotho conducted this survey in 1977. The main aim of the survey was to collect information on levels and patterns of fertility, together with their possible determinants (Bureau of Statistics, 1981 cited in Mturi and Hlabana, 1999: 147). The survey covered a nationally representative sample of 3, 603 ever-married women within the childbearing ages (15-49 years). While the data quality was alleged to be satisfactory, the survey excluded other women who were still at the risk of childbearing regardless of their marital status. Therefore, fertility estimation from this data source is suspicious. On the other hand, Lesotho also conducted a Demographic and Health Survey in 1991/92, which interviewed women on contraceptive knowledge and use, maternity and breastfeeding, immunisation of children, fertility preference etc. These two surveys are more than a decade old hence a bit outdated to estimate recent levels of fertility. This study has opted for more recent national survey data sets. In 2001, the Bureau of Statistics conducted a national survey, the 2001 Lesotho Demographic Survey (LDS). The survey was aimed at updating the 1996 population census by using similar questionnaire as the census. This could have been a rich data set to analyse in this dissertation in terms of bigger coverage, but the Bureau of Statistics (2003a) indicated that fertility information cannot be analysed efficiently as the reported children could not be uniquely identified and correctly linked to their mothers. Recently the 2002 Lesotho Reproductive Health Survey (LRHS) was conducted as a nationally representative survey and supplementary enquiry to the 2001 LDS. This data set is analysed in this study.

### 3.1.1 The 1996 Lesotho Population Census

The Bureau of Statistics conducted a population census on the 14th April 1996 with the aim of collecting demographic and socio-economic data of all persons in the country. This covered all persons resident in Lesotho, including those citizens temporarily absent from households (Bureau of Statistics, 1998). Household heads were the main targeted respondents, failing which any other adult person could respond. Fertility data was solicited for individual women aged 12 years and above regardless of their marital status. This is with the acknowledgement of significant births occurring outside marriage, which have rendered the conventional assumption that women exposed to the risk of childbearing are aged between 15-49 quite limited. In particular, teenage pregnancy is increasing in Lesotho with a significant number of births occurring to girls below 15 years of age (Mohai et al., 2002; Ministry of Health, 2003). Nonetheless, not all women were directly interviewed. Due to resource limitations, eligible women who were not present for interviews were represented by proxies who claim the best reproductive knowledge of the absent individuals. The acceptance of proxy responses is suspected to increase the potential for response errors in surveys (Little and Rubin, 1987), especially in the context of Lesotho where reproductive issues are still a taboo. Unfortunately, errors of this nature are not easy to evaluate except the likelihood of more 'do not know' responses (Preston et al., 2001).

A total of 462, 227 women within the reproductive ages (15-49 years) reported on their lifetime and recent fertility. The following questions were used to solicit information on fertility:

1. How old was (name of household member) on his/her last birthday?
2. Has (name of eligible female household member) given any live birth?
3. How many children born alive were with her on census night?
4. How many children born alive were elsewhere on census night?
5. How many children born alive have died?
6. When was (name's) last live birth?

### 3.1.2 The 2002 Lesotho Reproductive Health Survey (LRHS)

The Bureau of Statistics undertook the 2002 LRHS in February 2002 as a supplementary enquiry to the Lesotho Demographic Survey (LDS) conducted in May 2001. Since the LDS was aimed at updating the 1996 Population Census, it used census-type of questions. Therefore, the supplementary was undertaken to complement the LDS with key themes pertinent for understanding population dynamics. These included reproductive health, sexual behaviour, contraception, HIV/AIDS and other sexually transmitted diseases, as well as issues pertaining to gender and violence against women and children.

Based on the 1996 Population Census frame, the 2002 LRHS sample was designed to be nationally representative and included all districts, ecological zones as well as urban and rural areas. A total of 3, 753 households representing 1% of the total households were enumerated. The 2002 LRHS was a much detailed survey, as it had articulated fertility enquiries better than any other survey available in the country. Contrary to previous surveys, fertility questions were directed to males aged 12-54 years as well. In addition, similar to the 1996 census, fertility enquiries were directed to women aged 12 years and above. However, due to the methodological requirements, this study still adopts the traditional fertility analysis using women aged 15-49 years only. A total of 2, 634 women within the reproductive age reported on their fertility. The survey included a series of detailed and specific questions to facilitate estimation of retrospective and current fertility. The following questions were used in this survey to collect information on fertility:

1. What is your date of birth? Month of birth ___ and Year of Birth____.
2. How old were you on your last birthday? Age in Years
3. Have you ever had a live birth, even if the child is no longer alive or died soon after it was born?
4. How many children have you born alive in total?
5. How many sons are living with you?
6. How many sons are living elsewhere?
7. How many sons are dead?
8. How many daughters are living with you?
9. How many daughters are living elsewhere?
10. How many daughters are dead?
11. So altogether you had ___ children? (reconcile and write the confirmed total)
12. Have you had any live births in the past 12 months
13. If yes, how many boys and how many girls?
14. How many boys and how many girls are still alive?

It is obvious that the 2002 LRHS had more comprehensive questions aimed at minimising reporting errors. In view of this, assuming that the survey is representative, it would be expected to be the most appropriate data set to estimate recent fertility levels in Lesotho.

This dissertation uses the raw data from both the 1996 Populations Census and the 2002 LRHS to assess the application of the P/F Ratio method in estimating fertility levels in Lesotho. Raw data allows for basic data evaluation so as to enhance the general analysis of the research, and to ascertain the reliability of the fertility estimates derived from these data sets. The data sets also permit direct estimation of fertility and this will be used to compare with the indirect estimates.

## 3.2 Methodology

One of the key questions that confront social scientists using particular data sets for research is; what is the nature and magnitude of errors inherent in the data collected, with specific reference to the variables of interest? This question is the underpinning thrust of this research, because the usefulness and reliability of the fertility estimates derived from the data sets depend on the quality of the data collected. In order to ascertain data quality, the research tabulates and observe graphically the patterns of age and fertility reporting. Myers' Blended Method and the Age Ratio Method are also used to assess possible age-reporting errors. Where possible, the data is cleaned in order optimise the application of the P/F ratio techniques.

### 3.2.1 Data Quality

The research uses both the Myers' Blended Method and the Age Ratio Method to evaluate and adjust age data (for methodological details see Shryock et al., 1973: 203). As indicated earlier, age errors arise from coverage errors, failure to record age as well as misreporting of age. In particular, due to high levels of illiteracy and ignorance, age data from developing countries has been found to have high concentration at particular digits (ibid). The Myers' blended index is widely used to test age accuracy for single year distributions because it helps to identify whether there is a preference for ages ending in certain digits over others. The index shows the preference for, or avoidance of, each of the ten digits between 0 and 9 inclusive. By blending the population is such a way that each digit has almost an equal sum, the blended totals for each of the ten digits are expected to be nearly 10% of the grand total. Thus, the index represents deviation from 10% of the proportion of the total population reporting on the given digit; that is the extent of over-selection or avoidance of a particular digit. The index ranges from 0, indicating no age heaping, to 90, indicating that all ages are reported at a single digit.

On the other hand, the Age Ratio Method uses age-groups to detect the extent of age reporting error. An age ratio is defined as "the ratio of the population in the given age group to one-third of the sum of the populations in the given age group itself and the preceding and following groups, times 100" (Shryock et al., 1973: 218). The age index of the method assumes that variations from 100 imply shifting in reporting age; where an index below 100 suggests understating of age and an index above 100 suggests over stating of age.

### 3.2.2 The Brass P/F Ratio Method

The P/F ratio method was originally developed by William Brass and subsequently refined by a number of demographers. The method is a procedure for comparison of period fertility rates with reported average parities (Brass, 1964). The ratio of lifetime fertility to cumulative fertility, under a certain logical relationship and assumptions, is used to adjust levels of age patterns of fertility by the levels of fertility implied by the average parities of young women in order to obtain true estimates of recent fertility in a cohort (UN, 1983: 32). This is in light of that, the total number of children ever born (CEB) to a group of women of a given age should give a record of their childbearing experience from the beginning of their reproductive life to current period. Thus, average parity is a measure of fertility experience of a cohort. In addition, when age-specific fertility rates (ASFR) are cumulated upwards from the age at which childbearing begins, this should give the average number of children ever born for that cohort. Therefore, the logical relationship in this context is that, as a cohort of women moves through life, the average parity at each age equals the cumulated ASFRs to that age, provided that the fertility of surviving women is equal to that of women dying during the interval. Denoting F as the cumulated age-specific fertility rates up to age x calculated from current births, and P as the corresponding average parities, and if fertility remains constant and reporting is accurate, the series of F values should be equivalent to the corresponding series of P values. This then translates that the P value of women at the end of child bearing should reflect the TFR of that cohort.

Due to high levels of illiteracy (and probably ignorance of numbers) in less developed countries, there are often substantial omissions in the reported number of children ever born (CEB) to older women, but the reported numbers for younger women are generally more reliable (UN: 1983). According to Brass and Coale (1968), the events which young women are asked to recall have happened recently; the total number of births to each are typically not more than 2 or 3 so that the difficulties of counting large numbers in an illiterate society does not arise; and living children would often be present at the interviews and few will be omitted because they've grown up and left the household. Therefore, the P/F ratio method goes further to assume that reporting of births by younger women is accurate, thus their information is used as a correction factor. Assuming that age misreporting is the same for all women, the method acknowledges the P/F ratios of younger women to be fairly constant.

However, age-group 15-19 often shows erratic values that are attributed to uncertainties in age reporting by these women (Brass, 1996; 456). In updating the demography of tropical Africa, Adegbola (1977) indicated that it is important to take note of mis-recording of young women's fertility. Younger women who are believed to be least inclined to forget tend to have no children, and this is often documented as 'not stated'. As a result, failure to adjust for the mis-recording problem accounts for the general shape of the P/F ratio, where the curve tend to steeply decline between age groups 20-24 and 25-29. This would result in wrong estimates when using their P/F ratios as the adjustment factors. The adjustment factor for mis-recording of 'not stated' fertility has been suggested by El-Badry (El-Badry: 1961 cited in United Nations 1983: 230).

Coale and Trussell further developed a set of multipliers with which to derive comparable parity equivalents from current fertility rates (United Nations, 1983; 33). From these multipliers, it is possible to obtain parity equivalents of current fertility rates for ages above 20 and to compare them with lifetime fertility data. Thus, the P/F ratios for younger women aged 20-24 and 25-29 are used as the most satisfactory correction factor (multiplier) for all the current fertility rates. This has provided estimates that have been found to be consistent for many populations (Hobcraft, et. al, 1982).

On the other hand, information on current fertility may be incorrect for all women due to misconception of time, however, the method assumes that the reference period error is the same for all age groups. This does not alter the fertility pattern, however, the level of fertility is subject to errors. Thus the P/F ratio method combines the most accurate information available in order to obtain estimates of age-specific fertility rates for the recent past. The level of fertility is derived from the reported parities of women in their twenties or thirties, whereas the age pattern of fertility is derived from reported fertility rates during the 12 months preceding the census or survey.

In a nutshell, the P/F ratio method makes the following main assumptions:

1. Fertility has been constant in the recent past,
2. Young women report their fertility fairly accurately, and
3. Age-misreporting and under reporting of births are the same across all age-groups.

#### 3.2.3.1 Original Brass P/F Ratio Methodological Procedure

The P/F ratio method follows the subsequent procedure in order to estimate fertility levels (see UN, 1983: 32 for details):

**Step 1.** Estimation of the Reported Parities in each age-group

$P_i$ denotes the reported average parity of women in age group i. This is computed by dividing the total number of children ever born (CEB) to women in age group i by the total number of women in that age group ($W_i$).

$$P_i = \frac{CEB_i}{W_i}$$

Where i is age-group 1= 15-19 years, 2 = 20-24, ..., 7 = 45-49.

**Step 2.** Estimation of the Preliminary Fertility Schedule

Denoting the fertility rate of women in individual age groups as $f_i$. This is computed by dividing the number of births ($B_i$) that occurred in the previous year to women aged i by the total number of women in that age group ($W_i$).

$$f_i = \frac{B_i}{W_i}$$

**Step 3.** Estimation of Cumulated Fertility schedule for a Period

This is denoted by $\phi_i$ and is computed by multiplying the fertility rates computed in the previous step.

$$\phi_i = 5 \left[\sum_{j=0}^{i} f_j\right]$$

**Step 4.** Estimation of Average Parity Equivalents for a Period

The average parity equivalents are denoted $F_{(i)}$ and these are estimated by

$F_{(i)} = \phi_{(i-1)} + af_i + bf_{(i+1)}$, for i = 1, 2, 3, 4, 5, 6

and obtained slightly differently for F = 7

$F_{(7)} = \phi_{(6)} + af_{(i-1)} + bf_{(7)}$

Where *a* and *b* are corresponding age group coefficients for interpolation between cumulated fertility rates. These coefficients were derived by Brass who used simple polynomial model of fertility to calculate the relationship between the average parity and cumulated fertility for successive age groups for a range of age locations of the fertility model. Coale and Trussell (1974 cited in United Nations, 1983: 33) went further to propose fitting a second degree polynomial to three consecutive values of $\phi_i$ in order to estimate the average parity of women of an age group within the rage through evaluation of the integral of the polynomial. The interpolation equation that is used is

$F_{(i)} = \phi_{(i-1)} + a_{(i)} f_{(i)} + b_{(i)} f_{(i+1)} + c_{(i)} \phi_{(7)}$

Where the a, b and c parameters were estimated using least-square regression to fit the equation to model cases constructed using Coale-Trussell fertility model.

**Step 5.** Calculation of Fertility Schedules for Conventional Five-year age-groups

The age specific fertility rates ($f_{(i)}$) computed in step 2 above have been calculated from births that occurred during the preceding twelve months of the survey and these are classified by the ages of women at the end of the period. Therefore, these are specific for unorthodox age groups that are shifted by six months. In order to estimate a fertility schedule for conventional five-year age groups, $f^{+}_{(i)}$, the unorthodox age groups can be weighted using the following equation

$f^{+}_{(i)} = \{1-w_{(i-1)}\} f_{(i)} + w_{(i)} f_{(i+1)}$

where $w_{(i)} = x_{(i)} + y_{(i)} f_{(i)} / \phi_{(7)} + z_{(i)} f_{(i+1)} / \phi_{(7)}$

and the respective values of x, y and z coefficients are obtained by fitting the equation by least-square regression to the Coale-Trussell fertility model. It should be noted that there is no weighting factor for the last age group (i=7) since childbearing is assumed to cease after age 50. Although there are births occurring to women aged below 15 and to those aged above 49, this research ignores all these births in order not to misrepresent the denominator, which is women aged 15-49.

**Step 6**. Adjustment of Period Fertility Schedule

The P/F ratio method compares the average parity equivalents, $F_{(i)}$, with the reported average parities, $P_{(i)}$. Therefore, using the quantities computed in the preceding steps, the ratios of $P_{(i)}/F_{(i)}$ are calculated and these ratios should be fairly similar for different age groups (i). Given the often defective data in developing countries, these ratios are often far from being constant across all age groups. It should be noted that all the ratios are important as their pattern may be used to detect errors or changes in the fertility of the cohort. As is often the case, if children ever born are increasing omitted by older women, the ratios will tend to decrease as age increases, and this is expected over the age 30 or 35. Therefore P/F ratios of these women are discarded. Again $P_{(1)}/F_{(1)}$ is often disregarded because of the intrinsic difficulty in estimating $F_{(1)}$. Nonetheless, $P_{(2)}/F_{(2)}$ and $P_{(3)}/F_{(3)}$ have been found to be reasonably consistent, thus these ratios are used as an adjustment factor for the period fertility rates (Brass, 1996). In cases of disparity between the two ratios, a weighted average of the two is used. On the other hand, when there is evidence of declining fertility in a population, the value of $P_{(2)}/F_{(2)}$ is recommended as an adjustment factor as this is likely not to be affected by the decline. The adjustment factor for this dissertation is derived as

$$K = \frac{P_{(2)}/F_{(2)} + P_{(3)}/F_{(3)}}{2}$$

Thus an adjusted fertility schedule, $f^*_{(i)}$, is computed by multiplying the fertility rates for conventional age-groups, $f^+_{(i)}$, by the adjustment factor, K.

$$f^*_{(i)} = Kf^+_{(i)}$$

where K indicates the magnitude of under or over-reporting of observed current fertility compared to the average parities.

**Step 7.** Estimation of Fertility Rates

From these adjusted fertility schedules, total fertility rate (TFR) can be estimated as

$$TFR = 5\sum f^*_{(i)}$$

Some defects have been identified in the P/F ratio method. According to Zlotnik and Hill, (1981: 104), the original P/F ratio method may not represent reality adequately and thus likely to lead to bias estimates due to the simplification of the assumptions inherent in the application of the method. In particular, the assumption of constant fertility for a period of more than twenty years preceding the survey date so that the cohort and the cumulated period fertility are equal, has proved to be very flawed (Feeney, 1996). While the discrepancies between the cohort and cumulated period fertilities are usually ascribed to reporting errors and an adjustment factor for these errors can be permitted, there has been evidence of declining fertility of which the observed discrepancies may be genuine. Thus the use of an adjustment factor is likely to result in distortions. Zlotnik and Hill (1981) alleged that "the regularity they have to impose on the data in order to achieve the degree of simplification required prejudices the accuracy of the estimates they yield" (p. 104). It should be noted that these methods were developed when there was rudimentary knowledge of the vital rates in countries where indirect estimation was needed. The available evidence did not indicate rapid changes in vital rates and these were the basis on which indirect techniques were developed. But times have changed, knowledge has broadened and there is clear evidence of declining mortality and fertility. However, the data quality still needs to be compensated. This called for new developments of indirect techniques as well as the refinement of the Brass P/F ratio technique in order to accommodate the recent population dynamics.

Feeney (1996) has suggested a new interpretation for Brass P/F ratio method when fertility is declining. In instances of declining fertility, current fertility values will be lower than parity values across all ages even when recent and life time fertility are reported completely. This is because the P values cover the fertility before the change and after the change of the cohort. In addition, if the rate of the fertility decline has been constant over the life of the cohort, then the divergence between the F and the P values will increase with age, yielding increasing P/F ratios. It is therefore, suggested that the best adjustment factor to use in this case will be the P/F ratio of women aged 20-24. On the other hand, if it is only the children ever born that are completely reported, the P/F ratios will still rise but the overall level will be lower. Therefore, the P/F ratio that will be better for the adjustment factor will be that of older women since P/F ratios increase with age. However, to reduce likely errors that could be confounded in the data sets, this research will use the best P/F values presented by the data, with higher emphasis on younger women.

