Age and sex composition of the population of Mongolia. An evaluation of the population censuses, 1956-2000

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This paper describes trends and patterns in age and sex composition of the population of Mongolia from 1956 to 2000. Over the last 50 years, the population of the country almost tripled from 845.5 to 2373.5 between 1956 and 2000. This biggest demographic increase in the history of Mongolia impacts evidently the age and sex structure of the country by adding numerous growing young age population. Based on indexes and methods designed to describe age and sex structure, to evaluate age and sex data from population censuses, we identify and distinguish data inconsistencies from natural effect of the recent demographic processes. Some patterns that might be identified as data discrepancies are indeed real.

The paper addresses first general age and sex structure through population pyramid, the most basic tool for demographers. This useful starting point allows to sketch broadly data quality. Then, age data quality is first examined before turning to sex data quality. These two basic demographic attributes allow to detail more precisely the pattern sketched by the population pyramid's review.

Age data are analysed (1) by single years of age using Myers's blended method, and (2) by five-year age group data through an alternative measure of age data quality, the successive age ratio, and the conventional age-accuracy index. In assessing age data quality, it is shown that the classical measures of age quality can be biased in the case a population increases (generally due to mortality decline while fertility remains stable). Based on the assumption of linearity and rectangularity in the age distribution over age groups, these measures are unable to take into account the effect of a growing population.

In subsequent sections, the paper turns to sex ratio analysis, age-sex accuracy index, and pattern of under-enumeration. If sex ratio data by age groups are improving over the years, they still present doubtful pattern in 2000 (especially at age 50 and over). This is an issue that need to be tackled down. The age-sex accuracy index, developed by the United Nations in the 1950s, shows that Mongolia's census data can be considered as slightly inaccurate. But, since this index is also based on the assumption of linearity and rectangularity, it is also biased by Mongolia's demographic increase. Finally, the pattern of under-enumeration is addressed through intercensal cohort analysis. It shows that since the 1969 census pattern of under-enumeration are consistent with observations from other developing and developed countries. Some possible reasons to these pattern are briefly introduced.

To conclude, the main points are summed. The conclusion stresses that, taking into account Mongolia's past demographic increase, recent census age and sex data can be considered as accurate.

Keywords: Mongolia, age and sex composition, data quality, census data

Population's age and sex structure is an important variable for all social scientists, particularly demographers who consider age and sex composition as a starting variable in fertility, mortality, nuptiality, migration and other socio-demographic studies. Age and sex data are particularly useful when crossed with others demographic and socio-economic variables (risk of mortality, reproduction, marital status, educational level, economic activity,...). Age and sex constitute an illuminating tool for the separation and identification of different groups. But apart from these sole demographic interests, age and sex data are important to a wide array of administrative, scientific, technical and commercial sectors in order to plan community institutions (population in scholarly age, voting population, working population,...) and to foresee production or services (consumer goods, leisure industry, medical and sanitary sectors,...). So, assessing age and sex data quality in order to detect and correct errors and then ensure a near-accurate age and sex composition to produce reliable demographic analysis is one of demographer's basic task. By tracking data biases demographer would be plenty conscious whether his demographic analysis is representative or not. Hence the issue of data quality examination does deserves a careful attention since many policies are formulated based on empirical researches using datasets such as population census. An inconsistency of data impacts directly the conclusions and policy formulations. The specific objective of this paper is twofold, to assess data quality of Mongolian population censuses from 1956 to 2000 and to understand and distinguish data inconsistencies from the natural demographic processes since the middle of the 20th century. This study relies both on single years of age and five-year age distribution from the 1956, 1963, 1969, 1979, 1989 and 2000 population censuses of Mongolia at national level. The 5-year data are taken from *Mongolian Population in XXth* Century published by the National Statistical Office of Mongolia (NSO) for commemorating the 80th anniversary of inception of the NSO in Mongolia (NSO 2003). The single years of age population distribution is also used. The datasets for 1956 to 1989 taken from "Population of Mongolia" published by NSO in Mongolia (SSO, 1994). The 2000 census data is taken from *Demographic Yearbook, Special Census Topics, vol.1-Basic Population Characteristics* (Table 1a: Population by single years of age by sex and urban/rural residence: each census, 1985 - 2003) published by the United Nations.[1] Based on indexes and methods designed to describe age and sex structure, to evaluate age and sex data from population censuses, this analysis sketches the evolution of age and sex data, and its quality since the middle of the 20th century. The paper is structured as follows: first, general age and sex structure (population pyramid) is examined as a starting point before addressing more carefully age data and then sex data. These two basic demographic attributes allow to detail more precisely the pattern sketched by the population pyramids' review. Age data are analysed (1) by single years of age using indexes developed to assess single years of age data quality and (2) by five-year age group data through the successive age ratio – an alternative measure of age data quality – and the conventional age-accuracy index. The paper turns then to another classical demographic measure: the sex ratio. Before addressing patterns of under-enumeration, age and sex data quality is synthesised by the United Nations age-sex accuracy index. Finally, in a ultimate section, patterns of under-enumeration are addressed through cohort survival analysis. The conclusion gives a general overlook on Mongolia's age and sex composition and the quality of the 20th century censuses.

1. Evolution of Mongolia's population: an overview

Among demographer's toolkit, population

[1] This dataset is available and can be freely downloaded (Excel format) on the Web at: «http://unstats.un.org/unsd/Demographic/products/dyb/dybcens.htm» (last accessed 3rd May 2007).

pyramid constitutes one of the most simple, popular, and powerful synthetic tool to appraise age and sex structure of a population. Population pyramid not only shows absolute or relative population by age and sex, but also the present of a population by showing its state at a given time (classically at census time), its past by tracing the broad contours of the demographic history, and its future since the forthcoming evolution is largely rooted in the present age and sex structure.

Figure 1 presents the population pyramids of Mongolia at the six last censuses (1956-2000). They allow to see at a glance the relative importance of each age through the years and, whether age and sex structures are marked by irregularities – indicating both the effects of migration or any disturbing events such as war or epidemic and age misreporting or selective under-enumeration. Since the mid-20th century, Mongolian population experienced important changes both in terms of size and composition. Over 50 years, passing through the first stage of the demographic transition (decline of mortality with stable unchanged fertility)[2], the population tripled from 845.5 thousands in 1956 to 2373.5 thousands in 2000 and its age composition transformed with a rejuvenation of its structure. The main increase took place during the 1960s, 1970s and 1980s with mean annual growth rates attaining more than 2.5 percent, implying a doubling of the population in around 25 years (table 1). In 1956, the population pyramid is almost rectangular. This shape is the result of high mortality which prevailed during the first part of the century and which is related to both epidemiological environment, political repression of the 1930s and the effects of World War II. Because of demographic inertia, this rectangular profile disappears only progressively throughout the censuses as mortality transition is underway. Since 1963, and until 1989, due to the decline in mortality, the expansion of the base of the pyramid bears out an increase in young ages. Thanks to imported western medicine (through USSR), socio-economic development and governmental pro-natalist policies (Neupert 1996), the surviving proportion in all age groups rises and especially the proportion of surviving children. The proportions of three broad age groups (based on total population by sex) are shown on figure 1. The proportion of 0-14 reaches 40-45% of the population in 1969, 1979 and 1989 against 30 percent in 1956. The 1969, 1979 and 1989 pyramids present a very young profile with a broad base, triangular shape indicating very high proportions in young age groups, large families, and declining mortality. The last decade of the century witnesses an impressive fertility reduction (significant deficit in the child ages) coinciding with the transition towards a market oriented economy (the population aged 0-14 declines, but still reaches 35% of total population).

