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**CENSUS QUALITY ASSURANCE AND EVALUATION**

Register-based censuses

**Evaluating the Integrated Census in Israel**

Note by Central Bureau of Statistics, Israel

**Summary**

The upcoming Israeli census (December 2008) will be an "Integrated Census". It will be based on administrative data, and data obtained from a large field sample survey. The field sample survey will serve to estimate over-coverage and under-coverage of data from administrative sources and to add socio-economic information unavailable from those sources, such as labor force characteristics, household typology, education, housing, sustainable goods ownership and disability.

In order to evaluate the results of the Israeli Integrated Census, the traditional methods – based on Post Enumeration Surveys - are not adequate, and alternative methods had to be developed for a reliable evaluation. The present paper describes the work conducted to develop procedures and methods for the evaluation of the new Israeli Integrated Census.

## **I. BACKGROUND**

1. The upcoming Israeli census (December 2008) will be an "Integrated Census". It will be based on administrative data, and data obtained from a large field sample survey (approximately 17% of the households in the country). All relevant administrative data sources will be merged into a comprehensive file, the Improved Administrative File (IAF).
2. The field survey of the census serves two main purposes:
  - a) Estimating over-coverage and under-coverage of the IAF;
  - b) Adding socio-economic information unavailable from administrative sources, such as labor force characteristics, household typology, education, housing, sustainable goods ownership and disability.
3. The main administrative source for the IAF is the Population Register (PR). The PR contains - in addition to personal, demographic and address information on each citizen (and permanent residents) - information on relations between family members. In order to improve the PR, it was merged with three independent registers; the Student (elementary, secondary and high school) Register, the Electricity Meter Register and the Vehicle Register. Administrative families were constructed by applying a specially developed algorithm, based on family relations and addresses. Non-residents were identified by another algorithm, and marked as such in the IAF.
4. The field survey component is designed as a dual survey: an area sample, to estimate "under-coverage" ("U"); and a sample drawn from the PR, to estimate "over-coverage" ("O"). Over- and under-coverage are estimated independently for each "Statistical Area (SA)". An SA is a compound of consecutive blocks consisting of an average of 5,000 inhabitants, with clear borders and a local meaningful cluster. For a comprehensive description of the Integrated Census method and the dual estimation model, see: [http://www.cbs.gov.il/mifkad/integ\\_census.pdf](http://www.cbs.gov.il/mifkad/integ_census.pdf)
5. Each SA was subdivided into "cells" - a cluster of blocks - with each cell containing approximately 50 households. Approximately 20% of the cells in each SA were drawn to form the "U" sample. All dwellings (residence units) within the cell were to be interviewed in a Computer-Assisted Personal Interview (CAPI) interview. Persons whose addresses appeared in the sampled cells of the IAF were drawn to form the "O" sample, and interviewed in a Computer-Assisted Telephone Interview (CATI). In localities with no addresses (such as small localities and Arab towns which have no street names and numbers) the "O" sample is drawn randomly from all persons registered in the locality in the IAF. The dual system model estimates the number of persons not found in any of the dual system, who nevertheless live in the SA, in order to estimate the number and distribution of residents in the SA.

To evaluate the quality of the Integrated Census each component of the census should be evaluated. These are independent components and one component's level of quality does not apply to another one's.

6. In the preliminary planning stages of the Integrated Census two Post Enumeration Surveys (PES) were proposed, one PES for the "U" survey, and a second PES for the "O" survey. The proposed PES imitated the classical PES system on a small sample of the "U" and the "O", employing the best-qualified staff under close supervision of the procedure. The PES's were planned to be applied after all census operations had been completed. As planning of the Integrated Census progressed, it became obvious that adding a third and fourth phase (the two PES's) to evaluate the two field surveys ("O" and "U") and an evaluation procedure for the administrative file, was hardly justified, because it would most probably achieve poor results, due to the time lag between the census field work and the PES. It would also impose a heavy response burden on the sampled households and a long period of census operation in the field - almost a full year - which would heavily interfere with other CBS planned operations. These led to the decision to look for other ways to evaluate the quality of the Integrated Census.

