*Send Orders of Reprints at bspsaif@emirates.net.ae*

*The Open Public Health Journal*, **2013, 6, 1-5** **1**

**Open Access**

# Estimation of the Immunization Coverage in Mayotte in 2010

Solet Jean-Louis*[,a], Baroux Noemie, Lernout Tinne, Filleul Laurent, Petit Alice[b], de Montera Anne-Marie, Mazeau Fabienne[c] and Folliot-Garou Florence[d]

[a]*Institut de veille Sanitaire, InVs, Département de coordination des alertes et des regions, Cire ocean Indien, Saint-Denis, Reunion*

[b]*Mayotte Hospital Centre, Mamoudzou, Mayotte*

[c]*Mayotte Subsidiary Education Authority, Mamoudzou, Mayotte*

[d]*Nursing Care Training Institute, Mayotte Hospital Centre, Mamoudzou, Mayotte*

**Abstract:** *Objectives:* A survey was carried out in 2010 in order to assess the immunization coverage among children and adolescents living in Mayotte, a French collectivity located in the South Indian Ocean.

*Methods:* This is a transversal two-stage cluster survey. Data was collected for 676 randomly selected children aged 24 to 59 months, 692 children aged 7 to 10 years and 590 adolescents aged 14 to 15 years based on immunization cards.

*Results:* The immunization coverage among children aged 24 to 59 months was high (close to 95%), with the exception of Hib (90%). For children aged 7 to 10 years, the immunization coverage was inadequate (≤ 82%) except for hepatitis B and BCG (>90% coverage). For adolescents aged 14 and 15, coverage rates were low (≤ 75%) and far below the target levels.

*Conclusion:* We recommend a better monitoring of the vaccination status including a follow up and a catch-up vaccination among children and teenagers.

**Keywords:** Immunization coverage, immunization, Indian Ocean, Mayotte, vaccination.

## INTRODUCTION

Mayotte is a French collectivity that became the 101st French *département* in April 2011; it is located in the Mozambique Channel and is part of the Comoro Islands. It has an area of 374 km² and consists of two main islands, Petite-Terre and Grande-Terre, and approximately 30 islets scattered around these two. The population is estimated at 186,287 (2007 population census), of which 54% is under 20.

Due to its geographical location, a humid tropical climate, and often crowded housing and living conditions, Mayotte remains exposed to infectious diseases, including those that can be prevented through immunization. Up until 2010 no survey on immunization coverage had been carried out in Mayotte. Routine coverage data are collected by Mother and child protection (MCP) services but only for those children consulting their clinics.

The vaccination calendar in Mayotte is in line with national recommendations [1] completed by BCG vaccination for newborns in a context of tuberculosis endemicity. The immunizations are free of charge for children under six in all the MCP clinics. For children over six and adults, vaccination is implemented mainly through the public hospital (vaccination center) and healthcare centers.

Following a measles outbreak in 2005 [2] and the identification of a case of indigenous diphtheria in an infant in 2007 [3], two immunization campaigns were organized by the health agency in Mayotte (Agence de santé ocean Indien, ARS OI). In 2006, an initial campaign against measles, mumps and rubella (MMR) targeted primary school children. Between November 2008 and June 2009 a second immunization campaign against diphtheria, tetanus, polio (DTP) and pertussis as well as catch-up immunizations for MMR took place in schools (both primary and secondary, 5-14 years old).

In 2010, a survey was conducted to assess the vaccination coverage for children and adolescents living in Mayotte. The aim of the survey was to assess the immunization status of i) mandatory vaccinations : diphtheria, tetanus, polio (DTP) and ii) recommended vaccinations : pertussis, *Haemophilus influenzae* type B (Hib) hepatitis B (Hep B), measles, mumps, rubella (MMR) and BCG. Targeted age groups were children aged 24 to 59 months, 7 to 10 years and adolescents (14-15 years).

The results of this survey should allow public health authorities to identify vaccination objectives to achieve and to as-

*Address correspondence to this author at the Institut de veille Sanitaire, In Vs, Département de coordination des alertes et des regions, Cire ocean Indien, Saint-Denis, Reunion; Tel: 262 (0)2 62 93 95 41;
Fax: 262 (0)2 62 93 94 57; E-mail: Jean-louis.solet@ars.sante.fr

**1874-9445/13** **2013 Bentham Open**

sess the outcome of immunization campaigns implemented over the past few years in order to adjust the local policy.

## METHODS

The survey was coordinated by the regional office of the French Institute for Public Health Surveillance (*Institut de Veille Sanitaire* [FIHS].