Along with the increasing population at young ages, the importance of old ages decreases. The proportion of the people aged 60 and over declines since the middle of the century. However, with the significant recent fertility decline, the old ages will grow in importance during the coming years because the more youth a population counts and the more it has increased in the recent decades, the higher its potential aging. Meanwhile, like many other countries, before these proportions of the population will age, Mongolia will experience "an exceptional period with a demographic situation that is very favourable to economic development; a situation where the proportion of adults of working ages will reach a historical maximum for a certain time [...]." (Vallin 2005: 149). This period is generally called the demographic bonus or the demographic window. Regarding its population structure, Mongolia opened recently its demographic window (Neupert and others 2004: 91-92).

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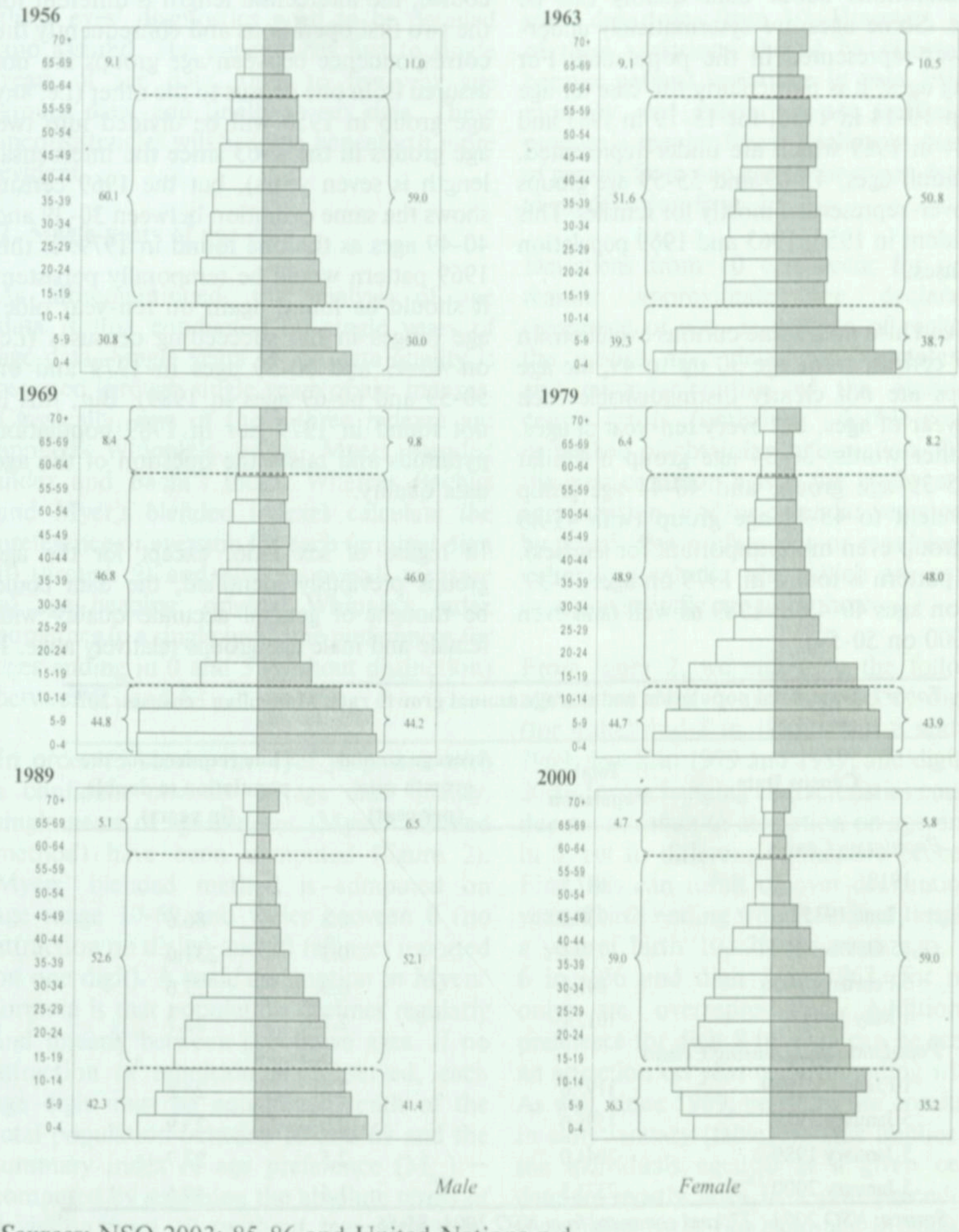
[2] The gains in mortality began in the late 1940s, see Riley (2005).

Figure 1: Population pyramids of Mongolia (per cent of population), 1956-2000



Sources: NSO 2003: 85-86 and United Nations n.d.
Note: Numbers show the proportions (based on the population by sex) of 0-14, 15-59 and 60+ population.

Based on visual diagnostic, some considerations about data quality can be made. Some ages are systematically under- or over-represented in the population. For young ages, it is particularly the case for age group 10-14 in 1956, for 15-19 in 1963 and 20-24 in 1969 which are under-represented. For adult ages, 45-49 and 55-59 age groups are over-represented mostly for females. This is evident in 1956, 1963 and 1969 population censuses.

One can also note some curious evolution. In 1969 census, from age 30 up to 49, the age groups are not clearly distinguishable each five-year of ages, but every ten-year of ages. In other words, 30-34 age group is similar to 35-39 age group, and 40-44 age group equivalent to 45-49 age group (with 45-49 age group even more important for females). This pattern is found in 1979 on ages 30-39, and on ages 40-49 in 1989 as well (and even in 2000 on 50-59).

If this pattern can be considered consistent from 1979 to 2000 (because it is found at each censuses but in ten-year older age groups), it is more curious that it is not found in the previous 1956, 1963 and 1969 censuses (for example, on ten-year younger ages groups in 1969, i.e. ages 20-29). Of course, the intercensal length is different for the two first operations and consequently the correspondence between age groups are not assured from one census to the other (i.e. any age group in 1956 will be divided into two age groups in the 1963 since the intercensal length is seven years), but the 1969 census shows the same evolution between 30-39 and 40-49 ages as the one found in 1979. If this 1969 pattern would be temporally persistent it should be found again on ten-year older age ranges in the succeeding censuses (i.e. on 40-49 and 50-59 ages in 1979 and on 50-59 and 60-69 ages in 1989). But, this is not found in 1979 nor in 1989 population pyramids and raises the question of the age data quality.

