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Date of examination: 14/11/2015
Dedication:

To my family,
to my friends.

Special thanks dedicated to my father for his support and guidance
Acknowledgment:

I would like to extend my sincere gratitude and thanks to my research supervisor Dr. Aatif Breama Saad Breama and my co-supervisor Dr. Arafa AL Qurashi for their assistance, useful suggestions, and guidance which were embodied in this research. I also wish to express my thanks to schools’ principals and staff, and Microbiology lab at Al Ribat Hospital for their co-operation and valuable help. Finally, my deep appreciation and gratitude to my family for their support and encouragement throughout period of the study.

Salma Ihsan Allah Osman Ali

Abstract

For generations, hand washing with soap and water has been considered a measure of personal hygiene. But only in the last two centuries importance and necessity of hand washing has attracted attention and been clearly established. Hand washing is well-known worldwide as one of the most effective and inexpensive ways to prevent spread of diseases especially among school age children, but yet rarely practiced. The aim of the study is to assess knowledge, Attitudes and Practices of hand washing among Basic Schools Pupils in East Nile locality, Khartoum state, Sudan. This study is an analytical cross-sectional in design, was carried out in 3 basic schools located in East Nile Locality – Khartoum/Sudan. A total of 189 students were randomly selected from grades 1-5. To collect data a structured questionnaire used to assess knowledge and attitudes, a checklist used during observation of hand washing practices and during site inspection for washing facilities and supplies, hand swabs also used to assess microbial contamination. Data was statistically analyzed using SPSS software (Statistical package for social sciences). According to the results revealed, most of study population appears to have a good knowledge and positive attitudes towards hand washing. Students reported convenient hand washing practices, 55.6% of children reported practicing hand hygiene after sneezing or coughing, 65.1% reported washing hands with soap after using toilet, and 82.5% reported its best to wash hands before eating. Yet, via observing hand washing practices, 100% of students didn’t wash their hands before eating, and only 15.3% wash their hands after eating, playing (after break). The majority of study population 32.20% didn’t perform hand washing techniques correctly (didn’t follow all steps but only rubbed hands together). Microbiological swabbing has verified that 93.7% of hand swabs found to harbor variety of bacterial species and yeast cells. Gram-positive cocci bacteria were the most common 64%, including the following species: Staphylococcus aureus spp 30.3%, Staphylococcus non-aureus 19.0%, and Streptococcus spp 14.3%. All schools didn’t have supply of soap, hand washing facilities were not sufficient in number, and in two schools out of three hand washing stations were improperly located (far from toilets and classes). As many other studies in developing countries, the study findings provide objective evidence that hand washing is still a serious problem in schools, thereby, the study recommended continuous provision of hand washing supplies and application of recommended standards of hand washing.
facilities. Regular monitoring and supervision over students’ hand washing practices at critical times. Development of educational and practical training programs for both students and teaching staff to participate in, to improve hand washing techniques and enhance culture and commitment toward hand washing among school children.
تقييم المعرفة، والمواعف، والممارسات الخاصة بغسل اليدين بين تلاميذ مرحلة الأساس في محلية شرق النيل، ولاية الخرطوم، السودان 2015