A two stage cluster sampling design as recommended by the Expanded Program on Immunization (EPI) of World Health Organization was used [4]. For each age group, the sample size was estimated at 600 individuals, based on an estimated immunization coverage ratio of 80%, a cluster effect of 2, and a precision of 4.5%. The survey was conducted from May 17 to June 11, 2010.

Based on 2007 census data, a two-step sampling procedure selected 80 of the 783 districts proportional to the number of inhabitants in each district. Then households were selected within each district using a stereotyped walk from a randomly selected start. The first 8 children aged 24 to 49 months and the first 8 children aged 7 to 10 years were enrolled in the study. Demographic data (gender, date and place of birth) was collected by interview of the parents. Information on vaccination history (name of vaccine, date and place of administration) was collected through vaccination cards, by medical interviewers. Children without vaccination card were nevertheless included in the study. A second house visit was carried out in case of absence of the inhabitants.

For adolescents, a two-stage cluster sampling survey was carried out in schools. A total of 600 students aged 14 to 15 were randomly selected among 18 of the 19 junior high schools in Mayotte (as one didn't wish to participate), proportionate to the size of the schools. Data on immunization status as recorded on the individual vaccination cards were collected by school health nurses.

Double data entry was performed using the Epidata software program (version 3.1). No personal data were entered. Data were analysed using Stata 11® (StataCorp, College Station, Texas, USA).

A child or adolescent was considered to be fully immunized if he or she did receive all vaccines as recommended by the French High Council of Public Health (HCSP) in its 2010 immunization schedule at the time the data were collected, regardless of the age at which the vaccines were administered. For each age group two analyses were performed: one taking into account only those individuals that had an immunization card (higher estimate) and the other involving all respondents, with the assumption that those without an immunization card were not immunized (lower estimate). Comparisons between ratios were performed using the $\chi^2$ test or the Fisher exact test. Immunization coverage and 95% confidence intervals were adjusted for clustered survey design for each age group. Immunization coverage rates were compared with the critical threshold of collective immunity as defined in literature [5, 6]. P values <0.05 were considered statistically significant.

A second analysis concerned timeliness of vaccination for completely immunized individuals, for each injection and each antigen, according to the French immunization schedule.

## RESULTS

Out of 1,958 questionnaires collected, 1,909 were included in the study; 49 children who did not correspond to the inclusion criteria were excluded (Table **1**).

Vaccination cards were presented for 99.7% and 99.1% of children aged 24 to 59 months and 7 to 10 years respectively. In schools, vaccination cards were lost or not presented for 9% of the 14-15 year olds included in the study.

The sample was representative of the general population for sex, age and place of birth except for the gender distribution in the 14-15 years age group (men: 45.2% versus 49.8%; women: 54.8% versus 50.2%) and for a slight underrepresentation of individuals born in Comoros. Therefore, data were adjusted for this age group.

Since higher and lower estimates of immunization coverage were not statistically different for all age groups, only higher estimates are presented. Immunization coverage rates by antigen and by age group, as well as critical threshold of collective immunity as defined in literature [5, 6] are presented in Table **2**.

Among children aged 24-59 months, the immunization coverage was 94.6% for mandatory vaccinations (DTP) and greater than 90% for recommended immunizations, except for MMR (85.6%). Children aged 7-10 years had low immunization coverage rates, with the exception of hepatitis B and BCG for which values were higher than 90%. Immunization of adolescents was far below the levels needed for disease control (Table **2**).

The compliance with the national immunization schedule for each injection and each antigen is presented in Table **3**.

For DTP, pertussis and Hib, 75 to 84% of the children and adolescents have received the first injection after the recommended age (2 months). For the second and third in-

**Table 1. Number of Individuals Included in the Study by Age Group, Mayotte Immunization Coverage, 2010**

| | Nb. of Individuals Questionned | Nb. of Individuals Excluded | Nb. of Individuals Included |
|---|---|---|---|
| 24-59 months | 676 | 8 | 668 |
| 7-10 years | 692 | 13 | 679 |
| 14-15 years | 590 | 28 | 562 |
| Total | 1,958 | 49 | 1,909 |

