The relationship between nutritional and sociodemographic factors and the likelihood of children in the Dominican Republic having a BCG scar

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ABSTRACT

Objectives.   *To critically assess the prevalence among schoolchildren 6 to 9 years of age throughout the Dominican Republic of a bacille Calmette-Guérin (BCG) vaccination scar, and to examine the relationship between nutritional and sociodemographic factors and the likelihood of having a BCG scar.*

Methods.   *This correlational study used the database of the Second National Census on Height and Weight of Elementary School First Grade Students, which was conducted in the Dominican Republic August 2001–May 2002, to provide a critical assessment of BCG coverage nationwide. The Census information for the children included the presence of BCG scar, their nutritional status, and basic demographic data. We developed a new sociodemographic indicator, the "Rosa Index," to examine the potential influence of poverty and other environmental characteristics on scar presence. We used logistic regression models to predict the presence of a BCG scar.*

Results.   *An overall BCG scar prevalence of 55.3% (85 644/154 887) was found. Malnourished children were less likely to have a BCG scar than were children with adequate nutritional status (odds ratio = 0.91; 95% confidence interval: 0.87, 0.95, P < 0.05). Children who were 7–9 years old were less likely to have a BCG scar than were children 6 years old. Children in the areas of the country more than two hours' driving distance from the capital city of Santo Domingo more often exhibited lower BCG scar prevalence levels than did children in Santo Domingo. A higher Rosa Index (better level of socioeconomic characteristics) was correlated with higher BCG scar prevalence values (r = 0.54, P < 0.05).*

Conclusions.   *Our study findings indicate that BCG coverage appears to be inadequate for schoolchildren in the Dominican Republic. Nevertheless, the presence of a scar in a higher proportion of younger children suggests that coverage has improved in recent years. More programmatic and economic emphasis needs to be placed on extending early BCG vaccination coverage to the areas of the country where vaccination coverage is lower, and on examining the potential role that poverty may have on vaccination effectiveness.*

Key words   Tuberculosis, BCG vaccine, cicatrix, vaccination, population surveillance, socioeconomic factors, Dominican Republic.

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Bacille Calmette-Guérin (BCG) vaccination has been used to prevent tuberculosis (TB) since 1921, and it was incorporated in the World Health Organization (WHO) Expanded Program on Immunization (EPI) in 1974 to strengthen the fight against childhood TB in developing countries (1–3). Though there are controversies regarding the vaccine's efficacy, it is generally agreed that it is effective against disseminated disease and meningitis in childhood TB (4–7). Favorable outcomes of BCG vaccination have also been reported in the prevention of leprosy (8) and in the treatment of superficial bladder carcinoma (7).

The presence or absence of a BCG scar is often used in clinical settings as an indicator of vaccine effectiveness, and the same is done in surveys carried out by EPI and other health programs in order to assess vaccine uptake (9). However, BCG scar as a measure of vaccine coverage is still a subject of controversy. It has been reported that approximately 10% of children successfully immunized with BCG don't develop a scar. Discrepancies that are found in vaccine effectiveness can be explained by vaccine characteristics (nonpotent BCG strain dose, or quality), poor vaccination techniques, recipient characteristics (e.g., age at vaccination, immunity and nutritional status, race), and information bias or falsified child records (10).

The Dominican Republic has a high TB incidence rate, approximately 45 cases per 100 000 inhabitants (11). BCG vaccination has been carried out in accordance with WHO guidelines, under the aegis of the immunization program of the Ministry of Health. Since 1978, intradermal administration of BCG has been recommended at birth in any hospital, health post, or other health facility. Since 1991, the same strain of BCG has been used across the country (11).

As of 2005, the Dominican health authorities estimated the BCG coverage in children less than 2 years of age to be 98% (12). Despite this high vaccination rate, and an HIV prevalence among the general population (15–60 years of age) of 1% (12), the incidence of pediatric

tuberculosis meningitis (less than 2 years of age) per 100 000 cases in the Dominican Republic increased from 0.1 per 100 000 cases in 2004 to 0.7 per 100 000 cases in 2005 (11).

This study was conducted to assess nationwide BCG scar prevalence in Dominican children, and it also examined the relationship between nutritional and sociodemographic factors and the likelihood of having a BCG scar.

