Social inequalities and vaccination coverage in the city of Salvador, Bahia

Desigualdades sociais e cobertura vacinal na cidade de Salvador, Bahia

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Abstract

Objective: To estimate the vaccination coverage in children born in the city of Salvador, analyzing these coverages by socioeconomic conditions. **Method:** A household survey on vaccination coverage was conducted with children born in 2005, in Salvador, Bahia, northeastern Brazil, who were aged between 18 to 36 months at the time of this study. Cluster sampling was performed in multiple stages. Census tracts were stratified using data from the national census conducted in 2000. Data was collected on socio-economic households. The sample size was defined by a specific methodology developed for immunization coverage surveys. The questionnaire was based upon the information contained in the vaccination cards. The estimated vaccination coverage in the various strata considered the sampling complex plan, weighting the observations according to the sampling fraction, the losses and the design effect. **Results:** There was inequality in the socioeconomic strata analyzed, where the coverage rate was directly proportional to socioeconomic status. Strata D and E showed statistically significant differences when compared to stratum A. Regarding to the complete scheme, children living in strata D and E have significantly less coverage than those residing in strata B. For vaccines not included in the basic scheme, the differences are very marked, showing less than 3% in stratum D and E. **Conclusions**: Vaccination coverage for the complete schedule at the end of 18 months of age with valid doses, was unsatisfactory and shows significant differences among the socio-economic strata with poor coverage in the poorest groups.

Keywords: Vaccination coverage. Inequalities in health. Population surveys.

Resumo

Objetivo: Estimar as coberturas vacinais alcançadas em crianças nascidas na cidade de Salvador, analisando essas coberturas por condições socioeconômicas. **Método**: Foi realizado um inquérito domiciliar sobre cobertura vacinal, na cidade de Salvador, capital do Estado da Bahia, Nordeste do Brasil, sendo incluídas crianças nascidas em 2005, que no momento do estudo apresentavam 18 a 36 meses de idade. Foi realizada amostragem por conglomerados em múltiplas etapas. Os setores censitários foram estratificados utilizando-se dados do censo demográfico realizado em 2000. Foram coletados dados socioeconômicos dos domicílios. O tamanho da amostra foi definido a partir de metodologia específica para inquéritos de cobertura vacinal. O questionário foi aplicado tomando por base as informações constantes na caderneta de vacinação. Foi estimada a cobertura vacinal nos diversos estratos considerando o plano complexo de amostragem, ponderando as observações segundo a fração amostral, as perdas e o efeito do desenho. **Resultados**: Observou-se desigualdade socioeconômica nos diversos estratos, com um gradiente diretamente proporcional entre cobertura vacinal e nível socioeconômico. As diferenças mostram-se estatisticamente significantes entre os estratos D e E comparado ao estrato A. Em relação ao esquema completo, as crianças residentes nos estratos D e E apresentam cobertura significantemente menor que aquelas residentes no estrato B. Para vacinas não incluídas no esquema básico, as diferenças são muito acentuadas, sendo inferior a 3% nos estratos D e E. **Conclusões:** A cobertura vacinal pelo esquema completo ao final dos 18 meses de idade, com doses válidas, foi insatisfatória e foram observadas heterogeneidades entre os estratos socioeconômicos com pior cobertura nos grupos mais pobres.

Palavras-chave: Cobertura vacinal. Desigualdades em saúde. Inquéritos populacionais.

Introduction

Vaccine-preventable diseases still represent a significant proportion of childhood morbidity and mortality. It is estimated that approximately two million children die from vaccine-preventable diseases worldwide per year[1]. Vaccine use can prevent this situation or even eliminate some of these diseases, as was the case with smallpox, which caused nearly 300 million deaths in the world in the 20th century before being completely eradicated. In Brazil, the last cases of smallpox were recorded in 1971 in the state of Rio de Janeiro and the WHO certification of disease eradication was issued in August 1973 in this country. The last case known was reported in Somalia in 1977. In 1980, the 30th WHO Assembly announced the eradication of smallpox worldwide[1,2].

