

Immunization coverage in Italy*

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In Italy information on immunization coverage against pertussis, measles, and rubella is absent or incomplete. In 1985 the Istituto Superiore di Sanità (ISS) organized a series of immunization coverage surveys for these diseases in several local health units (Unità Sanitaria Locale) (USL). The surveys were conducted simultaneously in 80 USLs in 1985 with modified EPI cluster sampling techniques, using schools attended by children aged 3 to 10 years as the clusters. Information on previously performed immunizations was collected for each child sampled. The total immunization coverage and proportion of immunized children in eight birth cohorts were calculated.

Low immunization coverage was reported by the USLs surveyed, and regional differences in the coverage were apparent between the north, centre, and south of Italy. In addition, a steady or decreasing trend in the use of pertussis vaccine was found, while an increasing coverage was observed for measles and rubella immunizations.

In December 1984 a WHO European Conference on Immunization Policies took place in Karlovy Vary, Czechoslovakia, and a series of recommendations on immunization policies and practices were signed by all the member states of the European Region. One of these recommendations stated that "by 1985 all countries should be reporting their immunization coverage annually and should indicate the methods used in collection of data" (1).

In Italy three vaccine-preventable diseases (poliomyelitis, diphtheria, and tetanus) are controlled by the compulsory immunization of all newborns, and the coverage, which was estimated by a seroepidemiological survey (2), is very close to 100%. For these immunizations, an official record is kept at local health units (Unità Sanitaria Locale (USL)),^a and schools require a certificate of immunization from pupils upon entry. For the other vaccine-preventable diseases included in the WHO Expanded Programme on Immunization (EPI), immunizations are only recommended, e.g., for measles and rubella, or left to the parents' decision, e.g., pertussis. Mumps immunization is also recommended but the vaccine is not yet marketed in Italy. These recommended

vaccines are often administered by private paediatricians and records are not available in the USL or with families. For measles, mumps, pertussis, and rubella, vaccine uptake is unknown; however, the few knowledge-attitude-practice studies indicate that the levels are quite low (3, 4).

In order to investigate a standardized method for estimating the immunization coverage for pertussis, measles and rubella, the Istituto Superiore di Sanità (ISS) coordinated a series of surveys in 1985. During the study, data on the incidence of four EPI target diseases (pertussis, measles, rubella, and mumps) were also collected.

Here, we report the results on immunization coverage in the 80 USLs where the surveys were carried out, using a cluster sampling method in which schools were taken as clusters. Since in Italy the target age groups for pertussis, measles, and rubella immunization are different, the surveys included children aged from 3 to 10 years and information was collected on previously performed immunizations in order to define not only the point prevalence of these diseases in 1985 but also the children's immunization history.

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^a The USL is the basic unit of the Italian National Health Service. Each USL serves a population of between 50 000 and 200 000 inhabitants and is in charge of delivering primary health care.

MATERIALS AND METHODS

Enrolment in the study

In January 1985, a letter was sent to each of the 670 USLs in Italy, asking whether they were interested in participating in a survey of some vaccine-preventable diseases. Those who responded positively received a

preliminary survey protocol and were asked to send the ISS a complete list of all the schools (private and public) attended by children aged 3 to 10 years in their area, specifying the total number of registered children for each school. In mid-April 1985, positive respondents were invited to attend a 1-day meeting to discuss details of the protocol, and the occasion was used also to distribute the questionnaires, letters, envelopes, random tables, and coding sheets needed for the survey.

Pilot study

A pilot study was carried out in one USL in Rome to test the cluster random sampling methods, the questionnaire, the coding, and the general organization of the survey. The results obtained were presented during the 1-day meeting and were taken into account when elaborating the final draft of the survey.

Survey

In order to simplify the overall organization of the study, children in kindergarten (aged 3 to 5 years) and in primary school (aged 6 to 10 years) were taken as the target population.

The sampling method used was a modification of the EPI cluster sampling method (5). As in the EPI method, the proportion of immunized children was assigned a value of 0.5 (in order to maximize the size of the sample). For estimates, a precision of 10% and confidence limits of 95% were considered to be acceptable. This led to a sample size of 96 children, which was increased twice for the 3–5-year age group and three times for the 6–10-year age group, according to Cornfield's observations on cluster sampling size (6).