METHODS

National Census on Height and Weight of Elementary School First Grade Students

In August 2001–May 2002, Soriano et al. carried out the Second National Census on Height and Weight of Elementary School First Grade Students (*II Censo Nacional de Talla y Peso en Escolares de Primer Grado de Básica*) in the Dominican Republic (13). All children from 6 to 9 years of age attending public or private elementary school were included in the Census on Height and Weight. A trained school teacher interviewed the caregivers of the children, who accompanied the children to the school. The interviews typically lasted 30 minutes and were performed in a private classroom in the school.

A pretest was conducted with 50 schoolchildren from the different school regions of the Dominican Republic. (There are 16 school regions in the Dominican Republic, with each region comprised of different provinces and municipalities (Figure 1). The school regions were created by the Secretariat of Education to facilitate logistics (food distribution, data collection, etc.) among rural and urban areas of the country). As part of the training procedures, school teachers were instructed on how to recognize the BCG scar, perform anthropometric measures, and conduct the interviews. Methods were standardized for filling out and reviewing the study forms.

The teacher interviewers were trained to obtain measurements of height,

using standard anthropometric methods. Height was calculated with a locally made centimeter measuring board placed on the wall at a 90-degree angle, as recommended by the Pan American Health Organization.

The interviewer examined both of the child's arms for the presence of a BCG scar and recorded the scar's presence or absence on a data collection form. Basic demographic data (age, sex, and place of residence (school region)) of the subject were obtained, as well as information about the legal guardian's socioeconomic status. Information about the school building, such as type of toilet, trash collection, and type of construction (wood or cement), was also collected, and recorded on the data collection form.

The Census on Height and Weight data included the prevalence of malnutrition by school region. To estimate nutritional parameters (height-for-age), percentiles were calculated using the United States National Center for Health Statistics tables with < 2 standard deviations as the cutpoint for malnutrition estimators.

A secondary data analysis of the BCG scar prevalence in Dominican children

This research was a correlational, secondary data analysis study intended to determine the effect of sociodemographic and nutritional parameters on the likelihood of having BCG scar.

We performed the statistical analysis of the collected data using SPSS 11.5 (SPSS, Chicago, Illinois, United States of America) and NCSS 2004 and PASS 2002 (NCSS, Kaysville, Utah, United States). BCG prevalence proportions were calculated, and the effects of the study variables (basic demographic data, residence of the subject, and nutritional indicators) on the likelihood of vaccination (as indicated by the scar's presence) were estimated by means of odds ratios (ORs) and 95% confidence intervals (95% CIs), obtained through logistic regression, employing univariate and multi-