Another advance in global public health, obtained with vaccine use, was the reduction in the number of cases of poliomyelitis from 350,000 in 1988 to 1,352 in 2010. In the Americas, the WHO certification of poliomyelitis eradication was issued in 1994 and there have not been any autochthonous cases in this area since 1991. The Western Pacific region was certified in 2000 and Europe in 2002. Currently, only three countries continue to be endemic for poliomyelitis (Nigeria, Pakistan and Afghanistan) and there is virus circulation in other three countries after reintroduction from imported cases[3].

In Brazil, the national immunization program was created in the 1970s, aiming to control the transmission of infectious diseases and to reduce child mortality, which at that time still primarily resulted from problems associated with malnutrition and preventable diseases that accounted for the majority of deaths in the post-neonatal period[4]. In addition to the eradication of poliomyelitis in Brazil in 1989, this program enabled the control of measles, neonatal tetanus, diphtheria, tetanus and pertussis, among other diseases[4]. The program activities are organized to achieve universal coverage uniformly distributed in the

country, combining routine activities developed in primary health units with "national vaccination days", aimed at increasing the coverage of population groups who, for different reasons, have difficulty in using routine services[4]. One of the main goals is the achievement of high homogenous coverage in different population groups to guarantee the interruption of the chain of transmission and prevent the occurrence of disease outbreaks in inadequately immunized groups.

Vaccination is not mandatory in Brazil and vaccines are provided without cost in SUS (Unified Health System) services. Although the program is universal, several surveys conducted in this country pointed to differences in the coverage of social groups stratified according to socioeconomic indicators[5,6]. More recently, national results have indicated lower coverage of higher socioeconomic groups[7].

Salvador currently has 141 Family Health Program teams, who are responsible for providing service to 15.08% of the population living in this city. There are 125 primary health units in the city, which perform routine vaccine-related activities. Apart from these units, there are two Special Vaccine Referral Centers[8]. The present study aimed to estimate the vaccination coverage rates achieved in the cohort of children born in 2005 in the city of Salvador, BA, describing these rates according to socioeconomic conditions with the purpose of identifying the homogeneity of coverage and the existence or not of clusters of susceptible children.

Methods

A household survey was conducted in the city of Salvador, capital of the state of Bahia, in Northeastern Brazil. This city currently has a population of 2,676,606 inhabitants and an area of 707 km^2[2,9].

This study included children born in 2005. The field work was performed in 2007-2008 and children included in the sample were aged between 18 and 36 months during data collection, enabling the complete recording of vaccines given during the first 18 months of life.

Sample size was defined according to the WHO calculations for vaccination coverage surveys, using the following parameters – 95% confidence interval, 80% of expected vaccination coverage and 7% of accuracy – and estimating 10% of refusals and a design effect of 1.5. The total sample was obtained with the random selection of 30 clusters and seven children per cluster were considered to be sufficient to estimate coverage[10]. In 2005, 37,603 live births were recorded in the city of Salvador and the required sample estimated with these parameters was 1,050 children[9].

Multiple-stage sampling was performed, including the stratification of census tracts (CT) according to living conditions, enabling representativeness of each socioeconomic stratum, the systematic random selection of census tracts proportional to the estimated size of the population aged between one and four years, and the random selection of the starting point of the routes for the sequential search for seven children in each selected cluster.