All public and private schools were identified within each USL. The schools were treated as clusters, and the proposed sample of 500 children was divided into 10 clusters: four in kindergarten schools and six in primary schools. The ten schools were selected, with probability proportional to size, during the 1-day meeting held at ISS. Within each cluster, 50 children were then randomly chosen from the main school list by the USL staff involved in the survey.

A standard form together with a letter of invitation to cooperate was given to each child included in the study. Parents were asked to record information on the form about the immunization history of their child for poliomyelitis, pertussis, measles, and rubella, as well as pathological anamneses for measles, pertussis, rubella, and mumps. The questionnaires were collected and a first rough data validation was performed by the USL staff, who checked the general consistency of the questionnaires before coding them.

All the surveys were carried out in May and June 1985.

Analysis

Data analysis was centralized. The original questionnaires were retained by the USLs and the record sheets sent to ISS: the data were entered into an IBM 4341 computer. The internal validity of data was checked at two levels. Firstly, for any single questionnaire, by a computer program designed to detect omissions or inconsistent entries. Input errors were then either corrected or the record was deleted. Secondly, parents' replies to the questionnaire were validated by cross-checking with indirect indicators such as the history of the child's poliomyelitis immunization and consistency of reported rubella immunization with the target group. Data were analysed using BMDP software (7). The analysis was carried out separately for each USL. Since the geographical distribution of the USLs might have affected the results, and since immunization practice is not homogeneous in Italy, the final analysis was carried out according to the following three main geographical areas: north, central, and southern Italy.

The immunization coverage in each USL was calculated, and for each of the three geographical areas the proportion of immunized children was expressed by the mean and the median of the distribution. In the sampling framework used, children aged 3–5 years were over-represented compared to the national population; a standardized immunization coverage was therefore determined by a direct method using the population of 3–10-year olds reported in the 1981 Italian census. Since there is high variability of coverage among the USLs, the range was also determined.

The total immunization coverage for the samples, including children born in different years, reflects the interaction of at least two factors: the age of the child and the year. The probability that a child is immunized in a certain period depends on whether he or she is in the target age group when the vaccine (which is not given routinely) is offered. The proportion of immunized children by birth cohort was first calculated and the linear trend of the proportions tested using the Cochran method (8). For each cohort the approximate age (computed as the difference between the year of birth and that of the reported immunization) when most of the immunizations were performed (measles and rubella) or completed (third dose of pertussis) was also calculated.

RESULTS

Eighty-six USLs (12.8% of those in Italy) in 19 out of the 20 regions of the country completed the survey

by June 1985 and returned their code sheets to ISS. Six USLs (7%) were excluded from the analysis because their sample included less than 400 children. The distribution of the 38 755 USL immunization records by geographical area is shown in Table 1, while Table 2 shows the distribution of children by year of birth and geographical area. The age and sex distributions in the three geographical areas were homogeneous (Kolmogorof and Smirnof test, $P > 0.05$). For the 80 USLs, Table 3 shows, by geographical area, the mean, median, and range of reported coverage for poliomyelitis immunization as well as the mean adjusted for age, median, and range of the proportion of children who completed the third dose of pertussis immunization. Also shown are the results of a similar analysis for measles and rubella immunizations. For poliomyelitis the results are consistent with previously reported values, while for pertussis the coverages are low with small differences between the north (14.9%), centre (15.6%), and south (11.5%). The highest coverage against pertussis was reported by a USL in the north, where 58.3% of the children sampled were immunized. For measles the coverage reported was even less than that

Table 3. Reported immunization coverage for poliomyelitis, third dose of pertussis vaccine, measles, and rubella

	Coverage (%)		
	Mean	Median	Range
<i>Poliomyelitis</i>			
North	98.2	99.6	84.8-100
Centre	98.8	99.6	95.5-100
South	98.1	98.7	90.9-100
<i>Third dose of pertussis</i>			
North	14.8 (14.9) ^a	9.2	1.4-58.3
Centre	15.2 (15.6)	12.2	1.3-34.0
South	11.5 (11.5)	9.6	2.5-29.6
<i>Measles</i>			
North	12.6 (12.0)	10.8	0.8-42.9
Centre	10.3 (9.9)	7.1	1.4-46.0
South	4.1 (4.0)	4.1	1.0-10.3
<i>Rubella^b</i>			
North	28.7	28.8	0-94.4
Centre	11.3	6.3	0-44.8
South	6.1	3.2	0-53.8

^a Figures in parentheses are standardized means calculated using the national population in the same age group in the 1981 Italian census.

