Technical Brief

Technical Guidance: Post Enumeration Surveys in Population and Housing Censuses

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Introduction

Assessing the quality of population and housing census data is increasingly seen as an integral part of the census operation. Hence, UNFPA advocates for more countries to carry out some sort of quality assessment exercise.

Such assessments need to consider two kinds of quality measures, namely:
1. Census coverage, i.e. the percentage of actual population/households enumerated. The most common problem is under-coverage, particularly in certain specific groups, e.g. young children, young mobile men and undocumented migrants. Over-coverage also happens, especially if local authorities, with an interest in exaggerating their populations, are able to influence the data collection.
2. Content errors, i.e. the extent of incorrect answers for some key variables. Individual data are often provided by an informant (the head of household or other adult household member) who may not know all the details regarding each person. The household members themselves may be unsure or misunderstand the question. They may even hide or distort information on purpose. Finally, the enumerator may make mistakes or even take shortcuts in filling out the questionnaire, to save time. As a result, data quality may be poor, despite excellent coverage.

There are several methods for quality assessment. Content errors can often be detected through internal consistency analysis. Inconsistencies (e.g. between children's ages and educational status, or young girls' ages and number of children, etc.) indicate poor data quality. But not all errors lead to inconsistencies.

Some errors are hard to detect at the individual level, but produce improbable age patterns that can be detected in the aggregate. For example, systematic errors in the declaration of children born during last year preceding the census may produce

patterns of fertility by age of the mother that deviate considerably from what is considered plausible. In the 2015 census of Timor-Leste, for example, the fertility of women in their 40s was found to be improbably high, leading to the suspicion that these women might have declared grand-children as if they were their own.

A phenomenon called "age-heaping" is often observed in countries where date of birth information is not available or not considered important. It is typically manifested by excess numbers of persons reported to be of an age that ends in "0" or "5" (if the census question is formulated as in "how old is [name]").

A criterion often used to assess the quality of age reporting is the regularity of age declaration patterns measured through the Whipple, Myers blended and United Nations combined indices. These indices are easy to calculate, but their usefulness is limited. They give a good idea about the prevalence of specific types of age declaration errors, but they provide no direct information on other common errors such as under-declaration of economic activity and particularly on coverage errors.

Another method is to compare the census with other data sources, like surveys or administrative records. Omissions can occur among specific subgroups, and can be identified by disaggregation across the suspected criteria (i.e. ethnic group, geographical region, etc.). In the 2008 census of the DPRK, maternal deaths were checked against Ministry of Health administrative records. The number of births in the year before the census may be checked against DHS or birth registration data. This too has limitations because the variables for which alternative data are available are limited and definitions may be different. Poor quality of the alternative source may make it impractical to use it as a yardstick. Comparisons with survey data are limited by sample sizes. Most importantly, if the census omits some people and the survey omits different people, the results may be similar, even though both sources are biased. Comparison of individual level data can remedy this problem but is generally not possible with surveys that were not designed for this purpose. More powerful is comparison with an earlier census, especially if it has been found to be of acceptable quality and is not too old. With two censuses a plethora of analytical techniques become available, particularly the analysis of cohorts, whereby persons in the older census are assumed to be present, but older, in the later census.

Due to the limitations of the methods above, many countries opt for a more thorough and more systematic evaluation instrument called the Post-Enumeration

Survey (PES). The basic idea is simple: replicate the census shortly after the main census operation (3 months or less) for a sample of the population, asking a subset of predetermined census questions and compare the results, both in terms of coverage and content. The closer the results are, the better the quality of the census.

Of the 134 countries or territories responding to a UN Statistics Division (UNSD) questionnaire on census implementation in the 2010 census round, 89 had conducted a PES to evaluate the coverage of the census; among them 75% used the PES to evaluate content errors. In Africa, Asia and South America, 78% of countries undertook a PES, compared to only 40% of countries in Oceania. One third of the countries implementing a PES used the results to adjust census figures.

However, the apparent simplicity of the PES is deceptive. Many countries that carried out a PES in the 2010 census round never published the results or only issued estimates of national coverage, without a methodological report or detailed breakdown of the results. This occurred even in countries with long and solid census traditions, such as Brazil which decided not to publish its PES results of the 2010 census because they were considered unrealistic.[1] Angola published a national estimate of 6% undercount, but no methodological report or detailed breakdown of the results. The Lao PDR and Timor-Leste, among others, were unable to publish their PES reports due to major problems in the application of the methodology. Other countries, like South Africa, did extensive analysis on their PES, but found higher than expected problems of coverage.