**Table 2. Immunization Coverage Rate by Age Group and Threshold of Collective Immunity, Mayotte Immunization Coverage, 2010**

| | 24-59 Months | 7-10 Years | 14-15 Years | Critical Threshold of Collective Immunity (%) |
|---|---|---|---|---|
| | % CI[a] 95% | % CI[a] 95% | % CI[a] 95% | |
| DTP | 94.6 [92.7-96.5] | 69.1 [64.6-73.6] | 42.6 [36.4-48.9] | 80-85[b] |
| Pertussis | 92.3 [90.1-94.6] | 80.4 [76.1-84.6] | 32.4 [20.9-46.4] | 92-95 |
| Haemophilus b | 90.5 [87.9-93.2] | 82.0 [78.4-85.7] | 4.5 [2.3-8.9] | 95 |
| Hepatitis B | 94.9 [93.2-96.6] | 91.1 [88.6-93.6] | 75.0 [68.5-80.5] | Unknown |
| Measles | 85.6 [82.2-89.0] | 48.9 [42.4-55.4] | 61.1 [50.8-70.5] | 92-95 |
| Rubella | 85.6 [82.2-89.0] | 48.9 [42.4-55.4] | 68.3 [57.6-77.3] | 85-87 |
| Mumps | 85.6 [82.2-89.0] | 48.9 [42.4-55.4] | 59.9 [49.8-69.3] | 90-92 |
| BCG | 92.9 [90.7-95.2] | 93.3 [91.5-95.1] | 72.9 [63.9-81.8] | Unknown |

[a] Confidence Intervals
[b] Not applicable for Tetanus, Polio (80-86)

jections, the timeframe between injections was in line with the recommended schedule for 61 to 79% of the subjects. The situation is much less satisfactory with regard to first boost immunizations for these antigens, as more than 97% of injections were performed belatedly. Further booster immunizations were administered with a delay for 60 to 77% of second DTP and pertussis boosters respectively, and 49.5% of third DTP booster doses.

For the 29-59 months and 7-10 age groups, 90% of vaccinations were carried out at MCP facilities (Fig. **1**), except for the first dose of the hepatitis B vaccine, administered at the day of birth at maternity for 80% and 70% of children per age group respectively. The majority (60%) of immunizations of 14-15 year olds, including first injections, were administered in health centers, except for the first dose of the hepatitis B vaccine (71 % administered at maternity).

This survey allowed to assess – for the first time in Mayotte – the level of protection among children and adolescents against diseases that can be prevented through immunization.

We found that the immunization coverage for children aged 24-59 months was high for mandatory (DTP) and some recommended vaccines (pertussis, Hep B, BCG) but insufficient for Hib and MMR. For children aged 7-10 years the immunization coverage was insufficient, except for hepatitis B and BCG. Immunization of teenagers aged 14-15 years is far below targeted levels to prevent diseases.

Some coverage rates might have been underestimated. Immunization coverage for pertussis and *Haemophilus* among adolescents (14-15 years) is most likely widely underestimated. Since 78% of the brand names of DTP vaccines administered to this age group were not registered on the vaccination card, it was impossible to know if the vac-

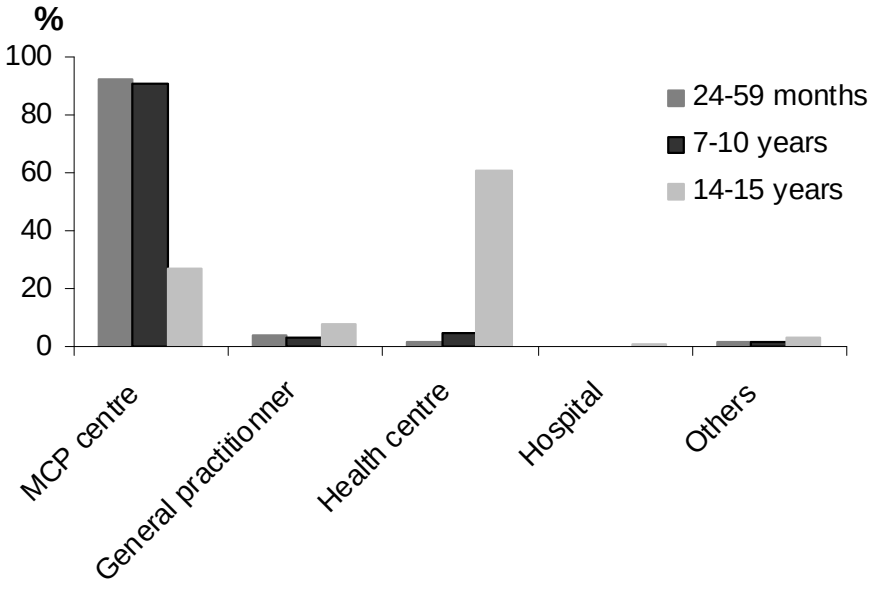


**Fig. (1).** Vaccinator by dose, Mayotte immunization coverage, 2010.

**Table 3. Percentage of Compliance with the French Immunization Schedule by Dose, by Antigen and by Age Groups, Mayotte Immunization Coverage, 2010**

