Surveillance of risk factors for chronic diseases through telephone interviews

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Keywords
Health surveys. Health status monitoring. Chronic disease, epidemiology. Interviews, metods. Telephone. Risk factors. Socioeconomic factors. Chronic non-communicable disease.

Abstract

Objective
To describe methods and initial findings of a surveillance system of risk factors for chronic non-communicable diseases (CNCDs) based on telephone interviews.
Methods
Interviews undertaken in a random sample of the adult population of the Municipality of São Paulo living in households with telephone. Sampling was done in two steps and included the random selection of households and the random selection of the household member to be interviewed. The system's questionnaire investigated demographic and socioeconomic characteristics, food consumption and physical activity patterns, smoking, consumption of alcoholic beverages, recalled weight and height and reported medical diagnoses of hypertension and diabetes, among other topics. Prevalence estimates of selected risk factors for CNCDs were calculated for the adult population with telephone and for the city's entire adult population. In this last case, we applied sample weighting factors that took into account demographic and socioeconomic differences between the adult population with telephone and the entire adult population of the municipality.
Results
Strong differences between sexes were found for most risk factors: low consumption of fruit and vegetables, high consumption of alcohol and overweight were more frequent among men while sedentary lifestyle and hypertension were more frequent among women. Additional possibilities of stratification of risk factor prevalences allowed by the surveillance system are illustrated using age groups, schooling, and place of residence in the city.
Conclusions
System performance was considered as good and was better than the performance observed in similar systems operating in developed countries when evaluated with basis on the representativeness and reliability of the estimates and on costs. The cost per concluded interview was eight times lower than the cost usually seen in similar systems in developed countries and four to eight times lower than the cost of traditional household surveys undertaken in the city of Sao Paulo.

INTRODUCTION

Chronic non-communicable diseases (CNCDs) are extremely relevant to the current health profile of human populations. This is true for both the global population as a whole and the Brazilian population in particular. The World Health Organization (WHO) estimates that CNDCs already account for 58.5% of all deaths worldwide and for 45.9% of the global disease burden, expressed as lost years of healthy life.[25]

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Study conducted at the *Núcleo de Pesquisas Epidemiológicas em Nutrição e Saúde da Universidade de São Paulo* (NUPENS/USP).
Study financed by the Brazilian Ministry of Health (*Convênio MS/FUSP* 1390/2002)
Received on 28/4/2004. Approved on 13/9/2004.

In Brazil, it is estimated that cardiovascular diseases and neoplasias alone account for almost one-half of all deaths by known causes.[6] Mortality time series, available for the Brazilian capitals, indicate that the proportion of deaths due to CNCDs more than tripled between the 1930's and 1990's.[1]

Cross-sectional and prospective epidemiological studies have provided exhaustive proof of the association between several of the major CNCDs (cardiovascular diseases, respiratory diseases, diabetes, and certain types of cancer) and a relatively small group of risk factors, noteworthy among which are smoking, excessive alcohol consumption, overweight, arterial hypertension, hypercholesterolemia, low fruit and vegetable consumption, and physical inactivity.[23] According to recent WHO estimates, these seven risk factors are part of the list of fourteen factors most relevant to the total global disease burden. In countries like Brazil, these same risk factors are part of the list of nine factors that most cause death and disease among the population.[22]

Although potentially relevant to the definition of the epidemiological profile of the Brazilian population, and, more importantly, potentially preventable, risk factors for CNCDs are not being adequately monitored. Household surveys on the occurrence of health and nutrition conditions in the Brazilian population have shown a sharp increase in obesity , especially in poorer socioeconomic strata.[11,13,15] Notwithstanding, in light of the wide intervals separating these surveys (10-15 years) and of the impossibility of sorting data by state and municipality, one cannot consider the issue of obesity in this country as being adequately monitored. Knowledge of the time trends of food consumption and of physical activity patterns is even more scarce. Regarding the former, periodical information are restricted to the trends in metropolitan areas, estimated based on surveys of family budgets, which refer to the purchase of food by families rather than to the actual consumption pattern of individuals.[9,14] As to the latter, a single recorded household survey estimated the frequency of physical activities during leisure time in the Northeast and Southeast Regions of Brazil in 1996/97.[16] Anyhow, data in both cases point towards patterns of food consumption and physical activity that greatly favor the occurrence of CNCDs. The most recent estimates on the consumption of cigarettes and alcohol in the country date from 15 years ago and also cannot be sorted by state and municipality,[7] whereas estimates of the prevalence of arterial hypertension and hypercholesterolemia are mostly punctual, and refer to very specific populations.[2]

One of the explanations proposed for the dissatisfactory monitoring of risk factors for CNCDs in the Brazilian population is that household surveys, the major instrument employed in the country for generating monitoring information, are operationally complex, costly, and generally involve long stretches of time between study planning and the publication of results. Such conditions render household surveys inadequate as the single or main source of information for monitoring systems, particularly for state or municipal ones.