In addition, the Brass P/F ratio method has frequently been used as a diagnostic tool in evaluation of quality of fertility data (Hobcraft et. al, 1982). Deviations of cumulated recent fertility (F) from average parities (P) clearly indicate existence of errors in reporting of maternity experience of a cohort. If the level of recent of fertility is overstated or understated, reported parities can be used to adjust recent age specific rates to yield the correct level of fertility. Although reported number of births twelve months prior the survey might be incorrect, the proportionate error might be constant across the ages, so that the age pattern of recent fertility could be accepted even when the level is disputed.

### 3.2.3.2 The Relational Gompertz Model

The relational-Gompertz Model was initially designed to measure the force of mortality in 1825 by Benjamin Gompertz. In the early 1960s, the model was developed for fertility estimation to represent age-specific fertility rates, and later modified by Brass by introducing a fixed empirical transformation of the age scale (Brass, 1996). Zaba (1981) applies the relational Gompertz model to adjust and correct fertility distributions without assuming that the quality of reporting varies with age of women and that fertility has been constant in the recent past.

Like the Brass P/F ratio, the relational Gompertz provides a diagnostic tool and estimation technique for adjusting and correcting fertility estimates derived from reports on retrospective and current fertility distribution(Brass, 1981). The model is generally used due to its parsimonious parameters, and for its convenient fitting methods. It fits the Gompertz function to reported recent fertility rates (ASFRs) and the average number of children ever born. ASFRs provide the shape of the fertility distribution and data on average parities give corrected age-specific and total fertility rates. According to Brass (1981), the main advantage of the method is that when fitting averages of ASFRs, the estimated F values are less vulnerable to chance and erratic errors in the measures under 25 years than with the traditional P/F ratio multipliers. The application of the model is facilitated by the use of auxiliary measures calculated from the standard, but in many circumstances the estimates of the

TFR are unreliable (Brass, 1996). Changes in fertility over time lead to an increasing divergence of P from F as age increases hence the need for standard distribution. Booth provided the general standards representing age-specific patterns of fertility in Third World countries (Booth, 1984). Later on, Zaba (1981) modified the model by providing the methods for separating the examination of fertility patterns from estimation levels. It is important to note that this model became one of the most satisfactory and widely used method for defective fertility data (Paget and Timæus, 1994).

In the following section, the research presents details of the relational Gompertz model in estimating fertility levels (See Zaba, 1981 and Odimegwu, 1998: 88). The basic equation of the relational model is

$F_x/F= A^{Bx}$ **1**

Where $F_x$ is cumulated fertility up to age x derived from age-specific fertility rates

F is the total fertility rate by the end of the reproductive life.

A and B are constants for a particular set of rates and lie between 0 and 1

This function can be reduced to a linear function of age by taking logarithms twice, thus:

$Y_x = -\ln[-\ln(F_x/F)] = \alpha + \beta x$ **2**

where $Y_x$ is fertility rate at age x

This function gives a broad representation of the pattern of fertility with age, but the shape is not quite right as only the cumulated fertility distribution of middle aged women tend to be linear (Brass, 1974). This violates the assumption that $-\ln[-\ln(F_x/F)]$ follows a straight line. A more efficient method was then developed. Brass (1974) has argued that a better fit can be obtained by introducing a standard fertility schedule which is related to the observed fertility of a population. Booth (1984) provided empirical scale transformation, examined the goodness of fit to observations and investigated the estimation problems. The standard female schedule was constructed for use in societies where total fertility exceeded 5 children. The generic standard was based on 33 fertility patterns generated using Coale and Trussell's model to represent high fertility countries. Thus if $Y_{s(x)}$ represents a standard value, then the relational Gompertz model will be

$Y_x = \alpha + \beta Y_{s(x)}$ **3**

where $\alpha$ and $\beta$ are parameters reflecting the fertility patterns of the population.

$\alpha$ is intercept and $\beta$ is the slope of the plot of the transformed fertility schedule s denotes the transformation for a standard age-specific fertility schedule.

The transformed fertility schedule is assumed to be linearly related to the standard fertility schedule rather than the age, implying similar deviations of the observed and standard fertility from the Gompertz function. If the standard and the observed schedules are exactly equal, then the y-intercept ($\alpha$) is equal to zero, while the slope ($\beta$) is equal to one. However, changes in $\alpha$ change the location of the model, while changes in $\beta$ determine the spread or degree of concentration of the schedule. This model retains sufficient flexibility to generate plausible schedules with very different characteristics from the standard. Newell (1988 in Paget and Timeaus (1994: 334) has indicated that $\alpha$ ranges from -0.5 to 0.5 where -0.5 corresponds to populations with very old childbearing pattern, while 0.5 corresponds to extremely young pattern of fertility pattern. Thus a value of zero indicates that half of the births are born by age 27. On the other hand, the $\beta$ parameter varies from 0.65 to 1.5 where 0.65 suggests a wide spread of fertility distribution, while 1.5 indicates a narrow one.

Brass suggested two procedures for fitting the above equation. One is done by using parity data, and the other uses both lifetime and current fertility data. The estimation equations are defined as thus:

$Z(i) = -\ln[-\ln(P_i/P_{i+1})]$ **4**

$Z(x) = -\ln[-\ln(F_x/F_{x+5})]$ **5**

where $i = 1, 2, 3, \ldots 7$ refers to the five year age-groups, and

$x = 20, 25, 30, \ldots 50$ refers to the age

The model shown in equation 2 holds if $F_x$ is replaced by $P_i$, where $P_i$ is the average parity at age group i. Hence

$Y_i = \alpha + \beta Y_{s(i)}$ **6**

and $Y_i = -\ln[-\ln(P_i/F)]$ **7**

The model is used to examine the age pattern of average parity. It is also used to compare the observed and calculated average parity predicted by fertility models. This is done by taking the average parity of each age-group as a proportion of the total fertility estimate ($P_i/F$). Each proportion is transformed by taking the natural logarithm and changing the sign of the answer; taking the natural logarithm again and changing the signs once more. Equation 6 and 7 are utilized in this manner. $Y_i$ is the transformed relative parity for age i and its values are compared with model $Y_{s(i)}$ ratio.

The series

$Z_i = -\ln\{-\ln(P_i/P_{(i+1)})\}$

are calculated and a graph of $Z_i$ - $e_i$ is plotted and compared with the plotted $g_i$ values. The values of $e_i$ and $g_i$ are calculated from standard distributions prepared by Brass (see Booth 1984). Then the Gompertz parameters (values of $\alpha$ and $\beta$) are estimated from this fitted line ($Z_i - e_i$) and applied to the standard values ($g_i$) to compute the TFR. Recall that the $Y_{s(i)}$ are taken from Brass schedules and the fitted $Y_i$ is computed accordingly. Then compute

$P_i/F = \exp\{-\exp(-Y_i)\}$ **9**

The estimated of P/F ratios are used to divide the mean parities by the estimated P/F ratios in order to obtain the TFR. Thus the TFR is estimated by fitting the relational Gompertz model to mean parities of younger women.

When fitting Brass relational Gompertz model to current fertility data, the cumulated observed ASFRs. The cumulated fertility is then expressed as a proportion of total cumulative fertility over the whole range. The equation is as follows

$Y_i = -\ln\{-\ln(F_x/F_{(x+5)})\}$ **8**

The same procedure, as for fitting the mean parities, is followed except that the tabulated standard values used are specifically for current fertility.

# CHAPTER 4

# DATA QUALITY EVALUATION, ADJUSTMENT AND ANALYSIS

The overall task of this dissertation is to produce reliable fertility estimates in Lesotho using the P/F ratio method. While the P/F ratio method takes into account the most probable sources of error and minimise their influence, if the magnitude of these errors is high, then the effect of the method would be clouded. In order to improve estimation credibility, the research embarks on data evaluation in order to ascertain the nature and magnitude of the errors inherent in all variables necessary for the application of the P/F ratio method.

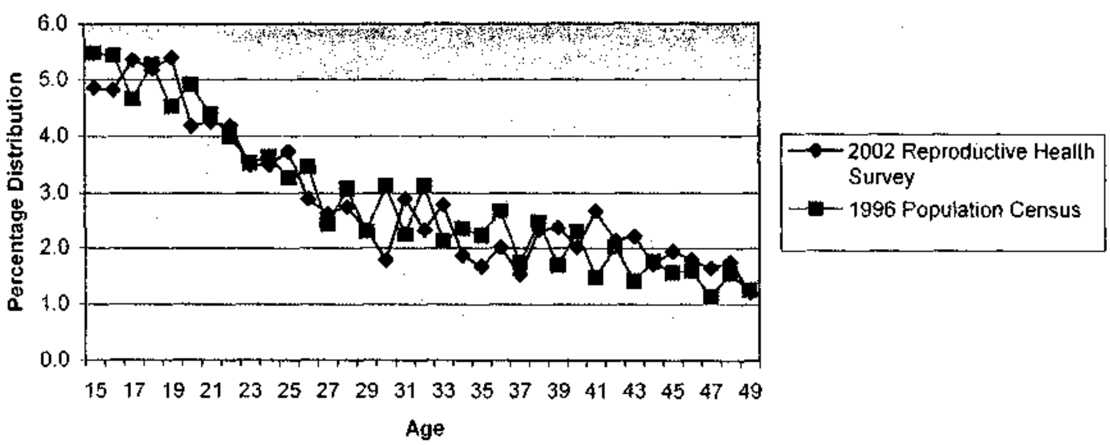
The errors evaluated include errors of failure to report events, misreporting of events and/or errors in the time allocation of events. Shryock and Siegel (1981) assert failure to report events correctly to high literacy levels in developing countries. This argument is also reiterated by Iversen et al. (1999), who suggested that functional literacy such as reading skills and general literacy competence, are associated with reporting errors in censuses and surveys even in a developed society like the USA. In addition, failure to report events is said to increase with the duration of recall lapse (Potter, 1977). Information on women's retrospective births is often subject to recall lapse hence higher levels of misreporting for older women. It is believed that careful interviewing and editing can yield better estimates, nonetheless failure to report events is inherent in the data and must be corrected according to the presumed nature and extent of the error (Bogue and Bogue, 1970 in Potter, 1977: 337). However, verification is limited to individual responses at this point. Preston and colleagues (2001) assert that error assessment is useful even if correction is not feasible "because it indicates the degree of confidence that can be placed in the estimates" (p. 211). This research concerns a set of respondent errors: omitted and misreported responses.

On the other hand, the dissertation acknowledges that the need to produce accurate results may sometimes compromise the integrity of the data. Hence caution is exercised in employing any correctional measures. This chapter is aimed at evaluating the feasibility of the application of the P/F ratio method using the proposed data sets. This will be achieved by objectively assessing the quality of individual variables required in the P/F ratio method. These variables are: the number of women and their age reporting, the reported number of children ever born as well as the reported number of births in the 12 months preceding the census/survey dates.

## 4.1 Coverage Errors

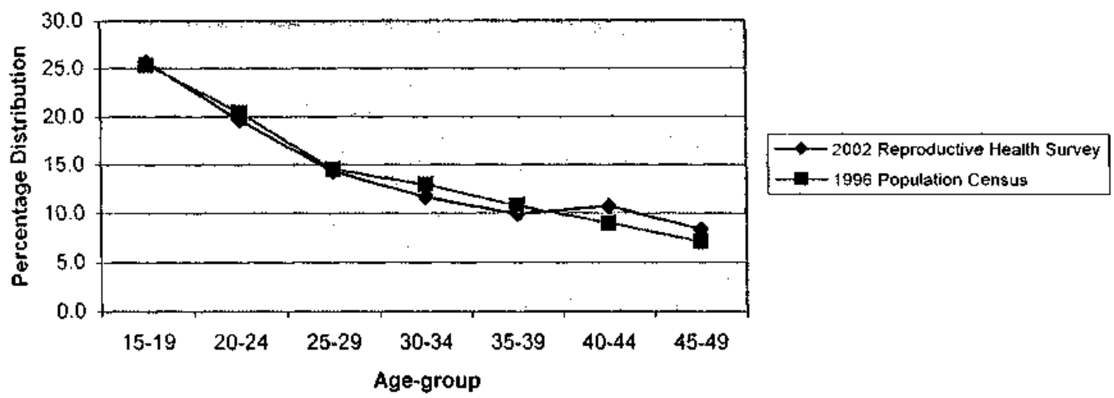
In order to ascertain compatibility between the two data sets, this research first tries to match the distribution of women in the reproductive-ages. Smith (1994) pointed out that fertility estimates can be distorted by unrepresentative samples of women as different sample designs are likely to yield different estimates. This is supported by Muhwava (2002) who suggested that the controversies in Zimbabwe fertility levels and trends are a result of different samples used for estimation. In terms of the representativeness, the Bureau of Statistics (2003b: 2) claimed that the 2002 LRHS sample was designed to be nationally representative and was based on the 1996 Census. It is, however, imperative to cross-check this represetativeness using the age distribution of the reproductive-age women as presented in figure 4..1

**Figure 4.1 Percentage Distribution of Reproductive Age Women by Age in 1996 Population Census and 2002 Lesotho Reproductive Health Survey**




Although there are disparities in the age distribution, there is a similar pattern in both the 1996 census and the 2002 LRHS. The differences in the age distribution could mainly due to sampling errors (over or under representation). On the other hand, these differences can also be a result of age misreporting which will be evaluated in the next sections. Ntozi and colleagues (1997) reiterate that the use of age-groups conceal most of the errors which are due to age misreporting. Based on this acknowledgement, the dissertation further evaluates the population distribution of the women in the data sets using age-groups. Figure 4.2 below displays a better, and systematic decline in population size for both data sets. Because the P/F ratio method uses age-groups to analyse and estimate fertility levels, this research accepts that distribution of the women in 1996 census and the 2002 LRHS is compatible and satisfactory for the research.

**Figure 4.2 Percentage Distribution of Reproductive Women by Age-groups in 1996 Population Census and 2002 Lesotho Reproductive Health Survey**

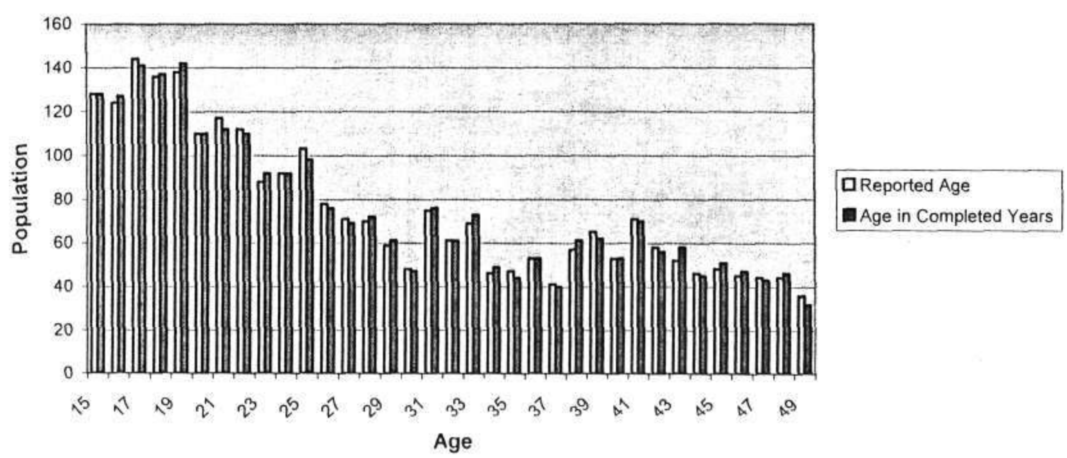



## 4.2 Age Misstatements

A substantial number of corrections were required to make both the 1996 census and the 2002 LRHS fertility data usable in this dissertation. The accuracy of fertility measures depends on the age structure of women, the shape of the age-specific fertility curve, as well as the age range of women under consideration (Brass, 1981). Data on age may be secured through direct questions on age, date of birth or month and year of birth, or by asking these questions in combination. The U.N recommendations allow for inquiring about date of birth or asking directly for age at last birthday (Shryock et al., 1976: 114). While the age reporting errors have been examined intensively in the demographic field, these same errors are still persistent in censuses and surveys data to date. Since the original Brass P/F ratio method cannot correct for distortions reported in age pattern of fertility (Zaba, 1981), it is imperative to minimise these errors in order to improve the methodological estimation. Nonetheless, further estimation using the Relational Gompertz model would take care of such flaws (ibid). This dissertation tests for the most common age errors identified in sub-Saharan African countries.

As articulated earlier, age-misstatement results in misplacement of births and parities, which in turn distorts fertility estimation, even when using the P/F ratio method. It is therefore very important to minimise the effect of these errors on the fertility estimates. The 2002 LRHS asked the women to report their age as well as the month and year of birth as a crosscheck. As observed in figure 4.3, there are disparities between the reported age and age in completed years derived from the Century Month Code (CMC). There is no clear pattern whether age reporting in the 2002 LRHS was over or under reported when using either the reported age or the CMC. But the pattern of age reporting is the same. Since there are no substantial differences in the age reports, the latter age variable – CMC - will be used for fertility analysis, as this is believed to be more accurate than the former.

**Figure 4.3 The 2002 Lesotho Reproductive Health Survey Age Reporting**




Contrary to expectation, it is also interesting to note that the number of women in the survey increases at older ages. There were more older women than middle age women in the 2002 LRHS. It has been stated that women in older ages tend to overstate their ages (Kpedekpo, 1982), and this could be used to explain figure 4.3. Similar to many African societies, gerontocracy is very prominent in Lesotho, with high respect given to the elderly. As a result, some older women tend to exaggerate their age in order to earn the associated respect. In addition, with recent social services rendered for old age (pensions, old-age homes as well as free commodities for the elderly), there is likely to be increasing age overstatement so as to access the services. Consequently, the exaggeration of the age of mothers causes some births to be reported for women beyond the reproductive ages (beyond 50) and these are excluded when estimating fertility in the conventional manner (Zaba, 1981). This also causes inflation in the fertility rates reported at older ages (for women beyond 40 years).

