**About the Quality of the 2013 Census of Population, Households and Dwellings in Bosnia and Herzegovina: Statistical Results versus Political Controversies**

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**Abstract**

*Census of Population in Bosnia and Herzegovina was conducted in 2013. Statistical offices conducted census in line with international standards. However, almost all main issues of the census were politicized. The census was given many non-statistical characteristics. It was presented by various interest groups as politically important activity, as a population register or a source of data, which could be used for tax policy or property management. For all these reasons, census activities were a subject of political controversies, topics for evaluation of several, mostly statistically unprofessional interest groups or individuals, who had more media attention than statistical experts and whose influence to the attitude of Bosnian citizens was non-ignorable. The Post-enumeration survey (PES) was conducted in November 2013. The objective of the PES is to provide indicators of the census quality.*

*In this paper, we will show how the PES was designed and conducted and which statistical models and methods were used for linkage of census and PES data and for the analysis of census quality. The last part of the paper will discuss the acceptance of the census results by different data users, such as statistical institutions, journalists, general and expert public. This part of the paper aims to give a rough picture of the general statistical culture in Bosnia and Herzegovina through the prism of the population census. In conclusion, the evaluation of the quality of 2013 census of population, households and dwellings in Bosnia and Herzegovina will be done, as well as some proposals for future work.*

**Keywords:** Census, quality, coverage, content

**1. Introduction**

Results of the 1991 census in Bosnia and Herzegovina were prematurely out of date because of war events. Demographic data were collected by several enumerations of population, which were of limited scope. The new census was conducted in 2013, but its purpose was, by various interest groups, intentionally misinterpreted, which decreased the confidence in statistical offices and was one of source of errors in census data, especially in terms of the over-coverage.

This paper presents a survey measuring the quality of Bosnian census and how its results were understood by users. In section 2, the overview of references on census quality is presented. Section 3 deals with the methodology of Post-enumeration survey (PES) and its application in Bosnia and Herzegovina. In the section 4 we discuss the (non)acceptance of census results by various interest groups. The paper ends with conclusion and proposal for future work.

**2. Literature review**

Official statistical surveys are regulated by different regulations, which ensure harmonization of procedures and comparability of results. The UN Principles and Recommendations for Population and Housing Censuses define the census as a survey with stated quality standards (UN, 2007). In measuring census quality, UN Statistical Division recomends the use of dual system estimation (DSE) within the Post-enumeration survey (UN, 2010). Fellegi and Sunter (1969) developed a model[[1]](#footnote-1) for comparison between recorded values in two surveys. This work has led to further development of statistical theory and softwares for dealing with record linkage (RELAIS, lEM or PANMARK). If all assumptions for the implementation of DSE are not met, the generic version of DSE must be adjusted (UN, 2010). In Bosnia and Herzegovina this correction was made by the latent class analysis (LCA), developed by Goodman, (Goodman, 1974), Hagenaars (1993a, 1993b and 1997), Wolter (1986), Biemer (2011) and many others.

The literature review has clearly highlighted the following issues: (i) independent measurement of the census quality is obligatory; (ii) PES is standard measure of census quality; (iii) DSE method can estimate the true population, and (iv) standard DSE has to be corrected, if some basic assumption for its use is not met.

**3. Post-enumeration survey in Bosnia and Herzegovina**

*3.1. Objectives of post-enumeration survey*

In every statistical survey, there are errors and they can occur at all stages. Also censuses suffer from different errors (UN, 2010): coverage errors occur due to omissions or multiple enumerations of statistical units, while content errors arise in the incorrect reporting of the characteristics of statistical units. Operational errors also contribute to coverage and content errors (UNECE, 2006).

Most important methods for measurement of census quality are (UN, 2010): (i) checks of the completeness and consistency of data; (ii) comparisons of results with other data sources; (iii) demographic analysis of data distributions, and (iv) post-enumeration survey. The objective of the PES is an independent re-enumeration of census units and linking each record with record from the census on a case-by-case basis (UN, 2010). This survey in Bosnia and Herzegovina was designed in order to collect the same data at the Census critical moment.[[2]](#footnote-2)

*3.2. Dual system estimation method (DSE)*

There are two types of census coverage errors: under-count and over-count.

Let *Ncensus* be the census count, *N* be the unknown true population count and *Nce*be the part of the census count correctly enumerated. The under-coverage rate is defined as:

(1)

while, the over-coverage rate can be defined as

(2)

The census net coverage error *D* is defined by *D = N −Ncensus*. A positive value of *D* indicates net under-count and a negative value indicates net over-count.

