Original article

Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey (Vigitel): changes in weighting methodology

doi: 10.5123/S1679-49742017000400003

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Abstract

Objective: to introduce the methodology used to calculate post-stratification weights of the 2012 Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey (Vigitel) and to compare the trends of indicators estimated by cell-by-cell weighting and raking methods. **Methods**: in this panel of cross-sectional studies, the prevalences of smokers, overweight, and intake of fruits and vegetables from 2006 to 2012 were estimated using the cell-by-cell weighting and raking methods. **Results**: there were no differences in time trends of the indicators estimated by both methods, but the prevalence of smokers estimated by the raking method was lower than the estimated by cell-by-cell weighting, whilst the prevalence of fruit and vegetable intake was higher; for overweight, there was no difference between the methods. **Conclusion**: raking method presented higher accuracy of the estimates when compared to cell-by-cell weighting method, proving to be most convenient, although it presents register coverage bias.

Keywords: Health Surveys; Telephone; Bias; Surveillance; Serial Cross-Sectional Studies.

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Introduction

The Surveillance System of Risk and Protective Factors for Chronic Diseases by Telephone Survey (Vigitel), implemented in 2006, is consolidated as a surveillance and management system.[1-6] Vigitel target-population is composed of adults aged 18 years or over, who live in households with or without landline, in the 26 Brazilian state capitals and the Federal District (FD). Its information is used for planning public policies, guidelines and specific actions for health promotion and prevention of risks and diseases.[7]

In the sampling process, Vigitel uses the registers of household telephone numbers, in order to randomly select household samples. Data of the Household Budget Survey (POF), conducted by the Brazilian Institute of Geography and Statistics (IBGE) between 2008 and 2009, point that 66.7% of the families who lived in Brazilian state capitals and the FD had expenses related to landlines in the 30 days previous to the study, and this coverage had remained stable in the previous six years (2003 to 2008).[8] Data of the 2010 Demographic Census[8] show that 61.0% of the private households located in the 26 state capitals and the FD had at least one landline. However, the landline coverage was not homogeneous throughout the country: the regions North and Northeast presented coverages of 38.0% and 44.0%, respectively, whilst the Midwest, South and Southeast had coverages of 56.0%, 70.0% and 74.0%, respectively.

> *The researchers chose to review the methodology used to calculate post-stratification weighting, trying to find alternative methods that could minimize the effect of weighting in the estimates accuracy and could consider the sociodemographic transitions.*

When part of the study population is excluded from the sample due to the low coverage of the register used to select the sample, some non-sample biases may appear.[9-11] Such situation happens at Vigitel survey, and is especially relevant in the capitals of the North and Northeast regions, whose landline coverage was under 50% in 2010. Bernal et al. show that this is a minor bias in regions with coverage over 70%.[12]

The post-stratification weighting to compensate low coverage is commonly used in order to minimize these potential biases.[13-16] Such procedure uses variables available in the sample and in the reference population, obtained from external sources to adjust the distribution of the sample with landline to what was verified for the whole set of the reference population. The choice of variables used in the construction of weights takes into consideration the characteristics of the population excluded, so the bias can be minimized.

Since the first edition of Vigitel, cell-by-cell weighting[17] had been adopted to calculate post-stratification weights, for each capital, using the population data from the 2000 Demographic Census as basis.[8] The combinations of categories of variables associated with landline – according to age group (18 to 24; 25 to 34; 35 to 44; 45 to 54; 55 to 64; 65 or over), sex (male, female) and education level (0 to 8; 9 to 11; 12 years or more of schooling) – compose the 36 cells used to calculate the weights, through the ratio between the relative frequency of each cell, the population from 2000 Demographic Census and the sample weighted by the basic design weights.[8]

However, at Vigitel recent measurements, there has been high variability of post-stratification weighting due to the presence of some cells with little sample information. The cells that compose the young population strata (18 to 24 years old) and with low education level (0 to 8 years of schooling) present the highest weights, due to the low frequency of the sample, because of the sociodemographic changes occurred in the period from 2000 to 2010.

In face of these results and after the population data of the 2010 Demographic Census was released, the researchers chose to review the methodology used to calculate post-stratification weighting, trying to find alternative methods that could minimize the effect of weighting in the estimates accuracy and could consider the sociodemographic transitions experienced by the Brazilian population between the 2000 and 2010 Demographic Censuses.