The census tract is a territorial unit of census data collection formed by a continuous area included in the same administrative district, with 250 to 350 homes or other types of buildings, enabling data to be collected by a single surveyor during the period defined for this activity[9]. Data from the 2000 demographic census were used to stratify the census tracts. The following were used as variables indicative of living conditions: the mean income of those responsible for permanent homes, the percentage of responsible adults per permanent home with 17 years of education or more, and the percentage of responsible adults per permanent home with an income higher than 20 minimum wages, obtained from the demographic census previously mentioned. All census tracts were ordered according to each of the variables selected and a corresponding rank was attributed. The sum of ranks enabled the division of

strata into quintiles, becoming strata designated by letters from A (best situation) to E (worst situation). A total of 30 clusters were randomly selected in each stratum to comprise the sample. In each selected cluster, residential blocks and the sides of polygons formed by the shape of streets were numbered, thus enabling a random selection from the starting point. From this point, the first seven children born in 2005 whose responsible adults agreed to participate in the study were included in each cluster. The method used has been described in previous studies[7,11].

The questionnaire was completed based on the information from vaccination cards. Interviewers were instructed to record the dates of application of each vaccine and the responses to items related to household conditions (length of stay in the district, grandmother living together, personal properties), maternal characteristics (level of education, paid income and presence of partner) and selected child characteristics (age, sex, order of birth and ethnicity).

The complete basic vaccination schedule in the first 18 months of life included a single dose of vaccine against the Bacillus Calmette-Guérin (BCG); three doses of vaccine against hepatitis B; three doses of tetravalent vaccine against diphtheria, pertussis, tetanus and hemophilus influenza B (DPT + HIB); three doses of oral polio vaccine (OPV); one dose of MMR vaccine against measles, mumps and rubella; and one dose of vaccine against yellow fever (YF), exclusively recommended for high-risk areas of transmission. This schedule must be completed in the first year of life, including booster doses at 15 months (OPV and DPT). The vaccine against the rotavirus was only introduced in the 2006 calendar and, consequently, was not available for the children of this cohort in their first years of life. Two new vaccines, the 10-valent pneumococcal and meningococcal C vaccines, were included in the basic vaccination schedule after this study was conducted.

The dates recorded were used to calculate the complete coverage of the basic vaccination schedule according to child age. Vaccination coverage in each stratum was calculated considering the complex sampling plan and weighting the observations according to the sampling fraction, losses and design effect. Both the point estimates and 95% confidence intervals were adjusted considering the clusters and using the resources available in the Epi-Info 2000 software for complex sample analyses (Csample), a process that has been described in previous studies[7,11]. The analyses considered the applied doses and the correct doses (those applied at correct intervals between doses and at the age recommended in the vaccination calendar). Statistical significance was set at $p<0.05$. All comparative analyses were performed using 95% confidence intervals, calculated according to losses and the design effect.

The present research project was approved by the Human Research Ethics Committee of the Central Hospital of the *Santa Casa de São Paulo*. All forms were filed with their respective informed consent forms at the *Centro de Estudos Augusto Leopoldo Ayrosa Galvão* (CEALAG – Augusto Leopoldo Ayrosa Galvão Center for Studies), responsible for the project coordination.

The databases created for this study do not include data that identify the children interviewed, such as child name, maternal name and address, thus guaranteeing confidentiality.

Results

Children whose information was obtained from the survey (761) are a representative sample of this cohort of newborns from 2005, who continued to be alive at the time of this survey (approximately 36,512 children). Homes in which there was information about the existence of children in the age group of interest and in which interviews could not be conducted after three attempts of contact were considered to be losses (6.1%). In addition to losses, a small proportion (3.8%) of adults responsible for the cohort children refused to participate

and there were situations in which it was not possible to find seven children belonging to the cohort of interest after surveying all cluster homes (17.9%). In such cases, the sample included only the children found (72.5%) and there was not a new random selection of clusters.

With regard to the socioeconomic characteristics of different strata of the population of the city of Salvador, data show great social inequality among these groups both in terms of income and level of education (Table 1).

The coverage estimated for the complete vaccination schedule with valid doses at the age of 18 months in the city of Salvador was 62.8% (95%CI: 56.9 – 68.7). The coverage estimated for the complete schedule for the group of Brazilian capitals and the Federal District with valid doses at the age of 18 months was 68.5% (95%CI:67.0 – 70.0).