In the application of the P/F ratio method, it is often found that P/F ratios decrease with age of women (Brass, 1996). In most exposition of the method, it is assumed that when fertility has been truly constant, this age pattern of declining P/F ratios is a result of omissions in reported parity, both of children who died a long time ago as well as those who are not living with the mother. Such omissions are presumably more common among older women (ibid). On the contrary, this explanation has been found incomplete in societies where age exaggeration is prevalent (Srinivasan and Muthiah, 1987). Major age exaggeration that increase with age violate the assumption of the correct age pattern of fertility underlying the P/F ratio method, with births at younger ages too low relative to births at older ages. Because parity increases with age, age exaggeration leads to underestimation of parity at all ages. Thus the P/F ratios will be too low for younger women and this will result in a lower TFR estimate when using this method (ibid).

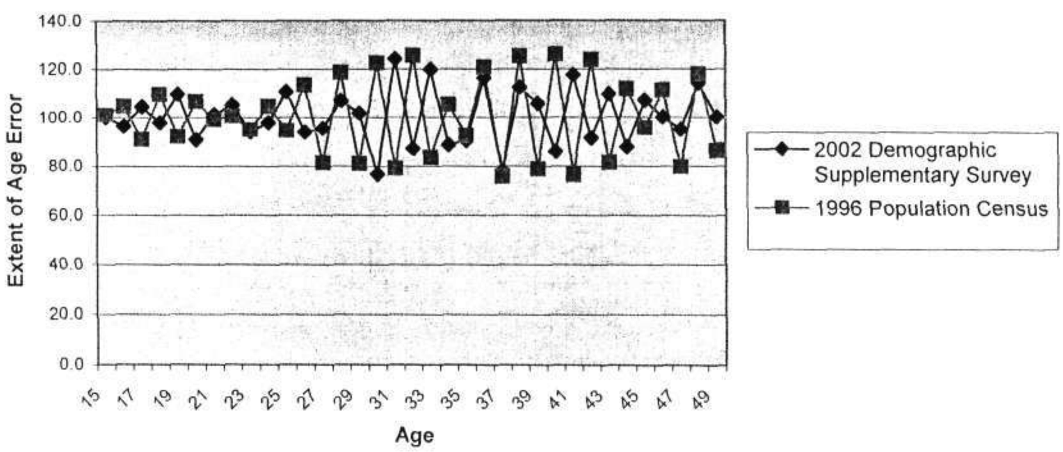
Contrary to older women, research has also discovered that younger women tend to understate their age (Kpedekpo, 1982). Among the many reasons for this behaviour, are the social and economic pressures associated with age. For instance, traditionally a Mosotho woman is expected to marry before a certain age, often mid-twenties, otherwise will be stigmatised, referred to as 'lefetoa'[3] (spinster) (Kimane et al., 1999). With no one wanting to be ostracised, younger women tend to want to remain young (below 30 years) in order to enhance spouse marketability. Moreover, economic pressures as well as women empowerment campaigns such as employment, educational and training opportunities favouring younger women, are likely to exacerbate the understating of age. As a result high and unrealistic fertility rates and parities can be reported at younger ages contradicting the assumption of the correct

[3] Lefetoa literally means one who has been passed.

pattern of fertility. Higher fertility (peak fertility) would be observed at the beginning of childbearing ages. The P/F ratios would also be high at younger ages. Again, while women who have children are likely to be married, therefore not likely to misreport their age in this regard, the increasing non-marital fertility evident in Lesotho is likely subject the data to this error. Moreover, the zero parity distribution of women would be distorted because of age understatement. While fertility and parity distribution would be evaluated later in the chapter, the above controversies rendered the need to evaluate the extent of age reporting error in the two data sets using Age Ratio Method.

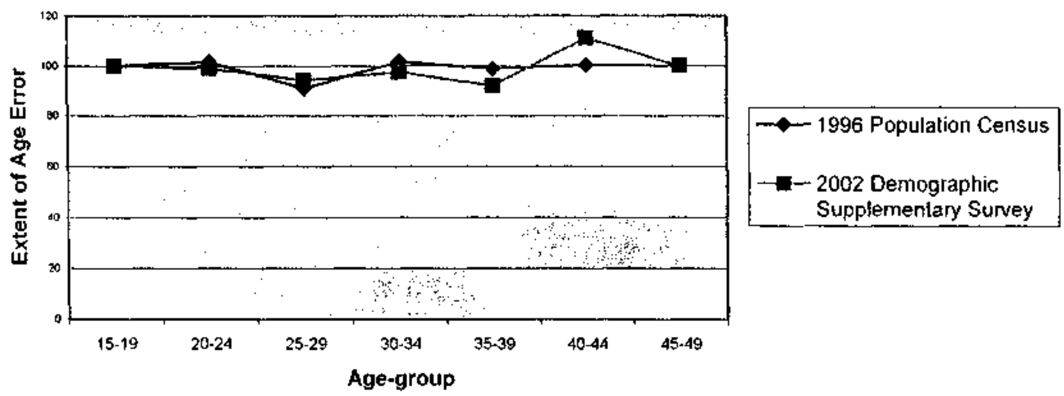
The Age Ratio Method assumes that variations from 100 imply age shifting in reporting of age. Figure 4.4 suggests erratic overstating and understating of age across reproductive-aged Basotho women. This erratic behaviour on age reporting refutes the allegations made earlier about age understatement and overstatement for younger and older women respectively. If this was the case we were going to see 100 and under 100 for old and young women respectively. However, the most striking age errors are observed for women beyond age 30 for the 2002 LRHS, and beyond age 25 for the 1996 census where there is about 20% plus age reporting error. Because these errors are not systematic, it can be assumed that the error effects on fertility estimates would cancel each other.

**Figure 4.4 Detection of Extent of Age Error by Single Ages for 1996 Population Census and 2002 Lesotho Reproductive Health Survey**



When using the same method to detect the extent of age errors by age-groups, a clearer pattern is observed in figure 4.5. Women aged between 25-29 and 35-39 tended to have understated their age in both data sets, with overstatement evident in the 2002 LRHS only for age group 40-44. Again acknowledging that age-groups offer better accommodation of age misreporting, then the magnitude of age misreporting presented here renders the previous allegations insignificant. However, it should be noted that this is not a correction, but age groups conceal most of the errors as suggested by Ntozi et al. (1997). This arrangement also supports the P/F ratio method's use of age-groups in minimising age errors. The most reliable age-groups presented by these results are the 20-24 and 30-34, and these would be taken into consideration for further analysis.

**Figure 4.5 Detection of the Extent of Age Error by Age-group for 1996 Population Census and 2002 Reproductive Health Survey**




On the other hand, there is also a tendency for people to report certain ages at the expense of others (Kpedekpo, 1982). This is referred to as 'Heaping or Digit preference'. While this can occur at any digit, evidence indicates high preference for 0 and 5 digits (ibid). Because of data restrictions on age, the Whipple's Index method to reflect the preference for 0 and 5 digits could not be used[4]. Nonetheless, a method to detect preference for all terminal digits is used. Myer's blended method yields an index of preference for each terminal digit representing the deviation from 10% of the proportion of the total population reporting on the given digit. From table 4.1 below, Myer's blended method indicated 21.25 and 15.45 indices for the 1996 census and the 2002 LRHS respectively. These two indices suggest little and declining age heaping among women in the reproductive ages in Lesotho.

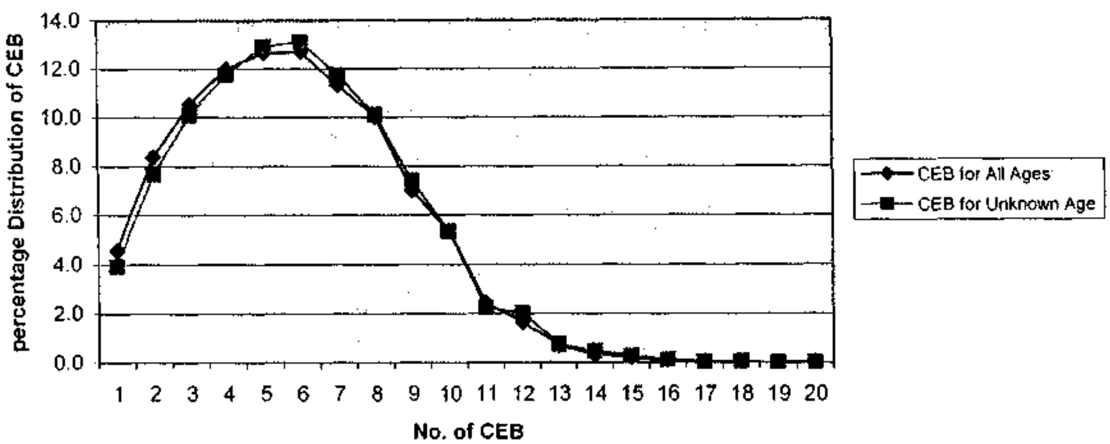
[4] The Whipple's Index method requires data for 23 to 62 age range, but these data sets have data from age 15-49.

**Table 4.1 Myer's Blended Method Results**

| Terminal Digit a | Blended Population | | | | Deviation From 10.00 | |
|---|---|---|---|---|---|---|
| | LRHS | Census | LRHS | Census | LRHS | Census |
| 0 | 1110 | 28144638 | 5.2 | 5.0 | 4.8 | 5.0 |
| 1 | 1684 | 29152976 | 7.9 | 5.2 | 2.1 | 4.8 |
| 2 | 1500 | 35968435 | 7.0 | 6.4 | 3.0 | 3.6 |
| 3 | 1678 | 27497972 | 7.9 | 4.9 | 2.1 | 5.1 |
| 4 | 1400 | 26736705 | 6.6 | 4.7 | 3.4 | 5.3 |
| 5 | 2698 | 88081254 | 12.6 | 15.6 | 2.6 | 5.6 |
| 6 | 2649 | 94388481 | 12.4 | 16.7 | 2.4 | 6.7 |
| 7 | 2648 | 64795820 | 12.4 | 11.5 | 2.4 | 1.5 |
| 8 | 3023 | 98748895 | 14.2 | 17.5 | 4.2 | 7.5 |
| 9 | 2970 | 71811630 | 13.9 | 12.7 | 3.9 | 2.7 |
| Total | 21360 | 565326806 | 100.0 | 100.0 | 30.9 | 42.5 |

Another common age reporting error in Africa is missing age (Kpedekpo, 1982). Omission or failure to report age could be a result of the interviewer having skipped the question or the respondent not knowing or reporting the age. Despite a lot of probing being used to solicit information, some respondents just do not give information (Preston et al., 2001). Missing data usually presents a problem in demographic analysis. Theories of missing data include case deletion, likelihood estimation, imputation, however, recent theories have shifted from seeing missing data as something to be gotten rid of. Rather missing cases should be analysed to examine any response biases (Little and Rubin, 1987). If missing cases are correlated with the outcome of interest, then ignoring it will bias the analysis. According to the Bureau of Statistics (1998) 4.7% of female respondents aged 12 years and above (12-98 years) did not give information on their age in the 1996 population census. Amongst these women, 61% had given birth to 83, 211 children. This amounted to 4.96% of all CEB reported in the census. The research went further to compare the distribution of CEB data for all the women against those who did not report their age. There seem to be no difference evident in CEB reports as a similar curve is observed in figure 4.6. As a result, this research assumes that there is random missingness of the age data thus no imputation is employed in this analysis. The missing cases are deleted from the analysis.

Figure 4.6 Comparative Distribution of CEB for All Ages and Unknown Age - 1996 Population Census




On the contrary, the 2002 LRHS showed 99.2% response rate to age reporting by all women in the survey. This is a better response rate, and the dissertation uses reported age cases only here as well.

Based on the preceding age data evaluation, this dissertation assumes that the age misreporting in the 1996 population census and the 2002 LRHS could have been random among women in the reproductive ages. There is no evident and substantial age misreporting, warranting the age data in the two data sets usable.

## 4.2 Lifetime Fertility

Information on the total number of children a woman has ever born is used to estimate lifetime fertility. A substantial number of corrections were required to make both the 1996 census and the 2000 LRHS fertility data usable. Information on CEB can be affected by age misreporting errors, as well as inclusion of still-births and non-biological children - adopted and fostered children, omission of dead children and children not currently residing with the mother (see table 4.2). It is however, acknowledged that the direction of reporting bias for immigrant and emigrant women depends on whether their fertility is substantially different from that of non-migrants. These women are often missed in the data collection due to their mobility and non representative proxies.

**Table 4.2 Errors in Lifetime Fertility Data and Direction of Bias**

| Error Type | Direction of Bias |
|---|---|
| 1. Dead women omitted | + |
| 2. Emigrant women omitted | + |
| 3. Immigrant women omitted | + |
| 4. Dead or absent children omitted | - |
| 5. Adopted or step children included | + |
| 6. Zero parity reported as not stated | + |
| 7. Not stated reported as zero parity | - |
| Net Effect | Negative (increasing with age) |

**Source**: Zaba 1993 Lecture Notes cited in Muhwava and Timæus (1996: 10)

In the 1996 population census, 187 women in the reproductive ages did not report on their parity. The non-reporting of parities could be a data entry error for women with zero parity, normally young women (see Elbadry, 1961 in UN 1983). When looking at the age distribution of these women, there was no clear bias to suggest that the women who did not state their births are young women whom are likely not have resumed childbearing. Since the unreported parity cases were insignificant proportion of all the women, these women were excluded from the analysis. Reported parities ranged from 0 to as far as 20 children - reported by 9 women. While it is acknowledged that there are variations in fertility among individual women, some women tended to have reported CEB that are biologically not possible when looking at their ages (see Appendix 1). For instance, 2 women aged 20 reported to have had 20 children! There were quite a number of similar unrealistic cases which will not be used in the fertility estimation because they would distort the estimates. Similar unrealistic cases have been deleted when using the P/F ratio method in South Africa (Udjo, 2003), Zimbabwe (Muhwava, 2002) and Pakistan (Feeney, 1996).

The decision to eliminate reported parity cases is often very difficult, unless the reports are just too extreme (Udjo, 2003). Just to recap, the potential or physiological capacity of a woman to bear children (fecundity) is determined by biology. However, the most important determining factor, which demographers often use is age, with parity increasing monotonically with age. There are variations in the median age at menarche among populations, and these vary from 12 years in Western countries, to more than 15 years in poor developing countries (Becker, 1993). According to the conventional fertility level estimation as well as the P/F ratio method, childbearing begin at 15 years for women. Nonetheless, Lucas (1994: 45) has indicated that there are observed births outside the reproductive period, but these are often insignificant. With increasing teenage pregnancy in the sub-Saharan African region, and in Lesotho in particular, this is a methodological short fall.[5] Given age limitations to childbearing, coupled with socio-economic and proximate determinants of fertility, the average maximum potential fertility (total fecundity rate) has been estimated at 15.3 in sub-Saharan Africa (Bongaarts and Potter, 1983). In Lesotho, a similar value of 15.7 has also been estimated (Mturi and Hlabana, 1999). In addition, postpartum infecundability, as a period following birth when a woman is not susceptible to the risk of conception is estimated at 12.4 months in Lesotho (ibid). Therefore, within the 35 years within which a woman in susceptible to the risk of conception, on average a Mosotho woman can, give birth every two years (every 21.4 months). This gives an average maximum fertility of 18 births per woman at the end of her reproductive period. This research acknowledges the possibility of multiple births hence caution is exercised in determining plausible cases.

If childbearing begins at 15 years, then on 'average' a 15 year old woman would be expected to have at the most one child, and because the next birth can only occur 21.4 months later. Then even a 16 year old woman would still have one child, although could be pregnant with the second child. Subsequently, a 17-year-old woman is likely to have two children. A similar logic follows for progressive ages. It is, however, acknowledged that individual women vary in reproductive patterns and levels and hence there are outliers in childbearing. Moreover, the rate of childbearing (age specific fertility rate) also differs across age groups, with a lower but increasing rates at the beginning of childbearing, stabilising in the middle ages, then followed by a declining rate (Preston et al., 2001). For that reason, in order to a minimise errors of misreporting of parities, this dissertation uses age-groups to establish maximum potential CEB by an average Mosotho woman. Based on this information, and table 4.3 below is created to clean the reported lifetime fertility from these data sets and only cases meeting this criterion will be used for analysis. It is important to note that it is possible that some true cases would be deleted during this process, but these are believed to be minimal.

[5] Recent surveys in Lesotho collect fertility information on women aged below 15 years.

**Table 4.3 Age-groups of women and the maximum potential CEB**

| Reproductive Age | Maximum CEB |
|---|---|
| 15-19 | 3 |
| 20-24 | 5 |
| 25-29 | 8 |
| 30-34 | 10 |
| 35-39 | 13 |
| 40-44 | 15 |
| 45-49 | 20 |

This research went further to evaluate the eliminated outliers to make sure they do not bias the fertility estimation. There were 753 cases, which did no meet table 4.3 criterion in the 1996 census. These were mainly young women as observed in table 4.4 below. These findings refute the principal P/F ratio method assumption that younger women report their parity better than older women. As a result inclusion of these cases would compromise estimation of fertility level in Lesotho using the P/F ratio method on the 1996 census data. Overstating of parities by younger women would result in an overestimated fertility level. Therefore, even the cleaned reported parities should be taken with caution when using the P/F ratio method.

**Table 4.4 Women Who Did Not Meet the Maximum No. of CEB Criterion in the Lesotho 1996 Population Census**

| Age-group | No. of Women | Percentage |
|---|---|---|
| 15-19 | 201 | 26.7 |
| 20-24 | 323 | 42.9 |
| 25-29 | 102 | 13.5 |
| 30-34 | 93 | 12.4 |
| 35-39 | 18 | 2.4 |
| 40-44 | 14 | 1.9 |
| 45-49 | 2 | 0.3 |
| **Total** | 753 | 100 |

Further evaluation of the reported parity showed that CEB increased from 957, 075 to 959, 657 children when the women were asked to report the survival and residence status of their children. However, non-response also increased with various enquiry specifications (see table 4.5). This research uses the computed aggregate number of CEB from reports on the number of children currently living with the mother, those living elsewhere and those who have died.