The raking method[11,18] was selected to calculate Vigitel post-stratification weighting. This method uses the simple frequency distribution of each variable, such as age group, sex and education level for each state capital, and allows the utilization of different external sources in the inter-census period, to calculate the weights. The main advantage of this method is the use of univariate distributions from different external sources, in different periods of time. A disadvantage of raking method is the need of an algorithm to calculate the weights. The advantage of cell-by-cell

weighting method is the easiness to calculate weights, but its disadvantage is the need of databases to generate the contingency table used to calculate weights.[11]

The objective of this study was to present the methodology used to create post-stratification weights of the 2012 Vigitel and to compare the trend of indicators estimated by the cell-by-cell weighting and raking methods.

Methods

In this panel of cross-sectional studies, the prevalences of smokers, overweight, and regular intake of fruits and vegetables for five or more days a week were estimated using Vigitel data from 2006 to 2012, using cell-by-cell weighting and raking methods.

The raking method[11,18] was used as an alternative to calculate post-stratification weighting to increase Vigitel sample. This method uses the annual frequency distribution of the variables 'age group', 'sex' and 'education level' of the population. Due to the absence of annual projections of the population's education level, we chose to estimate the education level, sex and age group using data of the 2000 and 2010 Censuses.

The procedures used to calculate the projections and to calculate weights using the raking method for each capital are presented below. Initially, we considered the microdata of the 2000[18] and 2010[19] Demographic Censuses for each state capital (i), in the calculation of the geometric mean rate ($rg_{(i)}$) of the annual growth of the adult population used for population projections during the inter-census period – Expression 1:

$$rg_{(i)} = \left(\sqrt[10]{\frac{Population_{(i)}^{2010}}{Population_{(i)}^{2000}}} \right) - 1$$

For each capital, we calculated the population growth rate, stratified by sex, for each of the six age groups (18 to 24; 25 to 34; 35 to 44; 45 to 54; 55 to 64; and 65 or over), and for four education levels (no schooling or incomplete Primary School; complete Primary School or incomplete High School; complete High School or incomplete Higher Education; Higher Education degree). Due to changes in the questions of 2000 and 2010 Censuses, IBGE provided the combinations of the classification variables of education level for each census. The use of the data imputation technique was necessary for the category 'Not mentioned' of the variable 'education level', by adopting the most frequent value within each age group – stratified by sex – for the missing cases.

The estimates of the adult population of each state capital, during the inter-census period (t), were obtained from the geometric mean rate of annual growth estimated for each one of the 14 population groups (six age groups for the total population and four education levels for each sex). Moreover, the total estimate of Vigitel population by age was adjusted using the total population from IBGE, provided by the Department of the Brazilian National Health System (Datasus)[19] for each surveyed year. This adjustment resulted from the multiplication of the total frequency per age, stratified by sex, by the total number of adults aged 18 or over in the population. The same procedure was used for education level, stratified by sex. In both cases, the total population, estimated from the adults' sample was adjusted to the total size of the population.

For each capital, the population estimates were calculated per age groups (six categories) and per education level, stratified by sex (eight categories), in the period from 2006 to 2011 – except for 2010. This information was used to calculate Vigitel post-stratification weights by raking method.[11,18] This method works with one variable at a time, leveling the distribution of the total variable in the sampling weights by the sample weights and in the population, through itineration procedure. This process is repeated to each one of the variables used to calculate the weights, so the sample distribution becomes identical to the population for these variables. The new post-stratification weights for each capital were calculated using the statistical software SAS (macro function Rakinge.sas[21]).

Vigitel sample weights, in each capital, are calculated by the ratio between the number of adults and the number of landlines, due to the random sampling, in two stages: first, the registers of household telephones are used so the household samples can be drawn; second, one adult resident of the picked household is also randomly selected.

The analyses of Vigitel data require the survey sampling complex plan (SCP) to be considered. The measure used to assess the impact of weights in the prevalence accuracy is the design effect (*deff*),[9] which expresses the ratio between the variance of estimates calculated with weights and the simple casual sample. A *deff* value equals 1 indicates that the weights did not change the estimate accuracy, whilst *deff* values over 1 indicate loss of accuracy due to the use of post-stratification weighting. *Deff* was calculated for each indicator using

the post-stratification weights by the cell and raking methods. The *deff* obtained from the raking method is expected to be lower than the one obtained by cell-by-cell weighting.

