
Summary
In the pre-immunization era, the measles were among the major public health problems of Brazil, representing in some regions the main cause of death in the 1 to 4 year age group, especially in areas with a high prevalence of infant malnutrition. Routine vaccination programs were started in the 1970's, but only after 1980 did they cover more than 50% of children up to 1 year of age, even though in a heterogeneous manner for the country, exceeding 80% coverage of the target population only after 1990. Despite the use of several strategies, routine vaccination did not prevent two extensive epidemics, one of them in 1984 and the other in 1986, with respective rates of incidence of 62.9 and 97.2/100,000 inhabitants, nor did it significantly modify the high levels of measles incidence up to 1987, when mass vaccination started to be used more frequently. A consistent and regular tendency to a fall in morbidity and mortality started to be observed since then. As a result of the activities of measles control, a 93.1% reduction in the incidence of the disease was observed from 1981 to 1995, and a 99.4% fall in mortality was observed from 1980 to 1993, with only 9 measles deaths reported among children younger than 5 years in 1993, as opposed to approximately 3000 deaths in 1980. Even though the mortality data may be somewhat underestimated, this fall is consistent with the evolution of other indicators that have been progressing favorably since the 1980, such as the expressive fall in infant mortality and in proportional infant mortality due to diarrhea, and the decrease in infant malnutrition, in illiteracy rates and in demographic growth. On the basis of the experience of measles control developed in other countries, we cannot think that we are close to the elimination of this disease, but the maintenance of a routine vaccine coverage of about 80% among children up to 1 year of age, the periodic utilization of mass vaccination and the improvement of the measles surveillance will probably prevent the return of high levels of morbidity and mortality caused by the measles in Brazil.
INTRODUCTION: The preventable diseases by immunization have presented a significant tendency to reduction in practically the entire world, as a result of efforts in the implementation of the Expanded Programme on Immunization (EPI). Mean world vaccine coverage for measles among infants less than 1 year of age was about 20% in 1974, and reached about 78% in 1990. Despite this international effort, the estimate is that approximately 880,000 deaths due to the measles occurred all over the world in 1990.

The relevance of measles in public health is mainly related to some particular characteristics of the behavior of the disease, among them a) the fact that it attacks almost all susceptible children, especially in urban areas, periodically causing great epidemics among unvaccinated populations or populations with low immunization coverage; b) the severity of the disease in infancy, especially among populations living in poverty; c) the spectrum of adverse events related to measles in infant populations living in underdeveloped communities, such as the worsening of malnutrition and the expansion of morbidity and mortality due to diarrhea and pneumonia; d) the social and economic cost of measles; e) the operational difficulties for its control, permitting even widely vaccinated populations to become victims of epidemics.

The severity of measles expressed by the lethality rate among children, especially during the first 12 months of life, varies as a function of a complex interaction between the infection and sanitary and social problems related to economic development, in particular malnutrition, poor housing, low educational level of the parents, and difficult access to health services. The lethality rate of measles is currently estimated at 2 to 6% in developing countries, and is perceptibly higher among infants under 1 year. During epidemics, lethality may reach approximately 30% of all cases in some communities.

In addition, the effect of the disease on health care costs is considerable. Surveys carried out in the 1980's reported that more than 57% of the cases studied in Sri Lanka required medical care, whereas in the U.S. about 15% of the notified cases required hospitalization.

Some studies have estimated that the control of measles by immunization could prevent 0.6 to 3.8% of all diarrhea episodes and reduce mortality due to diarrhea by a rate of 6% to 26%, an aspect that emphasizes even more the importance of the measles vaccination for the reduction of morbidity and mortality among children under 5 years.

Several operational problems may impair control of the disease. Among them are regional differences with respect to the velocity of loss of the protection conferred by maternal antibodies which, because of still unexplained mechanisms, appears to occur more rapidly in third world countries, exactly where the risk of early infection by measles virus is higher. This question is crucial for the establishment of control strategies such as the vaccination of infants under 1 year and the adoption of one or two vaccine doses, with the second, when indicated, being applied at about 15 months of age.

