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Factors influencing childhood immunisation in an urban area of Brazil

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Abstract

***Study objective*—The aim was to examine the factors associated with incomplete vaccination in an urban area in Sao Paulo, Brazil; and to explore whether differences in vaccine coverage in the catchment area of health centres remain after the demographic constitution of the population in these areas is controlled for.**

***Design*—The children were selected as controls for a case-control study. 455 children were selected at random (but age matched) from the health centre registries. Data was collected from the health centre records and from home interviews.**

***Setting*—All children were registered in FAISA, a municipal health service comprising a large network of health centres and hospitals. FAISA's services are free at the point of delivery, and over 85% of the city's children are registered.**

***Participants*—Participants were selected to represent, except in their age distribution, all children registered in the municipal health service.**

***Measurements and main results*—Information was collected on subjects' vaccine history, year of birth, sex, birth order and birth weight, and health centre of registration; their mothers' age, education, and marital status; and the family's income per capita and history of migration. Analysis was undertaken to identify risk factors for vaccination and whether the differential coverage in health centres' catchment areas remained after demographic characteristics of the population were controlled for. The high coverage for DPT and polio vaccines suggests that low overall coverage was not simply a result of mothers failing to bring children for vaccination. The variable that best predicted vaccine coverage was year of birth. Children born to immigrant mothers or into large families had lower vaccine uptake. The characteristics of children and their mothers did not account for the variation in vaccination coverage in catchment areas of different health centres.**

***Conclusions*—It is likely that in this area vaccination completeness was associated mainly with the health centre's ability to deliver vaccination to the target population.**
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In 1974, The World Health Organization (WHO) launched the "Expanded Program on Immunization" (EPI) aiming at reducing the incidence and mortality due to vaccine preventable disease by promoting the expansion of immunisation activities around the world. According to the latest estimate, however, 40% of children had not been reached by vaccination in 1986 in the developing countries.[1]

Early studies exploring the reasons why so many children remain unvaccinated have focused mainly on the demographic characteristics of children and their families.[2] Perception of disease severity, and of the efficacy of vaccines in preventing disease—the "health belief" model—were soon recognised as additional important factors behind the motivation of parents to seek vaccination for their children.[3–10] Several investigators argued that beliefs about supernatural disease causation and the efficacy of traditional medicine were obstacles to vaccination in developing countries.[9 11] Heggenhougen and Clement[12] challenge this assumption in a recent review, suggesting that "people are pragmatic" and use both traditional healers and allopathic services. Friede *et al*[13] suggest that both knowledge and a positive attitude towards vaccination result from access to immunisation services and previous experience with vaccination.

Studies of demographic characteristics and health beliefs have failed to show consistent results, and recent studies have looked at the role of the health services.[13 14] Studies carried out in Mozambique,[14] Ghana,[15] and Brazil[16] have reported low vaccination coverage associated with health system related factors, such as shortage of vaccine at local level, the number of days vaccination was performed, and distance to the nearest vaccination facility. Evidence from developed and developing countries has also identified specific practices within the health system that lead to low vaccine coverage: professional health workers doubting the efficacy of vaccines,[17] having exaggerated concern about adverse reactions, and following inappropriate contraindications.[17–19] Health services personnel failing to make use of opportunities for vaccination can account for a significant proportion of the failures to vaccinate children.[20] Sharp increases in coverage observed in some developing countries associated with mass immunisation campaigns have shown that the delivery system plays an important role in vaccination uptake.[21–24]

Methods

STUDY POPULATION

An analysis of cross sectional data on 455 children was performed to investigate factors associated with incomplete vaccination. The study site was the municipality of Santo Andre (population half a million), part of the Greater Sao Paulo area, the most industrialised area of Brazil. A public health system, The Fundacao de Assistencia a Saude de Santo Andre (FAISA), based on 23 health centres and referral health facilities, provided free and accessible well baby clinics, vaccination clinics, and paediatric care. About 85% of the children under 12 years in Santo Andre were registered at FAISA during the period of study.