**Table 4.5 Enquiries on Children Ever Born and Outcomes in 1996 Census**

| Variable | No. of Outcomes | No. of Women with No Response |
|---|---|---|
| Reported No. of Children Ever Born | 957274 | 187 |
| No. of Sons Living With the Mother | 335665 | 285 |
| No. of Daughters Living With the Mother | 312950 | 288 |
| No. of Sons Living Elsewhere | 96602 | 315 |
| No. of Daughters Living Elsewhere | 107685 | 317 |
| No. of Sons Dead | 58146 | 327 |
| No. of Daughters Dead | 48609 | 345 |
| Total No. of Children | 959657 | |

On the other hand, errors arising from ambiguous entries made by interviewers during data entry can result in misclassification of children ever born for women of parity zero, as well as those who did not state their parity. These errors include dashes (-) or no responses on the children ever born questions (United Nations, 1983: 230). In particular, this often relates to young women whose parity is zero (Adegbola, 1977). If these errors occur on sufficiently large scales, then the estimation of fertility using the P/F ratio method would be compromised. For instance if a considerable proportion of women with zero parity are classified as unstated parity, then their exclusion from the average parity estimation (P) would result in overestimation of average parity, particularly at younger ages which are used for the correction factor. On the contrary, if women whose parity is not known are assigned zero parity, then their inclusion in the calculation of the average parities underestimates the true average parities.

The 1996 census showed only 0.04% of women who did not report their parity compared to 40.24% of women who reported zero parity. The research went further to verify if there is a relationship between the zero parity women and those who did not report their parity. This was done by plotting the proportions of women with zero parity and those who did not report their parity relative to the total reproductive female population as shown in figure 4.7a and 4.7b below. The figures depict a consistent negative relationship between childlessness and age, and an irregular relationship between age and not reporting one's parity. With this, the research does not find enough evidence to believe that there is a relationship between childless women and women whose parity was not stated, which does not warrant the use of El-Badry's correction, but to discard the unclassified category.

**Figure 4.7a Proportion of Childless Women in the 1996 Population Census**

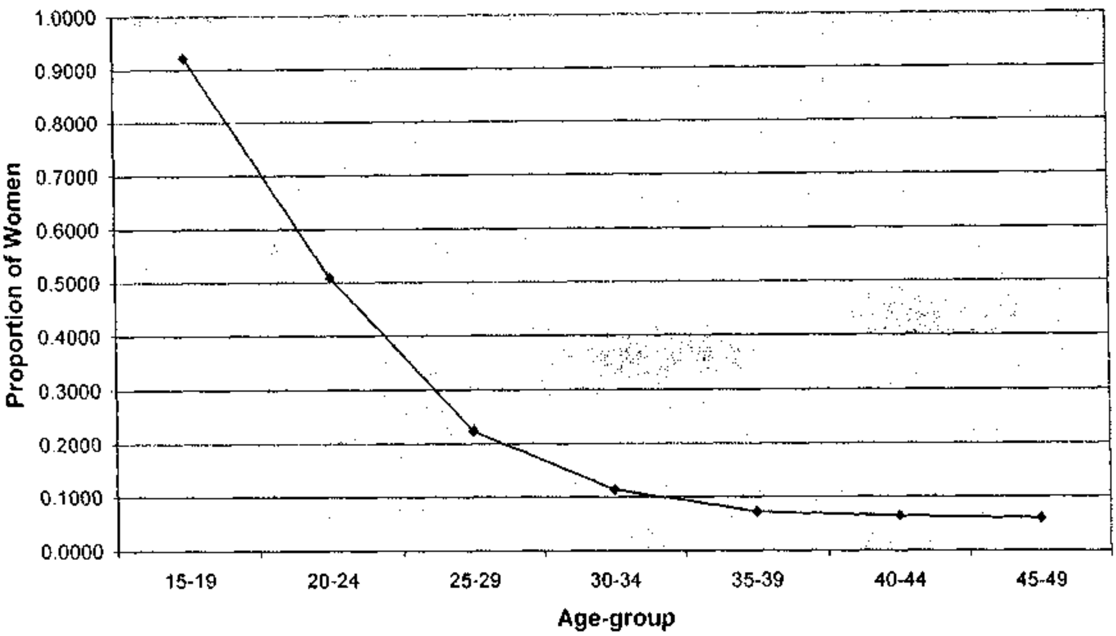
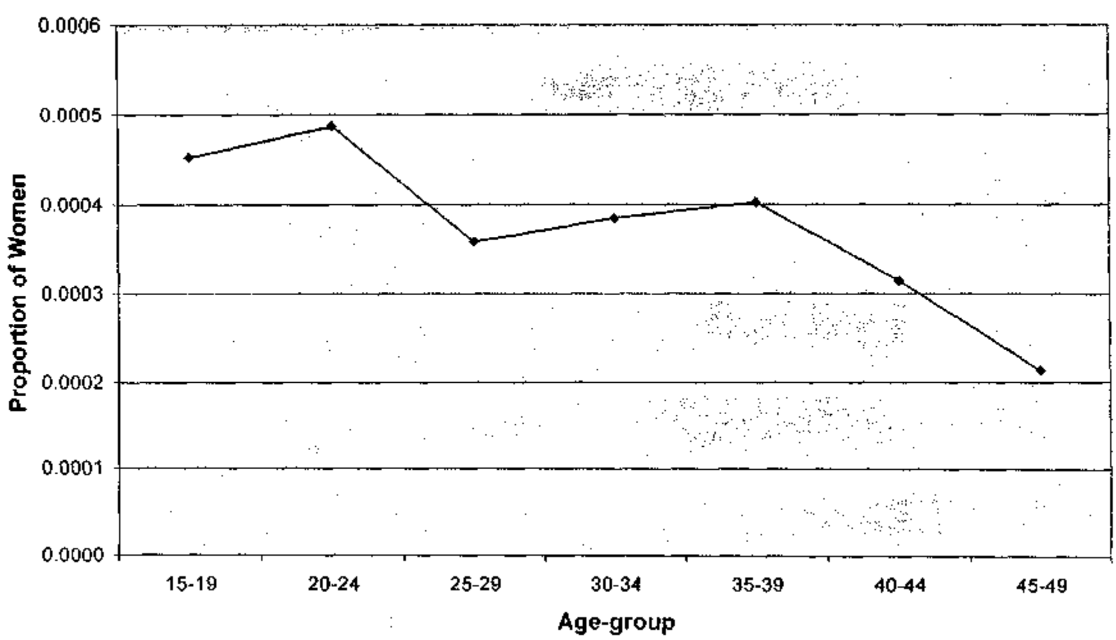



**Figure 4.7b Proportion of Women Whose Parity Was not Stated in the 1996 Population Census**




Based on the above examinations and corrections of the parity data, average parity plot was done by single ages and by age-groups (see figures 4.8 and 4.9). In both cases, the average parity curves display outstanding uniform increases in CEB by age.

Average parity distribution is expected to increase with age, and taper towards the end of reproductive period (Brass, 1981). It is even more interesting to observe that, despite omission of implausible cases, average parities of both the raw and cleaned data yield the same distribution by age-groups. This indicates minimal tempering of data, which is likely not to distort the fertility estimates. The average parity pattern looks satisfactory enough for analysis.

**Figure 4.8 The 1996 Population Census Average Parity Distribution by Single Ages**

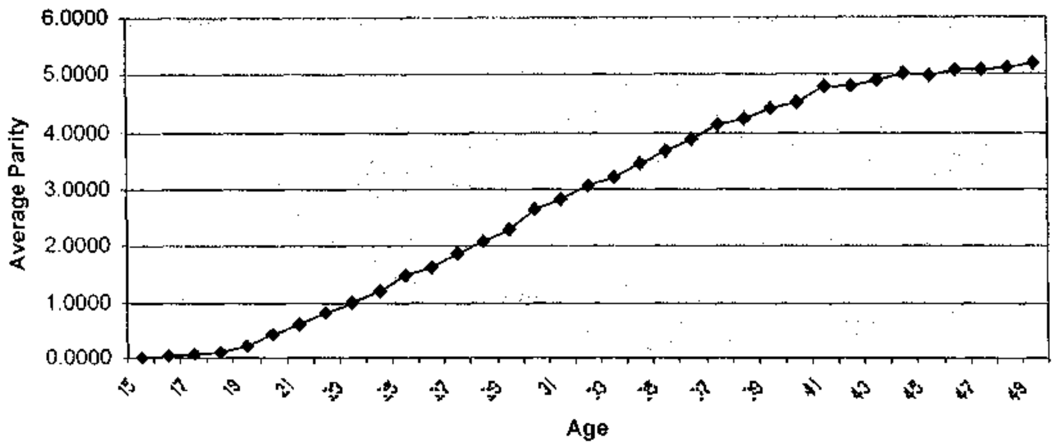
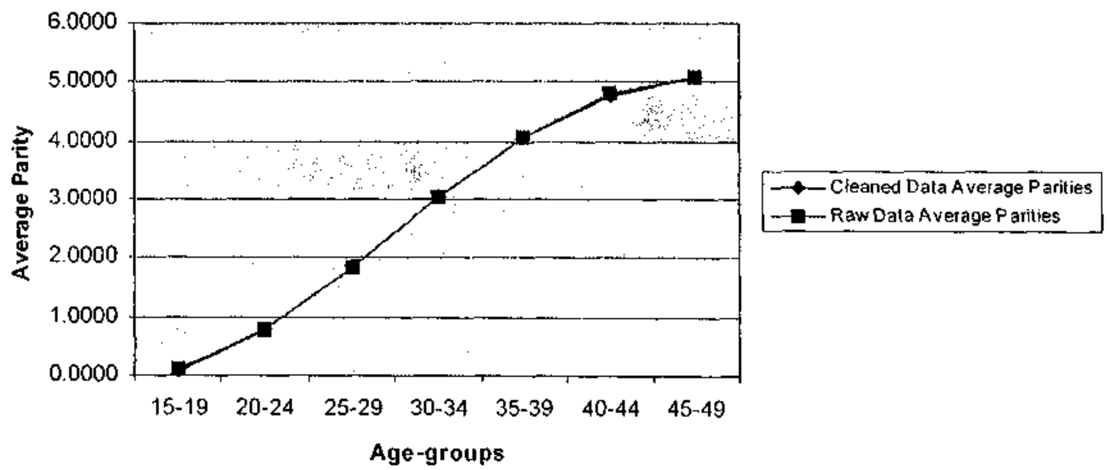



**Figure 4.9 The 1996 Population Census Average Parity Distributions For Raw and Cleaned Data**




On the other hand, compared to the 1996 Population Census, the 2002 LRHS showed a maximum of 13 children per woman in Lesotho. All the women in the reproductive age reported their lifetime fertility. It was surprising that out of a sample of 2634 women aged between 15 and 49 years, only one woman aged 18 years reported to have no children in this survey. However, table 4.6 below shows responses to questions on the number of children ever born (CEB) and the cross-check variable which breaks down the question, as well as the question on having given birth in the last twelve months, all indicated 887 missing cases. These missing cases are equal to the number of women who reported to have never given birth (see table 4.7). It is obvious from this information that 887 women in the sample had never given birth (zero parity) and these are the same women who have been reported missing when entering the data. Therefore, these missing cases were assigned zero (0) children ever born. Compared to the 1996 population census, there were no outliers of the number of CEB in the 2002 LRHS data set.

**Table 4.6 Responses to Questions on CEB and Births in the Past 12 Months**

| | | Ever Had a Live Birth | Number of Children Ever Born | Total No. of Children (cross-check) | Given Birth in the Last 12 Months |
|---|---|---|---|---|---|
| N | Valid | 2634 | 1748 | 1747 | 1747 |
| | Missing | 0 | 886 | 887 | 887 |

**Table 4.7 Responses to the Question on Ever Had a Live Birth**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Yes | 1746 | 66.3 | 66.3 | 66.3 |
| | No | 888 | 33.7 | 33.7 | 100.0 |
| | Total | 2634 | 100.0 | 100.0 | |

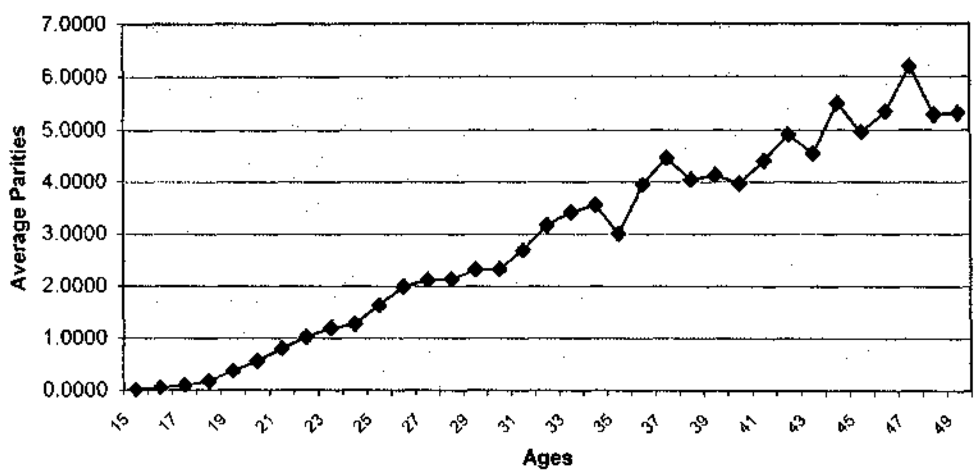
In total, 5, 780 children ever born were reported in the 2002 LRHS. However, when using the probing mechanism, the women were asked to report the number of children currently living with them, living elsewhere and those who are dead by sex, a total of 5781 children was reported (refer to table 4.8). This one child difference renders the reporting of parities in the 2002 LRHS satisfactory. Correct reporting of parities across all ages supports the use of the P/F ratio method because the assumption that young women report their parity better is not violated.

**Table 4.8 Detail Enquiries about the Total Number of Children Ever Born in the 2002 Reproductive Health Survey**

| Variable | Cases |
|---|---|
| Ever Given Birth | 1746 |
| Never Given Birth | 888 |
| No. of Children Ever Born | 5780 |
| No. of Sons Living with Mothers | 2097 |
| No. of Sons Living Elsewhere | 559 |
| No. of Sons Dead | 400 |
| No. of Daughters Living with Mothers | 1857 |
| No. of Daughters Living Elsewhere | 606 |
| No. of Daughters Dead | 262 |
| Total No. of Children | 5781 |

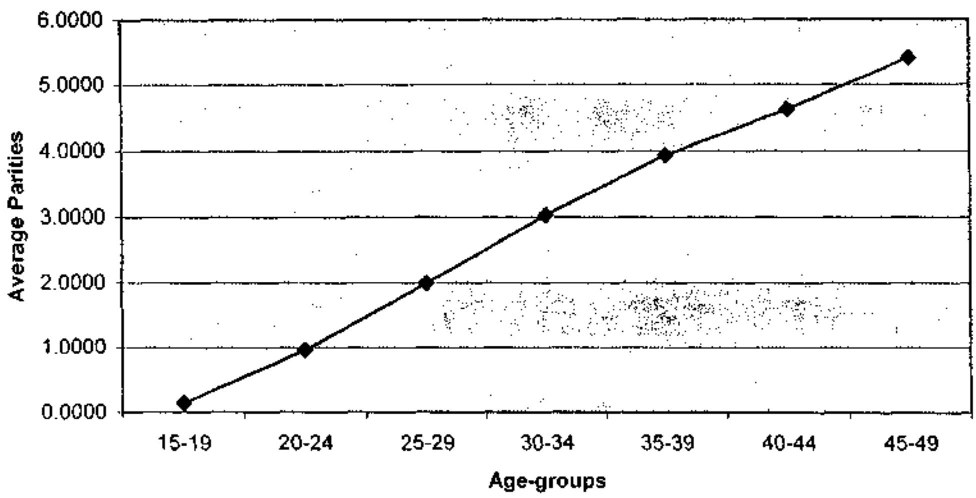
The average parities plot derived from the CEB by single ages of the women in the 2002 LRHS showed a meandering curve towards old ages (after 34 years) as shown in figure 4.10. Unless there have been irregular changes in fertility levels, the curve suggests that relative to older women, young women were consistent in their parity reports. This observation supports the P/F ratio assumption that younger women report their parities more accurately as the curve implies under-reporting of CEB by older women where there is a depression, or over reporting of CEB where there is an upturn.

**Figure 4.10 The 2002 Reproductive Health Survey Parity Distribution by Single Ages**




A similar plot of average parities by age-groups illustrates a constant rate of increase in the number of children ever born as women graduate into higher age-groups (see figure 4.11). As indicated earlier, in the absence of changes in fertility levels, average parities increase with age as more and more women resume childbearing, but the rate of increase diminishes towards the end of reproductive period as more women stop childbearing. It cannot be established whether this constant increase of average parities by age-groups is a result of overstating of children ever born by older women or a constant fertility decline in Lesotho. However, Mturi (1998: 5) showed that fertility in Lesotho has been declining in across all ages.

**Figure 4.11 2002 Reproductive Health Survey Average Parity Distribution by Age-groups**




## 4.3 Current Fertility Data

Current fertility is measured from women's reports on births occurring during the last 12 months preceding the census/survey date. Despite improvements made in recording current fertility, this data is still affected by misreporting of births and women's ages. The misreporting of women's ages results in misplacement of reported births (Zaba, 1981). Again, the misreporting of births is mainly attributed to confusion about the reference schedule - the exact period of twelve months preceding the survey date (Smith, 1994). Since surveys do not often happen on the 1st of January, reporting births which occurred within the twelve months prior to the survey can be overstated by including all the births in the previous calendar year, or understating by excluding some of the births within the given schedule. The likely errors in current fertility data, together with their direction of bias are listed below in table 4.9.

**Table 4.9 Errors in Current Fertility Data and Direction of Bias**

| Error Type | Direction of Bias |
|---|---|
| 1. Twins and 2 births omitted | - |
| 2. Age at census not birth | +/- |
| 3. Last dead birth omitted | - |
| 4. Last 12 months interpreted as this calendar year | - |
| 5. Last 12 months interpreted as last calendar year | +/- |
| 6. Date not stated reported as no birth | - |
| 7. No birth reported as date not stated | + |
| 8. No birth reported as no response | +/- |
| **Net Effect** | **Underreporting of Births** |

**Source**: Zaba 1993 Lecture Notes cited in Muhwava and Timæus (1996: 8)

Different researches use different data questions to minimise errors associated with recent fertility measurement. Although Cleland (1996) asserts that the date of the last live birth yields better estimates of fertility during the preceding 12 months than direct question on births during that period, Muhwava and Timeaus (1996) also state that misinterpretation of the reference period occurs in either case. Many studies use edited secondary data and this makes it difficult to ascertain the extent to which these errors influence the fertility estimates (Muhwava and Timeaus, 1996).