The following stages will be described, in order to present the raking methodology applied in Vigitel after 2012:

a) estimate of annual geometric mean rates of population growth in the municipality of Belém-PA, according to age group and education level, from 2000 to 2010;
b) comparison between the estimates of the population according to age group, provided by IBGE and available at Datasus website, with estimates produced by Vigitel;
c) methodological details of raking weighting;
d) estimation of design effect – *deff* – of Vigitel weights in the prevalence of smokers, per capital, per year – from 2006 to 2011 – and by raking and cell-by-cell weighting methods –; and
e) comparison between the time series and indicators differences (prevalence of smokers; overweight; frequency of fruits and vegetables intake), from 2006 to 2012, according to different weighting methods – cell and raking.

This study used secondary data, with no identification of subjects, in accordance with the ethical principles established at the Resolution of the National Health Council (CNS) No. 510, dated April 7th 2016.

Results

From 2000 to 2010, the adult population living in Belém-PA increased, on average, 1.2% per year, although in stratification per age, the variation rate of the population size from 18 to 24 years old has been negative. A bigger growth was observed in the age group from 55 to 64 years old. The population with no schooling or incomplete Primary School decreased 1.7% per year, whilst the population with complete High School or incomplete Higher Education increased, on average, 5.5% per year. The population with Higher Education degree increased almost 7% per year, with higher growth among women: 7.6% (Table 1).

In 2011, the outputs of the program Rakinge.sas carried out for Belém-PA (Figure 1) shows, for example, the results for the first and last iteration to calculate post-stratification weights. The first variable to calculate the weights is the age group, presented in column (1), with six categories (18 to 24; 25 to 34; 35 to 44; 45 to 54; 55 to 64; and 65 years or over). In the first iteration of age group, we can observe that the number of adults weighted by the base sampling weight is equal to 6,116.75 (2); and in the population, equals to 999,061 adults (3). When the sample relative distribution is compared (4) with the population (5), we can notice that Vigitel has less adults aged 18 to

Table 1 – Annual geometric mean rate of proportional variation (%) of population size according to age group, education level and sex, in the municipality of Belém, Pará, 2000-2010

Variables	Sex		Total
	Male	Female	
Age group (in years)			
18-24	-0.797	-0.983	-0.895
25-34	1.520	1.525	1.522
35-44	2.083	2.173	2.131
45-54	3.474	3.492	3.483
55-64	4.193	4.143	4.165
≥65	3.942	3.816	3.864
Education level			
No schooling/Incomplete Primary School	-1.477	-1.952	-1.727
Complete Primary School/Incomplete High School	0.396	0.476	0.438
Complete Primary School/Incomplete High School	5.645	5.319	5.461
Higher Education degree	6.275	7.565	6.980
Total	1.193	1.200	1.197

Raking by FET, iteration - 1

(1) FET	(2) Calculated margin	(3) Marginal control total	Difference	(4) Calculated %	(5) Marginal Control %	(6) Difference in %
1	1047.67	181627	180579.33	17.128	18.180	-1.052
2	1333.50	262280	260946.50	21.801	26.253	-4.452
3	1037.75	208865	207827.25	16.966	20.906	-3.940
4	1043.67	156756	155712.33	17.062	15.690	1.372
5	807.00	99599	98792.00	13.193	9.969	3.224
6	847.17	89934	89086.83	13.850	9.002	4.848
	6116.75	999061		100.00	100.00	

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Raking by SEXOFXESC, iteration - 1

(7) SEXOFXESC	Calculated margin	Marginal control total	Difference	Calculated %	Marginal Control %	Difference in %
1	55018.68	142750	87731.32	5.507	14.288	-8.781
2	64278.60	90902	26623.40	6.434	9.099	-2.665
3	199603.57	172392	-27211.57	19.979	17.255	2.724
4	87414.01	53609	-33805.01	8.750	5.366	3.384
5	93738.04	153077	59338.96	9.383	15.322	-5.939
6	85415.87	98583	13167.13	8.550	9.868	-1.318
7	286341.14	217849	-68492.14	28.661	21.805	6.856
(8)	999061.00	999061	(9)	100.00	100.00	
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-