The system presented in the present paper is a potentially simple, inexpensive, and agile system for monitoring risk factors for CNCDs. This system is based essentially on annual surveys carried out by means of telephone interviews with probabilistic samples of the population living in homes with fixed telephone lines. Similar systems are being used successfully* in populations in which telephone services reach the great majority of residences,[17] a scenario projected for most Brazilian cities in the relatively near future.**

Below we describe the methods and initial results of the pioneer experience in Brazil of implementing a CNCD risk factor monitoring system based on telephone interviews. Subsequent papers will report on additional results and focus on aspects related to system reliability and validation.

METHODS

In 2003, in the Municipality of Sao Paulo, we implemented a system for monitoring risk factors for CNCDs through telephone interviews (SIMTEL/MSP). The sampling procedures employed by the SIMTEL/MSP were aimed at obtaining a probabilistic sample of the population aged 18 years or older, living in households in the city of Sao Paulo with at least one telephone line in 2003. We established the minimum number of subjects to be studied by the system at 2,000, which would allow us to estimate the frequency of any risk factor in the studied population with a 95% confidence coefficient and a maximum error of about two percentage points. Maximum errors of about three percentage points would be expected for gender-specific estimates, assuming 45% of men and 55% of women in the final sample.[20]

The first stage of sampling was carried out in October 2003 and consisted of drawing 7,000 telephone lines from the electronic registry of residential fixed

*Centers for Disease Control and Prevention [CDC]. BRFSS: system state information [on-line] 2004. Available from: <URL: http://www.cdc.gov/brfss/dataused.htm> [2004 Apr 5]
**Fundação Instituto Brasileiro de Geografia e Estatística. [on-line] 2003. Available from: <URL: http://www.ibge.gov.br> [13 Sep 2004]

telephone lines in the municipality of Sao Paulo. This registry* comprised 2,915,860 lines. A telephone company staff member, who was supervised by one of the authors, carried out the draw. The draw, stratified and systematic, took into account the five strata into which the registry was divided, corresponding to the Central, North, South, East, and West Regions of the city. The same sampling fraction was maintained in all regions (1/416). The 7,000 lines drawn were then redrawn and divided into twenty replicates of 350 lines ordered from 1 to 20, each replicate reproducing the proportion of lines according to city region. We divided the total sample into replicates due to difficulties in estimating the proportion of lines in the registry eligible for the system (active residential lines) and, therefore, the total number of lines that should be drawn in order to reach 2,000 interviews.

The second stage of the sampling process was the selection of individuals – one per telephone line – to be interviewed by the system. This stage, carried out in parallel with the interviews – between 15 October and 31 December 2003 –, involved prior identification, among the lines drawn, of lines that were both residential and active (eligible lines) and the obtainment of the consent of users of these lines to participate in the system. To this end, we placed calls to the telephone lines included in the replicates drawn from one to nine, that is, to 3,150 lines (9x359). We considered as ineligible for participation in the system lines that were out of service (n=235), commercial lines (n=138) or unexisting phone number (n=109) , and lines for which we could not obtain an answer after ten calls placed on different days and at different times, including weekends and evenings, and that probably corresponded to closed residences (n=163), which resulted in a total 2,505 eligible telephone lines, or roughly 80% of the total initially drawn. Refusals to participate in the system were observed in 157 of the 2,505 eligible lines (6.3%). Another 37 lines remained busy (n=4) or were answered by fax (n=15) or answer machines (n=18) after ten calls placed on different days and times, including weekends and evenings. We were thus able to draw individual subjects in 2,311 (92.3%) of the 2,505 eligible lines. This draw was done based on the a list of all individuals living in the residence aged at least 18 years, ordered ascendantly by age, and by reference to random number sequences corresponding to the number of adults living in the household. Thus, for example, in households with four adults, we referred to a random sequence of numbers 1, 2, 3, and 4 (*e.g.*, 3,1,2,4,2,3,1,4,4,1,2,3 …), selecting for the interview the number immediately following the one selected for the previous interview.