The 1996 census uses the last open birth interval to estimate current fertility. The date of a woman's last birth can be converted into the elapsed time since last birth. Experts have identified this enquiry as an essential item for adequate fertility survey (Srinivasan, 1967, in Schmertmann, 1999: 505). However, this inquiry is subject to dates of birth not known or misreported. In addition, some births are likely to be omitted especially if a woman had multiple births and/or more than one birth in the twelve months. Therefore, open birth interval is likely to result in underestimation of current fertility (Schmertmann, 1999).

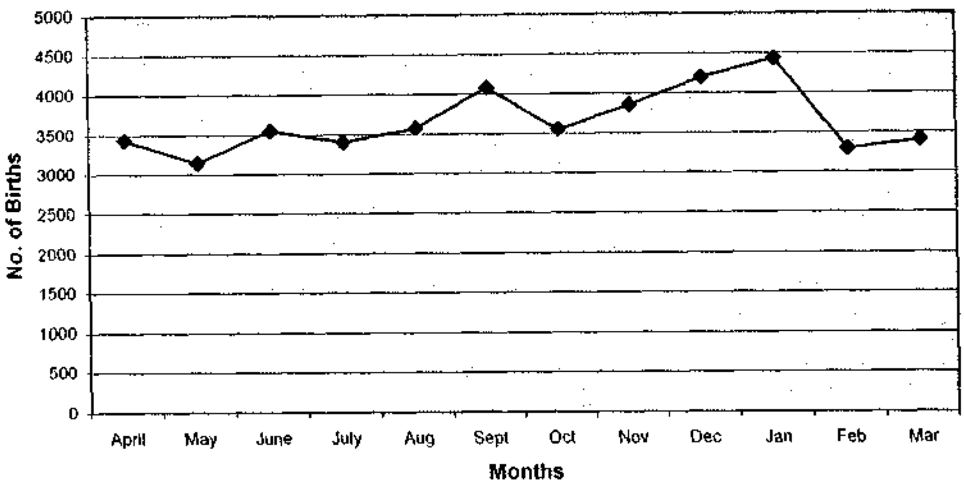
The 1996 census further asked questions on the sex, month and year of last birth as probing tools. However, 2.9% (13, 585) and 3.8% (17, 699) of the women within the reproductive ages did not know the year and month of their last births respectively, while sex of the last birth was not recorded for 1.4% (6, 282) of the women. A similarly, but more substantial, observation was made by the Swaziland Central Statistics Office, which reported serious under reporting of births in the 1966 and

1976 censuses because 25% of the women did not report the date of their last birth (Warren et al., 1992: 6).

Moreover, women within the reproductive ages in 1996 would be expected to have had children at least after 1961 (1996-35). But tabulation of the last births showed births as way back as 1901. This is likely to have been data entry error; otherwise it should have been detected at field level. All the births before 1961 together with those with unknown birth dates were discarded for this analysis. There were also reported last births which were older than their mothers. For instance, there were 15 year olds with last births before 1980. Such errors are obviously a result of enumerators or data entry personnel. Moultrie and Timæus (2002) have also highlighted data collectors' ignorance to be limiting fertility data analysis in South Africa.

In addition, the distribution of births in the twelve months prior to the census indicate an irregular pattern which could suggest many scenarios such as exclusion and inclusion of some births where there is descending and ascending of the curve respectively in figure 4.12. The increase of births by 14.2% between August and September 1995, and the high depression of about 25.7% between January and February 1996 are more pronounced. This research cannot ascertain whether the births distribution in the twelve months prior to the 1996 census is erroneous. However, the P/F ratio method corrects for misreporting of recent births, and therefore no adjustments are made to this data.

**Figure 4.12 The Distribution of Births Twelve Months Prior 1996 Census**




Further analysis is undertaken to verify the P/F ratio assumption of a correct age pattern of fertility in the 1996 census. Looking at the age specific fertility rates (ASFRs) distribution curves in figure 4.13 and figure 4.14, the 1996 census demonstrated adherence to this assumption. The ASFRs are very low at age 15 and 16 which is followed by a sharp increase in age-group 20-24 and 25-29, after which then the curves descend to very low levels at the end of reproductive period. The satisfactory age pattern of fertility renders the 1996 Census current fertility usable for fertility estimation.

**Figure 4.13 1996 Census Age Specific Fertility Rates Distribution by Single Ages**

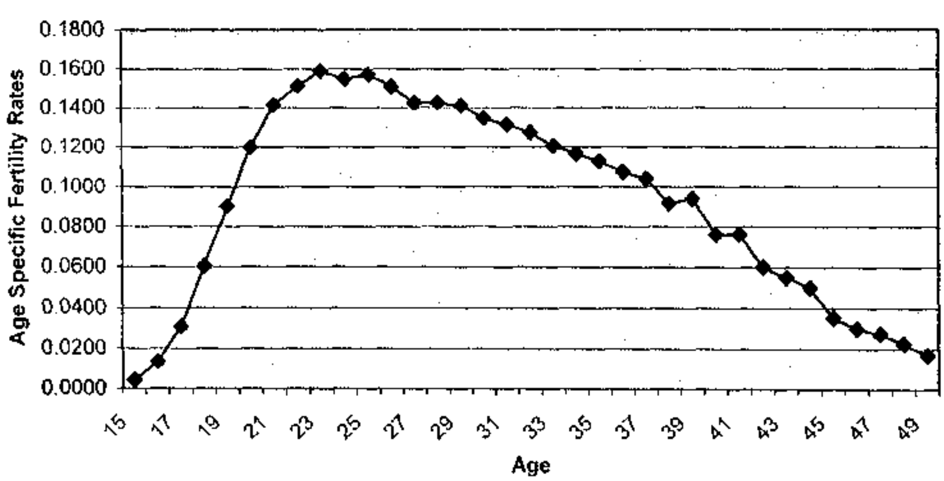
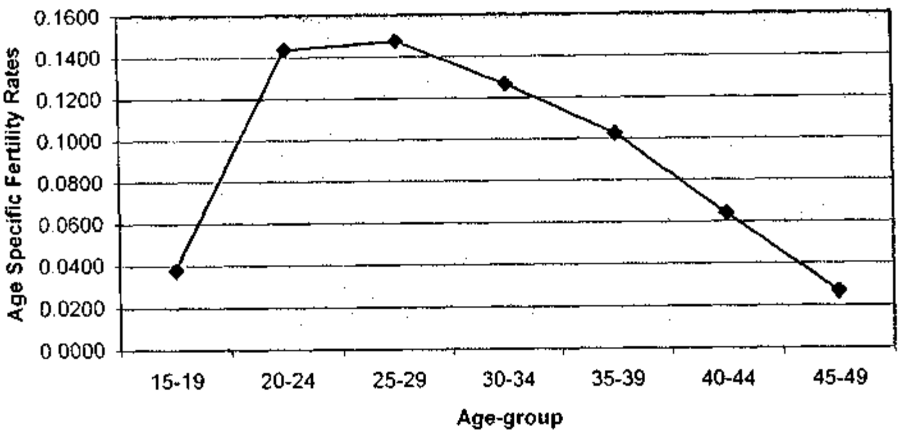


**Figure 4.14 1996 Census Age Specific Fertility Rates Distribution by Age-group**




The 2002 LRHS used a straightforward question on births in the past twelve months. Because this survey was conducted in January, it is believed that the errors arising due to the confusion about the reference period would have been minimised. Similarly to data on CEB, 887 women did not respond to the question on whether they had given birth in the past twelve months because they had previously reported to have never given any birth. Even in the data entry process, their information was still excluded. To counteract this problem, the 887 missing cases were recoded as zero births in the past year. As outlined in table 4.10 below, a total of 366 women reported to have given birth to 196 boys and 177 girls. This gives a total of 373 births in the previous 12 month, with a maximum number of 3 births born. There were 5 cases of twin sets. Taking into consideration international practice, births per woman in this survey do not exceed the upper limit set by the Demographic and Health Surveys (DHS), of 4 children per birth (Udjo, 2003).

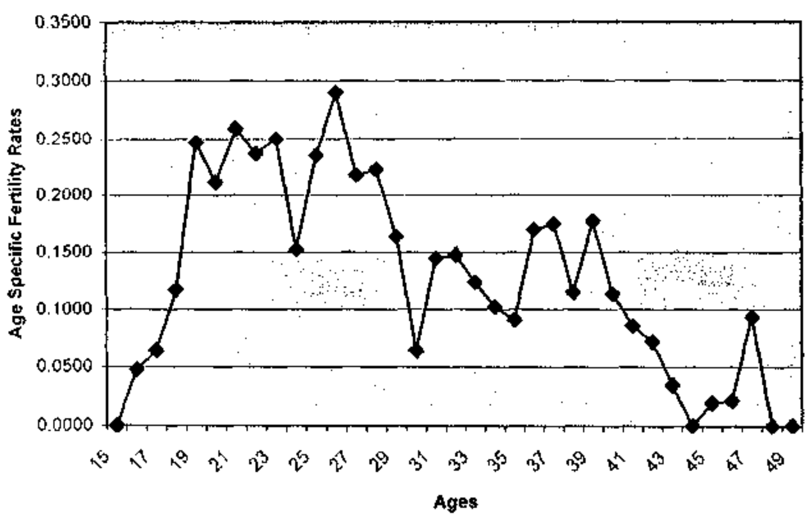
**Table 4.10 2002 LRHS Outcomes on the Current Fertility Enquiries**

| Variable | No. of Outcomes |
|---|---|
| No. of Women Given Birth in the Last 12 Months | 366 |
| No. of Boys Born in the Past 12 Months | 196 |
| No. of Girls Born in the Past 12 Months | 177 |
| **Total** | **373** |
| No. of Boys Still Alive | 193 |
| No. of Girls Still Alive | 171 |
| **Total** | **364** |

Further inquiries on the recent births in the 2002 LRHS gave a total of 369 children that were still alive, 196 boys and 173 girls. These reports indicate a very low infant mortality rate of 24 deaths per thousand live births relative to 80 deaths per thousand live births reported by the Bureau of Statistics (2003b). This could suggest sampling bias or reporting errors, but given that the surviving children are not greater than the reported births, and no further data digging could be done, the 373 births in the survey would be considered to be accurate.

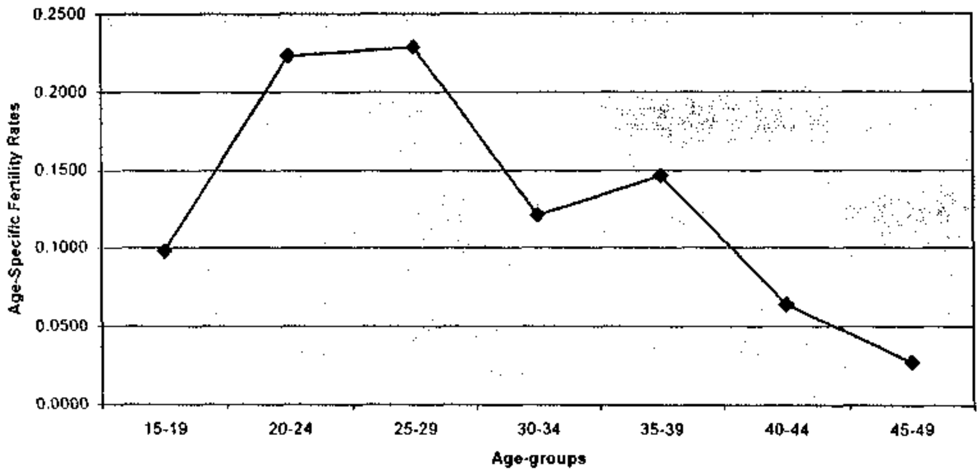
Using the above information on recent fertility in the 2002 LRHS, age-specific fertility rates plot by single ages, presented an undulating curve, as demonstrated in figure 4.15. This in contrary to the 1996 census ASFRs plot and it also violates the P/F ratio assumption of a correct fertility pattern. The ASFRs plot in the survey indicates either reporting errors, or sampling errors. In particular there could be issues of age reporting in effect here, which would result in misplacement of births and parities. As recalled the Myer's Blended method earlier suggested some age heaping in this data set. This is more pronounced at digits which are multiples of two. However, since our method uses age groups the research goes further to observe the ASFRs pattern by age-groups.

**Figure 4.15 2002 Lesotho Reproductive Health Survey Age Specific Fertility Rates Distribution by Single Ages**



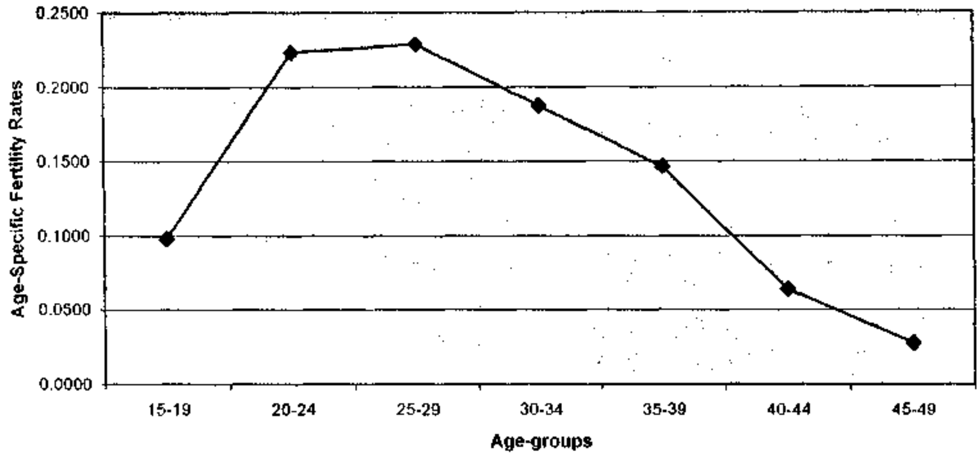

The plot by age-groups ingested the errors as ASFRs show an acceptable curve except the high depression in age-group 30-34 or the inconsistent increase after that depression in age-group 35-39 (see figure 4.16). The irregular shape of the ASFR curve could be due to lower reporting of births for the 30-34 age-group or higher reporting of births for the next age-group. Another possibility could be overrepresentation of women in the depression age-group. But based on previous examinations on population representation, this possibility is discarded.

**Figure 4.16 2002 Lesotho Reproductive Health Survey Age-Specific Fertility Rates Distribution by Age-groups**



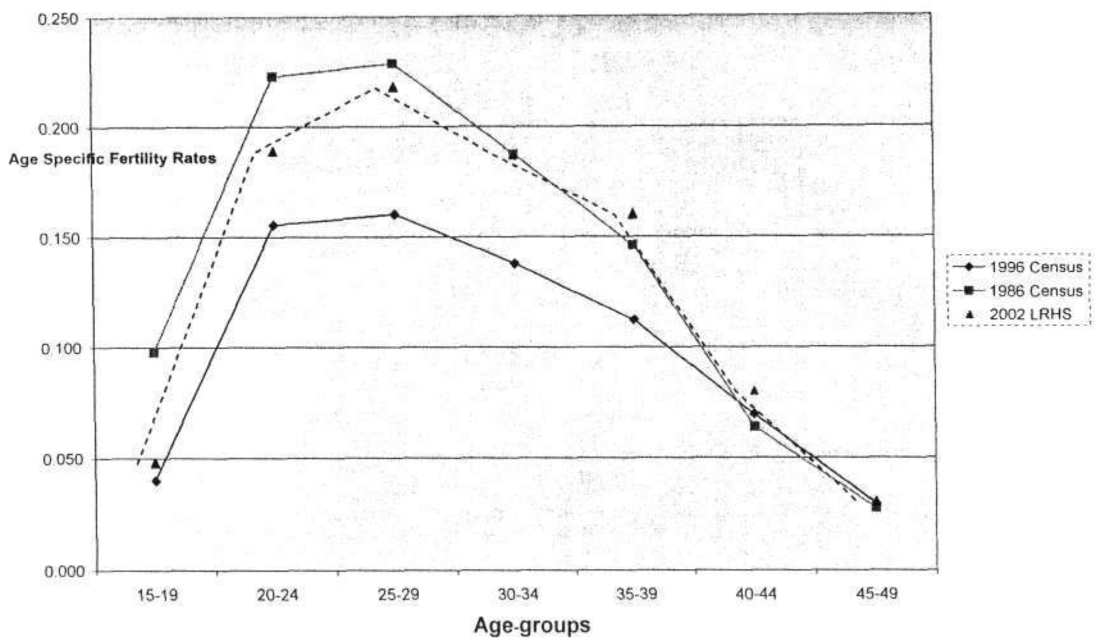

To counteract the problem of wrong fertility pattern, the research assumes that there is underreporting of births by women aged 30-34 in the 2002 LRHS. Therefore an average of ASFRs of women aged 25-29 and 35-39 is assigned to this group. This gives an average of 188 births per thousand women aged 30-34. As shown in figure 4.17 below, the fertility age pattern presented is now consistent with the P/F ratio assumption of correct fertility pattern.

**Figure 4.17 2002 Lesotho Reproductive Health Survey Age-Specific Fertility Rates Distribution by Age-groups**




It is important to indicate that ASFRs for the 1996 census were much lower that the 2002 LRHS. While this could imply increasing fertility levels in Lesotho, it could also suggest high under reporting of births in the 1996 census. When comparing these two data sets with the 1986 Lesotho population census ASFRs in figure 4.18, there is no clear fertility trend. In the 2002 LRHS, fertility rates were much higher for women below 35 years of age compared to the censuses. This suggests high early childbearing, and fast declining childbearing after 40 years of age. This observation contradicts the view of Caldwell and colleagues (1992) who stated that fertility decline in sub-Saharan Africa takes place across all ages. There are two scenarios that are possible here: under reporting of births in the 1996 census and/or over reporting of births in the 2002 LRHS. Further examination on these data sets is done using the P/F ratio method in the next section.