In regard of sex ratio, except for the age groups previously identified, the data could be thought of general accurate quality with female and male age groups relatively alike. If the total by the three broad age groups shown on figure 1 are considered, a slight male over-representation can be observed until age 60 for all censuses. Nevertheless, some difference can be noted regarding specific age groups. Hence, both in 1956 and 1963, women aged 45-49 and 55-59 are undoubtedly more numerous.

Table 1: **Date, total population and average annual growth rate, Mongolian censuses, 20th century**

Census Date	Total Population	Average annual growth rate (per cent)	Time required for the population to double (in years)
Population Census			
1918	647.5	—	
1 June 1935	738.2	0.8	86.6
15 October 1944	759.1	0.3	231.0
5 February 1956	845.5	0.9	77.0
1 May 1963	1017.1	2.7	25.7
Population and Housing Census			
10 January 1969	1197.6	2.8	24.8
5 January 1979	1595.0	2.9	23.9
5 January 1989	2044.0	2.5	27.7
5 January 2000	2373.5	1.4	49.5

Source: *NSO 2003 : 77, and computed from NSO 2003: 85-86*

Note: *doubling time computed by the continuous compounding,* $P_t = P_0e^{rt}$*, where* $t = ln(2)/r$.

In general, over the last 50 years, the quality of age and sex data improved manifestly but these eyes' diagnostics need to be detailed and assured. The paper turns first to single years of age data, then to five-year age groups data, and finally to sex data. These inconsistencies will become henceforth more evident.

2. Single years of age data

As aforementioned, the analysis of age data is first conducted on single years of age data. Single years of age data quality is assessed through single years of age indexes. Classically, one of these three indexes are applied: Whipple's index, Myers blended index and Bachi's index. Whereas Bachi's and Myer's blended indexes calculate the preference or aversion for each terminal digit (0 through 9) and give an overall measure of age heaping, original Whipple's index combines in a single index the preferences for ages ending in 0 and 5 (without distinction) between 23 and 62.

In order to secure the eyes judgment with a confident measure of age data quality, single years of age indexes (Myers' blended method) have been computed (figure 2). Myers' blended method is computed on age range 10-69 and varies between 0 (no attraction on digits) and 90 (all ages reported on one digit). A basic assumption in Myers' formula is that population declines regularly and linearly between successive ages. If no attraction or repulsion are observed, each age digit must be equal to a tenth of the total population between 10 and 69 and the summary index of age preference (M_{tot}) – computed by summing the absolute terms of deviation from 10 (without regard to sign) – reaches 0. M_{tot} values appear in brackets in the figure's caption (figure 2). In terms of overall data quality, the values shown are quite low, pointing to relatively good single years of age data quality for both sexes.

Regarding digit preferences, one can notice some departures from 10. However, some of these variations should be disregarded because natural variations in past fertility, mortality and migration are unlikely to produce a regular linear decline in number of persons from one age to the other, leading to no deviation from 10.

Deviations from 10 can occur for several reasons: approximate age declarations (ignorance of age, negligence of reckoning the precise age, deliberate misstatement, and misunderstanding of the questions), census errors (omissions, double-counts), or method of obtaining information. One of the most common bias is the preference for age, duration, and/or calendar years ending by 0 or 5. But preferences or repulsions for culturally symbolic ages which are country or region specific are also observed.[3]

From figure 2, we can note the following attractions; digit 6 and 8 in 1956; digits 3 (for males) and 8 in 1963; digits 8 and 9 in 1969; digit 8 in 1979 and 1989; and digit 9 in 2000. These changing characteristics could be due not as much to attraction on age ending in 0, but to different cumulative processes. First, this can result of over-declaration of year of birth ending with 0. Indeed, implying a year of birth 10, 20, or more ago, digit 6 in 1956 and digit 3 in 1963 (for males only) are overrepresented. Additionally, preference for digit 8 in 1963 can be seen as an attraction on year of birth ending with 5. As well, since 1969, censuses are conducted in early January (table 1). This implies that the individuals aged 0 at a given census date are mostly born in a year preceding a year ending by 0. For example, in 2000, the large majority of the persons of age ending by 0 are indeed born in a year ending by 9. Likely, the ones declaring a year of birth ending by 0 are indeed of age ending by 9 at the 2000 census. In 1969, 1979 and 1989, the

[3] Classically, 0 and 5 digits are the more attractive. However, in India and Nepal, beside these classical attractions, preferences on age digit 2 and 8 are observed as well (Retherford and Mishra 2001, Retherford and Thapa 2003, author's own calculation on 1971, 1981, 1991 and 2001 Census of India). In many East Asian countries (China, South Korea,…), digit 3 is preferred since the word "three" sounds like the word or character for "life" (Poston *et al.* 2003).

same occurs. The persons declaring a year of birth ending by 0 will be of age ending in 8 at census time. In addition, in Mongolian census questionnaire (based on the 2000 census (NSO 2001)), date of birth (year and month) is asked before the age (in completed years). It is likely that, in order to gain time, the interviewer skips the question on age and reckons personally the interviewed person's age, focusing so more on year of birth.

Figure 2: Preference indexes for terminal digits computed by Myers' blended method (M_i) by sex, Mongolia, 1956-2000

Sources: *SSO, 1994. Population of Mongolia8 State Statistical office of Mongolia, page 24-28, Ulaanbaatar*

Note: *Summary index of age preference (M_{tot}) – computed by summing absolute terms of deviations from 10 (without regard to sign) – appears in brackets in the figure's caption.*

Furthermore, it is also likely that, as in China and Korea, the traditional Mongolian way to reckon people's age is to count that a baby is one year of age at birth. Henceforth, the interviewer – being conscious of this traditional way of counting years – will correct and register an age ending in the preceding digit instead of the one declared. This could partly explain why digits 0 and 5 are not attractive, and digit 9 more represented. Finally and almost similarly, but as much important, the interviewers could have overcompensated by moving individuals reported as age digit 0 to age digit 9 with the aim of avoiding the age heaping on age ending by 0. Nevertheless, part of the pattern are difficult to understand and explain; i.e. over-representation of digits 8 in 1956, and of digits 6 in 1979 and 1989.

3. Five-year age group data

Classically, age data quality is assessed through the computation of age ratios. Two have been proposed and are generally applied. The first age ratio (AR), proposed by the United Nations in 1952, is computed by reporting the population of a given age group multiplied by 200, divided by the sum of the preceding and following age groups. The second age ratio (AR') (more often applied) can be defined as the ratio of the population of a given age group to one-third of the sum of the population in the age group itself and the adjacent (preceding and following) age groups.[4] Based on quasi-identical computation, these two age ratios give nearly identical results for Mongolia. But as they enter in the computation of the age accuracy index, and the age-sex accuracy index presented below, they are not shown here. However since the adjacent age groups intervene in the computation of these two ratios, it is more difficult to assess the specific age group's effect. We prefer henceforth to rely mainly on an alternative age ratio, the successive age ratio (SAR) which can simply be defined as the ratio of two successive age groups (Noumbissi 1994: 756):

$$SAR = {}_5P_a / {}_5P_{a+5} \quad (1)$$

with ${}_5P_a$ and ${}_5P_{a+5}$ two following 5-year age groups; ${}_5P_a$ the youngest and ${}_5P_{a+5}$ the oldest.