FIGURE 1. BCG scar prevalence among schoolchildren in the Dominican Republic, by school region, 2001–2002
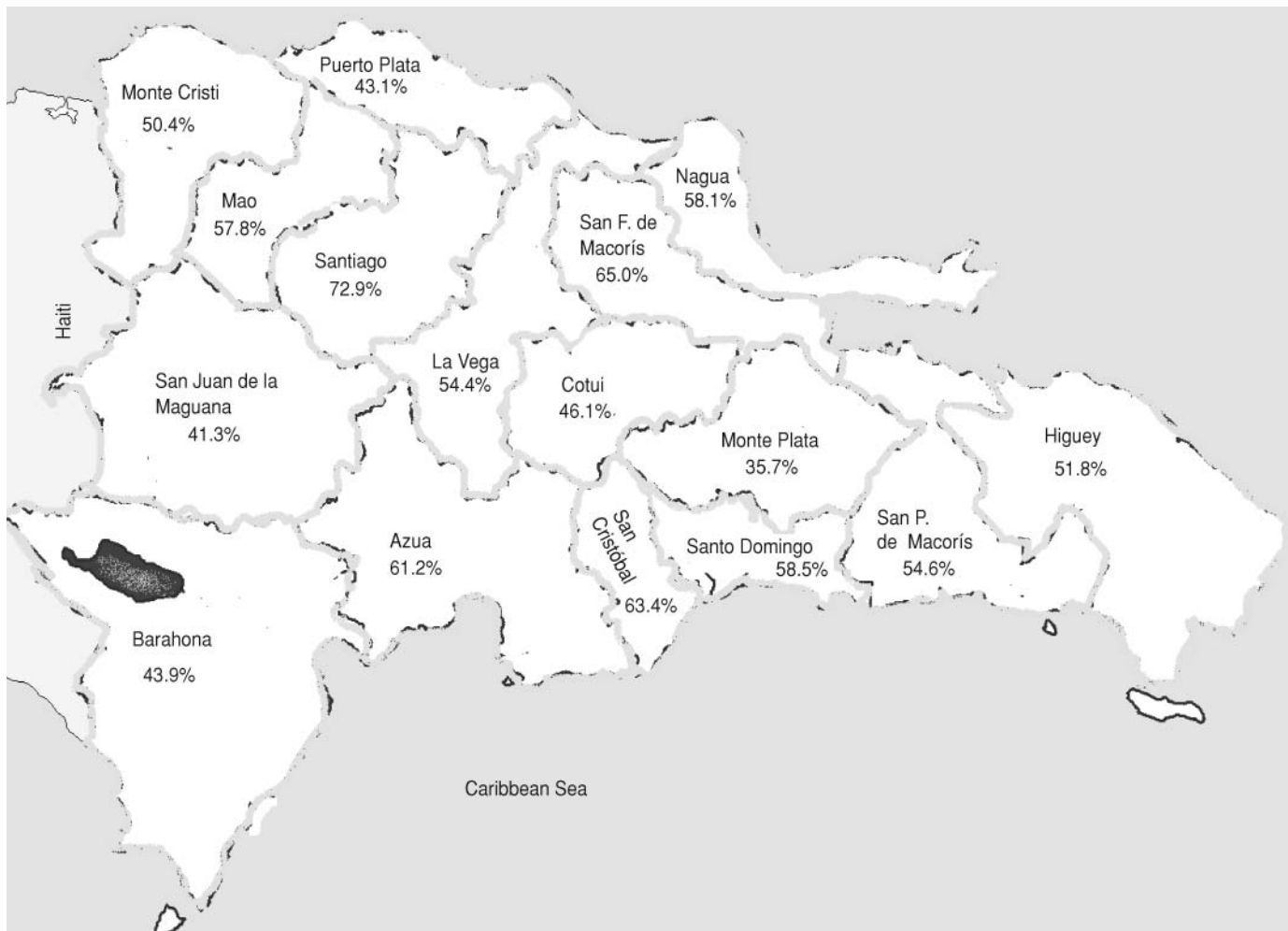
variate analyses (14). Logistic regression models were also developed to predict the presence of a BCG scar. In each model, the category most positively associated with the presence of BCG scar was generally used as the reference category.

To facilitate interpretation of the school data for univariate and multivariate models, the school regions were grouped into three geographic categories: (1) Santo Domingo (reference group), which is the capital of the Dominican Republic; (2) school regions one to two hours' driving distance from the capital ("Mid School Regions"); and (3) school regions more than two hours' driving distance from the capital ("Other School Regions").

The Rosa Index. To evaluate the impact of sociodemographic ecological variables on scar presence, a new quantitative sociodemographic indicator, the "Rosa Index," was developed by the main author (E. Pérez-Then) in collaboration with Rosa Urania Abreu and the authors of the Census on Height and Weight. (The term "Rosa" was used to acknowledge the contribution of Rosa Urania Abreu in developing the index.) This new approach assigned a possession score to every school region based on the mean values of monthly household income, as well as the mean proportional values of residential and schools characteristics for each region. The Rosa Index values were assigned according to the

sociodemographic data collected in the Census on Height and Weight in August 2001–May 2002. Possible index scores could range from zero (minimum) to 12 (maximum). The higher the index score, the better the "ecological" characteristics of the school region. The Rosa Index was also included in a multivariate model to predict the presence of BCG scar in Dominican children.

Multivariate analysis. For the multivariate analysis, variables were entered according to their statistical significance (in univariate analysis) and their biologic relevance. Various models were evaluated, including a full model containing all the variables

studied, in order to select the best possible model to fit the data. The goodness of fit of the logistic models was assessed taking into consideration the changes introduced into the log likelihood function. Alpha was set at 0.05.

Ethical issues. Ethical approval for the study was obtained, in the Dominican Republic, from the Human Research Subject Committee of the *Centro Nacional de Investigaciones en Salud Materno Infantil (CENISMI)* (National Research Center on Maternal and Child Health), and, in the United States, from the Institutional Review Board of the University of Miami.

RESULTS

BCG scar prevalence

The overall BCG scar prevalence found through the examination of the children's arms was 55.3% (85 644/ 154 887).