The SIMTEL/MSP questionnaire comprised 89 short, simple questions, the great majority of which included preestablished answer categories. Many questions in the questionnaires were linked and, depending on the answers obtained, many questions were skipped, thus reducing the actual number of questions by up to 40%. The questionnaire was constructed so as to allow for the telephone interviews to be carried out with the aid of a computer, that is, questions were read directly from a computer screen and answers were entered digitally (using the keyboard or mouse), directly and immediately. The questionnaire, built in 'fox-pro' language, allows for the automatic skipping of non-applicable questions based on prior answers, and provides direct and continuous feeding to a 'd-base' format data bank. After obtaining the subject's agreement, interviews were recorded and saved to electronic media for subsequent quality control.

The questionnaire addressed especially: a) individual demographic and socioeconomic characteristics (age, gender, marital status, ethnicity, schooling, occupation, neighbourhood of residence, number of persons and rooms in the household, number of adults, and number of telephone lines); b) certain characteristics of consumption and physical activity patterns associated to the occurrence of CNCDs (including frequency of consumption of fruit and vegetables and of foods rich in saturated fats, frequency and duration of physical exercise, and habit of watching television); c) characteristics related to body composition (recalled weight and height); d) frequency of consumption of cigarettes and alcoholic beverages; and e) self-rated health status and reference to prior medical diagnosis of arterial hypertension, high cholesterol levels, and diabetes. The construction of the questionnaire took into account models of simplified questionnaires used by systems for the monitoring of CNCD risk factors[17,21] and the experience accumulated in a number of surveys of health and nutrition carried out in Brazil. Preliminary versions of the questionnaire used in the system were tested during the two weeks preceding the beginning of interviews.

System operation and performance

The SIMTEL/MSP was operated by a technical team including one interview scheduler, two interviewers, one coordinator, and two coordination assistants. Overall, the system operated for a period of three months (1 October to 31 December 2003), including

*Registry owned by the *Telecomunicações de São Paulo S/A* (Telesp) telephone company.

two weeks dedicated to training and pre-testing the instruments used for data collection.

The interview scheduler placed initial telephone calls to all the drawn lines, repeated these calls in case of failure (at least ten times), confirmed whether the line at hand was an active residential line, explained to this person (if aged 16 years or older) the characteristics and goals of the monitoring system, requested the person's consent to participate in the study, listed the adults (= 18 years) living in the household in ascending order of age, selected the subject to be interviewed from this list according to the random number sequences, and recorded the best days and times for carrying out the telephone interview. In the three months during which the system operated, the scheduler placed a total 8,234 calls to the 3,150 selected lines, a mean 2.61 calls per line. As we saw above, these calls resulted in 2,505 eligible lines and in the selection of 2,311 subjects to be interviewed.

The two interviewers placed telephone calls to the selected subjects, repeated the explanations regarding the system, obtained subject's consent to be interviewed, and administered the questionnaire, recording all the answers obtained directly into the computer. The subjects selected for the interview were called at the date and time suggested by the household member who answered the initial call and, in case of failure, were called at least ten times at different times and days, including weekends. In the three months of system operation, the two interviewers placed a total 5,967 calls to the 2,311 subjects selected, which corresponded to a mean 2.58 calls placed per selected line. These calls resulted in 2,122 interviews, or 91.8% of all interviews programmed. Refusals accounted for the failure to carry out 5.8% of the programmed interviews, and in the remaining cases (2.3%), interviews were not carried out due to lines that went out of service or which were not answered even after ten calls. Considering the total of 2,505 active residential lines drawn from the telephone company registry, the final success rate (identification and selection of interview subjects and questionnaire administration) in the present study was 84.7%. The proportion of lines whose users refused to participate in the study was 11.7%, and the proportion of lines that could not be contacted was 3.6%. The median duration of the interviews administered was 9.3 (mean =9.9 minutes; standard deviation =3.4 minutes).