Although, generally speaking, the age and sex structures improve over the years, some irregularities – partly due to deficient age declarations – become apparent once this SAR is computed. The irregular evolution of this ratio, plotted in figure 3, can be attributed certainly to a transfer of persons from one age group to another or to an omission in some age groups, but it can also be due to natural changes and variations in the demographic processes. If two successive age groups present the same number of individuals, the SAR would be equal to 1. In a growing population like Mongolia, this ratio would be higher than 1, indicating that the youngest age group (${}_5P_a$) counts more individuals that the oldest one (${}_5P_{a+5}$).

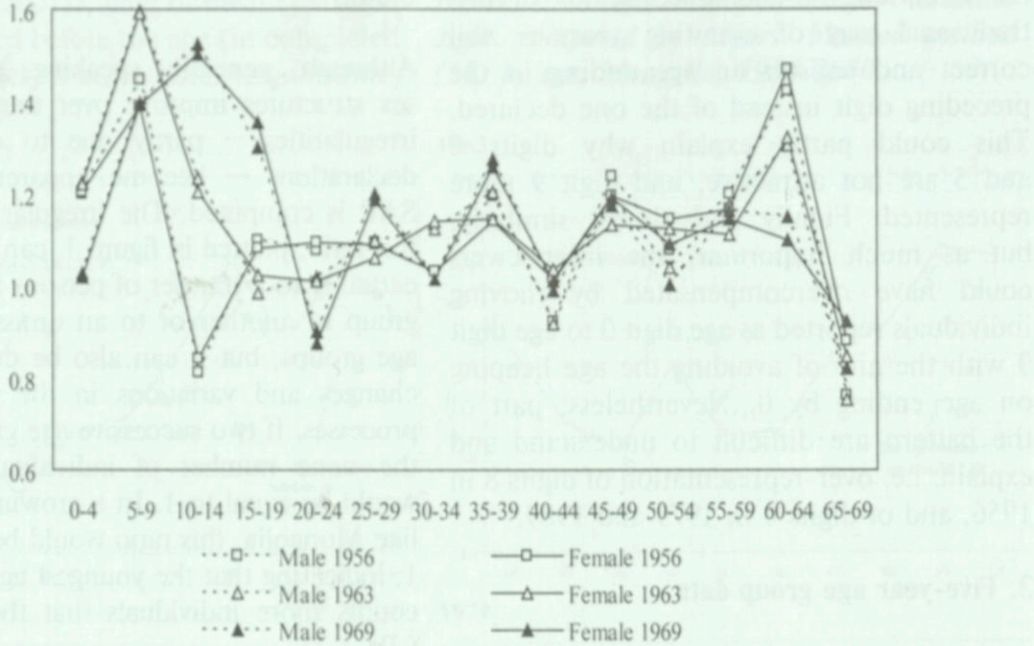
On figure 3, the disturbed evolution can mirror both a shortfall in the youngest age group (${}_5P_a$) and/or an over-representation of the oldest age group (${}_5P_{a+5}$) (falls on figure 3), or an excessive number in the youngest age group (${}_5P_a$) and/or a deficit in the oldest age group (${}_5P_{a+5}$) (rises on figure 3). At the exception of some irregularities, the same patterns are found between sexes and across censuses, pointing to a constancy in "errors".

More precisely, from age 25 to 59 and regardless of sex and census, 25-29, 35-39, 45-49, 55-59 age groups count more people than 30-34, 40-44, 50-54 and 60-64 (for this age group only since 1979). This is coherent with the previously identified pattern of digit preferences (figure 2), since the more represented age digits will be grouped in the same 5-year age group. As for young ages, both sexes present irregular attraction on 5-9 age group in 1956 and 1963. This pattern can be attributed to a transfer of 10-14 age group to 5-9 and 15-19 age groups, and/or an omission in 10-14 age group. Since 1979, this pattern almost disappears and even inverts in 1989.

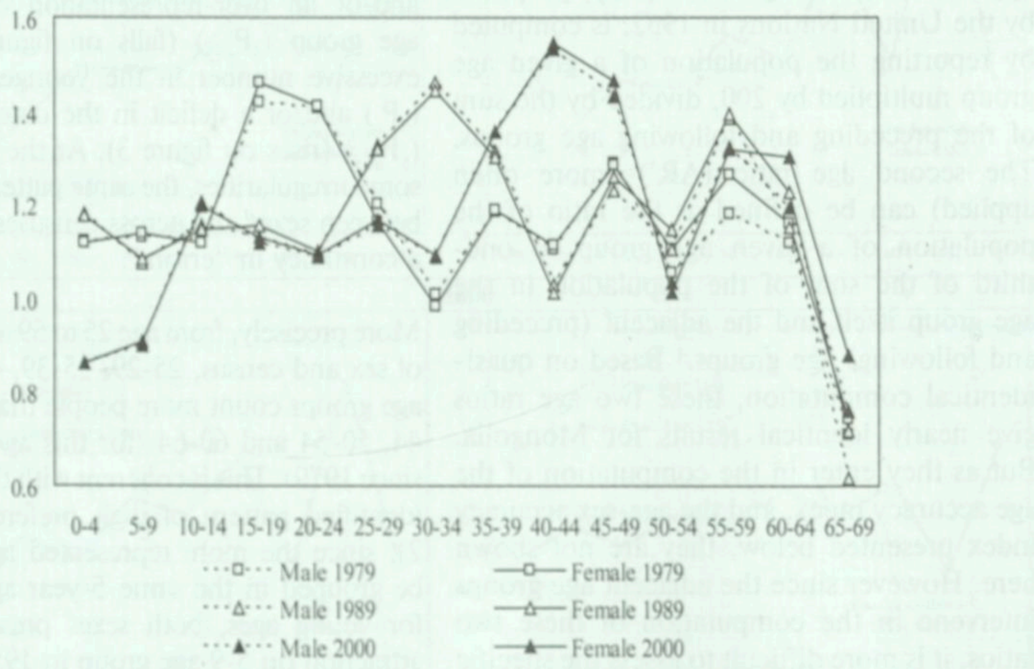
[4] The computational details of these two age ratios can be found in Hobbs (2004: 148-151).

Figure 3 a) and b): Successive age ratio ($_5P_a / _5P_{a+5}$), Mongolia, 1956-2000.

a) 1956-1969



b) 1979-2000



Source : NSO, 2003: 85-86

Moreover, what is striking is the high ratio on 10-14 age group and its two surrounding age groups in 1969 which is still found 10 years later in 1979, and then subsequently in 1989 and 2000 at older age groups. This redundant high ratio should be understand as the persistent effect of health's improvements and pro-natalist policies, implying a sudden and continuous growing number of surviving children which will move into older ages through time. The relatively stable ratios in younger age groups (after these highest ratios) witness the continuous demographic increase (table 1) with youngest age group ($_5P_a$) continuously higher than the oldest one ($_5P_{a+5}$) resulting in SAR higher than 1.