7. The quality of administrative data relies heavily on the interests and management of the data producer, while quality of field surveys relies on the quality of the sampling frame and the enumeration process. A purely administrative census can be evaluated through current household surveys. This can be done using "macro" evaluation - comparing frequencies and cross-tabulation of the results, and "micro" evaluation, in cases where a survey contains unique identifiers, which can be matched with the administrative records.

8. In the Israeli Integrated Census both options (micro and macro) are feasible for the administrative components. Nevertheless, it is essential to evaluate all data components of the Integrated Census; the administrative data as well as the enumeration process. The household survey component is considered a sort of a PES for the administrative part. The quality of the fieldwork component of the Integrated Census is evaluated through the dual survey processes.

## II. QUALITY EVALUATION PROCEDURES OF THE INTEGRATED CENSUS

9. Final census results are weighted, to correct for under-coverage and over-coverage in the IAF within the SA. Persons omitted from the enumeration process do not affect population counts as a result of the dual estimation model. Population estimates obtained from the Integrated Census are compared to current population estimates.

10. Nevertheless, underreporting in "U" could have an impact on the data based on direct collection only (socio-economic data). Census data will be evaluated for possible biases through the **dual model**, and by use of **auxiliary data**. Auxiliary data are administrative data obtained from various organizations, and data obtained from other current surveys conducted by the CBS.

11. Evaluation parameters:

- a) Evaluating the improvement of address data, achieved through the use of auxiliary data sources;
- a) b) Results of algorithm for defining the "non-resident" in the IAF;
- b) Results of algorithm for constructing administrative families;

- c) Field enumeration coverage rates (people who live at their registered address and were omitted in the enumeration process);
- d) Coverage rates of sampled persons with telephone numbers for the rest of the "O" sample, to be interviewed in the CATI survey;
- e) The dual estimation system, by CV's of the estimates.

### **III. EVALUATION PROCEDURES IN THE 2006 PILOT CENSUS**

#### **A. PERMANENT POPULATION RESIDING IN ISRAEL**

12. The IAF should represent the current permanent population of Israel. All persons registered in the PR who reside permanently outside of Israel should be marked as "non-permanent residents" in the IAF.

13. Israel has had a computerized system of border control for many years. In the past, the system was not online, and the Border Control Register was updated by batch updates. These updates were based on manually entered (into a computerized file) of paper cards, which were completed by travelers upon their departure and arrival at the border. The departure and arrival records were matched. A matched record meant that the resident was present in the country and the person was deleted from the border control file. The register had a substantial amount of unmatched records, with multiple arrivals or departures for the same person. Multiple arrivals or departures of a person meant that a person was either absent or present incorrectly. Unmatched records could be due to various mistakes; the most common being wrong entry of ID number in the file (control digits were introduced only in the early 'Seventies) and Israelis who entered or left the country on a foreign passport. The latter practice was forbidden only a few years ago.

14. The Integrated Census required that people not residing in Israel be defined, and marked as such in the IAF, and these were ignored in the estimates of the permanent population.

15. Current population estimates use a macro-level estimate for the number and distribution of the non-resident population that is used to update annual population estimates. The Integrated Census required a micro-level definition.

16. The CBS uses a method for flagging individuals in the PR as "absent", for a current sample survey drawn from the PR. The method is used for deleting the absent people from the sample. The method uses a deterministic conservative approach model (suitable for the survey purposes) to determine an individual as absent.

17. The deterministic conservative approach was used in the 2004 pilot census. The 2004 pilot census results found that there were no false positives. Nevertheless, the model missed almost 50 per cent of residents who actually resided in another country for more than 12 months (false negative). This result called for modification in the model for the Integrated Census. A broader definition for absent population was suggested and tested in the 2006 pilot census. The broader definition would mark a person "not present in the country" with high probability although not fully deterministic. Such parameters were: a person whose age was listed as more

than 120 years, or a person who was defined as living abroad in the 1995 census and had no action recorded in the PR since then. The latter parameter was also applied in the 1983 census.