Sociodemographic characteristics and BCG scar presence

The characteristics of the children are shown, by gender, in Table 1. There was a similar presence of BCG scar among males and females. Statistically significant gender differences were found for nutritional status and age (*P* < 0.05).

Univariate analysis

The univariate analysis showed associations between several variables and the presence of BCG scar (Table 2). Malnourished children were less likely to have BCG scar than were children in the reference group (OR = 0.91; 95% CI = 0.87, 0.95). Age was also an indicator, with children 7-9 years old being less likely to have a BCG scar than were children 6 years old (the reference group for age) (*P* < 0.05).

Another factor that was associated with scar presence was geographic location (Table 2). In general, children

living in Mid School Regions (less than two hours' driving distance from the capital) were more likely to have a BCG scar than were children living in Santo Domingo, the capital of the Dominican Republic (reference category). In contrast, children living in the Other School Regions (more than two hours' driving distance from the capital) were generally less likely to present a scar than were children living in Santo Domingo (Table 2).

Multivariate analysis

The multivariate analysis used a full three-model variable since removal of each of the variables did not result in a different and significantly improved

pattern to fit the data. The multivariate analysis revealed the same pattern of significance observed in the univariate analysis, except for nutritional status, which no longer had a statistically significant affect on the scar's presence.

The Rosa Index

To further elucidate variance in the likelihood of having a BCG scar, the Rosa Index was used (Table 3). The Rosa Index evaluated the impact of 12 environmental variables (residence characteristics and school characteristics) on scar prevalence. The highest score for a particular school region could be 12 points, and the lowest could be zero. The higher the Rosa

TABLE 1. Scar prevalence, nutritional status, age, and place of residence (school region), by gender, in study of BCG scar prevalence, Dominican Republic, 2001–2002

Variable	Males		Females	
	No.[a]	%	No.[a]	%
BCG scar				
Yes	45 567	55.3	40 077	55.3
No	36 826	44.7	32 417	44.7
Nutritional status[b]				
Malnutrition	6 568	7.4	4 015	5.5
Adequate	82 393	92.6	68 479	94.5
Age (yr)[b]				
6	34 838	45.7	34 083	50.8
7	24 633	32.2	21 246	31.7
8	11 469	15.0	8 158	12.2
9	5 512	7.2	3 626	5.4
Place of residence (school region)				
Santo Domingo (capital)	14 389	17.5	13 030	18.5
Mid School Regions[c]				
Santiago	7 391	8.9	6 816	9.4
La Vega	7 228	8.8	6 101	8.4
Azua	6 319	7.7	5 545	7.7
San Cristóbal	5 663	6.9	5 062	6.9
San Pedro de Macorís	5 735	6.9	5 003	6.9
Monte Plata	1 908	2.3	1 577	2.2
Other School Regions[d]				
San Juan de La Maguana	5 148	6.3	4 421	6.1
Barahona	4 879	5.9	4 497	6.2
San Francisco de Macorís	4 424	5.4	3 743	5.2
Cotui	4 151	5.0	3 464	4.8
Puerto Plata	3 678	4.5	3 428	4.7
Higuey	3 194	3.9	2 751	3.8
Nagua	3 275	3.9	2 721	3.8
Monte Cristi	2 530	3.1	2 123	2.9
Mao	2 346	2.9	2 104	2.9

[a] Total sample size is different for each variable (e.g., scar, nutritional status, age, and place of residence).
[b] *P* < 0.05. For nutritional status: odds ratio = 1.36; 95% confidence interval: 1.3, 1.4, *P* < 0.05. For age: χ^2 = 601, *P* < 0.0001.
[c] The Mid School Regions are ones that are one to two hours' driving distance from the capital, Santo Domingo.
[d] Other School Regions are ones that are more than two hours' driving distance from the capital, Santo Domingo.