The two first age ratios in 2000 (age groups 0-4 and 5-9) – showing values under 1 – witness the fertility decline subsequent of the 1990s transition. Due to a drop in the number of births subsequent of fertility decline, the youngest age group ($_5P_a$) is less numerous than the oldest one ($_5P_{a+5}$) and the SAR reaches level under 1.

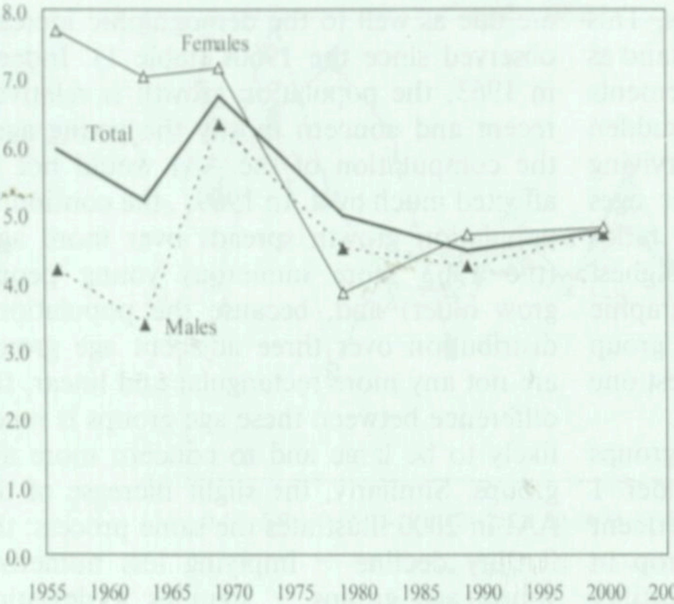
In order to evaluate the level and trend of age data accuracy, a synthetic measure – the age-accuracy index (AAI) – is usually used (Hobbs 2004). It can be obtained by treating all differences from the age ratio (AR', see first paragraph of this section) over all ages as positive (without regard to sign). The sum of these deviations and its mean deviation are computed for each sex before being averaged, giving a measure of the overall accuracy of age data. In the absence of any extreme fluctuations, the population should be distributed rectangularly and linearly over three age groups. In such case, the age-accuracy index would be zero. The higher the age-accuracy index, the more inadequate the census age data would be.

AAIs for Mongolia since 1956 are plotted on figure 4. The scores are quite different from one census to the other. But generally speaking, between 1956 and 2000, with a decline in the index, the accuracy of age data improved. However, this long-term improvement is marked by a deterioration in 1969 punctuated by an improvement (1989 census presents the most adequate age data). Clearly age data quality is an important factor in it, but part of these variations in the AAI are due as well to the demographic increase observed since the 1960s (table 1). Indeed, in 1963, the population growth is relatively recent and concern mostly the young ages; the computation of the AAI would not be affected much by it. In 1969, , the continuing population growth spreads over more ages (the 1963 more numerous young people grow older) and, because the population's distribution over three adjacent age groups are not any more rectangular and linear, the difference between these age groups is much likely to be large and to concern more age groups. Similarly, the slight increase of the AAI in 2000 illustrates the same process; the fertility decline – implying less numerous young age groups – signifies a deviation between adjacent age groups entering in the computation of the AAI. On the contrary, the difference between 1979 and 1989 adjacent age groups is likely to be less important because the past and sustained population increase has spread forward in older ages, implying smaller deviation between age groups. Hence, the changes in age structure yields to changing AAI. All these comments are roughly sketched by the smoothed or rough population pyramid's profile (figure 1).

However, these results suggest that reporting of age are improving over 50 years, though more importantly for females than males. With total age-accuracy index's values ranging from 5.94 in 1956 and 4.75 in 2000 (with a maximum of 6.72 in 1969 and a minimum of 4.46 in 1989), Mongolia stands between countries like Taiwan and Greece in the 1960s (respectively 4.7 in 1964 and 6.5 in 1961), between Sweden, Malaysia and China in the 1990s (respectively 3.8 in 1990, 3.9 in 1991 and 4.7 in 1990), and between South Africa (3.4) and Sri Lanka (5.2) in 2000[5]. These values are comparatively low and suggest that Mongolian age data are quite accurate.

[5] For the 1960s, values are taken from Shryock and Siegel (1976: 125); for the 1990s, from Hobbs (2004: 148); for 2000, from Poston et al. (2003: 130).

Figure 4: Age-accuracy index, Mongolia, 1956-2000



Source : NSO, 2003: 85-86

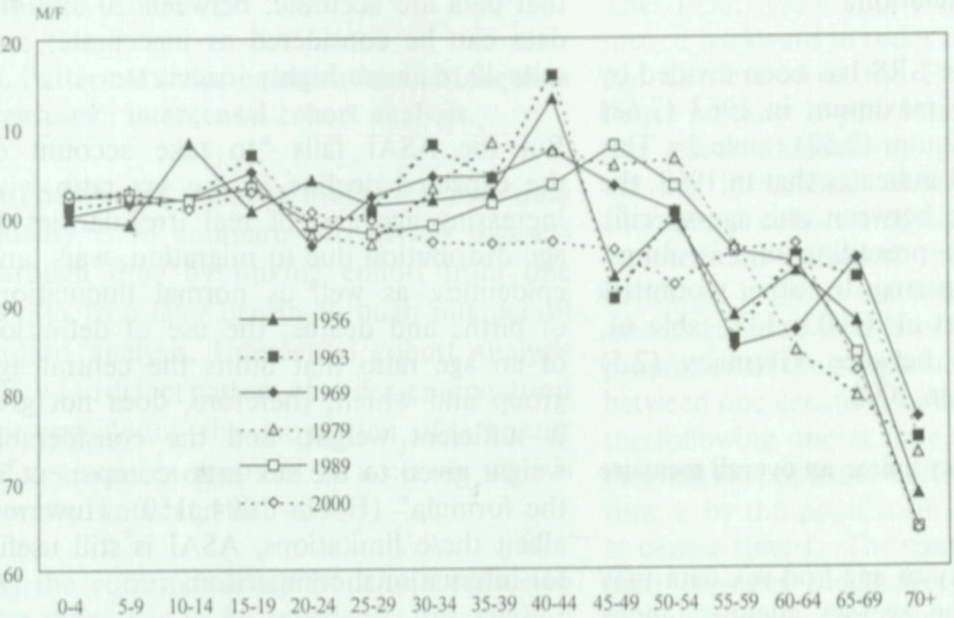
4. Sex ratio

Beside age, sex is the other most basic demographic variable. Crossed with age groups, a simple and classic measure of the quality of the sex composition of a population is to consider the sex ratio. "The sex ratio is the ratio of the number of males to the number of females, usually expressed as males per hundred females. The sex ratio at birth is typically around 105 males for 100 females. Small departure from this level may reflect random variations, while larger departures forewarn of possible data quality issues or social influences." (Rowland 2003: 87). Over the age-span, as an outcome of female longevity, sex ratio gets upturned passing from an excess of males in young age groups to a female surplus in older age groups. Despite discrepancies, Mongolia's profiles show this declining sex ratio with ages. The evolution sketched in figure 5 gives a much more close insight into what could be roughly noticed previously by the examination of population pyramids. A sex ratio exceeding 100 indicates an excess of males, and one below 100 an excess of females. In general, the sex ratio profiles improve from one census to the other, with the last 2000 census which can be considered of rather better quality (except at old ages). But across census, the sex ratio pattern exhibits some noticeable discrepancies.