Standard DSE is a model to estimate the unknown population total, *N,* on the basis of two enumerations: the first one is based on total enumeration and the second-one is sample-based enumeration. Results of these enumerations are represented in two lists of units, which are different in terms of size (*N1*=census total, *N2*=PES total and *N1*≠ *N2*). After linking the two lists, a 2×2 DSE table is set up, as in table 1. Following assumptions must be satisfied in order to use DSE (Biemer, 2011; Herzog, 2013;

**Table 1. Contingency table of the counts in the census and in the PES**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | **PES** | | **Total** |
| **Present** | **Absent** |
| **Census** | **Present** |  |  |  |
| **Absent** |  |  |  |
| **Total** | |  |  | N |

Source: Pfeffermann D. and C.R. Rao, 2009.

BHAS, 2017): a) captures in census and PES are independent; b) population measured in both sources is the same; c) records from both sources can be linked; d) units have the same capture probabilities within each source, and e) over-count in both sources is negligible. In this way, an unbiased estimator[[3]](#footnote-3) of *N* is given by

. (3)

Let *pab* be the probability of inclusion in the *ab*-th cell, with *a, b* = 1, 2, +. The probability of being counted twice is the product of the marginal counting probabilities, *p11* = *p1*+*p+1*, while the maximum likelihood estimators of the probabilities that a person will be counted in the census and in the PES, *p1+* and *p+1*, respectively, are:

 ,  (4)

*3.3. Methodology and results of the linkage procedure*

The linkage was based on the probabilistic model of Fellegi and Sunter (1969) and performed by using the software RELAIS. The resident and the enumeration status were included and only records declaring to be resident were considered in following steps. The final results of record linkage are presented in the table 2. It is evident that the over-count of individuals was unusual. There were three possible solutions of this problem: (i) use of administrative sources; (ii) new sample survey for evaluating the over-coverage, and (iii) adjustment of DSE. The last option was the only possible and it enables the use of the DSE method (Wolter, 1986).

Suppose that the census list comprises *Ncensus* enumerations, of which *Nce* are eligible and correctly enumerated, while *Z* are ineligible, then *Ncensus*=*X1*+ + *Z* = *Nce*+*Z*.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table 2. Contingency table of individuals enumerated in the census and in the PES-final data, unweighted cases** | | | | |
|  | | **PES** | | **Total** |
| **Present** | **Absent** |
| **Census** | **Present** | 34,603 | 2,656 | 37,259 |
| **Absent** | 448 |  |  |
| **Total** | | 35,051 |  | N |

Source: BHAS, 2017.

The goal is to estimate *Z* or *Nce*. If we assume that the PES list does not include ineligible persons, the adjusted DSE estimate of the population size, corrected by over-count,, is given by

 (5)

The adjustment of the DSE method is made by the consideration of the over-coverage before applying the generic DSE method. It is performed by the model of latent class analysis-LCA (Goodman, 1974; Hagenaars 1993a, 1993b and 1997; Wolter, 1986; Biemer, 2011). The best model[[4]](#footnote-4) for identifying units belonging to the target population in the set of units enumerated by the Census but not by the PES (cell *x12* of table 2) included three explanatory variables: Sex, Age and Matching status of the household. The model results with the marginal probability to belonging to the true population of 0.1379[[5]](#footnote-5) and the size of people estimated being in the population of 366 units.

*3.4. Census coverage errors*

LCA allowed the estimate of following coverage errors[[6]](#footnote-6) (BHAS, 2017):

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Table 3. Main coverage errors at national level for individuals-absolute figures** | | | | | |  |
| **Dual system estimate of the true population (DSE)** | **Census count before correcting for collective households** | **Census count after correcting for collective households (*Ncensus*)** | **Eligible and correctly enumerated in the Census (*Nce*)** | **Erroneous inclusion** | **Omission (*DSE-Nce*)** | **Census net coverage error** |
|
| 3,352,760 | 3,530,159 | 3,507,343 | 3,311,191 | 196,152 | 41,570 | -154,582 |

Source: BHAS, 2017.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 4. Coverage rates at urban, rural, entity and national level for individuals** | | | | | | |  |
|  | | **Urban** | **Rural** | **Federation of BiH** | **Republika Srpska** | **Brcko District** | **National** |
|
| **Over-coverage** | **Rate** | 6.4% | 5.1% | 5.0% | 6.0% | 15.4% | 5.6% |
| **95% CI LL** | 6.2% | 4.9% | 4.9% | 5.8% | 14.5% | 5.4% |
| **95% CI UL** | 6.7% | 5.3% | 5.2% | 6.3% | 16.2% | 5.8% |
| **Under-coverage** | **Rate** | 1.4% | 1.2% | 0.9% | 1.8% | 1.4% | 1.2% |
| **95% CI LL** | 1.2% | 1.0% | 0.8% | 1.6% | 0.6% | 1.1% |
| **95% CI UL** | 1.6% | 1.3% | 1.1% | 2.0% | 2.1% | 1.3% |

Source: BHAS, 2017.