Table 2 shows the vaccination coverage at 18 months of age for each vaccine of the basic schedule among children whose families were categorized into different social strata. In general, coverage is directly proportional to socioeconomic level. By analyzing confidence intervals, differences are found to be statistically significant when strata D and E are compared to stratum A for the majority of vaccines. In stratum E, none of the vaccines achieved coverage equal to or higher than 90%. The lowest coverage rates were observed for HVB and HIB. In stratum D, only BCG showed coverage higher than 90%. In all strata, the highest coverage rates were found for the BCG, DPT and OPV vaccines. The lowest coverage rates were found for the MMR vaccine, except for stratum E, where the lowest coverage was for the HIB.

Table 3 shows the coverage achieved with the complete basic schedule applied to each child, i.e. only children who received all doses recommended for their age with correct intervals between these doses were considered to be vaccinated. The analysis of confidence intervals revealed that children in the strata D and E had significantly lower coverage rates than those in stratum B. The confidence interval for the estimate in stratum A is wide due to the smaller sample size found in this stratum. In addition, the data on the group of Brazilian capitals and Federal District obtained from the same survey are shown.

Table 4 shows the coverage for the complete basic schedule for the capitals of states in Northeastern Brazil. Vaccination coverage of the complete schedule in the city of Salvador is similar to that found in Maceió and greater to those achieved in Recife, João Pessoa and São Luiz (as observed when comparing confidence intervals).

Table 5 shows the proportion of use of other vaccines not included in the basic schedule at the time of this study, which can be obtained in private vaccination services or applied in public day care centers, as established by the National Immunization Program. The differences in coverage rates for these vaccines are very significant among strata and the rate in strata D and E is lower than 3%.

Table 1 - Socioeconomic characteristics of the population by stratum, in the city of Salvador, 2000.
***Tabela 1** - Características socioeconômicas da população, por estratos, na cidade de Salvador, 2000.*

Stratum	Census tracts	Mean income (in reais)	% level of education > 17 years	% income > 20 MW
A	77	3.139.21	9.11	28.58
B	59	1.203.26	2.14	4.82
C	48	724.98	0.75	1.24
D	44	460.79	0.29	0.46
E	37	318.74	0.17	0.10

Source: *Fundação* IBGE (Brazilian Institute of Geography and Statistics Foundation). 2000 Demographic Census. / *Fonte: Fundação IBGE. Censo Demográfico 2000.*

Table 2 - Vaccination coverage and confidence interval of 95% for each vaccine regimen of the basic schedule, by socioeconomic stratum, Salvador, 2008.
***Tabela 2** - Estimativa da cobertura vacinal e intervalo de confiança de 95% para cada vacina do esquema básico segundo estrato socioeconômico, Salvador, 2008.*

Vaccine	VACCCINATION COVERAGE RATES				
	A	B	C	D	E
BCG	97.6 (94.4-100.0)	95.4 (91.2-99.7)	94.6 (90.9-98.2)	94.8 (90.8-98.8)	89.1 (83.7-94.5)*
DPT	96.4 (92.6-100.0)	88.9 (84.4-93.4)	92.2 (87.5-96.8)	87.4 (82.6-92.1)*	82.6 (75.4-89.8)*
OPV	96.4 (92.5-100.0)	94.1 (89.8-98.4)	94.6 (90.8-98.3)	89.1 (84.0-94.1)*	85.9 (78.9-92.8)*
HIB	86.9 (77.9-95.9)	88.2 (82.7-93.7)	88.0 (82.6-93.3)	83.9 (78.4-89.4)	74.5 (65.8-83.1)*
HVB	86.9 (79.3-94.5)	82.4 (74.1-90.6)	88.0 (82.3-93.6)	78.7 (72.3-85.1)*	74.5 (65.8-83.1)*
MMR	83.3 (74.9-91.8)	82.4 (76.6-88.0)	75.9 (67.3-84.5)	77.6 (69.9-85.3)	77.2 (69.3-85.0)
YF	78.6 (65.1-92.1)	83.7 (77.1-90.2)	86.7 (80.6-92.9)	83.3 (75.9-90.7)	77.7 (69.7-85.7)

