INTRODUCTION

Immunization is the process where by a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine ***(Candian immunization guide, 2015).***

Vaccines are a proven tool for controlling and eliminating life-threatening infectious diseases and is estimated to prevent between 2 and 3 million deaths each year. It is one of the most cost-effective health investments, with proven strategies that make it accessible to even the most hard-to-reach and vulnerable populations ***(WHO, 2015).***

The UNICEF estimates that 1.2 million deaths to children under five years of age could be prevented at low cost by vaccinating children. Despite the continuing high death toll, tremendous progress has been made in reducing deaths from vaccine preventable causes. Every year, three million children die world-wide from diseases that can be easily prevented with one to three doses of readily available vaccines ***(Saad et al., 2009).***

Vaccination coverage is the percentage of a target population that receives the full schedule of vaccinations. The schedule includes all the vaccinations recommended by the National Immunization Program (NIP), applied at the correct ages (epidemiological adequacy) and correct intervals (immunological adequacy). Combined institutional activities organized by the public sector at various levels are required to achieve adequate vaccination coverage ***(De Oliveria et al., 2014).***

Childhood vaccinations can prevent illness and death, but many children do not get vaccinated. There are a number of reasons for this. One reason may be that families lack knowledge about the diseases that vaccines can prevent, how vaccinations work, or how, where or when to get their children vaccinated. People may also have concerns (or may be misinformed) about the benefits and harms of different vaccines ***(Saeterdal et al., 2014).***

So, Knowledge of vaccination coverage facilitates monitoring the volume of susceptible individuals in the population as well as the identification of factors related to child health, supporting the planning and restructuring of vaccination programs through Immunization knowledge and practices of parent which could be improved in many ways that could increase the level of knowledge about the risks and benefits of vaccines by healthcare providers for guidance on immunization timing and administration ***(Al-lela et al., 2014).***

AIM OF THE WORK

The aim of this work is to assess fulfillment of vaccination status in Cairo Governorate to detect children with improper vaccination status and to increase children's caregiver awareness about vaccination in need.

Research questions

Are people giving their children their vaccines according to the schedule in Cairo governorate? Are they giving them extra-vaccines? And if they are satisfied with the vaccination services introduced to them?

Hypothesis of the study

Before we started this study the expectations were that some children in Cairo governorate would not be taking their obligatory vaccines properly. Those children's caregivers would to have increased awareness about vaccines. (Null hypothesis).

Chapter One

CHILDHOOD VACCINATION PROGRAM

Definition of Vaccination:

Vaccination is the administration of antigenic material (a vaccine) to stimulate an individual's immune system to develop adaptive immunity to a pathogen ***(Fiore et al., 2009).***

History of vaccination:

It is known that the process of inoculation was used by Chinese physicians in the 10th century ***(Gross and Sepkowitz, 1998).***

Scholar Ole Lund comments: "The earliest documented examples of vaccination are from India and China in the 17th century, where vaccination with powdered scabs from people infected with smallpox was used to protect against the disease. Smallpox used to be a common disease throughout the world and 20 to 30% of infected persons died from the disease. Smallpox was responsible for 8 to 20% of all deaths in several European countries in the 18th century. The tradition of vaccination may have originated in India ***(Lund et al., 2005).***

The Anatolian Ottoman Turks knew about methods of inoculation. This kind of inoculation and other forms of variolation were introduced into England by Lady Montagu, a famous English letter-writer and wife of the English ambassador at Istanbul between 1716 and 1718, who almost died from smallpox as a young adult and was physically scarred from it. Inoculation was adopted both in England and in America nearly half a century before Jenner's famous smallpox vaccine of 1796 ***(Henricy, 1796).***

But the death rate of about 2% from this method meant that it was mainly used during dangerous outbreaks of the disease and remained controversial ***(Gross and Sepkowitz, 1998).***