The study population consisted of all children born from 1971 to 1981 who were registered in FAISA. This analysis was restricted to children who were selected as controls in a case-control study on measles vaccine efficacy carried out at FAISA.[25] As in the previous study a case base sampling scheme was applied; the sampled children in that study represented not only those without measles but they were also an age matched random sample of the children registered at FAISA's health system. Hence the results of the present study can be extrapolated for all children of the same age in Santo Andre.[26]

DATA COLLECTION

Data were collected through a review of medical records of the children and a personal interview with their mothers. In FAISA, information on personal and family characteristics are recorded for each child at the time of registration. Home interviews were conducted by trained interviewers using a pretested standardised interview schedule.

Immunisation status was ascertained from either medical records or vaccination cards. In FAISA, information on vaccination is part of the child's medical record and a copy of the vaccination card is given to the mother. Information was collected on potential risk factors for incomplete vaccine uptake. Data on child's birth order, birth weight, child's year of birth and sex, and mother's marital status and literacy were ascertained from the medical records. In addition, information on age of mother, family income per capita, and mother's length of residence in Santo Andre was obtained from home interviews.

METHODS OF DATA ANALYSIS

Vaccination status was obtained for four vaccines; oral polio (poliomyelitis), DTP (diphtheria-pertussis-tetanus), BCG (tuberculosis), and measles. Children were defined as completely vaccinated if they had received the basic series of vaccines recommended by the state of Sao Paulo immunisation programme: three doses of DPT, three doses of oral polio, and one dose of BCG, and for measles, either one dose after 12 months, or one dose before 12 months followed by a booster. Since only 21 children had received no vaccination at all, the children with incomplete vaccination were grouped with those never vaccinated. Vaccination coverage was derived for individual vaccines and for the complete scheme.

Income per capita was grouped in quartiles of frequency. Mothers were classified into five groups according to time since migration. These were later collapsed into recent migrants and others (10 years since migration and natives).

Children were assigned to the health centre of registration. Health centres were classified according to the level of coverage of children from their catchment area in either three groups: low (less than 40%), medium (40 to 60%), and high (over 60%), or two groups: low (less than 50%) and high (50% or more).

The extent to which differences in coverage in children living in particular health centre catchment areas were explained by the children's demographic characteristics was determined using univariate analysis. The association between each risk factor and level of coverage on the catchment area defined as low or high was tested using Pearson's χ^2 test.

The analysis of the association between demographic characteristics and vaccination in individual children was conducted in two steps. Firstly, a univariate analysis was performed to assess the association between vaccination and the independent variables. Odds ratios were calculated using as the baseline the stratum with lowest risk for incomplete vaccination. Test based (Miettinen's methods) 95% confidence limits for the odds ratio were produced on SAS.[27] The association between each risk factor and vaccination was tested using Pearson's χ^2 test. Stratified χ^2 was used to evaluate linear trends. Secondly, multiple logistic regression was performed to assess the independent effect of each variable, using the computer program EGRET.[28] Those variables