سلمى إحسان الله عثمان

ملخص الدراسة

لأجيال اعتبرت عملية غسل اليدين بالماء والصابون مقياس للنظافة الشخصية، فقط في القرنين الأخيرين أهمية وضرورة غسل اليدين قد جذبت الانتباه وتم التأكيد والاعتراف بها بشكل واضح. فعمل غسل اليدين معروف عالمياً كأحد الوسائل الأكثر فاعلية وأقلها تكلفة للحد من انتشار الأمراض المعدية، خاصة بين الأطفال في سن المدرسة. لكن وبالرغم من ذلك نادرًا ما يمارس غسل اليدين. الهدف من الدراسة هو تقييم المعرفة، المواعف، والسلوكيات الخاصة بغسل اليدين بين أطفال المدارس في محلية شرق النيل – الخرطوم/السودان. هذه الدراسة مقطعية تحليلية في تصميمها. نفذت في ثلاث مدارس تعليم أساس تقع في محلية شرق النيل – الخرطوم/السودان. تم اختيار عدد 189 طالباً من الصف الأول حتى الصف الخامس عشوائياً. لتجميع البيانات تم استخدام استبيان لتقييم معرفة والمواعف الطلاب من غسل اليدين، قائمة لمراقبة ممارسات غسل اليدين وتوفر المواد والمراقبة اللازمة، مسحات من أيدي الطلاب أيضاً استخدمت لتقدير البقية الميكروبية. تم تحليل البيانات إحصائياً بواسطة برنامج SPSS (الحزم الإحصائية للعلوم الاجتماعية). وفقاً للنتائج، الجزء الأكبر من مجتمع الدراسة أظهر معرفة جيدة وموقف إيجابي تجاه غسل اليدين. أقر 55% من الطلاب باتباع ممارسات صحية (نظافة اليدين) بعد العطس أو السعال، 65.1% أقروا بغسل اليدين بالصابون بعد استخدام المرحاض، و 82.5% من الطلاب بأن من الأفضل غسل اليدين قبل الأكل. اتخاذ غسل اليدين. 65.1% أقروا بغسل اليدين بالصابون بعد استخدام المرحاض، و 82.5% من الطلاب بأن من الأفضل غسل اليدين قبل الأكل. من خلال مراقبة ممارسات غسل اليدين 100% من الطلاب لم يلتزموا بغسل اليدين قبل الأكل 15.3% فقط من الطلاب قاموا بغسل أيديهم بعد الأكل/اللعب. غالبية مجتمع الدراسة 23.20% من 93.7% من مسحات اليدين أظهرت وجود أنواع مختلفة من البكتريا ومبادئ ظهور فطريات. البكتريا الكروية موجبة الجرام كانت الأكثر شيوعاً بنسبة 64%, متشابهة الأنواع التالية: المكورات العنقودية الذهبية بنسبة 30.3%, المكورات العنقودية غير الذهبية بنسبة 19.0%, البكتريا الكروية المعدية بنسبة 14.3%. جميع المدارس لم تتوفر فيها المرافق اللازمة لغسل اليدين من صابون، ومراقب غسل اليدين وجدت غير كافية من حيث العدد في مدارس من أصل ثلاث مدارس مراقبة غسل اليدين كانت في مواقع غير مناسبة ( بعيد عن المرحاض والوصول الدراسة). كما العديد من الدراسات الأخرى في الدول النامية. نتائج هذه الدراسة أثبتت أن غسل اليدين لا يزال مشكلة في المدارس، وعليه أوصت الدراسة بالتزويج المستمر للمواد اللازمة لغسل اليدين والالتزام بتطبيق المعايير الموصى بها لمراقبة غسل اليدين.
الرقابة المنتظمة للطلاب خلال الأوقات اللازمة لغسل اليدين. تطوير برامج تدريبية وثقافية و إشراك الطلاب و المعلمين معا في هذه البرامج. لتحسين تقنيات غسل اليدين و تعزيز الثقافة و الإلتزام بتطبيق غسل اليدين بين الطلاب.
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List of Abbreviations

WHO: world health organization.

CDC: Centers for Disease Control and Prevention.

NVSPL: National Public Health Laboratory.


ASM: American Society of Microbiology.

ACI: American Cleaning Institute.

KAP: Knowledge, Attitude and Practice.

WFP: World Food Program.

UNESCO: United Nations Educational, Scientific and Cultural Organization

SHEP: School Health and Education Program.

FDA: Food and Drug Administration.

NTC: Columbian technical norm.

SPSS: Statistical Package for Social Sciences

HWWS: Hand Washing With Soap.

MRSA: Methicillin-resistant Staphylococcus aureus.

WSP: Water and Sanitation Program.
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MRSA: Methicillin-resistant Staphylococcus aureus.