## **2006 Pilot Census Results**

18. Approximately 50,000 people were interviewed in the 2006 pilot census. The model missed 19 persons (0.04 per cent) who were reported as living abroad for over 12 months (model's false negative). The model miss-classified 51 persons as living abroad who were reported as living in Israel. 42 of them were later found to be incorrectly reported in the field survey (mainly parents reporting a child as part of the household, although he/she was actually living abroad for more than 12 months). In total, only 9 cases were miss-classified by the model as living abroad (0.02 per cent model's false positive).

19. In conclusion, the probabilistic model proved to define absent people at an adequate rate, and will be used in the 2008 census.

## **B. ADMINISTRATIVE FAMILIES**

20. The Integrated Census requires a household definition in the full IAF. The definition is needed for estimation margins. The algorithm of building a family cluster scheme was based on the family relations registered in the IAF, and addresses of each family member, using the following steps:

- a) All related persons who share the same exact address (locality, street and number) were merged into an administrative family;
- b) If the house number was unavailable on the record - all related people living on the same street were merged into an administrative family;
- c) For persons for whom only the locality name was available, the house identification was obtained from the 1995 census file. If their registered locality was the same in the IAF and in the 1995 census – the house location from the 1995 census was attributed;
- d) Families with no exact address were formed, based on first-order relatives (married couples, with or without unmarried children, or unmarried siblings) forming a nuclear family;
- e) Married couples were unified with their unmarried children aged less than 20 years, even if they had a different address in the IAF. In some ethnic subgroups (such as Arabs), where it is not customary for unmarried persons to live apart from their parents, all unmarried children were unified with their parents regardless of their age;
- f) Married couples living at different addresses were unified.

21. The evaluation process compared administrative families in the IAF with the corresponding families actually interviewed in the “U” survey, yielding three possibilities of comparison outcomes:

- a) Administrative family = Actual family;

- b) Administrative families > Actual families (algorithm merged people that do not belong in the same family);
- c) Administrative families < Actual family (algorithm split up families who actually live together).

## 2006 Pilot Census Results

### 22. Families in the IAF: **14,725 (interviewed in “U” or “O”)**

Administrative family = Actual family	89.3%
Miss-identification of family members living at the same address (*)	1.4%
Family members with an incorrect address in the IAF (**)	8.8%
Incorrect split due the completion process (***)	0.5%

\* Incorrect codification of address

\*\* Some family members had a different address in the IAF.

\*\* Multi-generational families were split incorrectly.

### 23. Families interviewed in 2006 pilot census: **13, 352**

Identical administrative families	92.5%
Merged two or more administrative families	3%
Living in localities other than the 2006 pilot	4.5%

24. In summary, approximately 90 per cent of the families were constructed correctly. Among the 10 per cent of incorrectly constructed families, the errors occurred in both directions;

- a) Incorrect splitting of families –mainly due to out-of-date addresses registered in the IAF for part of family members;
- b) Incorrect merging of two or more families, who actually live apart – mainly due to children who left home but did not update their address in the PR.

### 25. Algorithm improvements applied for 2008 census:

- a) Adding apartment numbers to refine address resolution, whenever available;
- b) Adding parents' given names and surnames to improve and expand family relations, when unavailable in the PR (this has special added value for uncommon names).

## C. COVERAGE OF TELEPHONE INTERVIEWS

26. The “O”- over-coverage sample is a CATI (Computer Assisted Telephone Interview) survey. Telephone numbers are not available in the IAF. Telephone numbers were obtained for the “O” sample by matching ID numbers for all members of the administrative family, and other first-order relatives who live elsewhere, with telephone companies registers. Registers from telephone companies in the country were used (mobile telephones and land-line telephones) for

the "O" survey. All matched numbers were obtained, meaning that if a person had more than one number registered in his/her name, all numbers were attached to their record.