The tables above show that 196,152 persons were erroneously included in resident population, while 41,570 were omitted and, consequently, the net coverage error is estimated in amount of 154,582 persons. The over- and under-coverage rates are 5.6% and 1.2%, respectivelly, and both are significantly higher in urban areas. The net coverage census error for total population was -4.6% and it is significantly higher in urban areas[[7]](#footnote-7).

*3.5. Census content errors*

Content quality control is conducted to measure errors due to inconsistencies among census and PES data. They may arise out of mistakes coming from misreporting, interviewer or respondents’ bias, data entry errors and from other sources. Content errors are estimated only for successfully matched un-weighted units and for several variables. The aim of the content error analysis is not to establish which answers are right or wrong, but it just measures how differently answers are reported (variability in answers), i.e. the only response error component commonly estimated in PES is a variability and not a bias. Variability of answers is measured by five quality indicators.[[8]](#footnote-8) These indicators are presented in the table 5.

**Table 5. Content errors indicators for selected variables and their categories at census and PES**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable category** | **Net difference rate** | **Index of inconsistency** | **Gross difference rate** | **Aggregate index of inconsistency** | **Rate of agreement** |
| **Sex** | | | | | |
| M | -0.13% | 2.88% |  |  |  |
| F | 0.00% | 3.30% |  |  |  |
| Null | 0.13% | 99.48% |  |  |  |
| Total |  |  | 2.45% | 4.81% | 97.55% |
| **Age** | | | | | |
| 0-14 | -0,08% | 0,85% |  |  |  |
| 15-49 | -0,04% | 1,34% |  |  |  |
| 50-64 | -0,01% | 1,34% |  |  |  |
| 65+ | 0,03% | 1,40% |  |  |  |
| NULL | 0,10% | 52,04% |  |  |  |
| Total |  |  | 1,13% | 1,72% | 98,87% |
| **Marital status** | | | | | |
| Never Married | -1.74% | 10.69% |  |  |  |
| Married | 0.39% | 5.56% |  |  |  |
| Divorced | 0.00% | 27.96% |  |  |  |
| Widow/ Widower | -0.08% | 3.62% |  |  |  |
| Not applicable | -0.07% | 0.80% |  |  |  |
| NULL | 1.49% | 94.14% |  |  |  |
| Total |  |  | 5.15% | 7.66% | 94.85% |
| **Highest completed education** | | | | | |
| No education | 0.14% | 15.83% |  |  |  |
| Uncompleted basic education | 0.25% | 32.25% |  |  |  |
| Primary school | -1.15% | 34.45% |  |  |  |
| Lower secondary school | -0.16% | 11.82% |  |  |  |
| Post-secondary school | -0.05% | 1.76% |  |  |  |
| High school | 0.24% | 38.42% |  |  |  |
| Tertiary education | -0.16% | 17.13% |  |  |  |
| Not applicable | -0.07% | 0.80% |  |  |  |
| NULL | 0.96% | 100.02% |  |  |  |
| Total |  |  | 12.31% | 16.45% | 87.69% |
| **Activity status** | | | | | |
| Employed | -0.59% | 16.93% |  |  |  |
| Didn't work but has a job to return to | 0.20% | 82.02% |  |  |  |
| Unemployed | -0.24% | 19.67% |  |  |  |
| Not applicable | -0.07% | 0.65% |  |  |  |
| NULL | 0.69% | 100.00% |  |  |  |
| Total |  |  | 11.06% | 17.76% | 88.94% |
| **Citizenship** | | | | | |
| BiH | 0.64% | 19.58% |  |  |  |
| BiH and other country | -1.11% | 20.16% |  |  |  |
| Other country | 0.03% | 48.97% |  |  |  |
| Without citizenship | 0.04% | 100.00% |  |  |  |
| NULL | 0.41% | 100.00% |  |  |  |
| Total |  |  | 5.60% | 21.35% | 94.40% |

Source: BHAS, 2017.