^b Data refer to 10-year-old girls, the target population for rubella immunization in Italy.

Table 1. Distribution of immunization records by geographical area for the 80 local health units (USL) that participated in the survey

	No. of USLs	No. of valid records	No. of invalid records	No. of non-respondents	Total
North	37	17 743	621	327	18 364
Centre	24	11 167	171	46	11 338
South	19	8 899	154	43	9 053
Total	80	37 809 (97.6) ^a	946 (2.4)	416 (1)	38 755

^a Figures in parentheses are percentages.

Table 2. Distribution, by geographical area and year of birth, of the children sampled in the surveys

	Year of birth							Total	
	1974	1975	1976	1977	1978	1979	1980		1981
North	2340	2477	2176	1898	1907	2654	2307	1922	17 681
Centre	1285	1483	1402	1285	1291	1635	1472	1259	11 112
South	991	1144	1163	1069	1106	1261	1154	984	8872
Total	4616	5104	4741	4252	4304	5550	4933	4165	37 665 ^a

^a For 144 records, the year of birth was missing.

for pertussis (north, 12%; centre, 9.9%; and south, 4.0%) and there was a greater variation among the geographical areas. For rubella the highest coverage was in the north, where some USLs reported complete immunization of the target group.

The immunization coverage for pertussis and measles by year of birth and by geographical area is shown in Table 4. A decreasing trend for pertussis immunization was observed in the southern area and in the central area, where the proportion of immunized children in the 1981-birth-cohort was only 36% that of the 1974-birth-cohort.

An increasing trend in immunization coverage against measles was evident in the north and centre, while in the south the proportion of immunized children remained low over the period considered.

Immunization coverage against rubella among children aged less than 10 years was also low and was omitted from the analysis.

All answers affirming that a particular vaccine had been given also had to specify the year it had been administered; however, this information was not supplied on a variable proportion of questionnaires: for pertussis and measles immunizations the proportion of non-responders was related to the year of birth, presumably corresponding to the vaccination experience. In the north the proportion of non-responders to the year of pertussis immunizations varied between 17%, for children aged 10 years, to 10%, for those aged 3 years. In the centre and in the south of the country the same trend was observed, but the limits were from 27% to 15% and from 46% to 22%, respectively.

The proportion of parents who stated that their children had been immunized against measles, but who did not specify the year of immunization, was even more variable and was negatively correlated with the age of the children. In the north this proportion varied between 44% and 6%, in the centre between 26% and 7%, and in the south between 65% and 18%.

Since only one birth cohort was the target age group for rubella immunization, the proportion of non-responders by age was not calculated. Also, the age-specific proportion of immunizations performed was not computed because of the trend of non-responders by birth cohort. Moreover, in the absence of the exact date of immunization, the age of the children at this time was estimated from the difference between the year of birth and the year of immunization. The third calendar year after birth was taken as the best estimate for the age of children of at least 2 years old.

For children who were fully immunized against pertussis, the proportion of those who received three doses of the vaccine in their third year of life differed according to birth cohort and geographical area. The highest values were reported for children born in 1981: 87% in the north, 82% in the centre, and 50% in the south. A specific age at which most of the measles immunizations were performed was not evident; however, in the north and centre most were given to children in the fourth year of life, i.e., to children aged at least 3 years, while in the south, because of the low coverage, a reliable estimate could not be made.

Table 4. Reported immunization coverage for pertussis and measles vaccines by year of birth

	Coverage (%)							
	1974	1975	1976	1977	1978	1979	1980	1981
<i>Measles</i> ^a								
North	5.7	7.9	8.6	10.4	15.0	14.8	18.3	21.7
Centre	5.5	7.0	7.7	10.6	10.8	12.2	14.8	13.0
South	4.3	4.5	4.4	4.6	3.1	4.4	4.0	3.4
<i>Pertussis</i> ^b								
North	14.8	15.7	15.8	13.1	15.3	14.2	16.2	13.6
Centre	22.9	21.2	16.3	13.9	12.9	13.0	12.6	8.2
South	10.5	15.0	13.7	12.8	10.8	10.3	9.6	8.9

^a Tests for linear trend. North: $\chi^2 = 409.42$, $P < 10^{-6}$. Centre: $\chi^2 = 107.22$, $P < 10^{-6}$. South: $\chi^2 = 1.55$, $P = 0.21$.