Finally, the study coordinator, aided by two assistants, recruited and trained the remaining team members, prepared and distributed work charts to the scheduler and interviewers, reviewed recorded telephone interviews (the initial interview of all interviewers plus a random sample of 20% of subsequent interviews), indicated problems and failures in the voicing of questions or in the recording of answers, indicated the need for further telephone contact with the subject for the correction of answers, periodically evaluated the consistency of the database built based on the interviews, and produced simple tabulations of the frequency and distribution of selected risk factors.

Data analysis

The selected SIMTEL/MSP indicators presented below include behavioral variables (food consumption, physical activity, smoking, and alcoholic beverage consumption), weight and height, and reported prior medical diagnosis of arterial hypertension and diabetes. The selection of indicators took into account the importance of these indicators to the determination of the total burden of disease in Brazil, as estimated by WHO.[22]

We estimated the prevalence of these indicators for the population of adults with a telephone line in the municipality and for the total adult population of the municipality. In the first case, we employed individual weighting factors corresponding to the number of adults in the household multiplied by the inverse of the number of telephone lines. In the second case, we multiplied the individual weighting factor by an additional factor that took into account the sociodemographic differences between the population of adults with a telephone line and the total adult population of the municipality. In order to obtain this additional weighting factor, the population with a telephone line (studied by the monitoring system and already incorporating the weighting factor based on the number of adults and telephone lines in each household) was compared to a sample of the population of the municipality taken from the latest demographic census (10% of households studied in 2000). This comparison was based on the stratification of both samples according to male and female gender, six age groups (18-24, 25-34, 35-44, 45-54, 55-64, and 65 years and older), and four levels of schooling (0-4, 5-8, 9-11, and 12 or more years of schooling). We then calculated, for each of the 48 strata, the ratio observed between the frequency of the stratum in the census sample and the frequency of the same stratum in the sample from the monitoring system. We used this ratio as the additional weighting factor that, when applied to the individuals of each stratum, corrected an eventual under or overrepresentation of men or women, age groups, or social strata in the sample of adults studied by the monitoring system *vis-à-vis* the representation of the same strata in the total adult population of the municipality.

The prevalences of the selected indicators, adjusted to represent the total adult population of the Municipality of Sao Paulo, were calculated separately, with 95% confidence intervals, for men and women. In addition, as an illustration of the possibilities of stratification of the estimates provided by the system, we present prevalence estimates according to the age group and schooling level of subjects. Statistical analyses of the association between risk factors and stratification variables were performed using a statistical test based on the chi-squared distribution. Data processing and statistical analyses were carried out using Epi Info version 6.1 software, employing the 'csample' functions, that compute proportions with confidence intervals taking into account the complex nature of sampling (use of strata and weighting factors).[6]

Ethical aspects

Since interviews were conducted by telephone, free informed consent forms were replaced by verbal consent obtained from subjects during the telephone contacts. During these contacts, we made clear that the data obtained would be used only for research purposes and for the implementation of a municipal system for the monitoring of risk factors for chronic nontransmissible diseases. We also informed subjects of the possibility of refraining form participation in the study at any moment during the interview, of the inexistence of risk or of additional health hazards, and of the guarantee that all information provided were confidential. We provided a telephone number for the resolution of any doubts concerning the project. This research project was approved by the Ethics Committee of the School of Public Health of the University of Sao Paulo .

RESULTS

Table 1 compares sociodemographic characteristics of the sample of the population of adults with telephone line studied by the SIMTEL/MSP in 2003, with those of the total adult population of the municipality, studied by the 2000 demographic census. The population studied by the monitoring system has a greater proportion of women (60.6% versus 53.5% in the census), a lesser proportion of youths between ages 18 and 24 years (14.9% versus 19.8% in the census), and greater proportion of subjects with nine or more years of schooling (64.2% versus 45.2% in the census). Mean age and schooling in the studied population were 41.2 and 9.4 years, respectively, whereas the corresponding values for the total adult population in the municipality were 39.6 and 8.1 years.

Table 2 presents SIMTEL/MSP estimates for the prevalence of selected risk factors. The table presents estimates referent to the population of adults with telephone lines and to the entire adult population of the municipality. It should be noted that differences between the two estimates are relatively small and non-systematic: in most cases, absolute differences do not exceed two percentage points, above or below, and relative differences are always below 10%.

Table 1 - Estimated distribution (%) of the entire adult population and of the adult population with telephone according do sociodemographic variables. Municipality of Sao Paulo, 2000/2003.