Many countries embark on a PES without realizing the inherent difficulty of the exercise. UNFPA COs assisting national governments in deciding on the viability of a PES need sufficient information to help the statistical authorities to take an informed decision and avoid wasting valuable resources on exercises for which sufficient technical capacity or the appropriate organizational structure may not exist. The following outlines some of the difficulties facing the execution of a methodologically sound PES exercise, so that governments and UNFPA COs can take better decisions regarding the appropriateness of supporting a PES exercise in the concrete technical context in which it has to be executed.

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[1] The results were finally released in 2019.

General assumptions and provisions underlying the PES methodology

Two general characteristics of the PES methodology stand out: the assumption of independence of the census and PES data and the individual nature of the comparison.

The PES compares <u>two sources for the same data</u>. In theory, both might contain the same errors, thus yielding perfectly consistent, yet systematically flawed results. The important and non-trivial <u>assumption</u> is that this is not the case and that the errors in both sources are <u>statistically independent</u>. An individual may tend to wrongly declare that (s)he is economically inactive when in fact (s)he is an unpaid family worker, but it is assumed that his/her answer in the PES is not affected by the memory of the previous answer. Total independency is hard to achieve because respondents tend to stick to their answers, even if they are wrong, especially if the time between census and PES is very short. But this is not a justification for postponing the PES.

Nevertheless, everything possible must be done to make the results of the census and the PES as independent as they can realistically be. The most important is to ensure that the PES is carried out by different staff and using new household listings. At the very least, the PES has to use different enumerators, who should preferably be better trained than those of the census. The PES should use the same maps as the census, but the household listings have to be redone, to avoid omitting the same households omitted in the census. Ideally, the data processing of the PES should also be done by a different team, to avoid repeating the same data processing errors committed in the census. In practice, however, complete organizational independence is hard to achieve, due to limited human resources.

Organizational independence does <u>not</u> mean that no data should be shared. The PES staff must have access to the processed census data: not only the aggregate results, but also the processed micro-data. This is indispensable for matching the individual data of the PES to those of the census. The PES staff should have access to these data, but <u>not</u> to the procedures that were used to capture and edit them; these procedures should be developed independently by the PES staff. The census micro-data should <u>never</u> be used to "correct" the PES or vice versa.

Unlike the comparison of census with survey data referred to in the Introduction, the PES compares information at the household level, and information about

individuals within the household. This is much more demanding than the mere comparison of aggregate results. The fact that a PES reproduces the same population counts as the census does not guarantee the absence of under-count. It is perfectly possible that both the census and the PES under-counted. But unless they under-counted exactly the same population segments (which is unlikely), a comparison of individual level data should reveal that some people/households were counted in the PES, but not in the census, and vice versa. Many of the operational complexities of PES derive exactly from the need to make this individual level comparison of the data possible.

The actual process by which this comparison is carried out is known as matching. It is arguably the most important part of the PES and can be more labour-intensive than the collection of PES data in the field. It involves two stages: matching the households, and then matching the individuals within those households. Special provisions are needed for persons who were born, died or migrated to a different household between the main census and the PES data collection exercise. Most matches can be performed in an automated fashion, following explicit matching rules which define how different the characteristics of individuals in the census and in the PES are allowed to be in order to constitute a match. For example, a 1-year age difference would generally be considered admissible, but a difference in sex would not. However, there will inevitably be cases where finding the correct match requires further investigation or judgment calls that need to be handled personally by the PES staff. It may be necessary to revisit some households to clarify the situation; such visits are called reconciliation visits.

Implications for census organization

The most common error in organizing a PES is lack of coordination with the census itself. As always, the fact that a process is being evaluated requires certain provisions in its organization, to make an evaluation possible. If the PES is only planned in detail after the census field work, its proper conduct may have been compromised. The planning of the PES should be integral to the census itself. The following assumes a conventional census, where every household is interviewed.[2]

Census evaluation through a PES requires greater rigor in applying the census rules than otherwise needed. For example, every census has some out-of-area

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[2] Register-based censuses of the kind that now exist in several European countries present their own methodological challenges that will not be discussed here.

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enumeration, where enumerators counted households belonging to a different enumeration area. This is always to be avoided, but it may not seriously affect the census results, provided that it has been coordinated to avoid double counting. However, in a PES sample consisting of a certain number of enumeration areas (a common design), the consequences can be more serious. Unless the households are reassigned to their correct areas in the data processing stage, it can lead to "false negatives", i.e. households that are absent not because they were not counted but because they were erroneously included in an enumeration area outside the PES sample. Therefore, it is essential that such errors should be avoided or corrected.