Raking by FET, iteration - 7

FET	Calculated margin	Marginal control total	Difference	Calculated %	Marginal Control %	Difference in %
1	181623.37	181627	3.62626	18.179	18.180	-0.000
2	262277.63	262280	2.37050	26.252	26.253	-0.000
3	208864.48	208865	0.52154	20.906	20.906	-0.000
4	156757.15	156756	-1.15096	15.690	15.690	0.000
5	99600.72	99599	-1.71775	9.969	9.969	0.000
6	89937.65	89934	-3.64959	9.002	9.002	0.000
	999061.00	999061		100.00	100.00	

(10)

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Raking by SEXOFXESC, iteration - 7

FET	Calculated margin	Marginal control total	Difference	Calculated %	Marginal Control %	Difference in %
1	142748.58	142750	1.41543	14.288	14.288	-0.000
2	90902.30	90902	-0.30409	9.099	9.099	0.000
3	172393.06	172392	-1.05909	17.256	17.255	0.000
4	53609.17	53609	-0.16651	5.366	5.366	0.000
5	153075.42	153077	1.58073	15.322	15.322	-0.000
6	98583.07	98583	-0.07237	9.868	9.868	0.000
7	217850.19	217849	-1.19216	21.805	21.805	0.000
8	69899.20	69899	-0.20193	6.996	6.996	0.000
	999061.00	999061		100.00	100.00	

(11)

Figure 1 – Rakinge.sas for the calculation of post-stratification weights in the municipality of Belém, Pará, 2011

44, and more adults aged 45 or over (6). The second variable is education level stratified by sex (7), with eight categories:

i) men with no schooling or incomplete Primary School;
ii) men with complete Primary School or incomplete High School;
iii) men with complete High School or incomplete Higher Education;
iv) men with Higher Education degree;
v) women with no schooling or incomplete Primary School;
vi) women with complete Primary School or incomplete High School;
vii) women with complete High School or incomplete Higher Education;
viii) women with Higher Education degree.

In this stage the total expanded sample of Vigitel (8) is already equal to the total population, according to IBGE (9); however, when the relative distribution of the sample and education level are compared in Vigitel we observe a difference of -8.8% of men and -5.9% of women, both with no schooling or with incomplete Primary School. In turn, there are more adults with Higher Education degree. In the second iteration, the weighted sample of the variable 'age group' is the same as the population; however, the difference between the relative distributions of the population and the sample differs from zero. This procedure is repeated until the relative difference between Vigitel and the population is equal to zero. In this example, to meet the convergence criterion, seven iterations were necessary until the age groups (10) and education level stratified by sex (11) were equal to zero. At the end of the process, a file with post-stratification weighting is generated.

The evaluation of weighting impact in the accuracy of smokers prevalence, presented by the measure of design effect (*deff*) showed *deff* values >1; this means there was accuracy loss in the use of post-stratification weighting. *Deff* values produced by cell-by-cell weighting were higher than those produced by raking method, for all capitals and years. The higher the *deff* value is, the lower the estimate accuracy will be (Table 2). The accuracy loss happens due to the change in the sample size, expressed by the following formula:

$$n_{deff} = n/deff$$

For example, in 2006, the state capital Palmas-TO presents a *deff* of 5.12 and 2.54 – which corresponds to the effective sample size of 391 (2,000/5.12) and 787 (2,000/2.54), respectively. That is, the weighting makes the sample size equal to 2,000 correspond to the effective sample size, equivalent to 391 and 787 interviews, respectively (Table 2).

When we compare the historical series of adult smokers prevalences, for all the state capitals and the FD, estimated by cell and raking methods, we observe a decreasing trend for both methods; however, in raking method, this trend was more marked, with prevalences lower than those estimated by the cell-by-cell weighting. For the overweight estimates, we did not observe any difference between the methods. The prevalence estimates of regular intake of fruits and vegetables for five or more days a week presented increasing trend, and the prevalences estimated by the raking method were higher than those in the cell method (Figure 2).

Discussion

This is the first study that compared two post-stratification methods: cell-by-cell weighting and raking. Raking method was first adopted in Vigitel in 2012 and presents advantages over cell-by-cell weighting, because it uses annual population data, which reflect the changes occurred in the Brazilian population, whilst cell-by-cell weighting uses the same population data for different years of research. Although raking method does not eliminate the register coverage bias, it produces estimates that express more accurately the trends of risk factor indicators in the population, when comparing with cell-by-cell weighting. This new weighting method has already been used to produce new estimates based on Vigitel data, for the period from 2006 to 2011.