Variable	Adult population (2000)	Adult population with telephone (2003)
Sex		
Male	46.5	39.4
Female	53.5	60.6
Age (years)		
18-24	19.8	14.9
25-34	25.1	26.1
35-44	21.4	23.1
45-54	15.3	14.6
55-64	9.2	10.0
65+	9.2	11.2
Years of schooling		
0-4	30.1	21.6
5-8	24.7	14.2
9-11	27.5	36.8
12+	17.7	27.4

Sources: sample of 10% of households from the Demographic Census for the adult population in 2000 and sample studied by the SIMTEL/MSP (N=2,122) for the adult population with telephone in 2003

Table 3 presents SIMTEL/MSP estimates for the male and female adult populations of the Municipality of Sao Paulo. Substantial differences between the genders are observed with respect to the frequency of most risk factors studied. Significantly more frequent among men are the insufficient consumption of fruit and vegetables, excessive alcohol consumption, and overweight, whereas among women sedentary lifestyle and hypertension are significantly more frequent.

Figures 1 and 2 illustrate further stratification options made possible by the monitoring system, involving the age group and schooling of the interviewed subjects. Figure 1 makes evident two relevant risk factors for the male population of the Municipality of Sao Paulo: 1) after age 50 years the frequency of former smokers is substantially higher than that of current smokers; and 2) beginning to smoke seems to have declined substantially in the last decades – roughly 70% of subjects aged 45 years or older (born, therefore, before 1959) are smokers or former smokers, whereas only 32.8% of subjects in the 18-24 years age group (born after 1979) are in the same situation. Figure 2 indicates that sedentary lifestyle and obesity tend to be more frequent among women with less schooling.

DISCUSSION

The discussion of the present article shall focus mainly on two aspects that are crucial to monitoring systems based on telephone interviewing: the representativity of the estimates and the cost of the system. We used as a general reference for this evaluation, whenever possible, the system of monitoring by telephone interview used in the United States, the 'Behavioral Risk Factor Surveillance System' (BRFSS). The BRFSS, created by the US Centers for Disease Control and Prevention in 1981, is the oldest and largest telephone monitoring system in the world. It was implemented initially in 29 US states and, since 1994, works regularly in all 50 states, in the District of Columbia, and in the three US federal territories. Comparable to the system tested in Sao Paulo, the BRFSS interviews probabilistic samples of subjects 18 years or older with telephone lines in their household employing questionnaires that address risk or protective factors for CNCDs, including food consumption and physical activity patterns, smoking and alcohol consumption, recalled weight and height, and reported previous medical diagnosis of arterial hypertension, hypercholesterolemia, and diabetes, among other variables.[3]

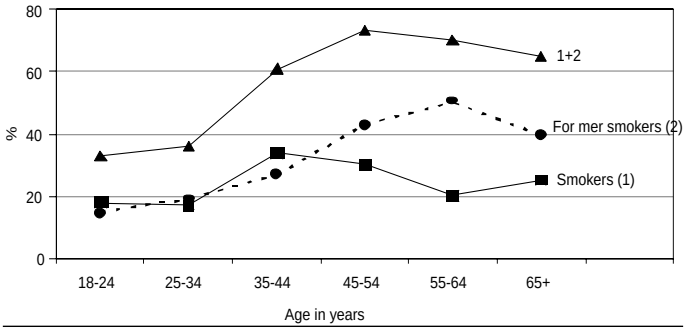

Figure 1 - Frequency (%) of smokers and former smokers according to age in the adult male population of the Municipality of Sao Paulo. SIMTEL/MSP, 2003.

An analysis of the representativeness of the sample of subjects studied by a monitoring system based on telephone interviews must take into consideration how well this sample represents the group of individuals that have a telephone and how well this same sample represents the entire population one wishes to monitor. In the first case, three aspects must be considered: the quality of the telephone registry used for drawing residential lines, the adequacy of the sampling system employed in the selection of telephone lines and users to be interviewed, and, finally, the proportion of interviews completed in relation to the total interviews programmed or predicted. In the second case, it is also important to evaluate the degree of coverage of telephone services in the population to be monitored and, in case of non-universal coverage, the differences between individuals living in households with

Table 2 - Estimated prevalence of risk and protection factors for CNCDs in the adult population of the Municipality of Sao Paulo according to two different adjustment procedures. SIMTEL/MSP, 2003.