The crucial requirement is an efficient <u>household identification system</u>. Based on the census questionnaire (or its electronic version) one should be able to identify the corresponding household in the field and vice versa. The ways to do this are:

1. In countries with a good system postal address system, each household can be identified by its address, which should be included in the questionnaire.
2. In the absence of such a system, the best option is to use GPS coordinates to pin down the localization of each household.
3. A third option is a unique code in the census questionnaire, to be left on the door of the dwelling at census time, for future reference.
4. Another possibility is to identify the household by the number of the enumeration area and the full name of the head of household.
5. If all else fails, a final possibility is to define a proximity measure based on the most salient household characteristics (number of rooms, name, ages, sex, relationship of household members, building materials, etc.) to decide which census household most closely resembles a given PES household.

Options 1) and 2) are clearly better than 3), 4) and 5). The danger of leaving a code on the door is that the sticker may be washed or blown off or even deliberately removed. Headship may change, people do not always declare their name in the same way, and it is possible for several households in the same enumeration area to have heads with identical names. Option 5) may not work if the recording of characteristics is deficient. Of course, it is also possible to combine systems. For example, the 2015 census of Timor-Leste used a combination of 2) and 3).

Depending on the design of the PES sample, the household identification can be more or less rigorous. The following designs can be considered:

i. The PES sample consists of census enumeration areas that are completely re-enumerated in the PES. This design requires a large number of

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households to have sufficient cases in all relevant sub-samples but it is easier to administer (including travel time in the PES), provided that:

   a. The enumeration areas are well defined, with explicit geographical boundaries, based on well-elaborated census cartography.
   b. Out-of-area enumeration in the census is almost non-existent.
   c. The interval between the census and the PES is very short (1-3 months), especially if household identification strategy 3).

 ii. The PES sample consists of a larger number of census enumeration areas in each of which a certain fraction of households are sampled.

iii. The PES sample contains no clusters, but simply re-enumerates every n-th household from a newly elaborated national household listing. This design is efficient from a sampling viewpoint, but it is difficult to administer.

To apply designs ii) or iii), it is imperative to use a rigorous household identification system (strategies 1 or 2). In its absence, design i) is the only viable option and even this may be challenging if conditions a), b) and c) are not satisfied.

For example, the 2015 census of the Lao PDR had to rely on household identification strategy 4) and sample design i). In addition, this census presented two other challenges:

   1. It did not use census cartography and hence did not have well defined enumeration areas with explicit physical boundaries (condition i.a) above), making it necessary to sample entire villages which could contain several enumeration areas and, in some cases, more than 1,000 inhabitants.
   2. The names of the household members were listed on the census questionnaires but were not part of the electronic data files, so that the matching process had to be done manually, using the physical questionnaires.

The latter is an example of insufficient coordination between the data processing of the census and the PES. In the absence of a PES, the names of the household members do not need to be part of the electronic data record because they are only used to identify the questionnaires. But in this case, where the names of household members were used for household identification purposes, they should have been included in the electronic record, at least for the enumeration areas of the PES sample.

As was mentioned earlier, about a third of the countries (e.g. Australia, South Africa) use the PES to adjust their census results for coverage errors. There are

several techniques to do this. The coverage rate can be directly used to adjust population size. On the other hand, synthetic estimation and regression modeling permit adjusting the distribution of the undercount at the geographic level appropriate to the measurement technique. The model obtained is then used to allocate the undercount to lower levels of geography or to areas. The former estimates persons missed as a percent of total estimated population for various demographic subgroups (e.g. by age and sex) for a specified geographic level. The method takes the undercount at high levels of geography and distributes it proportionally at lower levels of geography. Regression techniques fit a model to the undercount estimates at a set geographic level and then proceed in a similar fashion to apply the coefficients estimated at higher geographic levels to characteristics and variables observed in lower geographical levels. However, most PES exercises are not used for this purpose, but just to assess census data quality and coverage rates. Only countries with a long experience in conducting PES processes and that have perfected their many procedural and analytical details to guarantee the highest quality standards are in a position to use the PES for census adjustment. Countries that use their first or second PES experience to this end risk deteriorating, rather than improving the census results.

Other key PES issues to be considered

In addition to the above, some problems have to do with the PES as such. There are different design options for the PES. As noted earlier, the easiest to manage is a design where a sample of census enumeration areas is completely re-enumerated in the PES. As noted above, the main disadvantage of this clustered design is that it requires bigger samples than alternatives ii) and iii). On the other hand, it is less demanding in terms of travel costs and the household identification system.