There are several methods to calculate post-stratification weighting. Among them, the cell-by-cell weighting is widely used due to its simple weight calculation, which uses the cells of the population and sample contingency tables.[11] This method has a limitation regarding the need of available data to create the contingency table of the variables, since this information is available only every ten years (IBGE Demographic Census). The Brazilian population has been going through a demographic and socioeconomic transition,[20] and this large period of one decade constitutes a limitation for this method. In turn, raking method uses only the simple frequencies of each variable of population and sample, which enables the use of population information from different external sources, as well as interpolation of the

population variables during the inter-census period, covering the changes in the population occurred in the period. The limitation of the raking method is the higher complexity of weighting calculation, because it needs an algorithm which is available in the statistics package for post-stratification weighting.

In the comparison between the estimates of both weighting methods, the trends of the three indicators were similar; however, the values of the prevalences were different comparing the raking and cell-by-cell weighting. We noticed differences in the prevalences of smokers and fruits and vegetable intake, whereas overweight prevalence did not show any difference. The differences observed may be explained by the association between the indicators, regarding having a landline.[21,22]

Table 2 – Distribution of the design effect (*deff*) of weights in the Surveillance System of Risk and Protective Factors for Chronic Diseases by Telephone Survey (Vigitel) estimated through the cell-by-cell and ranking metods, in the prevalence of smokers, per state capital and year, in the 26 Brazilian state capitals and the Federal District, Brazil, 2006-2015

Capital	2006		2007		2008		2009		2010		2011	
	Cell-by-cell[a]	Ranking[b]	Cell-by-cell[a]	Ranking[b]	Cell-by-cell[a]	Ranking[b]	Cell-by-cell[a]	Ranking[b]	Cell-by-cell[a]	Ranking[b]	Cell-by-cell[a]	Ranking[b]
Aracaju	2.84	2.22	5.16	2.57	3.69	2.43	4.04	2.07	3.84	2.54	3.87	2.11
Belém	1.87	1.66	2.81	2.10	3.43	2.47	3.49	2.23	5.48	3.09	5.25	2.52
Belo Horizonte	2.02	1.53	2.31	1.61	4.84	1.62	2.71	1.46	2.96	1.57	2.80	1.50
Boa Vista	3.00	2.22	3.86	2.31	5.66	3.64	6.18	2.87	8.80	2.79	7.54	3.16
Campo Grande	2.51	1.79	3.48	2.06	3.40	2.02	4.14	1.78	3.11	1.62	3.74	1.53
Cuiabá	3.47	2.02	2.40	1.78	3.05	2.08	2.40	1.56	3.73	1.82	4.26	1.93
Curitiba	1.88	1.45	1.78	1.42	2.22	1.44	1.99	1.49	2.40	1.52	3.05	1.45
Florianópolis	2.19	1.55	2.54	1.77	2.40	1.47	3.25	1.63	2.72	1.66	2.45	1.53
Fortaleza	2.82	2.02	3.74	2.29	2.86	1.94	4.17	2.34	5.19	2.10	4.29	1.95
Goiânia	2.22	1.53	2.47	1.64	2.80	1.47	5.25	1.73	3.47	1.48	2.84	1.39
João Pessoa	2.87	2.01	3.41	2.28	10.40	2.53	4.30	2.45	7.37	3.30	3.11	2.28
Macapá	3.27	2.46	4.17	2.66	4.43	2.29	5.51	3.32	5.45	2.94	4.21	2.37
Maceió	3.03	2.01	2.76	2.29	3.14	1.98	5.72	3.15	6.36	2.66	4.08	2.29
Manaus	3.03	1.91	2.49	1.69	3.43	2.29	4.23	2.54	3.90	2.22	3.86	2.06
Natal	2.67	1.93	2.36	2.02	2.91	2.13	4.05	2.14	5.15	2.12	7.53	2.67
Palmas	5.12	2.54	3.79	2.42	7.68	2.47	6.22	2.46	7.86	2.44	6.30	2.42
Porto Alegre	3.05	1.75	2.62	1.79	2.07	1.52	2.37	1.76	2.62	1.98	2.20	1.49
Porto Velho	3.10	2.25	3.42	2.45	3.37	2.60	3.78	2.34	3.67	2.37	4.34	2.61
Recife	2.06	1.64	4.03	2.07	2.23	1.71	3.24	1.75	3.57	1.81	3.66	1.69
Rio Branco	3.02	2.07	3.92	2.77	6.91	2.73	5.38	3.27	7.13	2.77	4.61	2.23
Rio de Janeiro	1.53	1.38	2.66	1.53	2.81	1.62	2.77	1.56	2.41	1.45	3.06	1.52
Salvador	2.01	1.41	3.01	2.00	2.50	1.59	5.18	2.04	2.14	1.68	4.70	1.94
São Luis	2.45	1.95	3.06	2.15	2.91	2.64	3.38	2.32	3.80	2.06	6.40	2.64
São Paulo	2.19	1.43	2.12	1.48	4.92	1.56	3.76	1.61	2.29	1.56	2.63	1.48
Teresina	3.75	2.07	3.24	2.23	3.92	2.33	5.18	2.57	4.82	2.53	6.73	2.43
Vitória	2.37	1.52	2.92	1.43	4.42	1.50	4.35	1.72	3.37	1.76	3.39	1.48
Federal District	4.25	2.68	3.23	1.68	3.64	1.73	8.45	4.35	11.22	6.08	5.16	1.71