*p< 0.05. Comparison between confidence intervals, considering stratum A as reference.
**p < 0,05. Comparação entre os intervalos de confiança tomando o estrato A como referência.*
BCG: Bacillus Calmette-Guérin / *BCG - Bacilo-Calmette-Guérin.*
DPT: Diphtheria, Pertussis and Tetanus / *DPT - difteria, tétano, coqueluche.*
OPV Oral Polio Vaccine / *OPV- Poliomielite oral.*
HIB: Haemophilus Influenzae type B / *HIB - Haemophilus influenzae tipo B.*
HVB: Hepatitis B / *HVB - hepatite B.*
MMR: Measles, Mumps and Rubella / *SCR - sarampo, caxumba, rubéola.*
YF: Yellow Fever. / *FA - Febre Amarela.*

Table 3 - Complete basic schedule at 18 months, valid doses, according to socioeconomic stratum, Salvador and 26 Brazilian state capitals and Federal District. 2008.
***Tabela 3** - Esquema básico completo aos 18 meses, doses válidas, segundo estrato socioeconômico, Salvador e para o conjunto das 26 capitais dos Estados brasileiros e Distrito Federal. 2008.*

Stratum	Salvador		Brazilian capitals and Federal District	
	Coverage	95% confidence interval	Coverage	95% confidence interval
Total	62.8	56.9 – 68.7	81.3	80.2 – 82.4
A	69.0	55.7 - 82.4	76.3	74.2 – 78.4
B	70.6	63.0 -78.2	85.1	82.9 – 87.3
C	65.7	56.1 – 75.2	82.3	80.1 – 84.6
D	60.3	49.6 – 71.1	81.5	79.5 – 83.5
E	61.4	51.2 – 71.6	80.4	78.0 – 82.7

The frequency of the last vaccination campaign, in terms of the date when interviews were conducted, did not show differences between strata and remained higher than 80% in all strata. An unequal distribution was found in terms of the use of private services and this use was greater in the strata with a higher socioeconomic level, although the frequency of use of private vaccination clinics in stratum A itself was only 47% (95%CI:27.2-66.8). The use of private services ranges between approximately 15% (95%CI:7.9-23.4) and 18% (95%CI:8.9-27.4) in strata B and C, while this use is lower than 5%: 4.2% (95%CI:0.8-7.6) in stratum D and 3.7% (95%CI:0.4-6.9) in stratum E.

Discussion

Vaccination coverage of the complete schedule at the end of 18 months of age, with valid doses in children living in the city of Salvador who were born in 2005, was lower than 70% and it showed significant differences between socioeconomic strata with lower coverage rates in the population groups with worse living conditions. Considering the group of Brazilian capitals,

Table 4 - Complete schedule at 18 months, valid doses, to the capitals of the Northeast region, 2008.
Tabela 4 *- Esquema básico completo aos 18 meses, doses válidas, para as capitais dos Estados da região nordeste, 2008.*

Capital	Coverage	95% confidence interval
Aracaju	74.8	70.8 – 78.8
Fortaleza	71.5	66.9 – 76.1
João Pessoa	53.5	48.2 – 58.2
Maceió	67.4	62.7 – 72.1
Natal	73.0	68.7 – 77.4
Recife	49.8	45.0 – 54.6
Salvador	62.8	56.9 – 68.7
São Luiz	51.3	46.2 – 56.3
Teresina	83.7	79.7 – 87.8

Table 5 - Proportion of children vaccinated with vaccines that are not included on the basic scheme, by socioeconomic stratum, Salvador, 2007-2008.
Tabela 5 *- Proporção de crianças vacinadas com vacinas que não fazem parte do esquema básico segundo estrato socioeconômico, Salvador, 2007-2008.*