| Vaccine | | 24-59 Months % | CI[a] 95% | 7-10 Years % | CI[a] 95% | 14-15 Years % | CI[a] 95% |
|---|---|---|---|---|---|---|---|
| DTP | 1st dose | 18.1 | [14.4-21.7] | 15.7 | [11.8-19.6] | 16.0 | [10.0-24.6] |
| | 2nd dose | 70.5 | [67.1-73.7] | 71.0 | [66.3-75.8] | 73.3 | [67.2-78.6] |
| | 3rd dose | 61.3 | [56.9-65.7] | 67.5 | [63.9-71.1] | 77.7 | [71.6-82.8] |
| | 1st boost | 0.8 | [0.1-1.5] | 1.9 | [0.7-3.1] | 1.1 | [0.1-8.8] |
| | 2nd boost | NA[b] | | 24.3 | [21.0-27.6] | 12.4 | [7.6-19.5] |
| | 3rd boost | NA[b] | | NA[b] | | 50.5 | [39.0-62.0] |
| Pertussis | 1st dose | 17.7 | [14.0-21.4] | 14.4 | [10.9-17.9] | 15.6 | [8.6-26.6] |
| | 2nd dose | 70.3 | [66.8-73.8] | 70.4 | [65.8-75.1] | 78.6 | [71.4-84.4] |
| | 3rd dose | 62.1 | [57.9-66.3] | 64.1 | [60.1-68.2] | 74.0 | [65.5-81.0] |
| | 1st boost | 1.1 | [0.3-1.9] | 1.5 | [0.5-2.4] | 1.4 | [0.1-12.7] |
| | 2nd boost | NA[b] | | NA[b] | | 9.0 | [4.4-17.8] |
| Hib | 1st dose | 18.5 | [14.7-22.2] | 16.2 | [12.4-20.0] | 25.0 | [6.8-60.3] |
| | 2nd dose | 69.9 | [66.1-73.9] | 71.5 | [66.8-76.2] | 59.0 | [11.4-94.2] |
| | 3rd dose | 60.9 | [56.7-65.1] | 65.9 | [61.3-70.4] | 66.0 | [22.8-92.7] |
| | 1st boost | 1.1 | [0.2-1.9] | 1.5 | [0.5-2.5] | 0 | |
| Hepatitis B | 1st dose | 93.7 | [91.3-96.1] | 91.5 | [89.0-94.0] | 30.9 | [24.4-38.3] |
| | 2nd dose | 82.0 | [78.1-85.9] | 72.9 | [68.9-76.9] | 54.9 | [47.3-62.4] |
| | 3rd dose | 72.3 | [67.9-76.7] | 59.1 | [54.9-63.3] | 11.9 | [8.7-16.0] |
| MMR | 1st dose | 53.1 | [48.3-57.8] | 47.4 | [41.2-53.6] | 39.2 | [32.6-46.1] |
| | 2nd dose | 62.4 | [58.0-66.8] | 8.2 | [5.4-10.9] | 0.9 | [0.3-2.9] |
| BCG | | 36.9 | [32.6-41.3] | 25.4 | [20.4-30.4] | 68.4 | [61.3-74.7] |

[a] Confidence Intervals
[b] Not available

cine used contained other antigens than diphtheria, tetanus and polio. In the absence of any information, only the DTP antigens were taken into consideration, although it is very likely that vaccines containing other antigens as well have been used.

Routine vaccination against Hib being introduced in Mayotte in 1999, 14-15 year olds (born between June 1994 and May 1996) did not benefit from the vaccination. Therefore, although possibly underestimated, immunization coverage for Hib is very low (4.5%).

All children included in the survey were born after introduction of routine vaccination against hepatitis B in Mayotte in 1993. The results showed that this program of vaccination was largely followed among children aged 24 - 59 months and those aged 7 -10 years but much less for adolescents.

In 2005, the age of administration of the second dose MMR vaccine was lowered to 13-24 months instead of 3-6 years. This change did not influence the results of the coverage, since estimations are based on a 2-dose schedule regardless of the age at which vaccines were administered. On the other hand, it might explain most of the delays observed between the two injections among children aged 7-10 and 14-15 years (based on the 2010 vaccination program).

Despite of adequate vaccination coverage, immunity can still be inadequate at certain periods of children's lives due to the important delays observed.