Generally, content errors for analysed variables are considered reasonably low according UN thresholds (UN, 2010). Modest inconsistencies are evident only by few categories of the variables.

**4. Acceptance of census results by users**

The 2013 census in B&H was given huge political importance and it was presented as one of the most important political issues. Such presentations of several interest groups were stronger than the official census public campaign. These groups focused the attention only on three sensitive questions by presenting them as the greatest “ethnic” interest. They wrongly presented the census as a population register, source of data for property management and tax issues or as a potential tool for eliminating specific ethnicities from regions where they live for centuries. Very few persons or institutions were talking about the census in the right way. In favor of the above opinion is also the fact that most of the attention in the census results was focused on those of ethnic structure of the population. Some institutions and individuals had the opinion that the census count should be a result of the agreement between (political) organizations and not a product of the statistical analysis. Among them were also some members of the managements of statistical institutions, members of Bosnian Presidency and some politicians. If we ignore politicians for a moment, we are surprised by the attitude of some members of the managements of the statistical institutes, whose behavior in producing census results was directly against the principles of the Code of Practice of European Statistics and Law on Statistics of Bosnia and Herzegovina. This is, among other reasons, a result of the wrong selection of the managements of statistical and other institutions, which prefers politically promoted persons and ignores experts. In such selection procedures, experts do not have any chance to be appointed because the system is made as a closed circle that promotes in advance predetermined persons. The general impression is that we can talk about decline in confidence of general public and data users in the work of statistical institutions. This is certainly the phenomenon, which should be further investigated by sociologists, psychologists, professors of statistics and statisticians, but also by the highest authorities in the public administration and it is out of the scope of this paper. The aim of this paper is to open broader discussion about the general “statistical culture” in Bosnia and Herzegovina, to open up questions, what is the statistics, which is its purpose and place in the society.

The Agency for Statistics of Bosnia and Herzegovina was aware of the atmosphere in which the census is conducted. It has conducted the census and the PES in line with all relevant standards. The International Monitoring Organization and Eurostat have validated census and PES results and concluded that they can be used for policy and statistical purposes. But, today, almost five years after the census, its results have neither been used for policy nor statistical purposes. This gives enough evidence about the level of “statistical culture” in Bosnia and Herzegovina, if it exists at all.

**5. Conclusion**

In this paper, we presented the methodology of census quality measurement, which is based on the adjusted DSE. The estimate of the true resident population has given the evidence that the population was over-counted in the census and that the over-coverage was a bit unusual or atypical. The net coverage census error for total population was not in the scope to be evaluated as bad quality of census results. Similar evidence was also obtained for census content quality. Consequently, the overall quality of 2013 census of population could be evaluated as good and usable for statistical purposes and policy making. Nevertheless, for political reasons results of the census have remained unused until today, which indicates a very low statistical culture in the country. What is most surprising is that many factors within the statistical system contributed to this position. Lessons learned from the last census should be used in the preparation of the census 2021. For this purpose, three main issues must be discussed with the greatest attention: (i) census is a statistical survey; (ii) removal of sensitive questions on ethnicity and religion from census questionnaires, and (iii) politicians have nothing to deal with census. Only under these assumptions, the quality of the next census will be improved.

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1. Dual System Estimation (DSE) Model [↑](#footnote-ref-1)
2. More about PES sampling design and survey instruments, see in Sabanovic, E. and Somun-

   Kapetanovic, R., 2017 and BHAS, 2017. [↑](#footnote-ref-2)
3. Lincoln-Peterson estimator (Herzog, 2013) [↑](#footnote-ref-3)
4. Measures of goodness of fit of the model: E=0.0001; λ= 0.9992, see (BHAS, 2017). [↑](#footnote-ref-4)
5. (BHAS, 2017) [↑](#footnote-ref-5)
6. Under-coverage rate = Omissions/Census Count

   Over-coverage rate = Erroneous inclusions/Census Count

   Net Coverage error Rate = (DSE - Census Count)/ DSE

   Census Omission Rate = Census Omissions/ DSE

   Census Omissions = DSE - Correct Enumerations

   Erroneous inclusion rate = Erroneous inclusions/Dse

   Erroneous Inclusion = (Census Counts + Omissions) – DSE.

   Only main coverage errors for individuals are presented here. More indicators of census coverage

   quality are available in BHAS, 2017. [↑](#footnote-ref-6)
7. BHAS, 2017. [↑](#footnote-ref-7)
8. See definitions of those indicators in (UN, 2010) . [↑](#footnote-ref-8)