It was noticed during the 18th century that people who had suffered from the less virulent cowpox were immune to smallpox and the first recorded use of this idea was by a farmer Benjamin Jesty at Yetminster who had suffered the disease and transmitted it to his own family in 1774, his sons subsequently not getting the mild version of smallpox when later inoculated in 1789. But it was Edward Jenner, a doctor in Berkeley, who established the procedure by introducing material from a cowpox vesicle on Sarah Nelmes, a milkmaid, into the arm of a boy named James Phipps. Two months later he inoculated the boy with smallpox and the disease did not develop. In 1798, Jenner published "An Inquiry into the Causes and Effects of the VariolaeVacciniae" which coined the term *vaccination* and created widespread interest. He distinguished 'true' and 'spurious' cowpox (which did not give the desired effect) and developed an "arm-to-arm" method of propagating the vaccine from the vaccinated individual's pustule. Early attempts at confirmation were confounded by contamination with smallpox, but despite controversy within the medical profession and religious opposition to the use of animal material, by 1801 his report was translated into six languages and over 100,000 people were vaccinated ***(Gross and Sepkowitz, 1998).***

Since then vaccination campaigns have spread throughout the globe, sometimes prescribed by law or regulations. Vaccines are now used against a wide variety of diseases besides smallpox. Louis Pasteur further developed the technique during the 19^{th} century, extending its use to killed agents

protecting against anthrax and rabies. The method Pasteur used entailed treating the agents for those diseases so they lost the ability to infect, whereas inoculation was the hopeful selection of a less virulent form of the disease, and Jenner's vaccination entailed the substitution of a different and less dangerous disease for the one protected against. Pasteur adopted the name *vaccine* as a generic term in honor of Jenner's discovery. Maurice Hilleman was the most prolific vaccine inventor, and developed successful vaccines for measles, mumps, hepatitis A, hepatitis B, chickenpox, meningitis, pneumonia and Haemophilusin fluenzae ***(Offit, 2007).***

In modern times, the first vaccine-preventable disease targeted for eradication was smallpox. The World Health Organization (WHO) coordinated this global eradication effort. The last naturally occurring case of smallpox occurred in Somalia in 1977. In 1988, the governing body of WHO targeted polio for eradication by 2000. Although the target was missed, eradication is very close. The next disease to be targeted for eradication would most likely be measles, which has declined since the introduction of measles vaccination in 1963 ***(United States Centers for Disease Control and Prevention, 2011).***

How do vaccines work?

Vaccines produce their protective effect by inducing active immunity and providing immunological memory which enables the immune system to recognize and respond rapidly to exposure to natural infection at a later date and thus to prevent or modify the disease ***(Salisbury et al., 2006).***

The administration of a vaccine antigen triggers an inflammatory reaction that is initially mediated by the innate immune system and subsequently expand to involve the adaptive immune system through the activation of T and B cells. While the majority of vaccines provide protection through the induction of humoral immunity (primarily through B cells), some vaccines such as Bacille Calmette-Guerin (BCG) and herpes zoster act principally by inducing cell mediated immunity (primarily through T cells). Long term immunity requires the persistence of antibodies and/or the creation and maintenance of antigen specific reactivate to produce an effective immune response upon subsequent exposure to the same or similar antigen ***(Candian Immunization Guide, 2015).***

Role of vaccination:

Vaccination is the most effective method of preventing infectious diseases; widespread immunity due to vaccination is largely responsible for the worldwide eradication of smallpox and the restriction of diseases such as polio, measles, and tetanus from much of the world ***(WHO, 2015).***