TABLE 2. Nutritional status, age, and place of residence (school region), by BCG scar prevalence and univariate odds ratio, with 95% confidence interval (CI), Dominican Republic, 2001–2002

Characteristic	No. positive/total	BCG scar (%)	Odds ratio	95% CI
Nutritional status[a]				
Adequate[b]	80 755/145 462	55.5	1.00	
Malnutrition	5 627/10 583	53.2	0.91	0.87, 0.95
Age (yr)[a]				
6[b]	40 453/69 328	58.4	1.00	
7	24 900/46 209	53.9	0.75	0.73, 0.78
8	10 176/19 799	51.4	0.73	0.71, 0.75
9	4 461/9 204	48.5	0.67	0.64, 0.70
Place of residence (school region)				
Santo Domingo (capital)[b]	16 129/27 553	58.5	1.00	
Mid School Regions[c]				
Santiago[a]	9 845/13 503	72.9	1.53	1.46, 1.59
San Cristóbal[a]	6 824/10 764	63.4	1.23	1.17, 1.28
Azua[a]	7 284/11 898	61.2	1.12	1.07, 1.17
San Pedro de Macorís[a]	5 934/10 874	54.6	0.85	0.81, 0.89
La Vega[a]	7 279/13 384	54.4	0.84	0.81, 0.88
Monte Plata[a]	1 256/3 516	35.7	0.39	0.37, 0.42
Other School Regions[d]				
San Francisco de Macorís[a]	5 341/8 212	65.0	1.32	1.25, 1.39
Nagua	3 529/6 069	58.1	0.98	0.93, 1.04
Mao	2 576/4 454	57.8	0.97	0.91, 1.04
Higuey[a]	3 121/6 026	51.8	0.76	0.72, 0.81
Monte Cristi[a]	2 346/4 659	50.4	0.72	0.67, 0.76
Cotui[a]	3 571/7 744	46.1	0.61	0.58, 0.64
Barahona[a]	4 134/9 421	43.9	0.59	0.56, 0.63
Puerto Plata[a]	3 085/7 154	43.1	0.54	0.51, 0.57
San Juan de La Maguana[a]	3 985/9 656	41.3	0.50	0.47, 0.52

[a] $P < 0.05$.
[b] Reference group.
[c] The Mid School Regions are one to two hours' driving distance from the capital, Santo Domingo.
[d] The Other School Regions are ones that are more than two hours' driving distance from the capital, Santo Domingo.

Index score, the better were the "ecological" characteristics of the school region. The correlation between the Rosa Index scores and the BCG scar prevalences for the school regions was statistically significant ($r = 0.54$, $P < 0.05$).

When the Rosa Index was included in the multivariate model (Table 4), nutritional status was reduced in significance ($P = 0.052$), and the subjects' age and the Rosa Index were independently associated with the presence of BCG scar ($P < 0.05$). Elevated Rosa Index scores were found in school regions with higher BCG scar prevalence values.

DISCUSSION

Our analysis of the data from the Census on Height and Weight indicates that a large proportion of the Dominican children aged 6–9 years old did not appear to have been vaccinated against TB.

Several factors appeared to contribute to the lack of BCG scar presence. Malnourished children were less likely to have a BCG scar than were children with adequate nutritional status, suggesting that population groups with better nutritional status may have a stronger response to BCG vaccine, or that poorer children may have been less likely to be vaccinated and/or immunized. In evaluating these findings, it is worth recalling common limitations of correlational studies, particularly the inability to link exposure with disease in particular individuals (15). The higher likelihood of malnourished children lacking a BCG scar raises the possibility that malnutrition negatively

affects scar development through its impact on the immune system (16). However, from our study, it was not possible to determine the schoolchildren's nutritional status in infancy or to ascertain if there was a relationship between this variable and the presence of a BCG scar. This highlights the importance of obtaining information regarding vaccination history in future census programs implemented in the Dominican Republic.

A second major limitation is related to the representation of average exposure levels, rather than actual individual values. Thus, while it may appear from correlational data that there is an overall positive or negative association, this might actually be masking a more complicated relationship between exposure and disease (15), in this particular case, vaccine administration and the presence of BCG scar. Therefore, in this type of study design, malnutrition should be considered as an indicator of health inequalities rather than as a disturbance in a particular individual's immune system.

The univariate and multivariate analyses indicate an interesting age-related pattern. Children from 7 through 9 years of age were less likely to have the BCG scar than were children 6 years of age. To some extent this may reflect changes in the quality of the BCG vaccination program (e.g., periods of high and low coverage) caused by such factors as vaccine storage conditions and vaccine availability (17, 18). The higher proportion of young children with a BCG scar may also reflect a general improvement in vaccination coverage. Other factors at the individual or programmatic level could also be associated with this trend, and they need to be considered in future studies, in which the unit of analysis should be students, and not school regions.