**Figure 4.18 Comparisons of 1986 and 1996 Population Census, and 2002 LRHS Age Specific Fertility Rates**

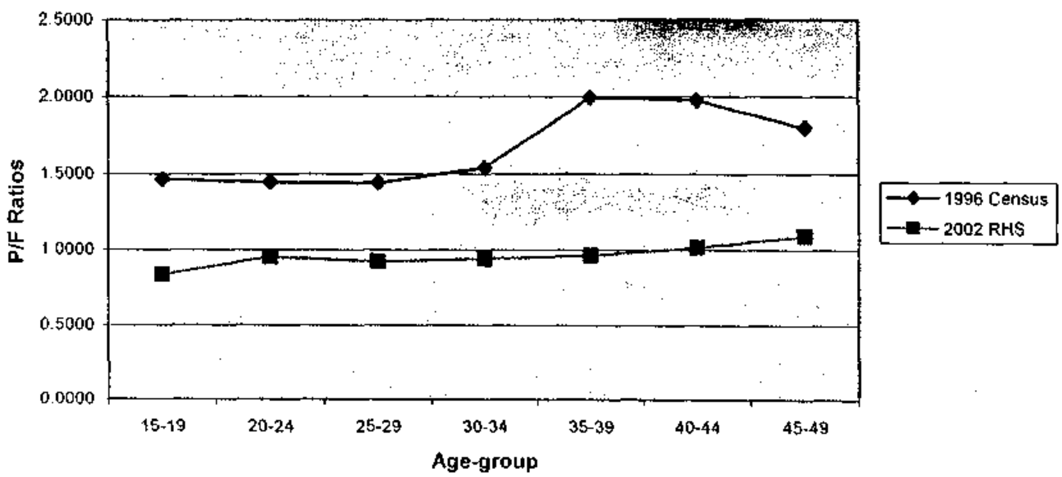



## 4.4 Using P/F Ratios to Evaluate Birth Reporting

Information on women's lifetime fertility as well as period fertility can be used to evaluate the completeness of birth recording. The P/F ratio method assumes constant fertility in the recent past so that the lifetime and the period cumulated fertility rates are equal (Brass, 1981). Therefore, the P/F ratios are expected to be equal to 1.0 for all the ages. If indeed fertility has been constant, discrepancies between the two are usually ascribed to reporting errors. However, in cases where fertility has been changing, these differences could be genuine, thus any adjustments would distort the estimates. If P/F ratios are greater than 1.0, it is assumed that there is under reporting of current fertility or over reporting of parities and visa versa for P/F ratios lower than 1.0. The P/F ratio method can also be used to detect fertility trends by examining the behaviour of the P/F ratios for younger and older women (Mahwuva, 2002). Nonetheless, it is important to note that it is often difficult to separate the impact of the reporting errors and changing fertility (Brass, 1996).

In the 1996 census the P/F ratios are consistently above 1.0 and become much higher after age 35, while the 2002 LRHS shows P/F ratios below 1.0 except for women who are over 40 years (see figure 4.19). Higher P/F ratios at older ages are largely attributable to one or more of the following: (i) distortions in the current fertility pattern by reporting errors; (ii) under reporting of current births; (iii) over-reporting of lifetime fertility (Brass, 1981). With regard to the 1996 census, the high P/F ratios support the under-reporting of births that was speculated in the previous analysis of the current fertility data. As Schmertmann (1999) argued, the use of open birth intervals in the 1996 census is likely to yield underestimation of current fertility. Again, it is clear that even with the limitations imposed on the maximum number of children ever born, average parities could still be exaggerated in the census. The higher P/F ratios at older ages suggest that average parities are close to two times more than current fertility. The magnitude of the P/F ratios, as well as the pattern of increasing P/F ratios with age, also point towards strong evidence of fertility decline in Lesotho.

**Figure 4.19 P/F Ratios Distribution in the 1996 Census and 2002 LRHS**




On the other hand, the P/F ratio values in the 2002 LRHS are fairly consistent. The P/F values for women aged 15-19 have generally been reported to be erratic (United Nations, 1983; Brass, 1996). Venkatacharya (1989 cited in Muhwava. 2002: 5) has also suggested that P/F values for women aged 20-24 can be unreliable too. These low P/F ratios suggest that average parities are 7.8, 5.9 and 3.7 percent lower than current fertility for women aged 25-29, 30-34 and 35-39 respectively. If it is assumed that younger women report their fertility better, this could indicate increasing fertility.

However, this would contradict fertility reports by Matabane (1996) and Mturi (1998) that fertility in Lesotho has began a downward trend. In addition, in the analysis of children ever born data, women in the 2002 LRHS had a maximum number of 13 children ever born per woman relative to 20 in the 1996 census. Therefore, it is likely that these low P/F ratios are attributable to under reporting of parities and/or over reporting of births in the 2002 LRHS. Contrary to younger women, the P/F ratios of older women in the survey are closer to 1.0 suggesting better reporting if the constant fertility assumption holds. Nonetheless, this could also mean that the reporting errors in both current and lifetime fertility negated each other. Similar to the 1996 census, the P/F ratios in the 2002 LRHS increase with age, supporting the possibility of declining fertility levels in Lesotho.

In a nutshell, the cleaning and correction of the above data sets renders the application of the P/F ratio method feasible as the errors presented in the data analysis can be taken care of by the method. The errors are likely to entail under reporting of births in the 1996 census and over reporting of births in the 2002 LRHS. The small sample size of the 2002 LRHS is also likely to compromise the fertility estimates. Nonetheless, both recent and lifetime fertility patterns were satisfactory, with just the levels being disputable. These characteristics satisfy the P/F ratio method assumptions. However, the magnitude and pattern of the P/F ratios conveys evidence of declining fertility levels in Lesotho. This evidence is in line with other fertility studies in the country, especially those presenting substantial increases in contraceptive prevalence (Bureau of Statistics, 2003a; Tuooane et al., 2003). Contraceptive use is by far the most hooted determinant of fertility in both developed and developing societies (Mason, 1997; Caldwell and Caldwell 2002). If indeed fertility has been changing, then the Brass P/F ratio method is not applicable as the main underlying assumption of constant fertility would be violated. The use of the relational Gompertz model would then be a better method to estimate recent fertility levels in the country because it does not assume constant fertility, while it would also adjust and correct the reported fertility distortions.

# CHAPTER 5

# ESTIMATION OF FERTILITY LEVELS

## 5.1 Application of the Brass' P/F Ratio Method

The results of application of the P/F ratio method to current and lifetime fertility in the 1996 population census are presented in Table 5.1. Indices of lifetime fertility presented by the average parities (Pi) suggest that childbearing mainly begins after age 20 in Lesotho, as most women in the age-group 20-24 have their first child. This is a different observation among Black South African women who tend to resume childbearing before age 20 (see Udjo, 2003; Moultries and Timæus, 2003). A similar higher average parity is also estimated for younger women in Zimbabwe (Muhwava, 2002). Nonetheless, contrarily, by the end of the reproductive period, a Mosotho woman would have more children than women in the two countries. Therefore, from the average parities, it can be concluded that an average woman would have born 5 children by the end of her reproduction period in Lesotho.

**Table 5.1 Brass P/F Ratio Method Applied to 1996 Population Census, Lesotho**

| Age | i | Pi | ASFR fi | φi | Fi | f⁺(i) | P/F | f*(i) | f**(i) | f***(i) | f****(i) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1 | 0.0808 | 0.0377 | 0.1885 | 0.0552 | 0.0469 | 1.4626 | 0.0678 | 0.0675 | 0.0723 | 0.0677 |
| 20-24 | 2 | 0.7704 | 0.1434 | 0.9055 | 0.5335 | 0.1494 | 1.4441 | 0.2158 | 0.2151 | 0.2301 | 0.2154 |
| 25-29 | 3 | 1.8397 | 0.1475 | 1.6430 | 1.2782 | 0.1465 | 1.4392 | 0.2115 | 0.2108 | 0.2256 | 0.2112 |
| 30-34 | 4 | 3.0283 | 0.1267 | 1.7697 | 1.9664 | 0.1243 | 1.5400 | 0.1796 | 0.1789 | 0.1915 | 0.1792 |
| 35-39 | 5 | 4.0430 | 0.1023 | 2.2812 | 2.0289 | 0.0997 | 1.9927 | 0.1440 | 0.1435 | 0.1536 | 0.1438 |
| 40-44 | 6 | 4.7822 | 0.0638 | 2.6002 | 2.4201 | 0.0587 | 1.9760 | 0.0847 | 0.0844 | 0.0904 | 0.0846 |
| 45-49 | 7 | 5.0844 | 0.0266 | 2.7332 | 2.8255 | 0.0225 | 1.7994 | 0.0324 | 0.0323 | 0.0346 | 0.0324 |
| TFR | | | 3.24 | | | | | 4.68 | 4.66 | 4.99 | 4.67 |

**Note: f*(i) is estimated using P2/F2**
**f**(i) is estimated using P3/F3**
**f***(i) is estimated using P4/F4**
**f****(i) is estimated using the average of P2/F2 + P3/F3**

According to the reported births in the twelve months prior the 1996 census, a Mosotho woman would have an average of 3 children at the end of her reproductive period. This figure is much lower than that implied by the average parities. The TFR figure is similar to that of South Africa, suggesting that Lesotho could have the lowest fertility level in Southern Africa. But it has been indicated in the previous data analysis section that recent birth reports in the 1996 Lesotho population census are likely to have been underreported. This allegation was also supported by the magnitude of the P/F ratios. As shown earlier, the P/F ratios indicate that the mean parities are about 50 to 100 percent higher than the current fertility. For this reason, the low reported TFR estimate is questionable, hence the need for adjustment.

Although the P/F ratios are fairly consistent for women aged below 30 years in the census, P1/F1 is disregarded because the number of births is small, and "the interpolation procedure is insufficiently flexible to replicate rapid increases with age in the rates" in this age group (United Nations, 1983: 39). Assuming that younger women report their fertility fairly accurately, the TFR is estimated using the adjustment factor of younger age-groups. The results in table 5.1 indicate that in 1996 an average Mosotho woman would bear 4.66 to 4.68 children at the end of her reproductive period. Fertility estimate using P4/F4 deviates substantially from the other estimates supporting that women in their 20s tend to report their fertility better. This research chooses the average of P/F ratios of women aged 20-24 and 25-29 as the best adjustment factor for the 1996 census fertility estimate, as these were fairly consistent. If fertility has remained constant over time, then the adjustment factor of 1.44 means that the fertility level based on retrospective reports is about 44% higher than that indicated by current fertility rates. Therefore, the Brass P/F ratio adjusted TFR for Lesotho in 1996 is estimated at 4.7 children per woman.

The estimated TFR of 4.7 children per woman is higher than TFR of 4.4 children per woman estimated by the Bureau of Statistics (2003a: 126) using the same method as well as the same adjustment factor. It is likely that the Bureau of Statistics overlooked some of the inherent errors in the data set, particularly the overstating of parities by younger women whose reports are used for adjustment. But this cannot be verified because there is inference made to data quality and adjustment by the Bureau.

On the other hand, the 2002 LRHS results reiterate the implications made in the 1996 census that fertility is low among Basotho women aged below 20 years. Based on the parity indices in table 5.2, an average Mosotho woman would have their first child between age 20-24 and by the end of her childbearing ages, she would have born 5.4 children. The reported TFR estimated from reports on births which occurred twelve months prior the survey shows a slightly lower figure of 4.9 children per woman. This reported fertility estimate compares with the 1991/92 Demographic and Health

Survey estimate implying constant fertility in the country in the recent past (Bureau of Statistics, 1998). However, the P/F ratios from the 2002 LRHS suggest over reporting of current fertility by women aged below 40 years, and under reporting of current fertility by women aged 40-49 years. As a result, the reported TFR estimate is also questionable.

**Table 5.2 Brass P/F Ratio Method Applied to the 2002 Lesotho Reproductive Health Survey**

| Age | i | Pi | ASFR fi | ϕi | Fi | f*(i) | P/F | f*(i) | f**(i) | f***(i) | f****(i) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1 | 0.1437 | 0.0978 | 0.4890 | 0.1721 | 0.1228 | 0.8352 | 0.1172 | 0.1132 | 0.1155 | 0.1153 |
| 20-24 | 2 | 0.9534 | 0.2233 | 1.6055 | 0.9992 | 0.2265 | 0.9542 | 0.2161 | 0.2088 | 0.2131 | 0.2127 |
| 25-29 | 3 | 1.9973 | 0.2287 | 2.7490 | 2.1662 | 0.2240 | 0.9220 | 0.2137 | 0.2065 | 0.2107 | 0.2103 |
| 30-34 | 4 | 3.0359 | 0.1875 | 3.6865 | 3.2269 | 0.1811 | 0.9408 | 0.1728 | 0.1670 | 0.1704 | 0.1700 |
| 35-39 | 5 | 3.9269 | 0.1462 | 4.4175 | 4.0787 | 0.1400 | 0.9628 | 0.1336 | 0.1291 | 0.1317 | 0.1315 |
| 40-44 | 6 | 4.6206 | 0.0638 | 4.7365 | 4.5541 | 0.0571 | 1.0146 | 0.0544 | 0.0526 | 0.0537 | 0.0536 |
| 45-49 | 7 | 5.4018 | 0.0274 | 4.8735 | 4.9618 | 0.0233 | 1.0887 | 0.0222 | 0.0215 | 0.0219 | 0.0219 |
| **TFR** | | | 4.87 | | | | | 4.65 | 4.49 | 4.58 | 4.58 |

**Note: f*(i) is estimated using P2/F2**
**f**(i) is estimated using P3/F3**
**f***(i) is estimated using P4/F4**
**f****(i) is estimated using the average of P/2/F2 + P3/F3 + P4/F4**

The P/F ratios are fairly consistent among women aged 20-39 years. These P/F ratios of younger women yield adjusted TFR estimates ranging from 4.49 to 4.65 children per Mosotho woman. Using just the P/F ratios from women aged 20-29, an average P/F ratio adjustment factor of 0.94 was obtained. If fertility has been constant in Lesotho, this figure implies 6.0% exaggeration of the reported current fertility in the 2002 LRHS. Therefore the adjusted Brass P/F ratio total number of children an average Mosotho woman would have born by the end of her childbearing period is estimated at 4.58 children in 2002.

Again, the 2002 LRHS Brass P/F ratio TFR estimate was still higher than the Bureau of Statistics estimate using the same method. The Bureau gave a TFR estimate of 4.1 children per woman for the survey using the same adjustment factor of women aged 20-29 (Bureau of Statistics, 2003: 124). Since the data evaluation on the 2002 LRHS did not seem to indicate many data reporting problems, this 11.7% difference in fertility level can be ascribed to disparities in the ASFR for women aged 30-34 which was adjusted during the data evaluation. There were also differences in the sample size. While this study used the original raw data from the Bureau of Statistics, the Bureau's report on the 2002 LRHS has a higher sample size of 2, 713 women with 373 births in the previous twelve months, relative to 2, 634 women and 373 births that were used in this study (see Bureau of Statistics, 2003a: 123).

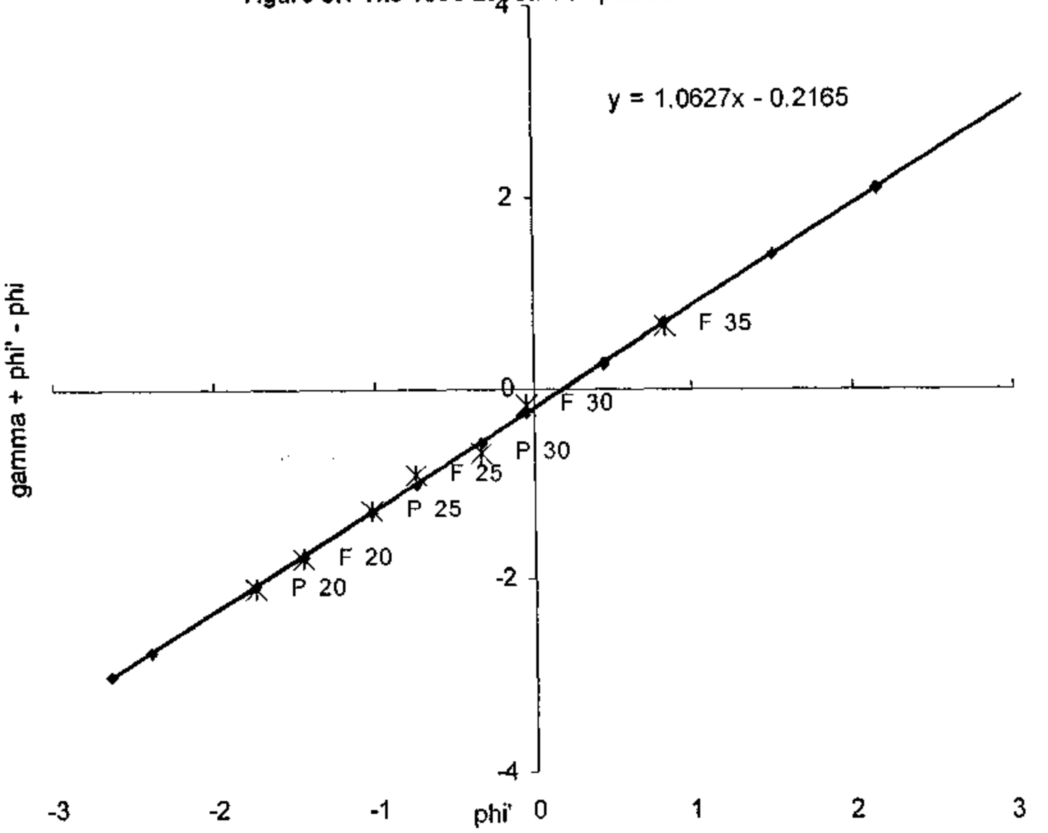
Because this study cannot overlook the possibility of changing fertility levels implied by the magnitude of the P/F ratios as well as previous studies, further estimation of fertility levels is undertaken using the Relational Gompertz Model. It should be noted that discrepancies between the Brass P/F ratio and the Relational Gompertz methods will not necessarily ascertain this possibility due to methodological differences. Nonetheless, this will give ground for further research. In addition, the Relational Gompertz model will correct distortions in the reported age pattern of fertility due to under reporting of births in the 1996 census and women aged 30-34 in the 2002 LRHS (see Zaba, 1981).