An important question especially in the urban areas of underdeveloped regions with high population densities is the high morbidity and mortality rate among infants under 9 months. In order to overcome this problem, vaccines with high titers of viral particles have been tested over the last few years using the Edmonston-Zagreb (EZ) strain, which proved to be immunogenic in children aged 4 to 6 months. However, recent evaluations have suggested that the application of this new vaccine has disadvantages since it may be associated with higher mortality rates among infant populations immunized with vaccines with high titers of viral particles EZ.

Another obstacle in the way of measles control is the occurrence of outbreaks in highly vaccinated populations, a fact attributed to primary and secondary vaccine failure. The primary failure, involving about 10 to 25% of all vaccinated individuals, may occur for different reasons, among them operational problems of vaccine storage and application and interference by passive antibodies of maternal origin. Secondary failure, characterized by the early production of antibodies against measles as a response to the vaccinal stimulus and later decay of these antibodies to non-protective levels, may occur in 3 to 5% of all vaccinated subjects and is held responsible for outbreaks of measles among schoolchildren in
populations with high vaccinal coverage. The above facts justify the effort of the World Health Organization to control measles, aiming at a 90.0% reduction in incidence and a 95.0% reduction in mortality by 1995, taking as reference the levels detected before the introduction of the vaccine.

Starting from the second half of the 1980’s, Brazil has played an outstanding role as one of the developing countries that obtained best results in the control of diseases that can be prevented by vaccination. Because of its characteristics as a country with a large population and territory; with important regional differences in the level of social, political and economic development; with metropolitan areas containing ample areas of poverty, we considered it opportune to present the evolution of measles morbidity and morbidity in the country from 1980 to 1995, analyzing these data on the basis of the impact of control measures implemented during the period and also commenting about the evolution of some socioeconomic, demographic and health indicators.

The Measles in Brazil
Characterization of the Area

With an area of 8.5 million km² and a population of approximately 147 million, among them 16.5 million children under 5 years, according to the 1991 Demographic Census, Brazil is the country with the largest territorial extension and population in South America (Figure 1). The South and Southeast regions, which contained a population of approximately 85 million in 1991, are industrialized areas with an appreciable level of development. The Northeast region, in turn, with a population of 42 million, is the poorest area in the country, with serious socioeconomic problems.

The most industrialized country in Latin America, Brazil suffered a profound economic crisis in the 1980’s, with a high inflation and periods of recession throughout the decade, with severe consequences for development. However, despite these factors, there was a favorable evolution in various social, demographic and health indicators, among them a fall in the rates of

![Figura 1]

| TABLE 1 |
|---------------------------|---------|---------------------------|
| **INDICATORS** | 1980 | 1990 Decade |
| Urban population (%) | 67.5% | 75.7% (1995) |
| Fecundity rate | 4.36 | 2.52 (1995) |
| Illiterate population ≥ 10 years | 25.3% | 16.2% (1995) |
| Infant Mortality Coefficient | 75.9/1000 lb. | 40/1000 lb. (1994) |
| Proportional Infant Mortality due to Diarrhea | 24.5% | 9.5% (1993) |
| Malnutrition among children <5 years (%) | 18.4 (1975) | 5.9 (1996) |

lb: liveborns
Source: Fundação Inst. Brasileiro de Geografia e Estatística (IBGE)
demographic growth and fecundity, and a reduction of illiteracy, infant malnutrition and infant mortality (Table 1).

**Evolution of the Measles Control Program**

In Brazil, measles vaccination started in the 1960's, although it was only included in the National Immunization Program in 1973, becoming legally compulsory in 1977, together with the use of a National Vaccination Certificate (vaccination booklet). The EPI, in turn, was incorporated into the goals of the Ministry of Health and of the State Health secretariats starting in the early 1980's.17

The transport and storage of vaccines at the national and state level became adequate during the early 1980's, and the same occurred with the supply and the cold chain at the regional and local levels, except for some more remote regions.17

The case definition of the measles adopted by the surveillance for the disease is an acute infection with high fever, generalized maculopapular exanthema lasting three to seven days, accompanied by one or more of the following signals: coughing, running nose or conjunctivitis. The source of information about notified cases utilized for the calculation of incidence varies slightly from state to state, but in general involves cases seen at hospitals and health units. The data concerning deaths due to the measles are obtained from the National Mortality System set up in the country in 1977, which uses standardized forms for death certificates.