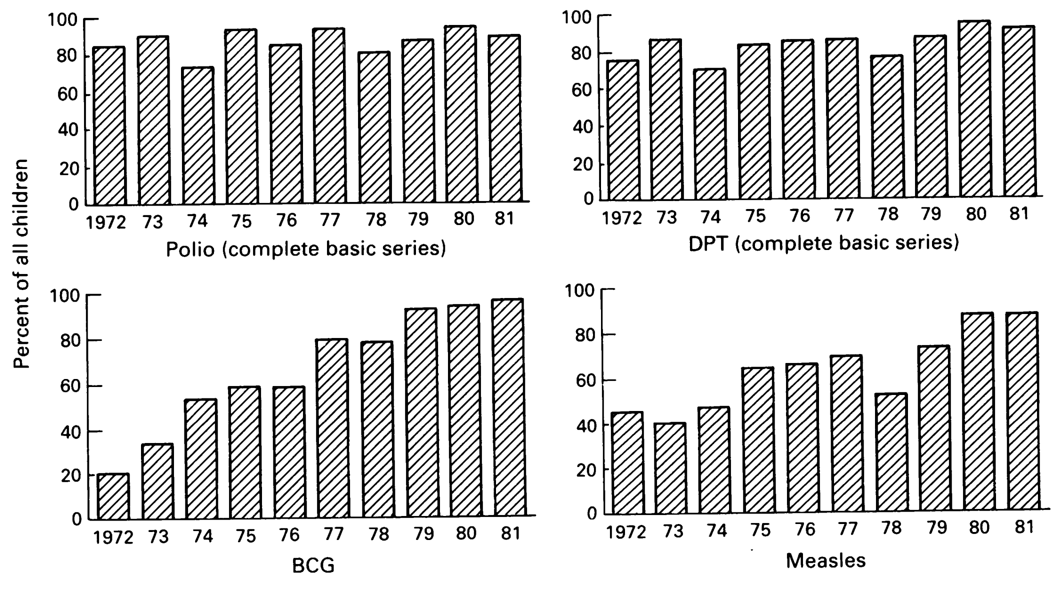

Figure 1 Percentage of children fully vaccinated for each type of vaccine by year of birth.

showing a statistically significant association at the 5% level on the χ^2 test in the univariate analysis were included in the multivariate analysis.

Finally, the health centres of registration were aggregated into the model, in order to assess the individual contribution of demographic characteristics and health centre practices.

Results

Of the 455 children studied, 214 (47%) were fully vaccinated and 241 (53%) had incomplete vaccination. The degree of compliance was high for each specific vaccination, and only 21 (4·6%) of the children had not received at least one dose of one of the four vaccines.

An increase in vaccine coverage with time during the whole period was evident. Figure 1 shows the proportion of children vaccinated by year of birth for the four types of vaccine. There was a linear trend with time in the proportion of children fully vaccinated, presented in fig 2, from 0% in 1971 birth cohort to 80% for those born in 1981 ($p<0·001$).

Figure 3 shows the percentage of children fully vaccinated by each type of vaccine. As DPT and oral polio are usually given together, the percentage of fully vaccinated children was similar for the two vaccines. The percentage of children who had received three doses of antipolio vaccine (87·7%) was markedly higher than that of the children who had only one (4·4%) or two doses (2·0%). The same was true for DPT vaccination: 4·6% had received one dose and 5·3% two doses, compared to 84·0% who had completed the DPT primary course (three doses). The percentage of children adequately vaccinated with BCG (69·5%) and measles (63·8%)—which require a singel vaccination each—was lower than we expected and showed the most marked increase with time.

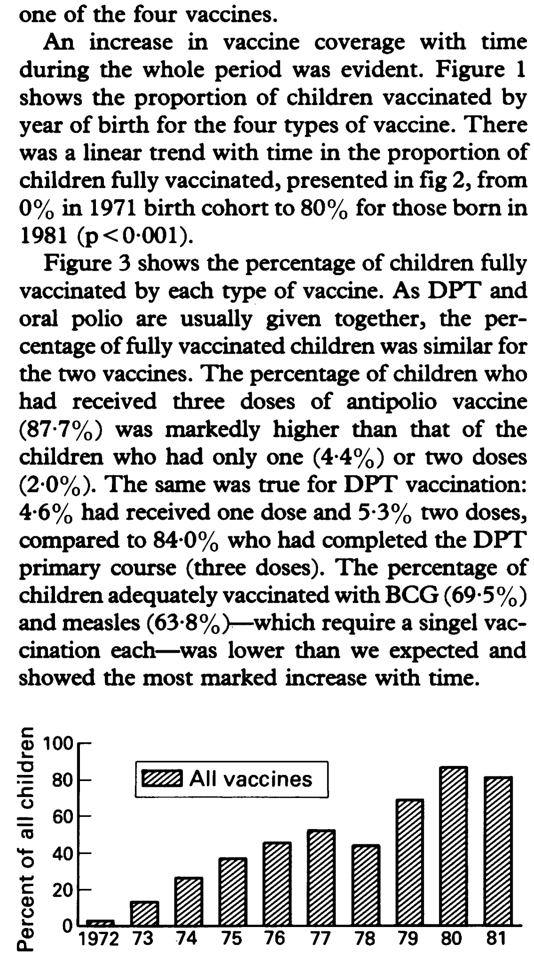

Figure 2 Percentage of children fully vaccinated by year of birth. Test for linear trend $p<0·001$