Notes:
a) population in the 2000 Demographic Census and cell-by-cell weighting.
b) population estimates in the years of research and raking weighting.

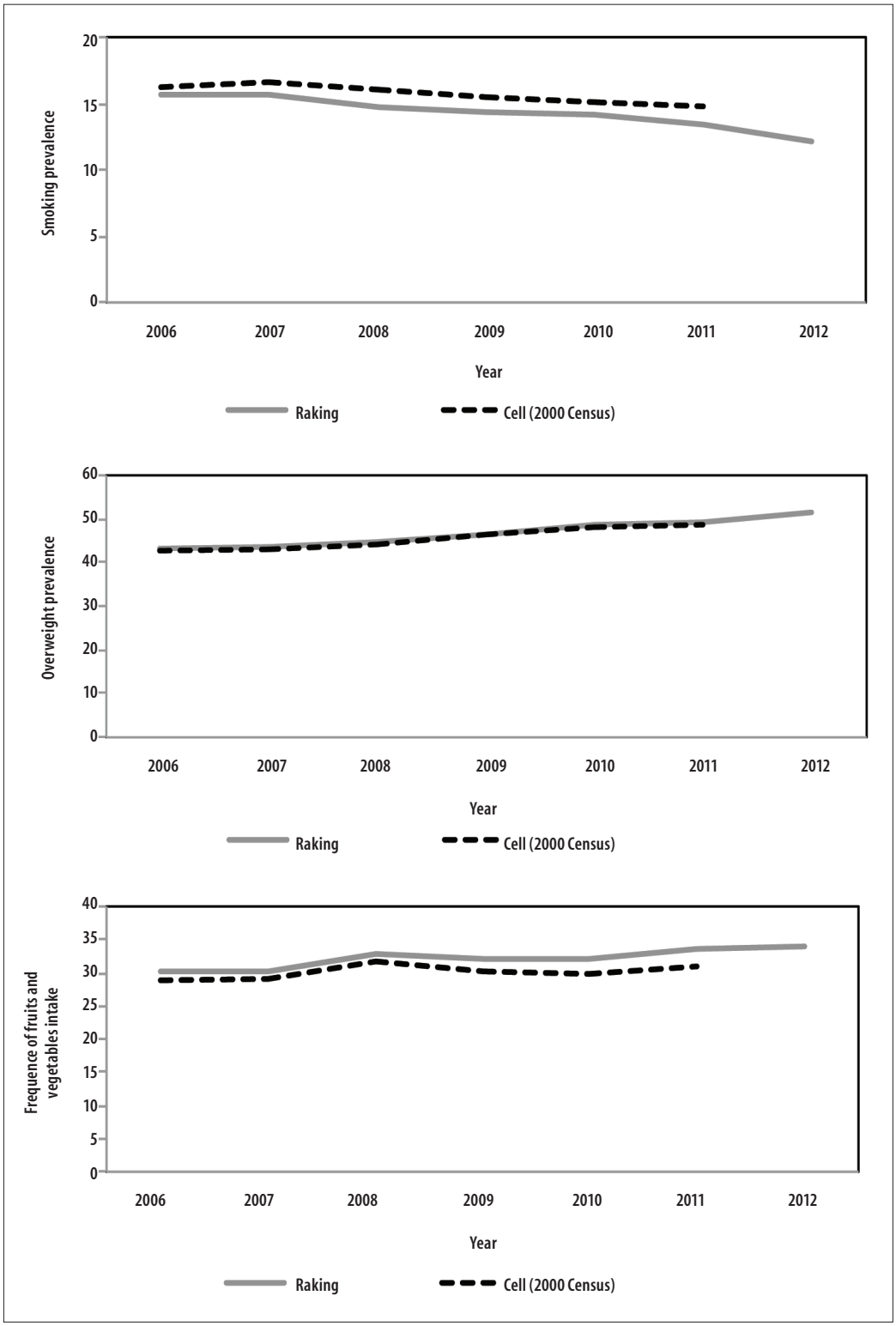

Figure 2 – Time series of prevalences of smokers, overweight and regular intake of fruits and vegetables in five or more days a week, obtained from Vigitel data, according to weighting method, in the 26 Brazilian state capitals and the Federal District, Brazil, 2006-2015

In the case of indicators positively associated to education level, the increase in schooling by the population in the inter-census decade, as well as its aging, might have led to the higher decrease of those indicators, as shown by this study. Other studies point that the smoking prevalence is associated to low schooling.[23] The increase in the education level of the Brazilians during the inter-census period justifies the reduction in the prevalence of smokers, which could be more consistently noticed by the raking weighting, since this method updates the population estimates of sex, age and education level. Thus, the raking method could reveal smaller prevalences; and a trend of sharper decrease of smoking among the Brazilian population, confirmed by the National Health Survey (PNS), conducted by the Ministry of Health in a partnership with IBGE, which pointed to a 20% reduction in smoking prevalence in the Brazilian population from 2008 to 2013.[24] Therefore, the raking method could obtain more accurate estimates using Vigitel data.

Similarly, in the United States, Battaglia et al.[13] evaluated the post-stratification weighting of 2003 data provided by the Behavioral Risk Factor Surveillance System (BRFSS), whose response rate was lower than 50%. The estimates obtained by the weighting and raking method were compared, both using population data from the Current Population Survey (CPS) to calculate post-stratification weighting, in order to minimize non response bias. The results of the North American study showed that the BRFSS tended to underestimate the indicators of risk factors of the population due to the low response rate, fewer than 50%, especially among the low income population, who presented higher prevalence of risk factors. And the estimates of prevalences obtained from the raking method were higher, when compared to those provided by the cell-by-cell weighting, given the association between the variables used to calculate weights and risk factors.