**Control Strategies**

The following schemes of routine vaccination were adopted: a single dose at 8 months up to 1976, a single dose at 7 months from 1976 to 1982, and a single dose at 9 months starting in 1982. In the mid-eighties, several states adopted two doses, the first at 9 months and the second at 15 months19.

The first National Vaccination Campaign against measles occurred in 1980, together with the National Vaccination Day against poliomyelitis, targeting children under 5 years; in 1987 there were mass vaccination campaigns in 14 states; in 1990 there was the National Multivaccination Day; in 1992 a National Vaccination Campaign against measles was held, covering approximately 48 million children under 15 years, with more than 95% coverage for the older than one year age group and a

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**Figure 3**

**Vaccine Coverage for Measles Under 1 Year**

**Brazil 1980-1995**

![Vaccine Coverage Graph](image)

Source: Min. of Health of Brazil
coverage of about 90% for infants under one year. Finally, a national campaign for mass vaccination of children under 3 years was promoted in 1993 (Figure 3).

Starting in 1981, according to administrative data, most States reached higher than 50% routine vaccination coverage among infants under 1 year, but still in a highly heterogeneous manner, ranging from 21% in the State of Acre to 98% in the State of São Paulo. Finally, in the early 1990's, coverage of about 80% was reached for routine vaccination of infants under one year in a manner reasonably homogeneous for the country (Figure 2). In 1995, vaccination coverage of infants under one year for Brazil as a whole was about 88%, with 78% of the municipalities having coverages of less than 95%.

Incidence
An analysis of the evolution of measles morbidity starting from 1980 shows high incidences up to 1986 throughout the country, especially its most populous regions, i.e. the Northeast and Southeast. During this period there was an important decrease in incidence only in 1981, possibly related to the multivaccination campaign of 1980 (Figures 2 and 3).

Despite the use of various strategies, routine vaccination did not prevent two extensive epidemics, one in 1984 and the other in 1986, with respective incidence rates of 62.9 and 97.2/100,000 inhabitants, the latter involving the notification approximately 129 thousand cases. Also, the high incidence of measles did not seem to change until 1987, when mass vaccinations started to be used more frequently, with a consistent and regular tendency to a reduction thereafter (Figure 3). After 1992, with the National Mass Vaccination Campaign directed at children under 15 years and after 1993, with the mass vaccination of children under 3 years, a drastic reduction in incidence was observed throughout the country.

It should be pointed out that, for a better comparison of the historical series, we maintained the same case definition for 1994 and 1995 as that used for the previous period but, according to the much more specific new criterion for the confirmation of measles cases adopted since 1994 as part of the program of elimination of the disease, we observed less than 50 cases in these two years.

With respect to the age distribution of cases, considered to be an important factor associated with the higher risk of measles
complications and with the higher lethality rate, we observed that, from 1982 to 1989, 15.5% and 36.1% of measles cases in Brazil occurred among infants under 1 year and among children aged 1 to 4 years, respectively. However, during the subsequent period, 1990 to 1993, there was a shift, on average, to older age groups (Figure 2). This shift to higher age ranges occurred in a heterogeneous manner in the country and was more marked in states that had achieved better results in the control of the disease.

At different times after 1987, there were epidemics involving schoolchildren and adults which occurred in some states that had obtained the best results in their programs of measles control, i.e., São Paulo, Santa Catarina and Paraná.

**Mortality**

Starting in 1987 we noted a sharp tendency to a reduction in the mortality rates due to measles throughout the country, still differing in intensity among regions (Figure 5). This tendency preceded the more significant increases in vaccination coverage among infants under one year and the wider utilization of mass vaccination campaigns, which were achieved only after 1991. This decrease in mortality, although presenting variations corresponding to the most extensive epidemics that occurred in the country in 1984 and 1986, does not follow by the same proportion the increases in incidence, this aspect we will discuss further on.