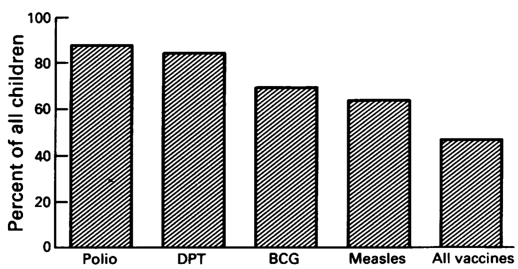

Figure 3 percentage of children with complete scheme for each vaccine.

Table I Vaccine coverage in health centre catchment areas: mean, standard deviation, minimum, and maximum.

	Mean	Standard deviation	Health centre coverage Lowest	Health centre coverage Highest
DPT	82·9	9·0	60·0	96·7
Polio	87·3	9·7	66·7	100·0
BCG	70·8	14·1	44·8	92·3
Measles	63·8	13·4	41·7	84·6
All vaccines	48·2	15·5	26·5	78·6

There was a wide variation in vaccination coverage according to the health centre to which children were registered. Table I presents the mean, standard deviation, and the range of coverage for each specific vaccine and for complete vaccination across the 23 health centres. The proportion of completely immunised children varied from 26·5% to 78·6% in different health centres. The mean value was 48·2% with standard deviation of 15·5%.

In order to explore whether the difference in vaccination coverage among health centres was associated with the demographic characteristics of its users we looked at the proportion of single and illiterate mothers, and the frequency distribution of mother's age, income per capita, number of years mothers were living in Santo Andre, and child's birth order in health centres with coverage below and above 50%. None of these were significantly different (table II) in the two groups of centres.

Table III shows unadjusted odds ratios and 95% confidence intervals (CI) for the association between vaccination and demographic characteristics. Illiteracy and marital status of mothers, birth weight and sex of children, and family income per capita did not influence vaccination uptake. High birth order and year of birth of the child, mother's migration into Santo Andre, age of mothers, and health centre of registration were significantly associated with incomplete immunisation ($p<0·05$) and were included as regression terms in the multivariate analysis.

Age of mothers lost its significance when adjusted for the year of birth of the child. Only mother's migration into Santo Andre, child's birth order, and year of birth remained statistically significant. The adjusted odds ratio of being inadequately vaccinated, in a model that

Table II Demographic characteristics of children registered in health centres with low and high coverage.

	Vaccination coverage[a] Low % (number)	Vaccination coverage[a] High % (number)
Mother living in Santo Andre*		
Native	17·6 (41)	23·3 (27)
1–2 years	5·6 (13)	2·6 (3)
3–9 years	14·2 (33)	11·2 (13)
10+ years	62·7 (146)	62·9 (73)
Birth order*		
First	37·7 (100)	40·4 (55)
Second	19·2 (51)	25·7 (35)
Third–fourth	28·7 (76)	17·6 (24)
Fifth	14·3 (38)	16·2 (22)
Mother's age (years)*		
<25	8·6 (23)	14·7 (21)
25–29	22·8 (61)	25·9 (37)
30–34	31·0 (83)	21·0 (30)
35–39	21·3 (57)	20·3 (29)
40+	16·4 (44)	18·2 (26)
Marital status*		
Married	92·5 (135)	93·4 (256)
Single	7·5 (11)	6·6 (18)
Mother's literacy*		
Literate	91·8 (245)	92·9 (130)
Illiterate	8·2 (22)	7·1 (10)
Income[b]*		
Less than 20$US	22·9 (55)	27·3 (38)
21 to 38$US	25·4 (61)	31·7 (44)
39 to 67$US	22·9 (55)	23·7 (33)
More than 68$US	28·8 (69)	17·3 (24)

[a]Coverage low <50%; high ≥50%
[b]Family income per capita per month.
*No significant differences found/Pearson's χ^2 test: two tailed p value >0·05.

included year of birth, was 1·73 (95% CI = 1·08–2·75, p = 0·022) for a third or later born child, and 2·40 (95% CI = 1·29–4·49, p = 0·006) for children born to a migrant mother.