^b Tests for linear trend. North: $\chi^2 = 0.62$, $P = 0.43$. Centre: $\chi^2 = 147.52$, $P < 10^{-6}$. South: $\chi^2 = 17.29$, $P < 10^{-4}$.

DISCUSSION

The EPI method of evaluating immunization coverage employs a cross-sectional survey with cluster random sampling of a specific population. The age group surveyed represents the target for the immunization programme, while the immunization coverage is given by the proportion of children in the sample who have been immunized during the year. This proportion is used to estimate the extent to which the immunizations are performed. The EPI method has been successfully applied in many developing countries but its use in developed countries, such as Italy, requires some modifications, as outlined below.

Firstly, the main aim of an EPI survey, which is to evaluate the proportion of immunized children, may be unsuitable in a developed country, where the coverage of a programme can be evaluated by routine

reporting of immunizations performed by dose of vaccine and age group, provided that the population of the target age group, or at least the number of newborns by year, is known. If a consolidated immunization programme does not exist, the EPI survey can be used to collect information on activities not organized in a nationwide health programme.

In Italy, poliomyelitis, tetanus, and diphtheria immunizations are compulsory for all newborns, and the routine reporting system provides data for the evaluation of immunization coverage. The number of immunizations against pertussis, measles, and rubella, however, depends mainly on whether the vaccine has been actively offered by a USL or at least recommended by private paediatricians. A heterogeneous coverage was expected according to the different degrees of public awareness and education on specific immunization practices. It was therefore decided that a series of EPI surveys was the only method of collecting information on the coverage in different local situations, even though not randomly selected. Also, the target population was not the same for all the immunizations considered here; for example, pertussis immunization is recommended within the first 2 years of life (and, in any case, is never given to children aged more than 3 years), while measles vaccine is recommended for children aged between 15 months and 8 years. Rubella immunization has been officially recommended in Italy for girls aged 10 years. Such a state of affairs requires different cross-sectional surveys, one for each target age group. Moreover, a household survey would have encountered major problems because of non-responders and would have been more costly and time-consuming than a survey of schools. Since a high proportion of children attend schools in Italy, the clusters used were considered representative of the entire target population.

Furthermore, immunization coverage was expected to vary not only geographically but also with time. It was also reasonable to expect a decrease in the uptake of pertussis vaccine, following reports of adverse reactions to it, and an increase in the uptake of measles and rubella, as a result of recent health education campaigns. The cross-sectional EPI survey would therefore have given only an estimate of the point prevalence of immunization coverage, which is of limited use, and it was therefore decided to couple the survey with a retrospective longitudinal study in order to determine the negative or positive trends of some immunization practices.

The quality of the data we collected requires comment. No records of voluntary immunizations are kept in Italy, and the reports by children's parents in the self-administered questionnaire were taken to be correct. It has been reported that parents' recall of an

episode of measles or pertussis is consistent with the immunological status of the children or with medical records (9, 10), and there seems therefore to be no reason to believe that their memories are less reliable for events such as immunization. The reported high proportion of children immunized against poliomyelitis was used as an indirect indicator of the general validity of the replies on the questionnaires. Nevertheless, the impossibility of checking our basic data has to be recognized as a disadvantage.

Most of the 80 surveys indicated that the proportion of children immunized against a particular disease was low.

Despite the decreasing trend for pertussis immunization in central and southern Italy, immunization against this disease seems to be the most uniform of those studied in the three geographical areas, although there were some differences in the age (approximately computed) at which it was performed. In the south, only 50% of immunized children were reported to have received the vaccine within the first 3 years of life, while, according to the recommended schedule, the three doses should be administered before children reach their second birthday. The importance of this observation is not limited to pertussis immunization, but this vaccine is administered in combination with diphtheria and tetanus toxoid (as DPT), and indicates a delay also for these compulsory immunizations. Geographical location seems to be the major source of variation for measles and rubella immunization, with the chance that a child is immunized decreasing progressively from the north to the centre to the south of the country.

Despite the health education campaigns carried out almost everywhere in Italy for promoting measles and rubella immunizations, the coverages reported are quite low. It is interesting to note that only for rubella, for which the target group has been operatively defined (girls attending the last year of primary school) by official recommendations, did some USLs report immunization coverages approaching 100%.