Stratum	Meningococcal C	Pneumococcal	Hepatitis A	Chickenpox
A	35.7(19.2-52.2)	28.6(14.7-42.5)	23.8(10.9-36.8)	28.6(13.3-43.9)
B	11.8(4.3-19.2)	5.9(1.6-10.2)	5.9(1.9-9.8)	7.2(2.8-11.6)
C	11.4(3.7-19.2)	3.6(0.0-7.3)	3.0(0.0-6.1)	4.2(0.4-8.0)
D	2.3(0.0-5.1)	1.1(0.0-2.8)	0.6(0.0-1.8)	1.7(0.0-3.7)
E	1.6(0.0-3.5)	1.6(0.0-3.5)	0.5(0.0-1.7)	1.1(0.0-2.60

the rate observed in Salvador nearly corresponds to the 30th percentile. In socioeconomic stratum A, coverage is higher than the median value, whereas in stratum E, it is below percentile 25th. In the 1990s, this city already showed low vaccination coverage rates, identified through surveys, despite the high administrative coverage rates[12]. In this decade, although an increase in vaccination coverage has been observed, such coverage was unequal among different strata.

These results suggest that children living in poorer areas of the city have lower access to immunization programs. From the point of view of supply, this fact may be associated with both the insufficient number of primary health units and their distribution in the country. There are approximately 125 primary health units performing vaccine--related activities, a number which appears to be sufficient to meet the demand. Other reasons related to service use may also be associated with the lower coverage found in poorer population groups. Service supply in itself may not be sufficient for mothers to use it. The distance between one's home and the services, the existence of public means of transportation, service opening hours and service organization are some of the relevant aspects. The fact that only 15% of the population is covered by Family Health Program activities may be one of the explanatory factors for the lower coverage rates found in poorer socioeconomic strata. However, coverage is also unsatisfactory in other population strata.

The comparison with the group of Brazilian capitals is unfavorable for the city of Salvador, showing lower coverage rates in all socioeconomic strata. It should be emphasized that coverage was lower than that recorded in the city of Teresina, the capital of one of the poorest states in Northeastern Brazil.

In countries or regions where there is not a national health system and immunization activities are not mandatory, coverage rates can be lower than those observed in Salvador, Brazil. In Turkey, depending on the area, coverage rates for the complete vaccination schedule can be similar or lower than 70%[13,14]. In a survey conducted in rural areas of Mozambique, authors reported a coverage rate of 72% for the complete schedule[15]. Coverage rates of nearly 70% were also reported in children enrolled in day care centers of Philadelphia, USA[16], and in American children in general, between 2001-2002[17]. In some European countries or regions, coverage can be very low, as observed in Austria[18] and Germany[19] and in gipsy children from Alicante, Spain[20]. Coverage rates are lower than those found in the poorest socioeconomic strata of Salvador, even lower than the rates recorded in certain areas of India, such as Rajasthan.[21] Coverage rates higher than those observed in Salvador were recorded among children of Catalonia (87.6%), schoolchildren of Costa Rica (99%), and children of Greenland (92.6%) and Italy (95%)[22-26]. Differences in coverage are also observed among American states. The national survey conducted by the Centers for Disease Control and Prevention (CDC) have frequently found differences in rates. In 2005 and 2007, vaccination coverage rates for children younger than 18 months varied widely, the lowest values being found in Vermont (62.9 and 63.1%, respectively) and the highest values in Massachusetts (90.7 and 91.3%, respectively) [27].

Social inequalities in coverage were also observed in other contexts. A study performed in Chicago in the 1990s found that, although there were public programs aimed at increasing vaccination coverage in children living in impoverished districts of this city, those with poorer socioeconomic conditions were the ones who had lower vaccination coverage and a higher proportion of non-vaccinated children[28]. A study conducted in 2000 enabled researchers to observe that children who remained in health care programs had a more adequate coverage, whereas others who abandoned these programs before the age of 24 months had lower coverage rates[29]. Data from the 2003 National Health Survey conducted in the United States enabled the analysis of the vaccination status of children who had health insurance or not. Children with health insurance had a coverage rate of 80%. Coverage was 64% among children without this insurance and only 56% among those who had public health insurance[30]. When these data were compared to those obtained in Salvador, researchers observed that children without health insurance or with public insurance had a vaccination coverage rate similar to that found in the poorest strata (D and E) and intermediate stratum (C).