Factors	Prevalence (%) according to adjustment 1* (N=2,122)	Prevalence (%) according to adjustment 2** (N=2,122)
Eating habits		
Consumption at least 5 days per week of		
Fruit	52.1	48.9
Raw vegetables	59.7	56.8
Cooked vegetables	28.9	24.9
None of the above	22.2	24.3
Physical activity during leisure time		
At least 30' of moderate or intense physical activity:		
1 or more days per week	29.4	28.7
3 or more days per week	17.2	15.6
5 or more days per week	7.0	6.0
Sedentary lifestyle		
Self-reported light or very light physical effort during work and no physical activity during leisure time:	47.4	46.7
Smoking		
Smokers	19.7	20.8
Former smokers	21.2	22.8
Alcohol consumption		
>2 doses per day:		
At least once a week	13.4	15.0
Every day or almost every day	3.7	3.8
Self-reported:		
Overweight (BMI ≥25 kg/m^2)	39.3***	40.8***
Obesity (BMI ≥30 kg/m^2)	10.5***	10.0***
Arterial hypertension	22.1	21.9
Diabetes	6.0	5.4

BMI: body mass index
*Adjusted to 'represent' the population of adults with telephone in the municipality
**Adjusted to 'represent' the total adult population of the municipality
***N=2,017

and without telephone. We shall examine each of these aspects below.

The telephone registry used by the SIMTEL/MSP seems to be virtually universal, given that the proportion of households with telephone service calculated based on this registry approaches the coverage calculated based on household surveys. Considering the number of lines in the 2003 registry (2,915,860 lines), subtracting from this number the percentage of commercial lines (4.4%), and also considering the mean number of lines per household (1,08), we arrive at a total of 2,581,076 households with telephone service, which would cover 84.9% of permanent households estimated for the same year (2003) in the Municipality of Sao Paulo (3,040,047 according to the *Fundação Sistema Estadual de Análise de Dados* – Seade).* We arrive at similar levels coverage if we base our calculations on the proportion of households in the Municipality of Sao Paulo with at least one telephone line in the year 2000 (67% according to Census data, processed by us) and on an expansion in coverage of about 10% per year in the 2000-2003 period (projection based on the evolution of fixed telephone coverage in the Southeast Region of Brazil between 1999 and 2001).** It is assumed that the telephone registries used by the BRFSS system include a large share of the universe of residential telephone lines, even though the registries fail to distinguish between residential and other lines in a number of states.[17]

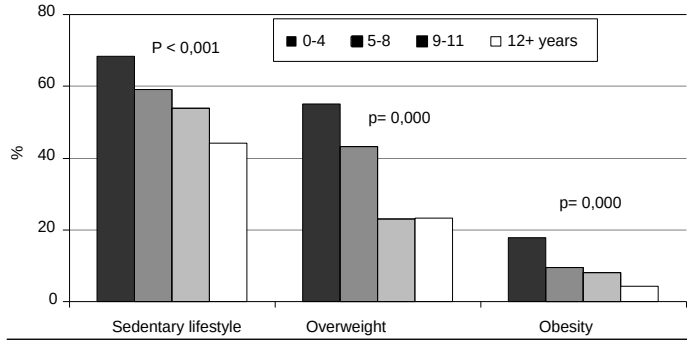

Figure 2 - Frequency (%) of selected risk factors according to years of schooling in the female adult population the Municipality of Sao Paulo. SIMTEL/MSP, 2003.

The availability of a computerized registry, stratified by area of residence and specific for residential telephone lines, allowed the use of systematic sampling by strata, which is a fairly simple, traditional and reliable sampling procedure for the selection of telephone lines.[18] In order to draw the telephone user to be interviewed, an equally simple and reliable procedure –selection based on random number lists – was employed.[8] The American BRFSS employs much more complex sampling systems due to the lack of a registry

Table 3 - Prevalence (%) of risk and protective factors for CNCDs in the adult male and female population of the Municipality of Sao Paulo. SIMTEL/MSP, 2003.