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Chapter One

1.1 Introduction

Hand washing is a process of removing soil and transient microorganisms from hands, through vigorous and brief rubbing of lathered hands by soap and water or disinfectant, followed by rinsing under a stream of water (CDC, 2009). Many studies have shown that hands are the primary carriers of many of infections (Aronson and Shope, 2009), as 80% of communicable diseases are transferred by touch (B4 Brands, 2013). Hand washing is now well-documented as one of the most effective and inexpensive ways to prevent the spread of communicable diseases (Mayoclinic.org, 2014) and (CDC, 2009) specially among school age children, such as hand-to-hand transmittable respiratory and diarrheal diseases that remain as the leading killers of young children in the developing world and claim approximately 3.5 million young lives each year (CDC, 2012a). Globally in 2010, estimates of diarrhea and pneumonia account for 12% - 17% of deaths in children in Africa (Saboori et al., 2013). WHO in 2004, opined that diarrhea alone kills almost 2 million children worldwide annually (Eseoghene and Ujiro, 2013). Though importance of hand washing, it’s not world wide spread and seldom practiced. WHO in (2008b) noted that observed rates of hand washing with soap at critical moments range from 0 to 34% worldwide (Mbeba, 2010). However, different factors known to hinder practicing of hand washing. In developing countries lack of soap and access to washing facilities was indicated as number one reason why hand washing is rarely practiced among school age children (UNICEF, 2011).

1.2 Problem identification and Justification

Hand washing is a healthy behavior, observations and statistics worldwide especially in developing countries have proven it's greatly underestimated, rarely practiced and almost a forgotten behavior. Many studies conducted in basic schools in developing countries reported that hand washing is still an issue among school children and rates are unsatisfying, moreover, most of these schools constantly reported a lack of soap and proper washing facilities, which was commonly signified by many studies as the main barrier to practice and sustain hand washing in schools. Furthermore, children known to
be vulnerable to diseases, in many cases it was found that school children harbor different harmful pathogens on their hands, while many official bodies have unanimously confirmed that infectious diseases are the lead causes of death and absenteeism among school age children in developing countries. In light of given facts and findings, this study of implementation is vital to an appropriate understanding of hand washing situation in area of study, and to draw attention to barriers and obstacles for implementing such a behavior.

1.3 Objectives

1.3.1 General Objective

1.3.2 Specific Objectives

1. To evaluate knowledge of hand washing among school children.
2. To assess availability of soap, water, and hand washing stations.
3. To determine factors that influence hand washing practices among school children.
4. To assess adequacy and correct implementation of hand washing among school children/ efficacy of hand washing practices.
Chapter Two

Literature Review

2.1 History of hand washing

For generations, hand washing with soap and water has been considered a measure of personal hygiene (Hamilton and Crane, 2014), and has been generally embedded in religious and cultural habits (WHO, 2009a). Though the germ theory is not even 200 years old, but the ancient Babylonians understood that cleanliness had a bearing on the spread of disease, according to the National Institutes of Health, an ancient Mesopotamian text explained the sickness of a patient by saying “He has come into contact with a woman of unclean hands, or his hands have touched one of unclean body” (Meitus, 2014), yet only in the last two centuries the link between hand washing and the spread of disease has been clearly established (Hamilton and Crane, 2014) and (WHO, 2009a).

Hand washing significance was first discovered by Holmes in 1843. While working in an obstetric ward about 25% of women delivering were dying from childbed fever. Investigations of Holmes found that it was transmitted through contaminated hands of doctors when delivering mothers, but the idea was turned down by medical specialists (Mbeba, 2010).