## 5.2 Application of the Relational Gompertz Model

The relational Gompertz model is used to obtain estimates of current fertility (TFR) by fitting a Gompertz function to the reported ASFRs and the average number of children ever born. Fitting the relational Gompertz model to the reports on current births (F) and CEB (P) in the 1996 census, only the P points of women aged between 20-39 and the F points of women aged 20-34 lied on the regression line, suggesting that reports from young women were more reliable (see figure 5.1). The parameter values used to estimate this regression line are $\alpha = -0.2165$ and $\beta = 1.0627$. It is good to note that these parameter estimates are within the estimated ranges. These parameters suggests that a lot of childbearing tends to concentrate at later ages (beyond age 27), with a wide spread of fertility distribution in Lesotho.

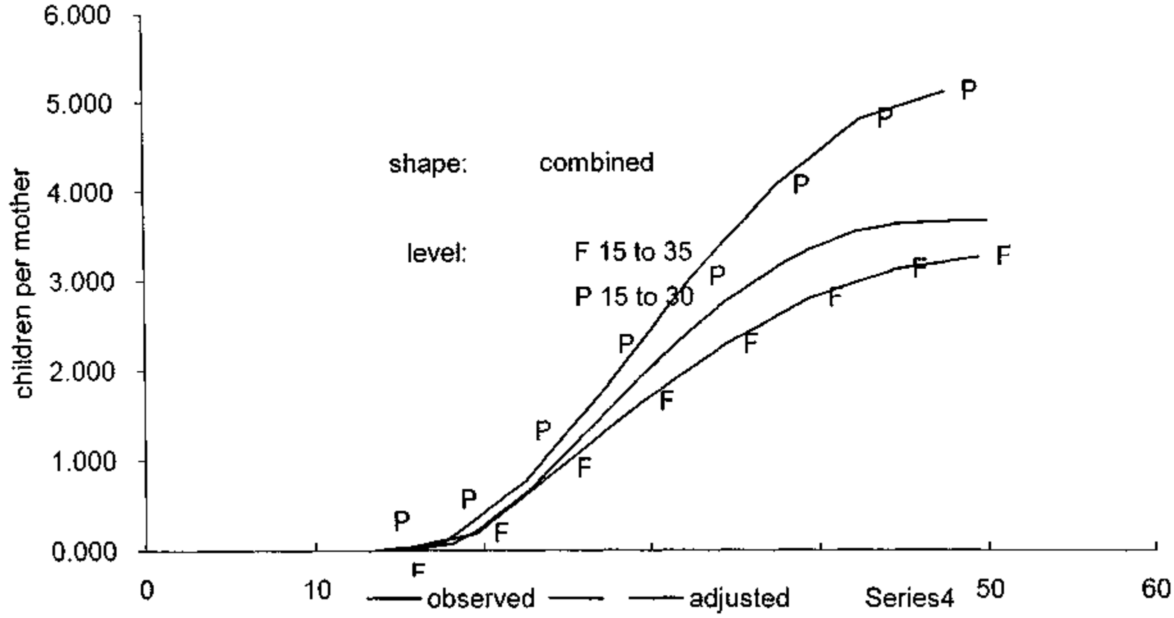
RATIO METHOD P & F PLOT

Figure 5.1 The 1996 Lesotho Population Census




As also observed in figure 5.2, the reported average parities are far higher than the reported recent fertility rates, and this disparity increases with age. This reiterates the under reporting of births in the twelve months prior the census, as well as the likelihood of overstating of parities by older women. Using the Gompertz function, the adjusted TFR estimate is higher (4.30 children) when using reported parities than the estimate from the current fertility (3.13 children). However, combining the two reports yielded an adjusted TFR of 3.65 children per woman in Lesotho. This estimate is still higher than the reported TFR, indicating 11.2% under reporting of current births in the census. On the other hand, relative to the original P/F ratio method, this estimate is lower by one birth, suggesting that fertility could be declining in the country. But still, these estimates are substantially very low due to the magnitude of the errors that could not be accounted for in the data. Again, the Relational Gompertz TFR estimate from the Bureau of Statistics report (2003a: 126) was 25.5% higher at 4.9 children per woman. Similarly, Mturi (1998) had a different estimate of 4.1 children per woman. These discrepancies insinuate that there were data adjustments carried out before the application of the method in the two studies, but these are not put forth for readers to judge the plausibility of the estimates.

**Figure 5.2 GOMPERTZ ADJUSTMENT OF P & F VALUES**
**1996 Lesotho Population Census**




On the other hand, figure 5.3 shows that in the 2002 LRHS, the P plots of women aged 15-39, and the F plots of younger women aged 15-34 laid on the fitted Gompertz regression line. This still confirms that younger women reported their fertility fairly well in the survey. The Gompertz parameter $\alpha$ = -0.0741, which is lower than the 1996 census parameter, indicates that about half of the births occur around age 27. $\beta$ = 1.0337 suggests a wide distribution of fertility in Lesotho. Looking at figure 5.4 both current and lifetime fertility had been overstated by women in their 40s as the curves deviate at these ages. At the same time the deviation shows that older women overstate their parities much more than their recent births. This resulted in over estimation of TFR. To counteract this, the adjusted fertility level using reported parities of younger women yielded a TFR of 4.16 while the current fertility reports produced a TFR of 4.45 children per woman. When combining these two reports, an estimated 4.32 children per Mosotho woman at the end of her reproductive period is obtained. As suspected earlier, this is indicative of 11.3% over reporting of current fertility in the 2002 LRHS.

**Figure 5.3 RATIO METHOD P & F PLOT**
**The Lesotho 2002 Reproductive Health Survey**

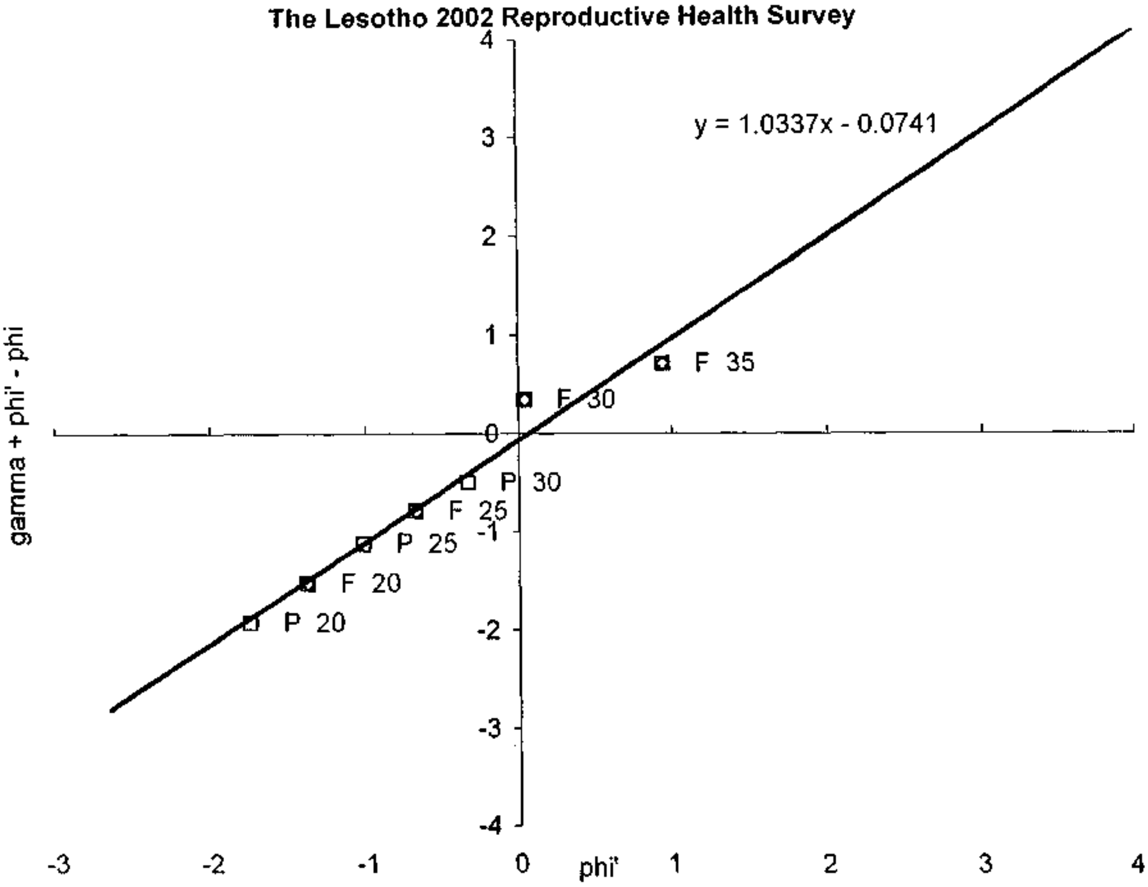
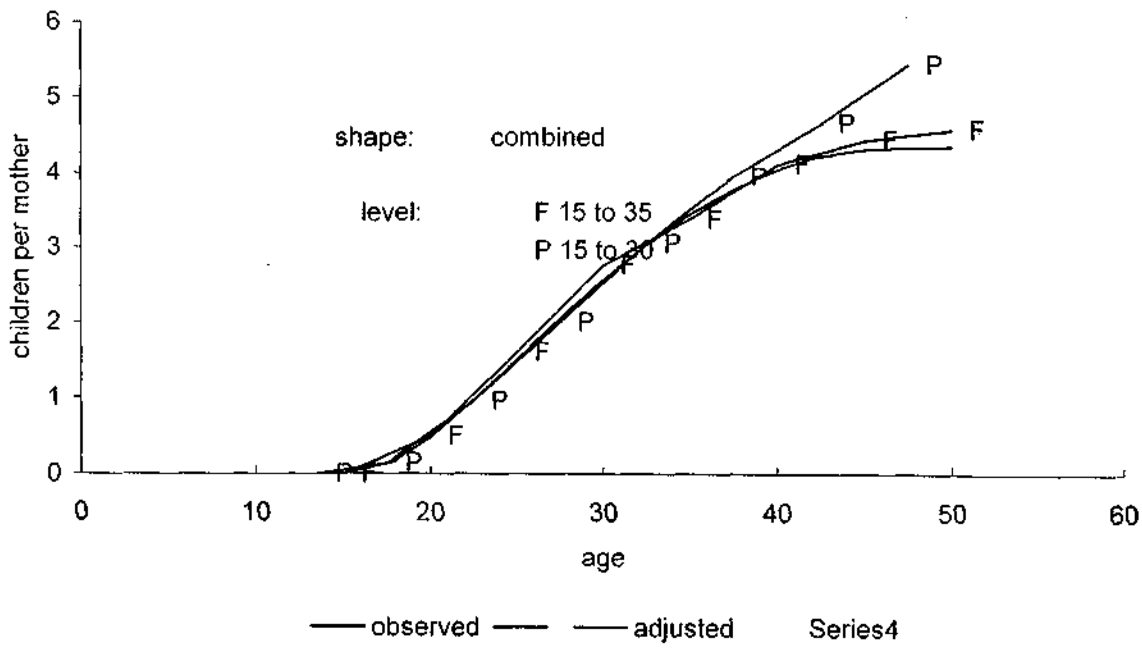



**Figure 5.4 GOMPERTZ ADJUSTMENT OF P & F VALUES**
**The Lesotho 2002 Reproductive Health Survey**



The Relational Gompertz estimate is also lower than the Brass P/F ratio estimate, demonstrating that the fertility pattern was distorted across all ages. A slightly lower TFR estimate of 4.2 children per woman was also estimated by the Bureau of Statistics (2003a: 126) using the same method. As suggested before, this could be due to sample size difference, as well as the adjusted ASFR for age group 30-34.

Based on the evidence presented above, this study acknowledges the possibility of changing fertility levels in Lesotho, and therefore presents the Relational Gompertz TFR estimates as the best estimates of recent fertility levels in the country. Table 5.3 below summarises and compares these estimates with those derived by the Bureau of Statistics using the same data sets and model - Relational Gompertz. A difference of 1.2 births between the Bureau and the current research in the 1996 census could be attributed to the adjustments made to the original data. Indeed the Bureau of Statistics does state that there was high under reporting of births in the census (Bureau of Statistics, 1998: 126), but what was done to counter this problem is not stipulated. There is also no inference to the magnitude of overstated parities by the Bureau. It is therefore difficult to make conclusions about the plausibility of the Bureau's estimates when the adjustments employed are not specified. However, the Gompertz estimates from the 2002 LRHS are almost similar. This is mainly because there were no serious data adjustments necessary in this data set. Nevertheless, the question that still remains unclear is what could be causing the disparity. As highlighted earlier, this research can only make inference to the sample size differences and the adjustment of ASFR for women aged 30-34.

**Table 5.3 Comparison of Relational Gompertz Fertility Estimates in Lesotho, 1996 Census and 2002 LRHS.**

| | Bureau of Statistics Estimates | Current Estimates |
|---|---|---|
| 1996 | 4.9 | 3.7 |
| 2002 | 4.2 | 4.3 |

**Source:** Bureau of Statistics (20031: 126)

Another important observation is that fertility estimates from the current study suggest increasing fertility levels in Lesotho between 1996 and 2002, while the Bureau's estimates indicate the opposite occurrence. The current estimates also contradict observations made by various studies on Lesotho and sub-Saharan Africa that fertility trend in Lesotho is on the decline (see Matabane, 1996; Gaisie, 1996; Mturi, 1998; Caldwell and Caldwell, 2002). This study does not contend these findings, rather it posits that the degree of under reporting of births in the 1996 was so high that the methodological adjustments could not account for. It is acknowledged that despite the powerfulness of indirect techniques, the final estimates are subject to the form of the original data (Brass, 1996). It would therefore be interesting to understand the data adjustments imposed by the Bureau. Given that this research has evaluated and corrected - where possible - the raw data, and declared it usable for the application of the P/F ratio method, the fertility estimates derived here are likely to fare better than those presented by Bureau of Statistics.

## 5.3 Fertility Differentials in Lesotho

Further insight on the application of the P/F ratio method in Lesotho is highlighted through estimation of fertility levels using different characteristics of women within the reproductive span. However, because of the small sample size in the 2002 LRHS, differentials in fertility levels were distorted as some characteristics had few or no cases. Although, the study presents fertility estimates derived from the reported births, the Brass P/F ratio method, and the Relational Gompertz method, estimates from the latter method are granted more attention because of the conclusion made earlier about changing fertility levels in Lesotho.

The relationship between fertility and socio-economic factors is a complex one (Kirk, 1996). Based on the Demographic Transition Theory, declines in fertility levels are ascribed to socio-economic developments, which in turn influence changes in fertility attitudes and behaviour (Mason, 1997). According to Kirk and Pillet (1998), total fertility rates in sub-Saharan Africa range from 3.7 to 5.7 children per woman in urban areas, and 5.7 to 7.1 children per woman in rural areas. Differences between urban and rural fertility are largely the result of compositional differentials in education, occupation and income (ibid). Therefore, it is expected that people residing in urban areas are more conscious about maximising their productivity and well being, hence the tendency to have small family sizes than rural dwellers. At the same time, rural residents practice old forms of production where the family operates as a unit of production and reproduction (Mason, 1997). Thus as long as large family size is perceived advantageous, fertility will also remain high in these areas.

Table 5.4 presents fertility differentials in Lesotho using the 1996 population census. In the census 21.5% and 78.5% of women within the reproductive ages reported to be residing in urban and rural areas respectively in Lesotho. The reported, the Brass P/F and the Relational Gompertz estimates imply that Basotho women living in rural areas have about 30% higher fertility than those living in urban areas. However, the results of the Brass P/F ratio and Relational Gompertz methods suggest higher reporting errors among urban women. This is contrary to expectation because urban women are supposedly better educated, and probably more knowledgeable about the importance of giving correct information. For instance, the Brass P/F ratio method shows 42.2% under reporting of births in the twelve months prior the 1996 census in urban areas relative to 33.7% in rural areas. In addition, the Relational Gompertz model also suggests better reporting of recent fertility in rural areas as the adjusted TFR is similar to the reported TFR estimate. Nonetheless, the Relational Gompertz results suggest that on average a woman residing in urban areas bears 3.3 children compared to 4.7 children born by her rural counterpart at the end of the reproductive period. This observation supports fertility theories on urban and rural fertility differentials (Kirk and Pillet, 1998).

**Table 5.4 Fertility Differentials in Lesotho, the 1996 Population Census**

| Background Characteristics | Total Fertility Rate Estimates | | |
|---|---|---|---|
| | Reported | Brass' P/F Ratio | Relational Gompertz |
| **Urban and Rural Residence** | | | |
| Urban | 3.20 | 4.55 | 3.30 |
| Rural | 4.78 | 6.39 | 4.71 |
| **Educational Attainment** | | | |
| None | 2.78 | 3.72 | 3.24 |
| Primary School | 3.60 | 4.82 | 4.11 |
| Secondary/High School | 2.85 | 3.81 | 3.16 |
| Vocational Training/Diploma | 2.12 | 3.84 | 2.72 |
| Graduate/Post Graduate | 2.25 | 3.02 | 2.24 |
| **Marital Status** | | | |
| Never Married | 1.18 | 1.57 | 1.46 |
| Currently Married | 4.88 | 6.53 | 4.61 |
| Separated | 3.17 | 4.24 | 3.16 |
| Divorced | 3.02 | 4.05 | 3.00 |
| Widowed | 3.50 | 4.68 | 3.79 |

Theoretically, educational attainment is inversely related to fertility (Caldwell, 1982). The depressing effect of education on fertility is due to the delayed entry into marriage as well as childbearing, adoption of small-family size norms, and knowledge and use of contraceptives (ibid). However, fertility disparities across educational attainment in table 5.4 do not seem to adequately support of this theory. Furthermore, the 1996 census reported 59.9% and 30.5% of Basotho women aged 15-49 who had attained primary school and secondary/high school education respectively. Based on the Relational Gompertz estimates, on average, women with no education in Lesotho have a lower TFR of 3.24 children, than women with primary education who have 4.11 children per woman. These figures are also lower than the sub-Saharan Africa estimates of 6.1 to 7.1 children to women with no education and 5.4 to 6.6 children to women with primary education (Kirk and Pillet, 1998). It should be noted that fertility studies in sub-Saharan Africa have shown that attitudes towards small family size and contraceptive use determine fertility levels than educational levels per se (Gaisie, 1996; Caldwell and Caldwell, 2002). However, the depressing effect of education seems to be significant beyond primary school level because these are schooling ages which coincide with the reproductive period. In particular, women who had attained graduate and post graduate education on average have one child less than women with no education, and about two children less than women with primary education.