In large countries with very heterogeneous populations, it may pay off to use a sample design of type ii) or iii) as described in the previous section. This makes greater demands on the household identification system (need for postal addresses or GPS) and implies more travel due to their greater geographical dispersion. Type iii) does not allow an estimate of the household coverage of the PES and hence of households likely to have been missed by both the census and the PES. It produces statistics on the number of households enumerated in the PES that could not be traced back to the census, but not vice versa. At the individual level, it does produce coverage statistics in both directions: in the households enumerated by

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both the census and the PES one may identify individuals enumerated only by the census, only by the PES, or by both.

As was mentioned earlier, the household listing for the PES must be prepared separate from the census household listing. Using the same listing violates the requirement of independence. An even more serious error is to use the list of households <u>interviewed</u> in the census as the basis for the PES. Doing so allows capturing content errors, but not coverage errors. A final error that has been found in some PES operations is one where formally the PES sample is defined according to design i), but where – for lack of time – only part of the households in each enumeration area are interviewed. In a way, this converts design i) into design ii), but with a sample that is too small and unlikely to be random.

Out-of-area enumeration can be a problem in the PES as well as in the census itself. It should be avoided as much as possible, but some cases may still occur. Therefore, it is important that any unmatched households found in the PES should be checked against census households in neighbouring census enumeration areas, before confirming that they are indeed unmatched. Failure to do so will result in an upward bias of the estimate of census under-enumeration.

A specific subject that requires planning and attention is how to deal with any changes in the situation of the households that may have occurred between the census and the PES, particularly regarding the household composition. Specific questions have to be included in the PES that allow the detection of such changes, taking either the census or the PES as a base line. If the PES is taken as a base line, a code has to be included for each household member to indicate whether (s)he:
1. Was also present in this household and dwelling at census time;
2. Was temporarily absent from the household and dwelling at census time;
3. Was born after the census; or
4. Resided in a different household and dwelling at the time of the census.

Note that 4) also includes the situation in which the entire household has moved from one physical dwelling to another. In cases 2) and 4), it may be wise to ask if the person was enumerated at the place where he or she spent census night. In addition, it must be verified if any residents at the census time have:
1. Died since then; or
2. Become residents of a different household and dwelling since then.

If the census is taken as a base line, the entire PES questionnaire has to be filled out according to the situation at census time and any changes have to be justified in terms of births, deaths and migrations or changes of physical dwelling.

Although the number of changes should be small, especially if the PES is carried out very soon after the census, correctly classifying them can be time-consuming, especially if the information is found to be inconsistent at the time of matching. Take the case of a household member who is declared in the PES as having been temporarily absent from the household at census time, but who is present in the household at the time of the PES (design ii, as described in previous section). The following possibilities exist:

i. The person was declared as member of the household at census time and the census was organized according to the de jure criterion. This would be correct. The best practice (which is not attainable in countries without well-defined postal addresses) is to verify the census records of the place where this person was at census time to check if (s)he was enumerated there, to detect any potential double counting.

ii. The person was declared as member of the household at census time and the census was de facto. This would be wrong. If the person was also enumerated at the place where (s)he spent census night, it would be a case of double counting. If not, it would be a classification error.

iii. The person was not declared as a household member at census time and the census was organized according to the de jure criterion. Depending on the person's enumeration status in the place where (s)he was at census time, it would be a classification error or an omission.

iv. The person was not declared as a household member at census time and the census was de facto. This would be correct. But in this case it would be particularly important to verify if (s)he was enumerated elsewhere.

The question whether a person was enumerated elsewhere in the census also arises if the person permanently resided elsewhere at census time. The best information obtainable in this case too may be based on his/her answer to the question, but verification may be impossible in all but the most sophisticated PES operations.

A slightly different situation presents itself in the case of persons who moved out of the household and dwelling after the census. In theory the PES should try to locate these individuals, to obtain their answers to the PES, to compare it to the census. Countries with a long history and high level of technical expertise in PES execution, such as Australia, actually collect this information. But in the PES

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processes of most developing countries, this is impossible and one has to assume that the PES data of such persons coincide with what they declared in the census.

The field reconciliation phase

Some inconsistencies in the information may require a return to the field for verification. For example, the PES may show a certain individual as being part of a household both on the date of the census and on the date of the PES, while the census records do not show him or her as having been part of the household. If the census is correct, the PES needs to be adjusted, to provide an explanation for the absence of this individual on census night. On the other hand, if the PES is right, this counts as an omission in the census record which may or may not be corrected, but even if it is corrected, it continues to count as an omission. The objective of the field reconciliation is to better characterize the nature of the errors in the census, not to correct them.

The number of situations that need to be verified in the field should be small, but they can be time consuming because they involve different types of problems and because the households to be revisited can be spread around the country very thinly, so that the verification requires a lot of travel time.

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