27. One of the foreseen limitations in the process was that not all families will have at least one telephone number attached to at least one of the administrative family member. One way to minimize this was that in the matching process, if no telephone number was found for the complete administrative family, first-order family relatives (belonging to a separate administrative family, such as parents of children living on their own) were attached to the family who lacked a telephone number. The assumption was that it would be possible to obtain core information on addresses from first-order relatives.

28. Although almost 100 per cent of the households in the country have possession of a phone, either a cord or a mobile phone, as known from current household surveys, some of the numbers could not be directly related to a person or family. Some telephone numbers are registered to a company, and some numbers are confidential numbers by request of the owner, and could not be revealed.

29. Two quality criteria were used for the process:

- a) No contact number;
- b) No response in "O" survey.

### 2006 pilot census "O" sample results

30.

Families in the "O" sample	11,360
Families without telephone numbers	1,413
Individuals in the sample	22,809
Individuals without telephone numbers	2,032

31. 12 per cent of all families and 9 per cent of all individuals had no telephone numbers. Small families had no telephone number with higher frequencies than large families. The 1,413 families without any telephone numbers were mailed a letter with a short questionnaire. Only 6 per cent of the phone-less families responded and mailed the questionnaire back. This procedure was abandoned for 2008 due to the low response rates.

32. The telephone interviews (like the CAPI interviews) were conducted in three languages (Hebrew, Arabic and Russian).

33. CATI interview response rates:

	Individuals	Percent
<b>Persons with telephone numbers</b>	20,604	100
<b>Full interview (*)</b>	14,754	72
<b>Partial interview</b>	1,083	5
<b>Matching mistakes</b>	441	2

<b>Not interviewed - total</b>	4,326	21
<b>Refused</b>		8
<b>No response to 15 calls</b>		5
<b>Disconnected telephone</b>		4
<b>Other telephone problems (**)</b>		4

(\*) Included are numerous persons who died during the field-work time-frame.

(\*\*) Wrong numbers, automated response service, an unrelated person etc.

34. In summary, approximately 13 per cent were not interviewed due to (wrong telephone numbers obtained from the telephone companies).

#### **D. USING THE “O” SAMPLE AS A PSEUDO PES (EVALUATION OF “U” SAMPLE ENUMERATION PROCESS)**

35. The “O” sample is drawn from the IAF in two different methods.

- a) Localities with street names and numbers, a complete address system – The “O” sample contains **all** persons registered at the addresses in cells included in the “U” sample;
- b) Localities without full addresses (mainly small rural localities and most Arab localities) – A random sample of persons registered in the locality in the IAF (approximately 15-20 per cent) of the administrative families; varies among localities).

36. The “O” sample was conducted a few weeks after the field enumeration of “U” was completed. 'O' in localities with full address serves as a pseudo-PES. All persons who were interviewed in the “U” sample were matched with the “O” sample (individuals registered in the sampled cell). All matched persons (definitive match or a high probability match) are not interviewed in the “O” survey. The unmatched persons in “O” are interviewed in a CATI survey.

37. In a perfect enumeration procedure, field enumeration would cover all residents of sampled cells and no person residing in a sampled cell would be present in the "O" sample.

38. Therefore, the core parameter in the evaluation of the "U" enumeration process, in localities with full addresses, is the number of persons who were located in the “O” survey and reported living in their exact IAF address, but were absent in the “U” enumeration process.

39. The results in the 2006 pilot census in full-address localities:

	<b>Thousands</b>
a. Total registered in sampled cells.	40
b. Total interviewed in “U”	27.2
c. Found at their registered address in “O”	4.3
d. Found in an address different from that registered in “O”	5.7



f – Total interviewed in “O”

$f = c + d = 10.0$  thousand

g – Living in their registered address

$g = b + c = 31.5$  thousand

h – Coverage rate- proportion of persons omitted in the “U” enumeration process

$h = c/g = 13\%$

40. A second parameter in the evaluation process is the similarity of the distribution of the enumerated and omitted person. In the 2006 pilot there were very minor differences in the age distribution between the two groups (the enumerated vs. the omitted), as found in the pilot census. The widest gap was found in the group of persons aged 18-30 years – 18 per cent vs. 22 per cent respectively.