Factors	Men (N=855) %	(95% CI)	Women (N=1,267) %	(95% CI)
Eating habits				
Consumption at least 5 days per week of				
Fruit	39.5	(35.0-43.9)	57.1	(53.2-61.0)
Raw vegetables	52.3	(47.8-57.0)	60.7	(56.6-64.8)
Cooked vegetables	17.6	(14.5-20.8)	31.2	(27.8-34.5)
None of the above	31.4	(27.2-35.7)	18.1	(15.3-20.9)
Physical activity during leisure time				
At least 30' of moderate or intense physical activity:				
1 or more days per week	39.3	(34.7-43.8)	19.4	(16.7-22.1)
3 or more days per week	17.3	(13.7-20.8)	14.1	(11.7-16.5)
5 or more days per week	6.4	(4.4-8.3)	5.7	(4.2-7.2)
Sedentary lifestyle				
Self-reported light or very light physical effort during work and no physical activity during leisure time:	33,9	(29.8-38.1)	57.9	(54.1-61.7)
Smoking				
Smokers	23.8	(20.0-27.6)	18.2	(15.4-21.0)
Former smokers	27.8	(23.7-31.8)	18.5	(15.6-21.5)
Alcohol consumption				
>2 doses per day:				
At least once a week	23.9	(19.9-28.0)	7.2	(5.4-9.0)
Every day or almost every day	7.4	(5.2-9.7)	0.6	(0.2-1.1)
Self-reported:				
Overweight (BMI ≥25 kg/m^2)	45.4*	(40.8-49.9)	36.3**	(32.7-39.9)
Obesity (BMI ≥30 kg/m^2)	9.4*	(7.0-11.8)	10.5**	(8.3-12.7)
Arterial hypertension	18.2	(14.7-21.7)	25.0	(21.9-28.2)
Diabetes	5.0	(3.2-6.8)	5.8	(4.3-7.2)

*N=844; **N=1,173
95% CI: 95% confidence interval
BMI: body mass index

*Fundação Sistema Estadual de Análise de Dados [online] 2004. Available from: <URL: http://www.seade.gov.br> [4 Apr 2004]
**Fundação Instituto Brasileiro de Geografia e Estatística. [online] 2003. Available from: <URL: http://www.ibge.gov.br> [13 Sep 2004]

specific for residential telephone lines. These procedures include a prior stage in which area codes are drawn for a study of the proportion of residential lines in each area code, and codes with greater potential for containing residential lines are selected. In addition to a greater number of telephone calls, these procedures also require the use of additional weighting factors in order not to compromise the final representativeness of the sample obtained.[19] In its early years, the BRFSS selected for the interview the subject whose birthday was closest to the date of the interview, but this procedure has recently been replaced by the use of random number sequences.[17] During the pre-testing of the system implemented in Sao Paulo, we observed that the selection procedure based on birthdays took an excessive amount of time and was not always properly understood by the respondent.

The proportion of completed interviews in relation to the total interviews predicted in the SIMTEL/MSP was 84.7%. This success rate is similar to those obtained in household surveys carried out in the 1980's and 90's in the Municipality of Sao Paulo[10,12] and higher than the success rate obtained in different US states by the BRFSS system (median success rate of 56.7% in 1999, ranging from 38.4% to 83.9%). The so called 'cooperation rate' (the proportion of interviews completed over the proportion of interviews completed plus refusals) was equally higher in the SIMTEL/MSP: 88.0%, versus 68.4% in the BRFSS.[4]

Therefore we conclude that the sample interviewed by the SIMTEL/MSP represents the population of the Municipality of Sao Paulo with telephone. Regarding the representativeness of the sample in relation to the entire population, as we have seen, one must consider the coverage of telephone services in the municipality and the differences between the population with and without telephone. In 2003, the proportion of households with telephone in the municipality, according to the estimates already mentioned, was of approximately 85%; a high, albeit far from universal, coverage. The differences between the population with and without telephone in the municipality cannot be determined directly, given that the most recent data available for such a comparison date from the year 2000, when the coverage of telephone services in the municipality was substantially lower than in 2003. Notwithstanding, a comparison between the distributions with respect to schooling in the sample studied by the SIMTEL/MSP and in the sample of the total adult population of the municipality suggests substantial – though not surprising – socioeconomic disadvantages to the population without telephone (Table 1). Differences between the two samples were also found in terms of gender and age, the monitoring system sample showing lesser proportions of males and of individuals aged 18-24 years than those projected by the census. Such differences, however, were due especially to the greater failure rates in the interviews with men and, generally speaking, with very young subjects. The BRFSS does not face problems related to the telephone coverage given the universal coverage in all American states. Nevertheless, higher failure rates in interviews with men and youngsters in general determine representativeness issues in terms of gender and age very similar to those observed in the Municipality of Sao Paulo. Thus, between 1981 and 1987, the proportion of men in the BRFSS sample ranged from 40% to 42% and the proportion of individuals aged 18-24 years form 11% to 14%, while the same proportions in the 1980 American demographic census were, respectively, 48% and 19%.[20] In the SIMTEL/MSP sample, the proportion of males was 39.9% and that of youngsters, 14.2%, versus 46.6% and 19.8%, respectively, in the 2000 demographic census.