Hispanic populations in the United States also had a coverage rate lower than that of the non-Hispanic white population, regardless of order of birth, maternal level of education, number of siblings and type of health service provider. Vaccination coverage was only equal among white Hispanics of families with an income below the poverty line[31].

The analysis of vaccination coverage of children born between 1993-1994 in Brazil, according to household income index quintiles and obtained from data of the 1996 Demographic Health Survey,[32] revealed lower coverage for the two first quintiles, i.e. the poorest families (56.6 and 74.0%, respectively), and for the fifth quintile, i.e. the richest families (73.8%). Considering the fact that the SUS was in the process of being implemented in the majority of the country at that time, such distribution could probably be considered to be that existing before the health system began to cover primary health care services. However, in Salvador, current data on the 2005 cohort show a profile compatible with previous vaccination surveys conducted in the city of São Paulo, where the lowest coverage was found in strata with the worst living conditions.[5]

When considered individually, coverage of each of these vaccines is higher than that observed for the complete vaccination

schedule, but lower than the expected values. Even the BCG vaccine, which frequently has higher coverage because it is applied while children are in the maternity ward, not requiring mothers to seek a primary health care service, shows a coverage rate lower than 90% in children living in areas categorized in stratum E.

The DPT and polio vaccines showed values lower than 90% in the two strata with the worst living conditions. The remaining vaccines showed coverage rates lower than 90% in all socioeconomic strata, which enables the accumulation of susceptible children and may pose the risk of future epidemics, despite the low circulation of etiological agents with a small number of cases in the population, such as the diphtheria and mumps or even in the context of polio eradication. Countries that currently have poliomyelitis virus circulation after the introduction of an imported case show low vaccination coverage rates, which is a possibility that should not be disregarded with the increase in the population flow[1,5].

Lower coverage rates of the MMR vaccine were found in all strata, except in stratum E, for which the lowest coverage rates recorded were for the HIB and HVB. Lower coverage for the hepatitis B vaccine was also observed in children living in Buenos Aires, Argentina, although this was not found for the MMR vaccine[33]. Probably, the lowest coverage for the three-HVB dose schedule is associated with the longer interval between the second and the third doses, resulting in a higher number of children who do not complete the vaccination schedule.

The 2005 National Survey conducted in the United States showed coverage rates higher than 90% for the basic schedule vaccines analyzed in this study[34]. There were practically no significant differences between vaccines. Differently from the profile observed in Salvador, neither the moment of application nor the interval between doses seem to have an influence on the achievement of high coverage rates. The data from Salvador suggest that the vaccines applied in the first months of life with shorter intervals between doses have a greater probability of showing higher coverage rates in all social strata analyzed.

The comparison between the coverage estimated with the household survey and the administrative data available in the Ministry of Health information system shows greater discrepancies about certain vaccines. Data were similar for the OPV and DPT vaccines and divergent for the remaining ones. With regard to the BCG, HIB, SCR and yellow fever vaccines, administrative data point to higher coverage rates: 114.7% for the BCG, 80.0% for the HIB, 98.4% for the MMR and 80.9% for yellow fever. Only the administrative data on HVB showed a coverage rate (77.3%) lower than that obtained with the survey.

There was a small number of children who received vaccines not included in the basic schedule of the national immunization program in all socioeconomic strata. Even among children belonging to stratum A, few received vaccines against meningococcal meningitis, hepatitis A, chickenpox and pneumococcal disease. Information from the American national survey shows that the coverage rates achieved with the chickenpox and pneumococcal disease vaccines were lower than those obtained with the basic schedule vaccines, although the differences were not as great as those observed among the children of Salvador[34].