There were also statistical differences in scar prevalence according to geographical location (school region). Better access to the health care services in urban areas, greater availability of pediatricians, and inability of the Dominican EPI to cover all regions of the country, especially the very poor regions along the border with

TABLE 3. Factors and their point value for the Rosa Index possession score used to categorize school regions in the Dominican Republic according to the characteristics of the homes and the schools in each of the school regions, 2001–2002[a]

Factor	Points		
	0	0.5	1.0
House characteristics			
Monthly household income (< US$ 83)	> 80%	50%–80%	< 50%
Homeownership	< 35%	35%–60%	> 60%
Poor quality of the house	> 50%	35%–50%	< 35%
Source of water is tap in the house	< 40%	40%–65%	> 65%
Flush toilet in the house	< 10%	10%–20%	> 20%
Trash collection (public/government)	< 25%	25%–40%	> 40%
Electricity	< 50%	50%–80%	> 80%
Stove	< 60%	60%–80%	> 80%
School characteristics			
School with good (cement) construction	< 25%	25%–40%	> 40%
Flush toilet in the school	< 25%	25%–40%	> 40%
Trash collection for the school (public/government)	< 20%	20%–35%	> 35%
School receives food[b]	> 70%	50%–70%	< 50%

[a] Using the Rosa Index approach, a total possession score was assigned to each school region based on points given for the mean value of monthly household income for the region as well as the residential characteristics and the school characteristics for each region. For example, a score of 0 points was given to a particular school region if more than 80% of the residents reported having a monthly household income of less than US$ 83 (using the 2002 US$ exchange rate in the Dominican Republic). In contrast, a score of 1 point was given to a particular school region if more than 60% of the residents reported homeownership. The highest score for a particular school region could be 12 points, and the lowest could be zero. The higher the Rosa Index score was, the better were the "ecological" characteristics of the school region.

[b] The poorest areas were prioritized to receive food (breakfast) from the government.

TABLE 4. Adjusted odds ratio and 95% confidence interval (CI) from multivariate logistic regression predicting the presence of BCG scar, including the Rosa Index in the model, Dominican Republic, 2001–2002

Predictor variable	Odds ratio	95% CI	P
Nutritional status			
Adequate[a]	1.00		
Malnutrition	0.96	0.92, 1.00	0.052
Age (yr)			
6[a]	1.00		
7	0.86	0.84, 0.88	0.02
8	0.79	0.77, 0.82	0.03
9	0.75	0.72, 0.78	0.03
Rosa Index score[b]	1.11	1.10, 1.12	0.02

[a] Reference group.

[b] The highest Rosa Index score, 11, was for the Santo Domingo school region, which was the reference group.

Haiti (17), may also have contributed to this pattern.

BCG coverage in Santo Domingo, the capital, was expected to be higher than in other areas of the country since a variety of factors affecting the probability of being vaccinated, including better socioeconomic conditions and improvements in public health policies, are present in this area. However,

children living in some of the school regions approximately one or two hours' distance from Santo Domingo were actually more likely to have a BCG scar than were children living in the capital. These unexpected results may be related to different logistic procedures of the Dominican EPI and to other, unknown factors inherent to those school regions that were not ex-

amined in this study and that will need to be considered in future research.

To increase understanding of other variables that could be impacting coverage, the Rosa Index, which included more "ecological" variables, was created. Our results indicate a relatively strong correlation between BCG scar prevalence and the Rosa Index ($r = 0.54$), suggesting that BCG prevalence could be related to factors impacted by poverty and other environmental characteristics. Nutritional status was only significant when the Rosa Index was included in the multivariate model. There was a positive correlation pattern between BCG scar prevalence and the Rosa Index, with the school regions with a higher Rosa Index score having a higher BCG scar prevalence. This finding suggests a potential role for poverty in vaccination effectiveness.

It is important to note that a number of factors that were not represented in the Rosa Index could have had an important impact on scar presence. These factors include the type of legal guardian (mother vs. stepmother, father, etc.), legal guardian's education, legal guardian's employment status, child's history of BCG vaccination, and child's birthplace (home, rural clinic, private clinic, etc.). Future census work in the Dominican Republic will need to evaluate multiple ecological factors in order to provide a broad perspective.