The proportion of measles deaths during the first year of life was more or less constant in Brazil at about 40% during the period from 1980 to 1993. By macroregion, this proportion was a little higher in the south and southeast (50.0%) and was below 40.0% in the remaining regions. This difference may be related to the lack of homogeneity in the sensitivity of the national system of mortality information, but also possibly reflects, to some extent, the greater intensity of transmission and the severity of the infection related to the increased population density brought about by greater urbanization in the south and southeast, especially due to the important nuclei of poverty existing in the metropolitan areas of these macroregions.

**Severity**

A noteworthy aspect is the evolution of the mortality/incidence ratio which decreased consistently and continuously from 1982 to 1993 (Figure 3 and 5). Although the heterogeneous quality of available information indicates that these data should be viewed with caution, and also taking into account the fact that the mortality/incidence ratio does not precisely express case fatality rate.
since deaths and cases are recorded by different information systems, these data suggest a decrease in the severity of the disease during the study period\textsuperscript{21}.

Considering that the severity of the measles is related to a complex interaction between infection and socioeconomic factors and the access to health services, we may assume that this possible fall in case fatality rate is related to the favorable evolution of several socioeconomic, demographic and health indicators, a fact observed in Brazil during the last fifteen years despite the serious economic crisis faced by the country in the 1980 decade (Table 1). A similar, although much more intense, phenomenon occurred in industrialized countries during the first decades of the century\textsuperscript{11}. The widespread vaccination of the infant population may have also contributed to the reduced severity of the measles in our country, and therefore also to the reduction in mortality rates. There are reports in the literature suggesting that cases of measles among vaccinated individuals usually have a more benign course\textsuperscript{3}.

**Comment**

There is little information available to allow a reliable estimate of the relevance of measles as a public health problem in Brazil before the introduction of the vaccine. Historical mortality series were available since the beginning of the century for the cities of São Paulo and Rio de Janeiro which represent the largest metropolitan areas in Brazil, containing approximately 10% of the Brazilian population\textsuperscript{13}. During this period, the measles were among the major causes of death among children under 5 years in both cities, accounting for a larger number of deaths than the sum of deaths caused by diphtheria and whooping cough.

The other important source of information is the Inter-American survey of infant mortality held from 1968 to 1972\textsuperscript{16}, which pointed out the measles as the major cause of death among children aged 1 to 4 years in the cities of Recife, Ribeirão Preto and São Paulo, accounting for 26% of all deaths in this age group and for 50% of all deaths caused by infectious diseases. The city of Recife presented one of the highest mortality rates among the cities included in the study, with a rate of 320.4 per 100,000 inhabitants, with emphasis on the fact that 71.8% of these deaths were associated with malnutrition.

Taking these data as reference, it is not difficult to evaluate the importance of the results obtained in measles control since the 1980’s. According to the results presented, a 96.8% reduction in the incidence of the disease occurred in Brazil from 1980 to 1995, as well as a 99.7% reduction in mortality from 1980 to 1993, with
only 9 deaths due to measles among children younger than 5 years in 1993, as opposed to approximately 3000 deaths in 1980 (Figures 3 and 5).

Even though the mortality data may be somewhat underestimated, this fall is consistent with the evolution of other indicators that also presented a favorable evolution since the 1980’s (Table 1). Furthermore, the high vaccination coverage of the infant population must have contributed to some extent to the decrease in morbidity and mortality due to diarrhea and possibly also to the reduction of malnutrition.6,10

The experience of programs of measles control applied in other countries does not permit us to think that were close to the elimination of this disease, but the maintenance of a vaccination coverage of about 80% among children under 1 year of age, the periodic use of mass vaccination and the improvement of the measles surveillance very probably will prevent a return to the high morbidity and mortality levels caused by measles in Brazil.7,20

As an example of the impact of vaccination campaigns, we may cite the results obtained by Panuti et al.15 in studies of the mass vaccination campaign for children aged 9 months to 14 years residing in the metropolitan São Paulo area, with an 86% coverage of the target population. This study, carried out 4 months after vaccination on a probabilistic sample of 8661 children, obtained a 94.1% proportion of children positive for measles antibodies. This result is definitely very promising, but the demonstration of a residual susceptible population of 6% is not negligible and indicates the difficulties in maintaining low incidence rates for prolonged periods of time without periodic vaccination of a significant proportion of the population.

REFERENCES