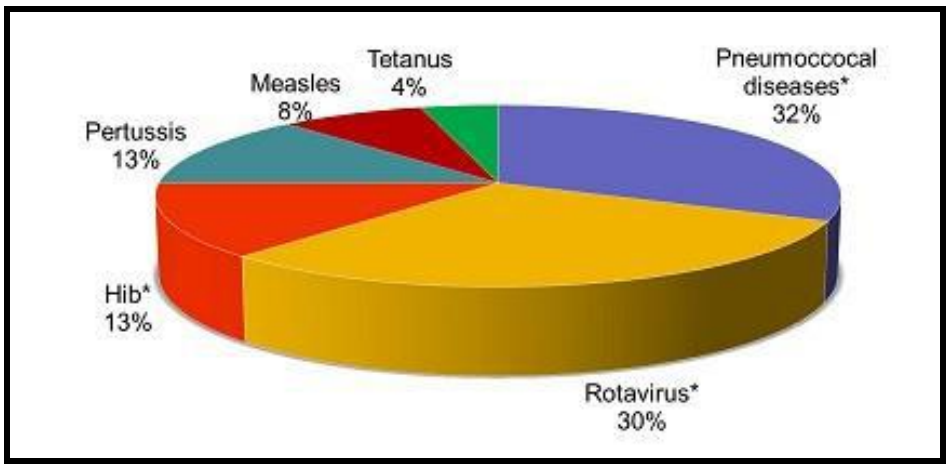

Figure (1): Distribution of the estimated deaths among children under 5 years of age, from diseases that are preventable by vaccination in 2008 ***(WHO, 2015)***.

Type of Vaccines:

Four types of vaccines are currently available: ***(Orenstein and Atkinson, 2011).***

1- Live attenuated vaccines:

Use the weakened (attenuated) form of the virus. BCG, measles, mumps, and rubella (MMR) vaccine and the varicella (chickenpox) vaccine are examples.

2- Killed (inactivated) vaccines:

Are made from a protein or other small pieces taken from a virus or bacteria. The flu vaccine is an example.

3- Toxoid vaccines:

Contain a toxin or chemical made by the bacteria or virus. They make the person immune to the harmful effects.

4- Subunit/Conjugate:

Contain only pieces of the pathogens they protect against.

Table (1): Types of vaccines:

Vaccine type	Vaccines of this type on U.S. Recommended Childhood (ages 0-6) Immunization Schedule
Live, attenuated	Measles, mumps, rubella (MMR combined vaccine) Varicella (chickenpox) Influenza (nasal spray) Rotavirus
Inactivated/Killed	Polio (IPV), Hepatitis A
Toxoid (inactivated toxin)	Diphtheria, tetanus (part of DTaP combined immunization)
Subunit/conjugate	Hepatitis B, Influenza (injection), Haemophilus influenza type b (Hib), Pertussis (part of DTaP combined immunization), Pneumococcal, Meningococcal
Vaccine type	**Other available vaccines**
Live, attenuated	Zoster (shingles), Yellow fever.
Inactivated/Killed	Rabies.
Subunit/conjugate	Human papillomavirus (HPV).

(Plotkin et al., 2008)

Vaccination Schedule:

A **vaccination schedule** is a series of vaccinations, including the timing of all doses, which may be either recommended or compulsory, depending on the country of residence ***(NIAID, 2010).***

Many vaccines require multiple doses for maximum effectiveness, either to produce sufficient initial immune response or to boost response that fades over time. For example, tetanus vaccine boosters are often recommended every 10 years ***(Mayo Clinic, 2008).***

Vaccine schedules are developed by governmental agencies or physicians groups to achieve maximum effectiveness using required and recommended vaccines for a locality while minimizing the number of health care system interactions. Over the past two decades, the

recommended vaccination schedule has grown rapidly and become more complicated as many new vaccines have been developed ***(The Children's Hospital of Philadelphia, 2010)***.

Some vaccines are recommended only in certain areas (countries, subnational areas, or at-risk populations) where a disease is common ***(Pan American Health Organization, 2007).***

In order to provide best protection, children are recommended to receive vaccinations as soon as their immune systems are sufficiently developed to respond to particular vaccines, with additional "booster" shots often required to achieve "full immunity". This has led to the development of complex vaccination schedules. In the United States, the Advisory Committee on Immunization Practices, which recommends schedule additions for the Centers for Disease Control and Prevention. ***(CDC, 2013),*** Recommends routine vaccination of children against: hepatitis A, hepatitis B, polio, mumps, measles, rubella, diphtheria, pertussis, tetanus, HiB, chickenpox, rotavirus, influenza, meningococcal disease and pneumonia ***(American Academy of Pediatrics, 2011).***