Few years later in 1847 a Hungarian obstetrician by the name of Ignaz P. Semmelweis, who was a house officer in one of the two obstetric clinics at the University of Vienna Allgemeine Krankenhaus (a general hospital) where doctors wards had three times the mortality of midwives wards due to childbed fever. Semmelweis discovered that the incidence of childbed fever could be drastically reduced from 13% to 2% or less when appropriate hand washing practices are done by medical workers, and published a book of his findings in Etiology, Concept and Prophylaxis of Childbed Fever. Dr. Semmelweis proposed the practice of washing hands with chlorinated lime solutions among his colleagues, however, his observations conflicted with the established scientific and medical opinions of the time and his ideas were rejected by the medical
community (Wikipedia, 2015b). Yet, Semmelweis's practice earned widespread acceptance only years after his death, and following to his recommendations, the mortality rate fell dramatically to 3% in the clinic and remained low thereafter. Semmelweis is considered not only the father of hand hygiene, but his intervention is also a model of epidemiologically driven strategies to prevent infection (WHO, 2009a). That was 150 years ago, it is now a well-known fact worldwide that the most effective line of defense against contagious diseases like common cold, Ebola, tuberculosis and MRSA (Methicillin-resistant Staphylococcus aureus) that sometimes seems beyond ability to contain, is a simple policy of hand washing compliance (Meitus, 2014).

2.2 Definition of hand washing

Hand washing or hand hygiene has been defined as the act of cleaning one's hands with or without the use of water or another liquid, or with the use of soap or other detergent for the purpose of removing soil, dirt, and/or microorganisms (Wikipedia, 2015a) and (Reference.md, 2012). The fundamental principle of hand washing is removing, not killing, as it suspends microorganisms and mechanically removes them by rinsing with water (Cdc.gov, 2009).

World Health Organization (WHO) defined Hand washing as washing hands with plain or antimicrobial soap and water, and defined hand cleansing as the action of performing hand hygiene for the purpose of physically or mechanically removing dirt, organic material, and/or microorganisms (WHO, 2009b).

And according to Centers for Disease Control and Prevention (CDC): Hand washing is the vigorous, brief rubbing together of all surfaces of lathered hands, followed by rinsing under a stream of water (Cdc.gov, 2009).
2.3 Importance of hand washing with soap (HWWS):

Normally humans carry millions of germs on their hands, most are harmless, but some can cause illnesses. These germs either picked from objects such as doorknobs, or when get in touch by other people who forgot to wash their hands, or aren't good hand washers. Thereby, people may spread these germs to others, or infect themselves by touching eyes, mouths, noses or cuts on their bodies (Microbeworld.org, 2014). Importance of Hand-washing with soap manifested as one of the most effective and inexpensive ways to remove germs, avoid getting sick, and prevent the spread of common communicable infections (Mayoclinic.org, 2014) and (Cdc.gov, 2013a).

2.3.1 Importance of hand washing to school age children:

Children are known to be active by nature; they pick up germs while they are moving around and touching various surfaces (Hpb.gov.sg, 2012), when sharing books and pencils, or when in contact with others (hand washing at school, 2007). Children also have a high rate of hand to mouth activity, they drink, eat, and breathe up to twice as much as adults do, moreover, they are more vulnerable to diseases as their bodies still growing and their immune systems aren’t fully developed, (Summerstone, 2007) and (USEPA, 2013). While germs harbor everywhere in school, some can live from 20 minutes to 2 hours and more on dry surfaces like cafeteria tables, doorknobs, and desks, and up to three days on moist surfaces (Hopkins, 2015), (Lee, 2015) and (Summerstone, 2007). So when children use contaminated hands to touch their face, rub their eyes or place fingers in their mouth, they are at risk to get infections like diarrhea, acute respiratory diseases, or hand, foot and mouth disease (HFMD) (Hpb.gov.sg, 2012). On the other hand school physical environment and cleanliness is a significant factor that affects children health and well-being. Too often children get infected in schools, as diseases spread faster where many children gather for many hours a day in cramped spaces with limited ventilation, unsanitary conditions, and no hand washing facilities or soap (Danquah et al., 2007). Many parents also tend to send their children to school whether they are well or not and most of these children may not have a great hygiene practices (Eseoghene and Ujiro, 2013).
CDC in 1996 has pointed out that nearly 22 million school days are lost due to the common cold each year and where certain strains of E. coli, salmonella and other bacteria can live on surfaces for up to two hours (ACI, 2015b). Statistics have shown that acute respiratory infections like pneumonia are the leading cause of child deaths, the United Nations Children's Fund (UNICEF) estimated that pediatric pneumonia kills 3 million children worldwide each year (Bennett, 2015), while diarrhea considered to be the second leading cause of death and absenteeism among children, WHO (2006) opined that about 2.2 million people mostly children and school students die worldwide annually due to diarrhea (Tambekar and Shirsat, 2013) and (Eseoghene and Ujiro, 2013). Hand washing with soap is a vital act to school children, it can cut rates of diarrheal diseases into half and rates of respiratory infections by about one-quarter (Unicef.org, 2008), it is a critical determinant for achieving and maintaining good nutrition, preventing micronutrient deficiencies, stunting, wasting, and deaths, the World Health Organization (WHO) estimated that 50% of children under-nutrition cases are due to repeated diarrhea and intestinal infections caused by poor sanitation and hygiene conditions or lack of safe water (GHWO, 2015).