If the variation in vaccination coverage in the catchment area of health centre was caused by these individual characteristics of the attenders, no variation would remian when the demographic characterstics were controlled for. So, in order to explore the effect of the health centre practices, we examined the association between health centres of registration (grouped as a three level factor according to its level of coverage) and vaccination, controlling for the effect of child's year of birth, length of time mothers were living in the city, and birth order. Adjustment for these variables had little effect on the results: health centre of registration remained an important predictor of children's vaccination status. This association is shown in table IV.

Table III Proportion exposed to each variable and unadjusted odds ratios for the association between children's and mothers' characteristics and vaccination uptake.

	Odds ratio (95% CI)	*Exposed % (number)*
Birth weight		
>2500g	1	91·6 (385)
≤2500g	1·1 (0·5–2·8)	8·6 (36)
Birth order		
First	1	40·3 (175)
Second	1·4 (0·8–2·2)	21·4 (93)
Third-fourth	1·6 (0·9–2·5)	24·2 (105)
Fifth +	2·4 (1·4–3·9)	14·1 (61)
Sex		
Female	1	51·0 (231)
Male	1·1 (0·8–1·5)	49·0 (222)
Mother living in Santo Andre		
Native	1	18·0 (78)
1–2 years	2·3 (0·8–6·4)	4·2 (18)
3–9 years	3·4 (1·6–7·1)	11·6 (50)
10+ years	1·2 (0·6–2·4)	(287)
Mother's age (years)		
<25	1	10·1 (45)
25–29	1·7 (0·7–3·8)	24·0 (107)
30–34	3·1 (1·2–7·1)	27·9 (124)
35–39	3·2 (1·3–7·1)	21·4 (95)
40+	3·4 (1·4–7·6)	16·6 (74)
Marital status		
Married	1	93·4 (424)
Single	1·4 (0·6–2·9)	6·6 (30)
Mothers literacy		
Literate	1	92·0 (405)
Illiterate	1·1 (0·5-2·1)	8·0 (35)
Income[a]		
Less than 20$US	1	23·8 (98)
21 to 38$US	1·3 (0·8–2·3)	27·7 (114)
39 to 67$US	1·1 (0·7–2·0)	23·4 (96)
More than 68$US	0·9 (0·6–1·5)	25·1 (103)

[a]Family income per capita per month
CI = confidence interval

Table IV Effect of the health centres of registration and demographic variables on vaccination completeness of linear logistic regression.

Health centre group[a]	*Odds ratio*	*95%CI*	*p value*
Group 1	1		
Group 2	2·16	1·33–3·50	0·002
Group 3	4·05	2·41–6·80	<0·001
†Year of birth			
Group 1	1		
Group 2	2·07	2·03–6·43	0·009
Group 3	3·61	2·03–6·43	<0·001
†Year of birth			
Natives	1		
Migrants	2·25	1·20–4·23	0·012
Group 1	1		
Group 2	2·01	1·16–2·01	0·012
Group 3	3·60	2·02–6·44	<0·001
†Year of birth			
Natives	1		
Migrants	2·37	1·25–4·47	0·008
<Third	1		
Third and later born	1·65	1·02–2·65	0·040
Group 1	1		
Group 2	1·76	1·02–3·05	0·042
Group 3	3·50	1·95–6·28	<0·001

†Adjusted for
[a]Health centre group: 1 = coverage higher than 60%; 2 = coverage between 40% and 60%; 3 = coverage below 40%