Attitudes to immunization practices were disease-specific: in the same USL a high immunization coverage for one disease, e.g., rubella, was rarely associated with a high coverage for others, e.g., measles, indicating that immunization practice was almost always oriented towards one specific disease and not integrated into a wider programme. Although the 80 USLs were not randomly selected, the results obtained are the only ones available for such a large number of children in Italy, and they agree with rough estimates of immunization coverage reported by the Ministry of Health. Until a routine examination programme is introduced, these results should be updated by cross-sectional EPI surveys.

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North. Piedmont: USLs 1, 5, 24, 43, 60, 63, 66, 70, 72, 76. Lombardy: USLs 62, 75. Trentino-Alto Adige: USLs BZ/1, TN/5. Veneto: USLs 7, 9, 18, 19, 28. Friuli-Venezia Giulia: USLs 6, 9, 11, 12. Liguria: USLs 2, 7, 9. Emilia Romagna: USLs 3, 4, 11, 17, 20, 22, 23, 29, 35, 36.

Centre. Tuscany: USLs 10/A, 10/D. Umbria: USLs 5, 6, 10. Marches: USLs 4, 10, 11, 15, 16. Latium: USLs RM/7, RM/9, RM/10, RM/12, RM/14, RM/16, RM/26, RM/29, FR/4, FR/7, LT/6, VT/4, VT/5, RI/1.

South. Abruzzi: USLs 5, 6, 12, 13, 14. Molise: USL 1. Campania: USLs 5, 22, 39, 40. Apulia: USL FG/9. Basilicata: USL 6. Calabria: USLs 20, 31. Sicily: USLs 24, 29, 55. Sardinia: USLs 1, 5.

RÉSUMÉ

COUVERTURE VACCINALE EN ITALIE

Afin d'évaluer la couverture vaccinale pour certaines vaccinations non obligatoires (contre la coqueluche, la rougeole et la rubéole) en Italie, l'Istituto Superiore di Sanità (ISS) a encouragé et coordonné une série d'enquêtes en 1985 dans plusieurs "unités sanitaires locales" (USL) en utilisant une méthode d'échantillonnage par grappes. On a pris comme grappes les écoles fréquentées par les enfants de 3 à 10 ans; chaque USL a choisi 10 de ces écoles pour les besoins de l'enquête. Dans chaque grappe, 50 enfants ont été choisis au hasard sur la liste d'élèves, de façon à former un échantillon total de 500 enfants pour chaque USL. Les données sur les vaccinations passées ont été recueillies au moyen de questionnaires remplis par les parents des enfants choisis. Au total, 80 USL réparties sur l'ensemble du pays ont procédé à cette enquête sur une période de deux mois, enquête qui a porté sur plus de 38 000 enfants. Les données reçues ont été utilisées pour calculer le taux global de couverture vaccinale et déterminer les vaccinations pratiquées sur des cohortes de naissance.

Pour l'analyse, on a regroupé les USL en régions géographiques (nord, centre et sud). D'après les réponses, la proportion d'enfants ayant reçu la troisième dose de vaccin anticoquelucheux était de 14,8% dans le nord, 15,2% dans

le centre et 11,5% dans le sud, avec un intervalle de valeurs variable selon l'USL. Dans le nord, les cohortes d'enfants nés entre 1974 et 1981 présentaient la même couverture vaccinale contre la coqueluche alors que dans le centre et dans le sud, on observait une diminution croissante de cette couverture chez les cohortes les plus jeunes.

La couverture vaccinale antirougeoleuse et antirubéolique présentait de plus grandes variations selon la région. La couverture moyenne contre la rougeole était de 12,6% dans le nord, 10,3% dans le centre et 4,1% dans le sud. L'analyse par cohortes de naissance a montré une augmentation de la proportion d'enfants vaccinés chez les cohortes les plus jeunes dans le nord et dans le centre. En ce qui concerne la rubéole, la vaccination vise essentiellement les filles de 10 ans, pour lesquelles la couverture moyenne était de 28,7% dans le nord, 11,3% dans le centre et 6,1% dans le sud.

La série d'enquêtes rapportées a permis non seulement d'évaluer la prévalence ponctuelle mais également de décrire la tendance de la couverture vaccinale. Les données obtenues serviront de référence pour toute évaluation future de la couverture vaccinale contre la coqueluche, la rougeole et la rubéole en Italie.

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