For the young age groups (age 0 to 19), an increase of masculinity is to be noted on 10-14 age group in 1956 and on 15-19 age group in the other census. The relatively low number of males aged 0-4 in 1956 is spurious and points to a curious hypothetical high male early mortality, but is certainly more due to under-reporting of male births[6] and to a transfer of boys aged 0-4 towards 5-9 age group (corroborating hence also the high 5-9 successive age ratio on figure 3). Still in 1956, the important masculinity's increase of the 10-14 age group could be due to (1) boys' transfer from 0-4 to 5-9 and from 5-9 to 10-14, (2) girls' omission, (3) girls' age overestimation (transfer from 10-14 to 15-19 age group), or (4) abnormally high girls' death rate in this age group. In regard of what as been said about the population pyramids' evolution, this last assumption is hard to accept. This pattern must be firstly related to girls' data quality (girls' age misstatement or girls' omission) and to a transfer of boys to older age groups. The same seems to be relevant for the 15-19 age group albeit the pattern is declining across censuses.

[6] The under-reporting of male births, implying low sex ratios, has been documented "in cultures where parents have wished to conceal and protect infant sons from super-natural forces, as in rural Nepal" (Rowland 2003: 87 building on Rajbanshi and Sharma 1980: 24). The same cultural practice is likely to be found in Mongolia, where parents do not cut the hair of their sons until age 3 in order to hide and protect them from super-natural forces.

Figure 5: Sex ratio by age groups, Mongolia, 1956-2000.



Source : NSO, 2003: 85-86

For adult age groups (20-54 years), the sex ratios present rather similar profile with some exceptions. Except for 2000 (and between age 20 to 34 in 1989), all censuses point out that men outnumber women after the age of 30. This increased masculinity from age 30 to 50 can be partly attributed to relatively high maternal mortality level (Neupert 1996). Excess female mortality is often greatest in the reproductive ages and fades at the end of the childbearing years around age 50.[7]

The slight decline of the ratio between 20 and 29 (at the exception of 1956) can be attributed to a higher difficulty to enumerate precisely young adult men who are more mobile than women. This pattern has been documented elsewhere both in less developed and developed countries (Anderson 2004).

In contrast, the 2000 census presents comparatively low masculinity ratios. This could be partly due to the increase of male mortality in adult ages as it has been observed for the countries of the former USSR. Indeed, Mongolian males experienced a volte-face in mortality since 1990 and the transition. For age group 20 and over, probabilities of dying are higher than before the transition, indicating a deterioration in adult men's situation (Spoorenberg 2006). Moreover, this low sex ratio can also be attributed to international migration which concern generally more active adult males (NSO 2002: 16).

Among censuses, the sex ratio pattern is not homogeneous, reflecting different biases. Both 1956 and 1963 censuses present relatively incoherent sex ratios between 40 and 59. The important increase of masculinity for those aged 40-44 is due to a transfer of women to the next 45-49 age group. Moreover, this relocation provides additional confidence in the pattern previously identified through the successive age ratio analysis (figure 3). The reason of this transfer remains however to be determined.

As Poston et al. have proposed (2003: 130-31), a way to gauge the sex composition of a population is to compute the sex-ratio score (SRS) based on the difference between the sex ratio of one age group and the sex ratio of the previous age group.[8]

[7] Maternal mortality affects much more high-parity older women who experienced short birth intervals (van Katwijk and Peeters 1998).

[8] This procedure enters in the computation of the age-sex accuracy index presented below in section 5.

Then, these inter-age groups differences is summed up (without regard to sign) and averaged in order to achieve a sex-ratio score for the whole population.

For Mongolia, the SRS has been divided by three between its maximum in 1963 (7.68) and its 2000 minimum (2.58) (table 2). This high value of 7.68 indicates that in 1963, the average difference between one age-specific sex ratio and the preceding one is almost 8 persons. Comparing to other countries listed in Poston et al. (2003: 133, table 6), Mongolia ranges between Germany (2.5) and Ireland (2.7) in 2000.

5. Age-sex accuracy index: an overall measure of data quality

The overall quality of age and sex data may be evaluate by the age-sex accuracy index (ASAI). This index has been proposed by the United Nations in two publications in 1952 and 1955. It combines "the sum of (1) the mean deviation of the age ratios for males from 100 (2) the mean deviation of the age ratios for females from 100, and (3) three times the mean of the age-to-age differences in reported sex ratios." (Hobbs 2004: 150). The ASAI is based on the idea that "accurate" age data are rectangularly distributed and that age-specific sex ratios decline linearly over the life-span as well. If age or sex data depart from these patterns, the index would indicate data inaccuracy. The evaluation's scale is as follows: an index under 20 means that data are accurate; between 20 and 40, data can be considered as inaccurate; and over 40, data are highly inaccurate.

But the ASAI fails "to take account of the expected decline in the sex ratio with increasing age and of real irregularities in age distribution due to migration, wars, and epidemics, as well as normal fluctuations of births and deaths; the use of definition of an age ratio that omits the central age group and which, therefore, does not give it sufficient weight; and the considerable weight given to the sex ratio component in the formula" (Hobbs 2004: 150). However, albeit these limitations, ASAI is still useful for international comparison.

For Mongolia, the ASAI reaches a maximum of 38.5 in 1963 and a minimum of 22.0 in 2000 (table 2). This general improvement is firstly the result of better sex data (SRS is counted three times in the ASAI). Compared to other countries, these values situate Mongolia between countries like Greece (35.5) and Taiwan (49.3) in the 1960s, Vietnam (22.9), Turkey (23.0) and Hungary (26.0) around 1990, and Yemen (21.7), Germany (22.1), or Taiwan (22.2) in 2000.[9] But, to sum up, albeit age and sex data improve significantly

Table 2: **Age ratio score (*AR*), sex ratio score (*SRS*), and age-sex accuracy index (*ASAI*), Mongolia, 1956-2000**

Census year	Age ratio score (*AR*)		Sex-ratio score (*SRS*)	Age-sex accuracy index (*ASAI*)
	Male	Female		
1956	6.20	11.46	6.44	37.0
1963	4.97	10.46	7.68	38.5
1969	9.44	10.67	4.38	33.2
1979	6.69	5.68	4.01	24.4
1989	6.29	6.95	3.24	23.0
2000	7.03	7.19	2.58	22.0

Note: $ASAI = 3*SRS + AR_{Male} + AR_{Female}$

[9] For the 1960s, values taken from Shyrock and Siegal (1976: 126); for the 1990s, from Hobbs (2004: 150); and for 2000, from Poston et al. (2003: 135).

over the last 50 years, the 2000 census data, with an ASAI of 22.0, are still considered as "inaccurate" according to the United Nations standards.