The results of our study are subject to some limitations. The main selection bias affecting the internal validity of the study involves non-responders, who may present different characteristics influencing their vaccination status than the responders. However, compared with the 2007 census data, participants were representative of the general population for children aged 24-59 months and 7-10 years and the data were adjusted for the adolescents aged 14-15 years. For the 14-15 age group, around 10% of students didn't present their health cards. Furthermore, health cards were less well completed than for the younger age groups and vaccine brand names were often missing. Also, results of the survey are representative of adolescents attending school and might not be fully representative of the entire 14-15-year-old population living in Mayotte. Assuming that the health of children attending school is more closely monitored, this bias would overestimate the real immunization coverage for this age group. However, considering that 92% of children aged 6 to 16 years attend school (as evaluated by Insee in 2002), the impact of this potential bias remains limited [7].

Despite the two immunization campaigns conducted in 2006 and 2008-2009, the coverage for the age groups that would have benefited from it (7-10 years and adolescents) remains too low to avoid potential epidemic outbreaks, indicating that these campaigns did not achieve the expected results. Therefore, other strategies must be developed in order to obtain the required result.

Several strategies are recommended in order to improve the immunization coverage. They should target the increase of vaccination coverage through individual catch-up immunizations involving the various healthcare professionals (mother and child protection centers, hospital centre, school-based health care and medical practitioners) and improve the quality of data on vaccinations.

Following actions are required to significantly improve the immunization situation in Mayotte: routine monitoring by the MCP services of the immunization status of children at 24 months and 48 months;

- monitoring of the immunization status at every visit to the hospital and in healthcare centers and performing catch-up immunizations if needed;
- routine monitoring of the immunization status of children entering 2nd grade (7 years) by the school-based health care services;
- routine monitoring by the school-based health care services of the immunization status of children entering the 6th grade and 10th grade (11 and 15 years);
- catch-up vaccinations in health centers, at any time.

Implementing catch-up immunization campaigns might be considered, provided they are renewed over time so as to ensure compliance with all immunization schedules.

Improving the collection of immunization data by MCP services and school-based health care services is recommended in order to follow-up immunization coverage annualy, completed by periodic immunization coverage surveys. Building the awareness of healthcare professionals on the issue of immunization is also recommended.

## CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

The study was funded by the Indian Ocean Health Agency for a total amount of 17850 euros.

## ACKNOWLEDGEMENTS

We greatly acknowledge the delegation of Mayotte's Indian Ocean Health Agency for their financial support and the Mayotte Hospital Centre, as well as the Mayotte's Education Authority for facilitating the implementation of the survey.

We would also like to acknowledge the investigators, the nurses from the Mayotte Nursing Care Training Institute as well as nurses from the Ministry of Education who collected all the information in the field, the various individuals who helped with data entry as well as the person in charge of the Insee field office in Mayotte for his help in sampling. Thanks to all the children and their parents who participated.

## AUTHORS' CONTRIBUTIONS

JLS, NB and TL designed the study protocol. NB carried out analysis. JLS, TL, NB, and LF carried out the interpretation of the data and critically revised the manuscript for intellectual content. JLS drafted the manuscript. All authors read and approved the final manuscript. JLS is guarantor of the paper.

## REFERENCES

[1] Calendrier des vaccinations et recommandations vaccinales 2010 selon l'avis du Haut conseil de la santé publique. Bull Epidemiol Hebd 2010; 14-15: 123-36.

[2] D'Ortenzio E, Sissoko D, Landreau D, Benoit-Cattin T, Renault P, Pierre V. Outbreak of measles in Mayotte, Indian Ocean 2005-2006. Med Mal Infect 2008 ; 38(11): 601-7.

[3] D'Ortenzio E, Sissoko D, Renault P, Balleydier E, Solet JL, Cadivel A, Pierre V. Un cas de diphtérie autochtone à Mayotte. Cire Réunion Mayotte. Bulletin Epidémiologique de la Réunion et Mayotte, Epirem 2008 ; 3 : 15-6.

[4] Lwanga S, Sapirie S, Steinglass R, Stroh G, Wylie A. Immunization coverage cluster survey – Reference Manual. WHO 2005 ; 129p.

[5] Boëlle PY. Epidémiologie théorique et vaccination. La revue de médecine interne 2007 ; 28 :161-5.

[6] Fine PEM, Herd immunity : history, theory, practice. Epidemiol Rev 1993; 15: 265-302.

[7] Insee Mayotte info n° 15, février 2004, « la scolarisation à Mayotte ».

Received: September 15, 2012 Revised: October 22, 2012 Accepted: October 31, 2012