This was a population-based study, and the rate of attendance in the Dominican Republic for children in elementary school is 99% (19). Consequently, the findings represent Dominican children between 6 and 9 years of age among different school regions of the country. The findings also overcome the limitations reported in previous, hospital-based surveys of BCG coverage implemented in the Dominican Republic (17, 18). Nevertheless, we recognize that including additional variables related to EPI logistical procedures, children of different ages (e.g., newborn, infants), and household sociodemographic conditions could increase the predictive value of the statistical models for the

presence of BCG scar, and might provide a more thorough explanation for the vaccine coverage levels.

In summary, it appears that an appropriate goal for the Dominican health authorities would be to ensure that all children receive the protection afforded by the BCG vaccine. The Census on Height and Weight could be an important tool to monitor coverage not only with BCG vaccine but also with other vaccines in the Dominican EPI. The effectiveness of the Dominican EPI interventions needs to be monitored and to be measured in terms of community perceptions on such priorities as access to health care facilities and vaccine availability. Otherwise, community "ownership" of the EPI efforts is unlikely, and it is doubtful that the EPI objectives will be achieved, even though health care services are, in principle, available. Qualitative surveys could be included in the Census on Height and Weight, in order to learn what caregivers perceive as their priorities for increasing vaccination coverage, how vaccination programs fit into these priorities, and how the perceived priorities could be achieved within the context of the existing constraints such as poorer access to the health care services in rural areas and the inability of the Dominican EPI to cover the very poor regions of the country.

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RESUMEN

Relación entre los factores nutricionales y sociodemográficos y la probabilidad de que los niños de la República Dominicana tengan cicatriz de BCG

Objetivos. Evaluar críticamente la prevalencia de cicatrices por la vacunación con el bacilo de Calmette-Guérin (BCG) en niños de 6 a 9 años de la República Dominicana y examinar la relación entre los factores nutricionales y socioeconómicos y la probabilidad de tener cicatriz de BCG.
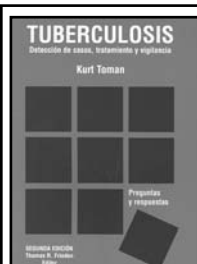
Métodos. Para este estudio correlacional se empleó la base de datos del II Censo Nacional de Talla y Peso en Escolares de Primer Grado de Básica, realizado en la República Dominicana entre agosto de 2001 y mayo de 2002, para evaluar críticamente el nivel de cobertura nacional de la vacunación con BCG. Entre la información censal de los niños estaban si tenían cicatriz de BCG, su estado nutricional y sus datos demográficos básicos. Se desarrolló un nuevo indicador sociodemográfico, el "índice de Rosa", para analizar la posible influencia de la pobreza y de otras características ambientales en la presencia de esa cicatriz. Se emplearon modelos de regresión logística para predecir la presencia de la cicatriz de BCG.

Resultados. La prevalencia general de cicatrices de BCG fue de 55,3% (85 644/ 154 887). Los niños desnutridos presentaron una menor probabilidad de tener cicatriz de BCG que los niños con un adecuado estado nutricional (razón de posibilidades = 0,91; intervalo de confianza de 95%: 0,87 a 0,95; *P* < 0,05). Los niños de 7–9 años tuvieron menor probabilidad de tener cicatriz de BCG que los niños de 6 años. Los niños de zonas del país que se encuentran a más de dos horas de viaje de Santo Domingo, la capital, presentaron menor prevalencia de cicatrices de BCG con mayor frecuencia que los niños de Santo Domingo. Se encontró correlación entre tener un mayor índice de Rosa (mejor nivel en las características socioeconómicas) y una mayor prevalencia de cicatrices de BCG (*r* = 0,54; *P* < 0,05).

Conclusiones. Los resultados del presente estudio indican que la cobertura de vacunación de escolares con la vacuna BCG parece no ser la adecuada en la República Dominicana. Sin embargo, la presencia de la cicatriz de BCG en una mayor proporción de niños más pequeños puede indicar que esa cobertura ha mejorado en años recientes. Se debe hacer un mayor énfasis programático y económico para extender la vacunación temprana con BCG a las áreas del país donde la cobertura de vacunación es menor y para analizar el papel que puede estar desempeñando la pobreza en la eficacia de la vacunación.

Palabras clave   Tuberculosis, vacuna BCG, cicatriz, vacunación, vigilancia de la población, factores socioeconómicos, República Dominicana.