6. Pattern of under-enumeration in Mongolian censuses : intercensal cohort analysis

An additional mean to evaluate census data quality is to compare two census datasets through time by linking cohort from one census to a later census through intercensal cohort analysis. Intercensal cohort analysis allows to detect pattern of under-enumeration by considering the proportion of a cohort of a given sex reported in a census who is counted in a later census.

As the correspondence from one census to the other has to be satisfied[10], this method of evaluation of data consistency can only be applied to censuses apart from 5 or 10 years and when net migration is assumed to be negligible (or data have to be corrected for migration). However, if at least one age distribution is by single years of age, the requirement concerning the intercensal length can be ignored.
This method is applied to the six Mongolian censuses, since single years of age population structures are available. Hence, although intercensal length between 1956 and 1963 censuses, 1963 and 1969 censuses, and 1989 and 2000 censuses are not multiple of 5, the intercensal cohort analysis can be conducted.

Regarding net migration, Mongolia has been closed during decades. With the centralised system, internal and external migrations were highly controlled. Hence, according to Neupert (1992, 1996), international migration could be considered as insignificant during the country's socialist period[11].

Moreover, since the census dates are different, each enumerated population has been adjusted to an exact number of years. The 1956, 1963 and 1969 population are moved backward in order to approximate the age distribution at the 5th January defining hence an exact n-year interval and removing the effect induced by population growth on the intercensal survivorship estimates. Intercensal cohort analysis to detect under-enumeration considers the proportion of a cohort of a given sex reported in a census who is counted in a later census. Here, the proportion of the people surviving at each age between one census conducted at time t_1 and the following one at time t_2 is calculated by dividing the population of a given age at census time t_2 by the population of n-year younger at census time t_2. The same applies between each censuses successively. In the absence of net international migration, proportions of surviving people exceeding 1 are spurious and point either to understatement in the first census or overstatement in the later one.

Figure 6 shows the proportion of surviving people in each age groups. In general, census quality is fairly good with most surviving proportions lower than 1. But there are some striking irregularities. One can note survival ratios higher than 1 for both sexes (1) for young age groups from 1956-63 to 1969-79; (2) for young adult ages in all intercensal periods at the exception of the last period; and (3) for adult ages in 1956-63 and 1963-69. Survival ratios higher than 1 are impossible if age data are accurate and the population was indeed closed to migration. Such ratios indicate data inconsistency.

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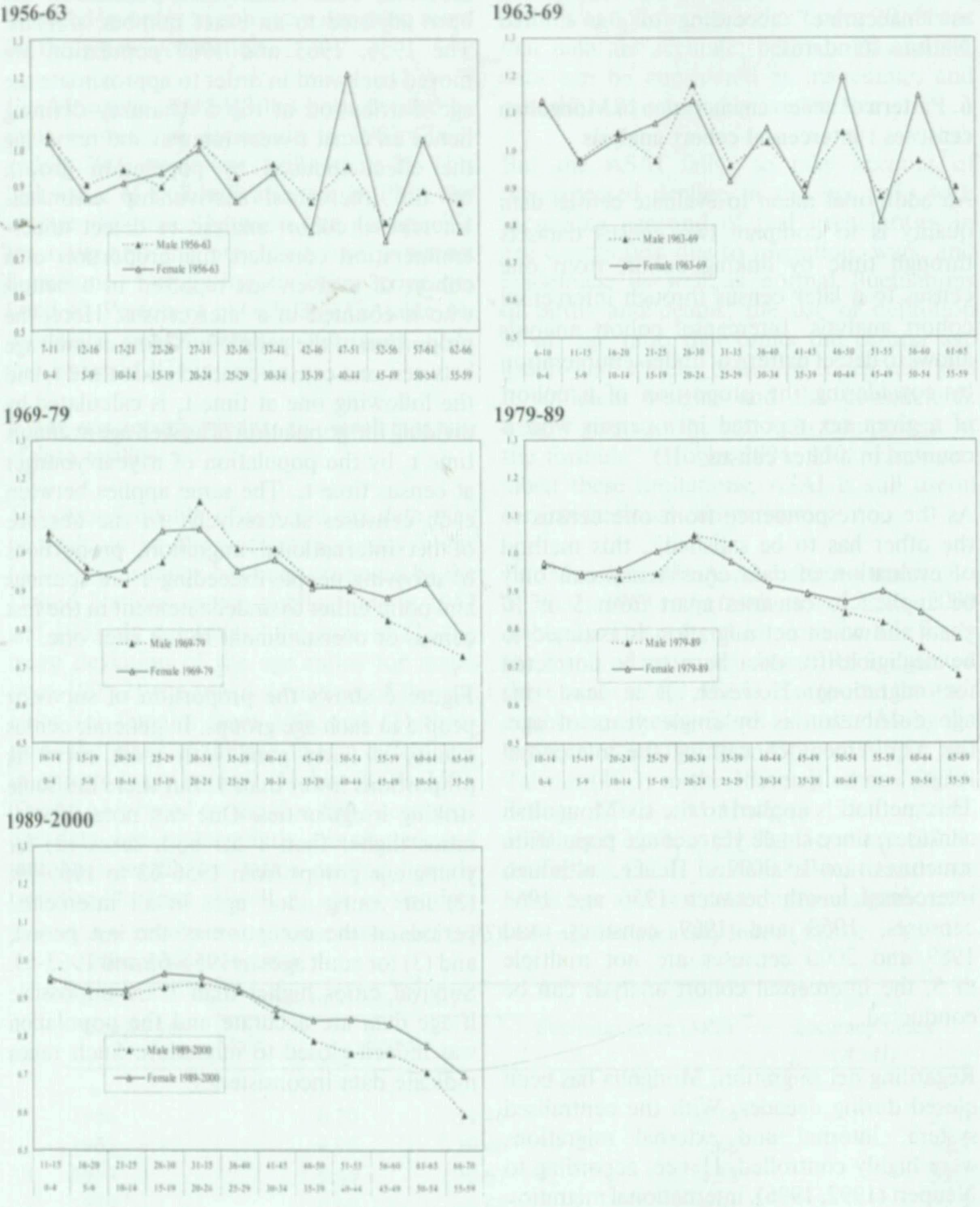
[10] i.e. in absence of migration, the individuals of one age group (${}_5P_a$) at time *t* should be found in age group (${}_5P_{a+n}$) at time $t+n$ if all of them survive.