Different studies have been conducted and confirmed the fact that regular hand washing with soap at critical times reduces incidence of diarrheal diseases, respiratory, skin and eye infections among school age children (UNICEF, 2003), For instance:

The Centers for Disease Control and Prevention (CDC) has been studying the role of hand washing in preventing these diseases in developing world settings. In a series of randomized, controlled studies of intensive hand washing promotion in Pakistan, CDC researchers found about 50% fewer diarrheal and respiratory infections among young children in low-income households that received weekly hand-washing promotion and a supply of soap for about a year, compared with households that did not receive these interventions (Cdc.gov, 2012a) and (Hpb.gov.sg, 2012).

Also, according to study in Detroit school, children showed that those who washed their hands had 24% fewer sick days due to respiratory illness and 51% fewer sick days due to upset stomach, while in China, distribution of soap in basic schools resulted in 54% fewer sick days (B4 Brands, 2013).
2.4 Pathogen Presence on Hands of School Children Age:

Children spend most of their active awake time in schools, and due to their activities and close interaction with many others during school day, they are likely to carry different kinds of germs on their hands. Micro-organisms found on skin include two categories:

1. Resident Micro-Organisms (normal flora):

   These are usually deep seated in the epidermis, are not readily removed and do not readily cause infections. However, during surgery/invasive procedures, they may enter deep tissues and establish an infection.

2. Transient Micro-Organisms:

   These are organisms that are not part of the normal flora and represent recent contamination, which usually survives for a limited period of time. They are easily removed by a good hand washing technique. They include most of the organisms responsible for cross infection, e.g. Gram-negative bacilli (E.coli, Klebsiella, Pseudomonas spp, Salmonella spp.), Staph aureus, MRSA and viruses e.g. rotaviruses (Brambury, 2006). Several studies were conducted and have confirmed the presence of different pathogens on hands of school children:

   A cross-sectional study was conducted in two schools of Bangalore and Kolkata to find out the extent of germs present in hands. Hand swabs of 61% children showed potential pathogens. The commonest of these was Staphylococcus aureus which was seen in 44% samples (Ray et al., 2011).

   In another study, in Amravati city Maharashtra, India, a total of 400 hand swabs were collected from 100 students from KG to PG. Swab samples were analyzed before and after hand washing. Hands of all students were found to harbor bacterial pathogens before washing which include Staphylococcus sp. (23%), Escherichia coli (20%), Klebsiella sp. (10%), Micrococcus sp. (9%), Proteus sp. (7%), Citrobacter sp. (7%), Streptococcus sp. (7%), Enterobacter sp. (6%), Enterococcus sp. (4%), Pseudomonas sp. (3%) and Salmonella sp. (2%) (Tambekar and Shirsat, 2009).
In 2009, samples were cultured from the hands of 90 school age children at the pediatric hospitalization unit of Hospital Estadual Bauru in São Paulo, Brazil. Bacteria were found in 98% of the samples. Coagulase-negative *Staphylococcus* was isolated in 64% of the samples, followed by *Staphylococcus aureus* (5%) and *Pseudomonas aeruginosa* (1%) (De Almeida et al., 2012).