In order to extend the representativeness of the monitoring system sample to the entire adult population of the Municipality of Sao Paulo we developed adjustment factors that simulate, in the sample, the structure in terms of gender, age group, and schooling observed in the entire adult population in the year 2000. These factors, when applied to the sample of the system, produce estimates that would be observed if the sociodemographic structure of this sample were the same as that of the entire population. An analogous procedure is adopted by the BRFSS in order to obtain estimates extendable to the entire US adult population.[17] In addition to making estimates closer to those that would be obtained in case the total population of the municipality could be studied directly, the use of adjustment factors also allows us to control any eventual changes that may occur in the structure of the monitoring system sample from year to year. Such possibility is especially important in our case, since changes in the structure of the population covered by telephone services are likely to occur on a short term basis, given the expansion that is still likely to occur in the coverage of the telephone system in the Municipality of Sao Paulo (and in other Brazilian cities).

The global cost of the SIMTEL/MSP involved basically four expense elements: 1) expenses related to physical installations and equipment (telephones, computers, software for recording interviews and for online data entry, among others); 2) expenses related to the working time of the researchers and technicians that designed the system, including sampling procedures, questionnaire elaboration and the formu-

lation of indicators; 3) payment of the technical team (coordinator, two assistants, and two interviewers); and 4) cost of telephone calls. The two first elements of the expense are hard to quantify, since their cost was absorbed by the institution (NUPENS/USP) that tested the system. In any case, equipment and system design tend to represent a small share of the total cost of the system, since these expenses are incurred in only once, and are therefore diluted throughout the entire period of system operation. The monthly earnings of the project team (R$700.00* for each interviewer and assistant and R$1,500.00 for the coordinator) amounted to R$6,201.60, or R$18,604.80 for the three months of operation, already including taxes and labor duties. The cost of telephone calls and of the monthly fees of the three telephone lines used amounted to R$4,530.80, taxes included. Thus the variable cost of the system amounted to R$23,135.60, or R$10.90 per completed interview.

Higher per-interview costs are usually observed in household surveys. The authors' experience in other household health and nutrition surveys carried out in the Municipality of Sao Paulo indicated mean costs per completed interview between R$50,00 and R$100,00, depending on the characteristics of the interview. The mean cost of the telephone interviews carried out in the American BRFSS system is estimated at 25-30 US dollars, (roughly 90.00 Brazilian Reais), two to five times lower then the mean cost of household interviews conducted in the United States.[17] In addition to being relatively inexpensive, the SIMTEL/MSP proved extremely agile: the entire process of sample selection, scheduling, and interviewing was completed in three months, a preliminary report was produced 30 days after the completion of the last interview, and a full report was completed after 120 days. We wish to highlight that, although the SIMTEL/MSP operated for three months, it would be equally possible to extend system operation to twelve months, so as to make system operation continuous, as in the American BRFSS system.

The present study showed that the system of monitoring of risk factors for CNCDs based on telephone interviews is capable of reaching good performance in Brazilian urban areas similar to Sao Paulo, be it in terms of sample representativeness, be it in terms of the cost and agility of the system. Further studies must focus on aspects related to the reliability and validation of monitoring systems such as the one implemented in the Municipality of Sao Paulo.

ACKNOWLEDGEMENTS

We would like to thank the local telephone company – *Telecomunicações de São Paulo S/A* (Telesp) – for its help with drawing the sample of residential telephone lines; Silvio Fernando Barbieri for his expertise in the field of informatics; and Rosemary Sena Alves, Maria Gabriela da Cunha, and Danira Martins Passos for the technical support in all stages of the project.

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*1 Real (R$) corresponds to about 2.5-3.0 US dollars.

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