Discussion

The characteristic which best discriminated children's vaccination status was the year the child was born, reflecting an increase in vaccination coverage (mostly BCG and measles) with time. Birth order was also strongly associated with vaccination completeness. Children from large families have been found to have low vaccine uptake by several investigators.[2 5 7 9 29] This has been interpreted as reflecting the difficulty experienced by a mother with many children in taking up the immunisation services. Children born to immigrant mothers were also less adequately vaccinated. The role of migration on vaccination coverage has been addressed in a few studies. In Yaounde[30] children born to mothers with a history of migration were less vaccinated and were settled in areas of low coverage. In a study in Mozambique[14] migrants were found to be less well vaccinated when compared with the long term residents in the area. However, migrants were found living in areas of higher coverage. Vaccination coverage of migrants might be associated with their level of integration in the new society, but it may also reflect, in the case of recent migrants, the coverage of the area of origin. In our study, it was remarkable that vaccination coverage remained low even nine years after migration.

There was no difference in coverage by sex of the child. Boys have a greater chance of being vaccinated in some developing countries.[29] These findings may reflect cultural discrimination against female children in those societies.

Marital status, age, and literacy of the mothers were not associated with use of immunisation services in our data. Other studies have had different results. Both older[7 29] and younger[5] mothers have been found to have less well vaccinated children. Lack of association between maternal age and vaccine uptake has also been reported.[2] Low educational level of mothers has been associated with low vaccine coverage,[2 5 9 28] but other studies have found no association.[7 13]

Income per capita was not associated with vaccination uptake. In Brazil, the public and private health system exist side by side, competing with each other. The public system is predominantly used by low income families. However, about 85% of the children aged 12 years or less were registered at one of FAISA's health centres, and the range of income in our sample was wide (US$ 2.38 to US$ 484.00 per capita per month). The same measure was a good predictor for measles infection in the sample,[25] so it is unlikely that the lack of association was due to lack of difference in socioeconomic status in our sample.

The lack of an association between vaccination completeness and most of the demographic characteristics of the children and their families observed in our study is consistent with findings from other studies. Friede *et al*[13] reported that vaccine uptake was not associated with either demographic characteristics or socioeconomic status in Cavite (rural Philippines) and stressed the influence of features of health services on vaccination. It is interesting that in societies as different as Cavite and Santo Andre, when other barriers such as availability, distance, and direct payment of health services are removed, there is no differential use of vaccination services with wealth.

The analysis of the immunisation patterns suggests that an important role is played by health service practices in our study place. The proportion of fully vaccinated children increased sharply over the study period. The speed of this increase suggests that it was not caused by changes in cultural attitudes and beliefs, which are normally slow. It is likely that the creation of FAISA in 1967, which established a local regionalised public health system, influenced the levels of vaccination coverage in Santo Andre by facilitating the access to vaccination services.

Fifty three percent of the children were inadequately vaccinated, in spite of the fact that only 4·6% of all children had received no vaccination at all, showing that a large proportion of children who started the course of immunisation did not complete it. The propotion of children fully immunised was consistently high during the whole period under study for DPT and oral polio, which required at least three visits to the health centre for complete coverage, with a very low drop out rate between the first and the third doses. In spite of the fact that full coverage of BCG and measles requires only one dose, coverage for these vaccines was low and increased with time. This again suggests that the overall increase in coverage in Santo Andre resulted from better performance by health centres rather than from an improvement in mothers' compliance. Studies from Pakistan,[22] India,[24] and Mozambique[14 32] identified missed opportunities and inappropriate contraindications as important factors inhibiting better coverage. A study on measles vaccine uptake in Sao Paulo found that contraindication to immunisation was responsible for 35% of non-vaccination.[31]

In summary, the only demographic variables which had a statistically significant association with vaccine coverage were birth order and migration. Our results support the hypothesis that differences in practices across health centres had a major impact on vaccine coverage. This is reassuring news for health planners, as it suggests that improving health centre procedures and making the management of vaccination services responsive to the needs of large families and migrants could increase vaccination coverage. Research on causes of low vaccine uptake should also concentrate on investigating features of the services, including application of contraindications, clinic staff attitudes towards measles and BCG vaccination, provision of vaccines, and missed opportunities.

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