In 2011, the Centers for Disease Control and Prevention (USA/CDC) implemented many changes in the BRFSS.[25] The CDC/USA included in its survey sample the population that uses only mobile phones (added to the population that uses landline) and changed the weighting method. The system started using the raking method to calculate post-stratification weighting, due to the double register (landline and mobile phones), the reduction of non response bias and the improve in the estimates accuracy. The methodology changing process adopted by BRFSS was recommended by experts, with the release of studies that evaluated different variables used in the construction of post-stratification weights, in order to reduce the bias generated by the low response rate.[26,27]

Regarding Vigitel, the post-stratification methods used aim to reduce possible distortions in the estimates associated to the method of participants' selection, through landline, which generates a selection bias. To eliminate this bias, Vigitel should introduce in its research individuals without landline.

While Vigitel sampling process does not change we recommend the use o raking method. It enables the collection of more accurate prevalence estimates – when comparing with the cell-by-cell weighting –, making them closer to the reality presented in the 2010 Census. Thereby, it is possible to support the monitoring of risk and protective factors for chronic non-communicable diseases, besides subsidizing, more adequately, public policies for health promotion.

Authors' contributions

Malta DC contributed to the study design and article's revision. Bernal RTI contributed to the study design, conducted the statistical analysis and wrote the article text. Iser BPM and Claro RM contributed to data analysis, writing and article revision. All the authors approved its final version and declared to be responsible for all aspects of the study, ensuring its accuracy and integrity.

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Received on 30/11/2016
Approved on 24/04/2017