A study done by the educational project “Clean hands – dead germs”, organized by PONTEM, Ltd. and the National Public Health Laboratory (NVSPL), also investigated 88 parasitological and 45 bacteriological samples in three schools in Lithuania, Baltic. Results showed that 62.2 percent of samples had gram-negative bacteria that can cause diarrhea, abdominal pain and even diseases such as salmonellosis. Mold fungi, which may disrupt the respiratory activity, and cause bronchial asthma or its acute exacerbation, were found in over 15 percent of hand samples. Over 2 percent of hands were contaminated with pinworm eggs, which may cause enterobiasis. The research concluded that six out of ten students are contaminated with disease-causing bacteria (Pontem.lt, 2014).

Another study in basic school in Mauritius, where 200 school children hands were swabbed, and the bacteria were identified by gram staining and conventional biochemical tests. Out of the 200 samples, 91.0% (182) showed bacterial growth. Coagulase negative *Staphylococcus* was the most common bacterium isolated from 76.9% (140) of the samples followed by Micrococcus, *Bacillus*, *Pseudomonas*, *Proteus* and *Escherichia coli* (Padaruth and Biranjia-Hurdoyal, 2014).

A number of 1956 samples from hands, and 1470 samples from surfaces were collected from 20 basic schools in Heraklion, Crete, Greece. Fecal *streptococci* were found at 52.9% of children's hands and at 16.7% of other surfaces (Kyriacou et al., 2009).

Another study was designed by Tambekar and Shirsat 2013 in Amravati district, Maharashtra state, Indi, where 1200 hand swabs from left and right hands were collected from 300 students before and after hand washing. All students (100%) found to harbor bacteria on their hands before washing hands, variety of pathogens were identified before taking the mid-day meal at school viz *Escherichia* species (27%), *Staphylococcus*...
species (17%), *Pseudomonas* species (11%), *Proteus* species (9%), *Klebsiella* species (8%), *Enterobacter* species (8%), *Micrococcus* species (7%), *Streptococcus* species (5%), *Citrobacter* species (5%), *Enterococcus* species (2%) and *Salmonella* species (1%) (Tambekar and Shirsat, 2013).

Also, on hands of school students of Bangalore and Kolkata, Ray et al., (2011) found that swab samples of 61% children harbors potential pathogens before taking food. Presence of pathogenic microbes included S. *aureus*, *E. coli*, Enterococcus faecalis, *Klebsiella* spp, commensals flora (Tambekar and Shirsat, 2013).

A study undertaken in 2 basic schools in Malawi to determine the efficacy of hygiene practices, one of methods used was to determine presence of *Escherichia coli* on the hands of 126 school students. *E. coli* found on hands of (71%) of study population (Grimason et al., 2014).

### 2.5 Common infections in schools:

A **communicable/infectious disease**: means an illness caused by an infectious agent or its toxins that occurs through the direct or indirect transmission of the infectious agent or its products from an infected individual or via an animal, vector or the inanimate environment to a susceptible animal or human host (CDC, 2012b). Infectious diseases have been a major concern globally because of their increased morbidity and mortality among school age children. Death due to these diseases was the highest in developing countries for instance they were rated 62% of all deaths in Africa and 31% of all death in South East Asia against only 5% of all deaths in Europe (Eseoghene and Ujiro, 2013).

Spread of diseases happens very fast in schools than just about any other place in the society, and according to WHO (2007) and CDC (2007) they are preventable and could be halved by a simple hand washing with soap (Eseoghene and Ujiro, 2013). Common infections school children are exposed to include:
1. **Diarrheal Infections:**

   Diarrheal diseases are often described as water-related, but more accurately should be known as excreta-related, as the pathogens come from fecal matter. These pathogens make people ill when they enter the mouth via hands that have been in contact with feces, contaminated drinking water, unwashed raw food, unwashed utensils or smears on clothes. Hand washing with soap breaks the cycle (PPPHW, 2008).