In the Brazilian case, the fact that these vaccines were obtained through direct payment could explain the small proportion of use among children from strata B through E, although it does not explain the restricted use among those in stratum A. Another factor that could be considered is the parents' low level of knowledge about these vaccines or yet the pediatricians' lower offer.

The proportion of children who received at least one of the vaccines in private clinics was also small in all strata, not reaching 50% in any strata, not even stratum A. This fact suggests that families preferably use public services for vaccination and that few seek private care, even among those with a higher socioeconomic condition. These

data, associated with the high frequency of "National Vaccination Days", could be showing the trust that the population, including those with a higher income, have in public services for this type of preventive action.

The coverage of the complete basic schedule with valid doses was similar among children who used private vaccination services and those who did not. Coverage was estimated to be 76.9% (95%CI:66.4-87.5) in the group that used private services, whereas this value was 72.3% (95%CI:67.4-77.3) in the remaining groups.

Participation in the last vaccination campaign was lower among children who had been previously vaccinated in private services. In this group, the participation rate was 74.2% (95%CI:64.4-84.0). Among children who did not use private services, this proportion was 89.6% (95%CI:86.7-92.5). These data suggest that the frequency of campaigns is less valued among individuals from higher socioeconomic strata, probably due to medical recommendation or the maternal awareness of the lack of need to participate in campaigns when the vaccination schedule has been completed.

The main limitation of this study was the loss of accuracy of confidence intervals due to the lack of children from the 2005 cohort in the number estimated for each cluster used as sampling unit. The fact that the survey was conducted eight years after the demographic census caused the number of children found to be lower than what was expected. In addition to the children not located in the randomly selected census tracts, there was an additional small number of refusals and losses primarily concentrated in stratum A, resulting in a lower level of accuracy of estimates for this group.

However, the survey overcomes problems of population estimates, frequently used in the official calculations of vaccination coverage rates, to be solved and information about the proportion of children who received the complete schedule to be obtained, thus providing more accurate information about the vulnerability and heterogeneity in the distribution of susceptible children.

Conclusions and Recommmendations

The survey of vaccination coverage of the cohort of children born in 2005 in the city of Salvador revealed two important aspects: the unsatisfactory coverage of practically all vaccines of the basic schedule and the heterogeneity among socioeconomic strata. The fact that children of stratum E systematically had low coverage rates, considering the valid doses or those applied, aggravates this situation, as these children are more vulnerable to infectious diseases due to their poorer living conditions.

Although the national immunization program guarantees the acquisition of vaccines and their supply without direct costs for the population, there are social inequalities and differences in the use of such vaccines. The fact that children belonging to poorer socioeconomic strata have lower coverage emphasizes: the need for more accurate territorial location or an increase in the primary health care service network; and the use of new strategies to universalize access.

The World Health Organization defines a set of strategies to increase vaccination coverage. The first strategy is the increase in the supply closer to the community through the work of health community agents and educational activities. The second strategy recommended by the WHO is the dissemination of information through mass communication campaigns, participation of NGOs and guidance provided by health professionals when individuals are in contact with health services. The third strategy includes the change in health service practices, seeking to improve quality with the reduction in the number of abandonments and missed opportunities, use of reminders for the parents, home visits and other continuous monitoring and follow-up actions. Finally, the fourth strategy is associated with new administrative practices, including vaccination promotion and coverage monitoring through routine surveys[35].

The adoption of a group of similar

practices could contribute to the achievement of higher coverage rates and to the reduction in the heterogeneity found in Salvador, helping to decrease the social inequalities in the use of one of the health programs with the greatest coverage in Brazil. Obviously, the reduction in inequalities in the access to and use of the national immunization program could contribute to a more effective control of vaccine-preventable diseases and reduce the vulnerability of the population of Salvador to disease outbreaks and epidemics.

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