The large number of vaccines and boosters recommended (up to 24 injections by age two) has led to problems with achieving full compliance. In order to combat declining compliance rates, various notification systems have been instituted and a number of combination injections are now marketed (e.g., Pneumococcal conjugate vaccine and MMRV vaccine), which provide protection against multiple diseases. Besides recommendations for infant vaccinations and boosters, many specific vaccines are recommended at other ages or for repeated injections

throughout life—most commonly for measles, tetanus, influenza, and pneumonia. Pregnant women are often screened for continued resistance to rubella. The human papillomavirus vaccine is recommended in the U.S. (as of 2011) and UK (as of 2009) ***(CDC, 2013).***

Different vaccination schedules:

The vaccination schedule is chosen by the official authorities in each country. It is decided based on various criteria, including in particular the incidence of a contagious disease, the availability of certain vaccines, the epidemiological situation, financial resources, prices of vaccines ***(Oxford Vaccine Group, 2015).***

Immunization schedule in Egypt:

In 1960, the Expanded Program on Immunization (EPI) started in Egypt targeting 6 diseases for eradication: diphtheria, whooping cough, tetanus, measles, poliomyelitis and tuberculosis. 4 additional vaccines have now been added to the routine infant immunization schedule; including hepatitis B, German measles, mumps and Haemophilus influenza type b ***(WHO, 2016).***

A child is considered fully immunized if he took

1. BCG vaccination against tuberculosis
2. 3 doses of the DPT vaccine to prevent diphtheria, pertussis, and tetanus
3. 3 doses of polio vaccine
4. Measles vaccination during the first year of life.

In Egypt there are two types of vaccination:

Obligatory and non-obligatory vaccines

Obligatory vaccine:

Table (2): Immunization schedule in Egypt (Obligatory vaccine)

BCG	At birth
Pentavalent (DPT-Hep B-Hib)	2,4,6 and 18 months
OPV	At birth, 2, 4, 6, 9, 12 and 18 months
MMR	12 and 18 months

(Ministry of Health and Population May 2015)

Non -Obligatory vaccines:

Table (3): Recommended but not included in expanded program of immunization.

Age	Vaccine
2 months	PCV (pneumococcal Conjugate vaccine) Rota
4 months	PCV (pneumococcal Conjugate vaccine) Rota
6 months	PCV (pneumococcal Conjugate vaccine)
12 months	Chicken pox vaccine (1st dose) Hepatitis A vaccine (1st dose)
18 months	Booster doses of PCV (pneumococcal Conjugate vaccine))
2 years	Meningococcal vaccine (1st dose) Hepatitis A vaccine (2nd dose)
4 to 6 years	Booster dose of BCG vaccine 2nd dose of chicken pox vaccine Meningococcal vaccine (2nd dose)

(Vacsera, 2016)

United States specific schedule:

The most up-to-date schedules are available from CDC's National Center for Immunization and Respiratory Diseases. In the US, the

National Childhood Vaccine Injury Act requires all health-care providers to provide parents or patients with copies of Vaccine Information Statements before administering vaccines ***(CDC, 2016).***