41. Other parameters of quality in “U” sample enumeration process are:

- a) Partially completed questionnaires;
- b) Proportion of dwellings with no questionnaires;
- c) Proportion of exact match with IAF.

42. These parameters were evaluated from the enumeration process results, unrelated to the dual survey method. Although not all evaluation parameters could be calculated in the pilot, some steps were taken to improve enumeration outcomes. The most important steps were:

- a) Smaller fees for a partial questionnaire;
- b) Reduction of fees for self-administered questionnaires (only demographic details);
- c) A geographic expert’s assistance in locating cell borders.

## **E. POPULATION ESTIMATES**

43. The quality of the final population estimate results of the Integrated Census are evaluated by three parameters:

- a) CV of the estimates.
- b) Imputed probabilities of a person residing at the address registered in the IAF, for non-responses in “O
- c) Compatibility of census estimates with current population estimates

44. CV’s were calculated in two ways, by Taylor expansion and by Jackknife for calculating CV’s. The first places more emphasis on the model, and later, on the sampling.

### **2006 Pilot Census Results**

45. Both Taylor and Jackknife methods were applied to calculate CV’s for each estimation group designed by the model. The CV’s calculated by both methods yielded similar results,

indicating that the model designed was appropriate. For most of the estimation groups the CV's in both methods were within the expected variance limit and did not exceed 10 per cent. Nevertheless, it should be noted that when response rates in the "U" sample are below 50 per cent - response rates obtained in two areas in the 2006 pilot - the weights assigned by the model do not produce valid estimates.

46. The results of the imputation evaluation proved that in cases with low response rates (as mentioned above) the model fails, and the range of imputed probability values would produce invalid census estimates. In areas with response rates below 70 per cent (combined "U" and "O" response rates), the census estimate will disregard the enumeration process, and the census estimate for those areas will be extracted from the IAF without weights (weight 1 for all).

47. The comparison between current population estimates and the pilot census estimates, demonstrates that the Integrated Census results were reliable and valid estimates. All discrepancies that exceeded the set limit of 10 per cent were justified by either enumeration problems or current estimation updates.

#### **F. INSTITUTIONALIZED POPULATION**

48. We plan to compare the Institutionalized People Register obtained in 2008 with various available lists, to evaluate the enumeration procedure in institutions. Such lists are: students living in boarding schools, long-term hospital patients, inmates of welfare institutions, etc.

#### **G. LABOR FORCE PARTICIPATION**

49. Distribution of LFS and income tax files compared to census enumeration results (enumeration evaluation). Was not conducted for the pilot census, and this evaluation will only be calculated in the 2008 census.

#### **H. DISABILITY PREVALENCE**

50. Handicap allowances paid by government organizations, (enumeration evaluation). Data from the National Insurance Institute (Social Security) is not available yet. The questions used in the 2006 pilot did not comply with UN recommendations. The questions were modified in the final census questionnaire, to be compatible with UN recommendations.

### **IV. CONCLUSIONS**

51. As with any other census method, the Integrated Census is subject to flaws and misconduct, with the findings summarized and made available to data users. A traditional method to evaluate conventional census results is the PES survey. An unconventional census such as the Integrated Census calls for untraditional evaluation methods. As some of the potential pitfalls and flaws of a traditional census are resolved by the dual system of the Integrated Census, there is no necessity for conducting a PES. Census results can be evaluated by other methods and produce reliable evaluation.

52. One of the main concerns with the quality of the Integrated Census was to minimize the bias in socio-economic information, which is unavailable from administrative sources and is collected in the field enumeration process. If the responding households do not represent the total population, the estimates could be biased.

53. As a result of the three pilot censuses, potential flaws in the process were detected and some actions were taken to improve procedures and to minimize their effect. We hope that the evaluation methods applied in the Israel Integrated Census will give a comprehensive evaluation of the census results, and a good estimate of potential biases, which may have occurred.

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