The Relational Gompertz model results suggest that women with no education under reported their births slightly more (14.2%) compared to women with primary education (12.4%). This is not surprising because underreporting of events is associated with low literacy levels (Kpedekpo, 1982). However, the more educated women with secondary/high school as well as vocational training/diploma had lower fertility but higher under reporting of births. This observation may imply that there are other factors to reporting of events than educational level. It is also likely that the more educated women were not available at home to respond hence their proxies misreported their reproduction experiences. Nevertheless, the graduates and post-graduates showed the lowest fertility as well as better reporting of recent fertility. Thus ability and willingness to report events correctly is complicated in Lesotho.

Although there have been substantial increases in premarital fertility in sub-Saharan Africa, marital fertility cannot be over played. If all women within the reproductive period were married, fertility would be higher than currently observed (Bongaarts and Potter, 1983). In Lesotho, TFR would increase by 35% if all reproductive women were married (Mturi and Hlabana, 1999). Based on the 1996 census reports, majority (62.4%) of women within the reproductive ages had ever married in Lesotho. The currently married women reported the highest TFR of 4.88 children per woman. Although the P/F ratio method suggested about 25% under reporting of births across all marital groups, the Relational Gompertz model indicated under reporting of births only for never married and widowed women. Currently married women over reported their recent births by 5.3%, while the separated and divorced tended to have reported their fertility well. The Relational Gompertz estimates indicate that marital dissolution results in forgoing one extra child when compared to the currently married. The 37.6% never married women had the lowest TFR of 1.46 children per woman, though with the highest under reporting of births in the twelve months prior the census.

# CHAPTER 6

# CONCLUSION AND RECOMMENDATIONS

## 6.1 Summary

Accurate fertility estimation is important for analysis of population dynamics and policy development. This research has presented substantial defectiveness in Lesotho fertility data, hence the usefulness of indirect demographic techniques. The impetus of the research was to highlight necessary steps to undertake in order to optimally estimate fertility levels in Lesotho using the P/F ratio method. Brass (1996), as the father of the indirect techniques, has asserted that the plausibility of the estimates depends on the form of the original data. Therefore, in this research information on retrospective and current fertility from the 1996 Population Census and 2002 Lesotho Reproductive Health Survey (LRHS) was evaluated, and where possible corrections were employed to improve the quality of the data, and to make the fertility data usable for application of the P/F ratio method. In particular, the data was evaluated to verify the following P/F ratio assumptions; (1) constant fertility; (2) accurate reporting of fertility by younger women; and (3) correct age pattern of fertility.

Examination of the age distribution of women showed irregular under and over reporting of age across all ages in both data sets. However, the use of age-groups absorbed the effect of possible distortions on the fertility estimates, with a resultant satisfactory distribution. When comparing the 1996 census and the 2002 LRHS, it was interesting to observe a similar age distribution, which rendered the two data sets comparable.

Data evaluation on the reports on CEB showed considerable over reporting of parities in the 1996 census. For instance, there were girls aged 15 years who reported having had 15 live births. To correct for such misreporting on CEB, a table was developed with standardized maximum number of CEB average women in different age groups are likely to have. Using the table to sieve misreported cases, 0.12% cases were deleted from the census analysis. These were mainly older women, supporting the assumption that younger women report their fertility better than older women. It is possible that some true cases were deleted in the process, but the proportion is believed to have minimal effect. There was no over reporting of CEB evident in the 2002 LRHS.

Further analysis was done on reports on recent fertility. Using the Century Month Code (CMC), the 1996 census again presented substantial misreporting of date of last births, with some women having reported births that were older than the mothers. It is clear that some of these errors were due to ignorance of data collectors themselves. As a result, analysis of recent fertility reports showed substantial under reporting of births in the 12 months preceding the census date. On the other hand, the 2002 LRHS showed underreporting of births by women aged 30-34. This problem was adjusted using average birth reports of women in the immediate preceding and succeeding age-groups. The ASFRs distribution suggested over reporting of births in the survey. The analysis of the P/F ratios confirmed the underreporting and over reporting of births in the 1996 census and the 2002 LRHS respectively. In both data sets, the fertility levels were unsatisfactory, but the age pattern of fertility was acceptable, conforming to the P/F ratio assumptions. The errors were likely to be corrected by the P/F ratio method.

While none of the P/F ratios was equal to one in the two data sets, the P/F ratios of younger women fared better than those of older women – still supporting that younger women report their fertility better. At the same time the level and pattern of the P/F ratios suggested changing fertility levels in Lesotho. In particular, the 1996 census P/F ratios implied about 50 to 100% lower current fertility levels than life time fertility. While it is evident that there were huge under reporting of recent births, the possibility of declining fertility levels is portrayed by the increasing P/F ratios with age (Feeney, 1996). Muhwava (2002) used similar evidence to justify Zimbabwean fertility decline. If indeed fertility has been changing, as has been suggested by various studies (see Matabane, 1996; Mturi, 1998; Bureau of Statistics, 2003a), relative to the Brass P/F ratio, the Relational Gompertz model is a better method to estimate fertility levels in Lesotho because it does not assume constant fertility in the recent past.

This study has presented the Brass P/F ratio and the Relational Gompertz fertility estimates for the 1996 population census and the 2002 LRHS. Disparities between direct and indirect fertility estimates indicate the amount of errors in the fertility data.

The Brass P/F ratio method suggested that 30.6% of the births in the twelve months prior the 1996 census were not reported, while the Relational Gompertz method gave a lower under reporting rate of 11.2%. This observation was confounded by exaggeration of reported parities. Although the Brass P/F ratio indicated 6.0% over reporting of current fertility, the Relational Gompertz showed a higher over reporting rate of 11.3% in the 2002 LRHS.

As mentioned earlier, this research uses the Relational Gompertz estimates because of supporting evidence of declining fertility levels in Lesotho, which violates the Brass P/F ratio method assumption. Therefore, on average a Mosotho woman would have 3.7 children and 4.3 children by the end of her reproductive period, in 1996 and 2002 respectively. However, the 1996 fertility estimate is still implausible because the method could not account for the extent of under reporting of recent births. It is important to state that the current estimates are different from the official estimates given by the Bureau of Statistics. Not undermining the important work of the Bureau of Statistics, the current study challenges the Bureau's estimates, and declares own estimates as more likely precise estimates of recent fertility levels in Lesotho when using the P/F ratio method. This assertion is grounded on the basis that compared to the Bureau, the study undertook and presented detailed data evaluation and adjustments, as well as P/F ratio methodological adherence. However, the study also recognises that the Bureau has access to better resources to adjust for data errors, but these need to be specified.

## 6.2 Concluding Remarks

The dissertation has highlighted that violation of assumptions of estimating models distorts fertility estimates. In particular, evidence of changing fertility levels in Lesotho renders the Brass P/F ratio method inappropriate to use for estimation of recent fertility levels in the country. This research represents the Relational Gompertz model faring better in indirectly estimating recent fertility levels in Lesotho.

Nevertheless, the inherent errors in the Lesotho fertility data continue to compromise fertility estimates even when indirect techniques are employed. Whereas it is usually assumed that indirect techniques are robust to data errors, findings from this study suggest that these techniques are not as robust as they are assumed to be. While this research engaged in extensive data evaluation and adjustment, the current fertility estimates show that some of the inherent errors are not possible to eradicate at analysis level. Although the P/F ratio and the Relational Gompertz methods are quite powerful in indirectly estimating fertility levels, they do not provide an utopia to problems of data deficiency in the country. If the degree of data errors is enormous, then the techniques can also be sources of errors themselves (Fenney, 1996). Hence, serious prudence should be taken during data collection and processing in order to minimise the magnitude of the errors.

## 6.3 Recommendations

From the results of this study, the following recommendations are put forth in order to obtain optimal fertility estimates in Lesotho. First, data collectors like the Bureau of Statistics should exercise serious caution during data collection and processing in order minimise data errors as the type and magnitude of some errors cannot be solved at analysis level. It has been indicated in this study that some of the errors evident in the data sets were basically due to data collectors' and editors' ignorance. This carelessness leads to either distortion of fertility estimates or deletion of substantial cases for analysis. Therefore, thorough assessment of data quality should be a prerequisite before either direct or indirect methods are used to estimate fertility levels. Based on the results of this study, indirect techniques are not necessarily robust to the data errors when the data is too defective. The Bureau of Statistics is recommended to present these errors as well as their implications so that analysts can make their own judgement about the plausibility of the estimates.

Secondly, adherence to methodological assumptions is imperative to final estimates. Before embarking on estimation, this research presented the P/F ratio method assumptions, and tested if Lesotho fertility data adheres to them. This is important because violation of these assumptions create additional errors which distort the estimates (Feeney, 1996).

Lastly, though not least is the presentation of fertility estimates from different methods. It is important that researchers in Lesotho specify which estimate, and why, is the most precise estimate amongst different estimates from the different methods. The most precise estimate should be based on data quality and adherence to particular methodological assumptions. For instance, given the supporting evidence for declining fertility levels in Lesotho, the Brass P/F ratio method is not appropriate to estimate recent fertility levels because of violation of the constant fertility assumption. Rather, the Relational Gompertz model offers better estimation precision.

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## Appendix 1 1996 Population Census Children Ever Born by Age of Mother

| | Number of Children Ever Born | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 15 | 25079 | 185 | 30 | 19 | 10 | 7 | 4 | 4 | 1 | 1 | 4 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 16 | 24505 | 535 | 36 | 18 | 8 | 7 | 6 | 2 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 20278 | 1097 | 104 | 17 | 8 | 7 | 10 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 21461 | 2502 | 291 | 57 | 20 | 10 | 3 | 6 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 16671 | 3550 | 493 | 87 | 36 | 10 | 10 | 3 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 15290 | 5563 | 1379 | 279 | 103 | 34 | 21 | 4 | 2 | 3 | 4 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 21 | 11759 | 5770 | 2092 | 425 | 123 | 46 | 25 | 13 | 10 | 1 | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 8688 | 5754 | 2971 | 687 | 190 | 61 | 33 | 12 | 11 | 4 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 6470 | 4965 | 3391 | 1051 | 227 | 83 | 42 | 13 | 10 | 6 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | 5817 | 4716 | 4082 | 1524 | 393 | 144 | 44 | 22 | 9 | 2 | 5 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | 4210 | 3764 | 4042 | 2065 | 655 | 179 | 71 | 24 | 19 | 11 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 4054 | 3617 | 4388 | 2566 | 888 | 274 | 95 | 28 | 17 | 9 | 7 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 27 | 2308 | 2266 | 3049 | 2229 | 884 | 304 | 100 | 32 | 15 | 9 | 4 | 3 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | 2606 | 2491 | 3663 | 3101 | 1499 | 541 | 179 | 55 | 35 | 6 | 4 | 3 | 3 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 29 | 1769 | 1582 | 2558 | 2369 | 1411 | 565 | 201 | 65 | 31 | 14 | 7 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 1975 | 1838 | 3141 | 3158 | 2270 | 1097 | 487 | 212 | 117 | 55 | 30 | 8 | 6 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 31 | 1300 | 1160 | 1897 | 2319 | 1968 | 1010 | 412 | 137 | 74 | 21 | 11 | 8 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 32 | 1547 | 1495 | 2500 | 3001 | 2732 | 1719 | 855 | 317 | 154 | 56 | 36 | 12 | 3 | 3 | 0 | 1 | 1 | 2 | 0 | 0 | 0 |
| 33 | 972 | 953 | 1532 | 1907 | 1957 | 1370 | 651 | 244 | 106 | 39 | 20 | 12 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 34 | 989 | 876 | 1572 | 2019 | 2108 | 1696 | 909 | 386 | 161 | 63 | 34 | 13 | 7 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 35 | 833 | 836 | 1311 | 1742 | 2021 | 1604 | 1044 | 506 | 230 | 92 | 39 | 11 | 7 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| 36 | 953 | 891 | 1478 | 1872 | 2244 | 2096 | 1458 | 735 | 331 | 135 | 60 | 22 | 10 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | 534 | 522 | 877 | 1145 | 1391 | 1407 | 1033 | 599 | 301 | 109 | 45 | 18 | 9 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 776 | 731 | 1195 | 1523 | 1806 | 1866 | 1536 | 1007 | 523 | 211 | 94 | 30 | 11 | 8 | 2 | 0 | 1 | 0 | 0 | 0 | 0 |
| 39 | 524 | 430 | 808 | 996 | 1233 | 1205 | 1099 | 734 | 436 | 183 | 74 | 33 | 13 | 7 | 2 | 2 | 1 | 1 | 0 | 0 | 1 |
| 40 | 764 | 696 | 989 | 1305 | 1449 | 1555 | 1459 | 1032 | 672 | 337 | 176 | 64 | 34 | 17 | 5 | 2 | 2 | 1 | 1 | 0 | 0 |
| 41 | 434 | 383 | 575 | 705 | 931 | 992 | 1024 | 765 | 542 | 245 | 138 | 44 | 17 | 7 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 624 | 515 | 825 | 1039 | 1231 | 1248 | 1332 | 1029 | 779 | 371 | 215 | 69 | 37 | 14 | 5 | 5 | 2 | 0 | 1 | 0 | 0 |
| 43 | 379 | 377 | 558 | 707 | 803 | 923 | 908 | 787 | 502 | 296 | 160 | 56 | 25 | 8 | 6 | 0 | 2 | 1 | 0 | 0 | 0 |
| 44 | 464 | 511 | 675 | 818 | 987 | 1097 | 1096 | 954 | 726 | 413 | 241 | 73 | 45 | 14 | 6 | 3 | 1 | 1 | 1 | 0 | 1 |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | 470 | 454 | 615 | 760 | 886 | 905 | 912 | 825 | 648 | 383 | 218 | 83 | 42 | 8 | 8 | 6 | 2 | 0 | 0 | 0 | 0 |
| 46 | 431 | 420 | 592 | 738 | 891 | 970 | 948 | 860 | 676 | 386 | 236 | 87 | 49 | 18 | 6 | 2 | 1 | 1 | 0 | 0 | 1 |
| 47 | 304 | 312 | 451 | 514 | 607 | 671 | 721 | 568 | 490 | 280 | 175 | 72 | 32 | 17 | 3 | 4 | 1 | 0 | 0 | 0 | 0 |
| 48 | 436 | 433 | 554 | 747 | 854 | 922 | 856 | 780 | 626 | 434 | 276 | 122 | 56 | 15 | 8 | 6 | 3 | 1 | 1 | 0 | 0 |
| 49 | 323 | 361 | 472 | 588 | 662 | 711 | 719 | 652 | 567 | 349 | 235 | 92 | 48 | 15 | 8 | 7 | 0 | 0 | 0 | 1 | 0 |

**Appendix 2 2002 Lesotho Reproductive Health Survey Children Ever Born by Age of Mother**

| | Children Ever Born | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Age** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 15 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 0 | 45 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 44 | 14 | 3 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 0 | 56 | 30 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 49 | 40 | 12 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 28 | 46 | 27 | 4 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | 0 | 29 | 60 | 24 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | 0 | 31 | 72 | 45 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 0 | 17 | 58 | 57 | 12 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 0 | 17 | 36 | 51 | 32 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | 0 | 19 | 30 | 30 | 36 | 25 | 6 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 9 | 26 | 48 | 32 | 20 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | 5 | 26 | 30 | 16 | 20 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | 6 | 44 | 63 | 44 | 35 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | 8 | 24 | 27 | 64 | 45 | 18 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 9 | 22 | 42 | 68 | 50 | 48 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| 34 | 0 | 4 | 12 | 39 | 28 | 30 | 24 | 28 | 0 | 9 | 0 | 0 | 0 | 0 |
| 35 | 0 | 2 | 18 | 33 | 36 | 25 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 5 | 22 | 21 | 20 | 45 | 30 | 49 | 8 | 9 | 0 | 0 | 0 | 0 |
| 37 | 0 | 1 | 4 | 36 | 16 | 60 | 36 | 0 | 16 | 9 | 0 | 0 | 0 | 0 |
| 38 | 0 | 2 | 8 | 21 | 48 | 65 | 48 | 21 | 24 | 9 | 0 | 0 | 0 | 0 |
| 39 | 0 | 6 | 12 | 27 | 36 | 40 | 72 | 14 | 40 | 9 | 0 | 0 | 0 | 0 |
| 40 | 0 | 10 | 20 | 6 | 36 | 5 | 24 | 21 | 24 | 54 | 10 | 0 | 0 | 0 |
| 41 | 0 | 6 | 14 | 24 | 72 | 30 | 54 | 42 | 48 | 18 | 0 | 0 | 0 | 0 |
| 42 | 0 | 1 | 6 | 27 | 68 | 25 | 42 | 28 | 32 | 36 | 10 | 0 | 0 | 0 |
| 43 | 0 | 6 | 6 | 18 | 32 | 45 | 36 | 28 | 64 | 18 | 10 | 0 | 0 | 0 |
| 44 | 0 | 4 | 2 | 6 | 12 | 35 | 54 | 35 | 48 | 18 | 20 | 0 | 0 | 13 |
| 45 | 0 | 3 | 8 | 18 | 16 | 20 | 60 | 63 | 24 | 9 | 10 | 22 | 0 | 0 |
| 46 | 0 | 0 | 10 | 12 | 24 | 35 | 30 | 0 | 72 | 36 | 20 | 0 | 12 | 0 |
| 47 | 0 | 4 | 6 | 6 | 8 | 30 | 24 | 42 | 56 | 36 | 10 | 44 | 0 | 0 |
| 48 | 0 | 3 | 6 | 18 | 12 | 35 | 12 | 56 | 64 | 27 | 10 | 0 | 0 | 0 |
| 49 | 0 | 1 | 8 | 9 | 24 | 5 | 12 | 28 | 64 | 9 | 10 | 0 | 0 | 0 |