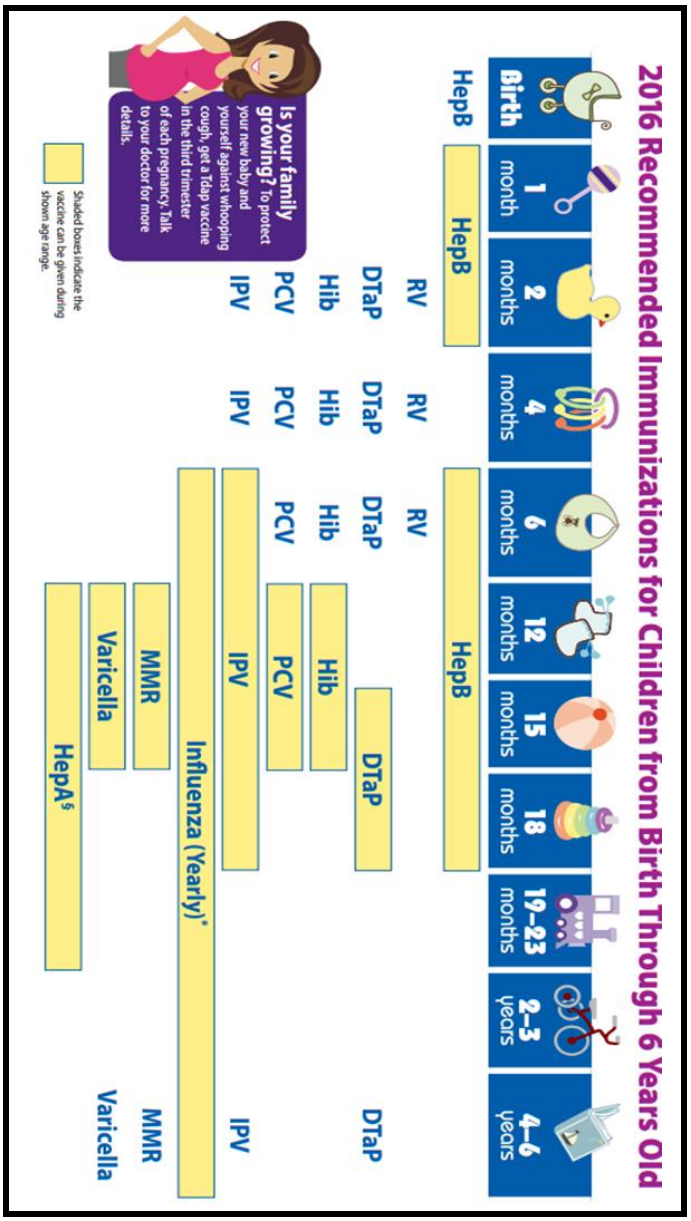

Figure (2): Vaccination schedule in USA: from birth through 6 years old- 2014 recommended schedules ***(CDC, 2016).***

World Health organization schedule:

The World Health Organization monitors vaccination schedules across the world, noting what vaccines are included in each country's program, the coverage rates achieved and various auditing measures.

Table (4): Recommendations for routine immunization according to WHO:

Types of vaccines		Dose	
BCG		One dose	
Hepatitis B		3 to 4 doses	
Polio vaccine		3 to 4 doses at least one dose of IPV with DTP	
DTP		3 doses	Booster DTP 1 to 6 years
Haemophilus influenza b	Option 1	3 doses with DTP	
	Option 2	2 or 3 doses with booster at least 6 months after last dose	
Pneumococcal conjugate	Option1	3 doses with DTP	
	Option 2	2 doses before 6 months of age plus booster dose at 9-15 months of age	
Rota vaccine		Rotarix: 2 doses oral 2 doses with DTP	
		Rota teq: 3 doses with DTP	
Measles		2 doses	
Rubella		1 dose	

Recommendations for routine immunization (WHO, 2016)

Commonly used vaccines:

I- BCG vaccine:

It is a vaccine against tuberculosis, prepared from a strain of the attenuate (live bovine tuberculosis bacillus, Mycobacterium bovis) ***(Venkataswamy et al., 2012).***

Dose, route of administration, and schedule: A single dose of 0.05 mL (0.05 mg) for infants (12 months of age and younger) and 0.1 ml (0.1 mg) for children (greater than 12 months of age) and adults. Reconstituted BCG vaccine should be administered by intradermal injection into the most superficial layers of the skin, the area over the deltoid muscle is the preferred administration site ***(Pickering et al., 2012).***

Contraindications of BCG vaccination: include tuberculin +ve reactors, those who have had a confirmed anaphylactic reaction to a component of the vaccine, neonates in a household where an active,

TB case is suspected or confirmed and people who are immuno compromised ***(CDC, 2012).***

Minor illnesses without fever or systemic upset are not valid reasons to postpone immunization ***(Salisbury et al., 2006)***.

Adverse reactions: large, local discharging ulcers, abscesses and keloid scarring are most commonly caused by faulty injection technique, excessive dosage or vaccinating individuals who are tuberculin positive ***(Smith and Starke, 2004)***.