[11] For Mongolia, precise data on international migration are not available. For recent years, international migration is therefore assessed through the comparison of the 1989 and 2000 censuses (NSO 2002: 16).

Figure 6: **Intercensal cohort survivorships from one census at time *t* to another at time *t+n*, Mongolia, 1956-2000.**



Source**:** *see figure 2.*

Note: *On x-axis, the upper age groups are from the later census; lower ones from the earlier census. Due to different intercensal periods, age groups differ.*

Except for the important variations in survival ratios at adult ages in the two first intercensal periods (which are due to transfer of people from one age group to another (section 3)), these patterns are typical of population undercount found in other populations both in less and well-developed countries (Anderson 2004). The age group 10-14 is enumerated more completely than the 0-4; and those aged 10-14 are enumerated more completely than those in their early twenties; and those in their thirties are enumerated more completely than those in their twenties. These patterns are generally comparable for males and females. Finally, even if the last two censuses (1989 and 2000) are generally of better quality, the 1989-2000 survivorships present the same profile as well (undercount of young children, and less complete record of those in their twenties than of those 5 years older or 5 years younger), but the survival ratios are not higher than 1.

Together with the improvement of enumeration, these lower survival ratios between 1989 and 2000 can be due to both international migration and change in health's conditions. Indeed, the 1990s transition goes along increasing emigration which are generally concerning more male young adults (NSO 2002: 16). Moreover, with the deterioration of the health's situation, both female and male death rates (but more importantly for males) are on the rise (Spoorenberg 2006). All these concomitant occurrences could explain the lower survival rates between the two last censuses.

Conclusion

Age and sex composition of the population enumerated at the six censuses of Mongolia conducted since 1956 have been analysed in this paper. Population pyramids indicate firstly some data problems regarding age, sex or both data, which are detailed through different methods and indexes designed to describe age and sex structure, and evaluate age and sex data from population censuses.

Myers' blended method, successive age ratio (SAR), age-accuracy index (AAI), sex ratio evolution, sex-ratio score (SRS), and age-sex accuracy index (ASAI) have been computed. All those show that Mongolian's age and sex data improved over the last 50 years and could be considered as "slightly inaccurate" at the end of the 20th century. Nevertheless, albeit this general improvement, both age and sex data present some inconsistent profiles, which should be tackled down in the future and corrected or smoothed in studies relying on these past census' data.

However, there is no need to be over-critical in identifying data inconsistencies. Since Mongolia experiences during the 20th century the biggest increase of its history, some patterns that could be identified as data discrepancies are indeed real. Over the last four decades of the 20th century, passing through the first stage of the demographic transition, the population of Mongolia experienced a considerable increase. However, more recently only, with the transition of the 1990s, fertility declined importantly and rapidly, breaking the past population growth. These trends have an effect on demographic data and therefore on quality measures computed. Most of the indexes used to assess data are based on the assumption that the population is distributed linearly over the age-span. But due to natural demographic process, the population of Mongolia does not present such linear profile. Hence, keeping in mind the effect of fertility decline on age indexes, the 2000 census age and sex data could be therefore considered as accurate.

References

Anderson, B.A. (2004), "Undercount in China's 2000 census in comparative perspective", Ann Arbor, University of Michigan, Population Studies Center, PSC Research Report No. 04-565.

Hobbs, F. (2004), "Age and sex composition", in J.S. Siegel and D.A. Swanson (ed. by), The Methods and Materials of Demography, second ed., Amsterdam [etc.], Elsevier, Academic Press, pp. 125-173.

Neupert, R.F. (1992), "Mongolia: Recent Demographic Trends and Implications", Asia-Pacific Population Journal, 7(4), pp. 3-24.

Neupert, R.F. (1996), Population Policies, Socioeconomic Development and Population

Dynamics in Mongolia, Canberra, Australian National University, Research School of Social Sciences.

Neupert, R.F and PTRC staff. (2004), "Age and sex distribution of the Mongolian population: Present and future implications", Mongolian Population Journal, 10, pp. 81-94.

Noumbissi, A. (1994), « Structures par вge et sexe et dynamique dйmographique. Le cas du Cameroun » (Population dynamics and age and sex structure of the population: the case of Cameroon), Population (French edition), 49(3), pp. 751-771.

NSO (National Statistical Office of Mongolia) (2001), 2000 Population and Housing Census: the Main Results, Ulaanbaatar.

NSO (National Statistical Office of Mongolia) (2002), Population Projection of Mongolia. Analysis based on the 2000 Census, Ulaanbaatar.

NSO (National Statistical Office of Mongolia) (2003), Mongolian Population in XX Century, Ulaanbaatar.

Poston, D.L., C.S. Walther, I. Hye Jin Chu, J.M. Ginn, G. Jin-Kai Li, C. Hong Vo, P. Wang, J. Juan Wu and M. Ming Yuan (2003), "The age and sex composition of the Republic of Korea and its provinces, 1970 and 1995", Genus, LIX(2), pp. 113-139.

Retherford R. D. and V. Mishra (2001), An Evaluation of Recent Estimates of Fertility Trends in India, Mumbai, International Institute for Population Sciences and Honolulu, East-West Center, Population and Health Series, National Family Health Survey Subject Reports, No. 19.

Retherford, R. D. and S. Thapa (2003), Fertility in Nepal 1981-2000: Levels, Trends, and Components of Change, Hononlulu, East-West Center Working Paper, Population and Health Series, No. 111.

Riley, J.C. (2005), "The Timing and Pace of Health Transitions around the World", Population and Development Review, 31(4), pp. 741-764 and the bibliography of more than 700 sources published separately on the Web at « http://www.lifetable.de/RileyBib.htm ».

Rowland, D.T. (2003), Demographic methods and concepts, Oxford, Oxford University Press.

SSO (State Statistical office of Mongolia). (1994), Population of Mongolia, page 24-28,

Ulaanbaatar

Shryock, H.S. and J.S. Siegel and Associates (1976), The Methods and Materials of Demography, condensed ed. by E.G. Stockwell, New York [etc.], Academic Press.

Spoorenberg, T. (2006), "From socialist to post-socialist Mongolia: National and regional perspectives on mortality", paper presented at the international seminar 'Mortality in the former USSR. Fifteen years after the break-up: change or continuity?', organised by the CDHE (Moscow), IDDS (Kiev), INED (Paris), MPIDR (Rostock) and IUSSP, Kiev, 12-14 October.

United Nations n.d. Demographic Yearbook, Special Census Topics, vol.1- Basic Population Characteristics, Table 1a: Population by single years of age by sex and urban/rural residence: each census, 1985 - 2003, available on the Web at:

«http://unstats.un.org/unsd/Demographic/products/dyb/dybcens.htm».

Vallin, J. (2005), "The demographic window. An opportunity to be seized", Asian Population Studies, 1(2), pp. 149-167.

van Katwijk, C. and L.L.H. Peeters (1998), "Clinical aspects of pregnancy after the age of 35 years: a review of the literature", Human Reproduction Update, 4(2), pp. 185-194.