2. **Acute respiratory infections:**

   Acute respiratory infection like Flu and pneumonia is the most common acute infections in school age children. Globally it’s a significant cause of absenteeism (Bundy et al., 2006). Flu and pneumonia: Flu viruses spread mainly from person to person through coughing or sneezing by people with influenza, a person can also become infected by touching something such as a surface or object with flu viruses on it and then touching their mouth or nose (PPPHW, 2008). Research in industrial countries found that flu infection affects attention and reaction time of students in classroom (Bundy et al., 2006).

   Most people who get influenza will recover in a few days to less than two weeks, but some will develop complications (such as pneumonia) as a result of the flu, some of which can be life-threatening and result in death (CDC, 2015c), these deaths occur almost exclusively in children with underlying conditions, such as chronic lung disease of prematurity, congenital heart disease, and immunosuppression. Although most fatalities occur in developing countries, pneumonia remains a significant cause of morbidity in industrialized nations (Bennett, 2015).

   Hand-washing reduces the rate of respiratory infections in two ways: by removing respiratory pathogens that are found on hands and surfaces, and by removing other pathogens (in particular, enteric viruses) that have been found to cause not only diarrhea, but also respiratory symptoms (PPPHW, 2008).
3. Intestinal worm and skin and eye infections:

Worms that affect the human intestine include threadworm (pinworm), roundworm and hookworm. All intestinal worms are parasites that use human body as a host to stay alive and reproduce, maturing from eggs to adult worms. This is a very common infection in children living in the tropical and subtropical areas. It is thought that up to 50% of school age children can be infected (Lu, 2015).

Intestinal worms are highly contagious. One can be infected directly through contact with an infected person, or indirectly through touching a surface such as stationary item such as pencil, or plates, cups and cutleries contaminated by an infected person. Worms are spread by swallowing the eggs. As intestinal worm is spread mainly by children, it is most often found in family members, child-care facilities, schools, and camps (Lu, 2015).

Heavier infections can cause a range of symptoms including intestinal manifestations (diarrhea and abdominal pain), nutritional impairment, general malaise and weakness, and impaired cognitive, growth and physical development (Who.int, 2015).

Studies have shown that hand washing with soap reduces the incidence of intestinal worms especially ascariasis and trichuriasis, skin diseases and eye infections like trachoma (PPPHW, 2008).

2.6 Hand washing practices:

Touching people, surfaces and objects throughout the day accumulates germs on hands, although it's impossible to keep hands germ-free, frequently hand washing specially at critical times can help limit the transfer of bacteria, viruses and other microbes (Mayoclinic.org, 2014).

All students and staff should regularly perform effective hand washing, which will reduce the amount of infections spread in school (dhh.louisiana.gov, n.d.). The following are hand washing practices which can cut transmission of diseases within school settings:
1. Before eating and drinking.
2. Before preparing food: Food handlers should wash hands before handling food and when hands are soiled.
3. After using the toilet.
4. After coughing, sneezing, wiping nose, and cleaning up messes.
5. After touching books and money.
6. Whenever hands are visible dirty or solid.
7. After playing out door.
8. After shaking hands.
9. After Handling garbage, or anything that could be contaminated: such as cleaning soiled shoes.
10. Before and after providing assistance to another person using the toilet.
11. After cleaning a child who has gone to the bathroom.
12. After cleaning potentially contaminated surfaces.
13. After handling animals if available in schools.


2.7 Hand washing process:

2.7.1 Hand washing steps and techniques:

Hand washing is only effective when it is done properly. It involves five simple and effective steps (Wet, Lather, Scrub, Rinse, Dry). CDC official recommendations for hand washing, is using soap with either warm or cold water, scrub well for at least 20 seconds (giving special attention to the backs of hands, between fingers, and under nails) and drying hands afterwards (Abrams, 2013), (Cdc.gov, 2015b) and (ACI, 2015a). CDC recommends humming the "Happy Birthday" song twice for an accurate measure of time (Abrams, 2013). Recommended steps and techniques for proper hand washing:
1. **Wet hands:**
Wet hands with clean running water (warm or cold).

2. **Apply soap:**
Apply enough amount of any kind of soap. There is no evidence that any form of soap, whether bar, liquid, gentle or antibacterial is more effective than the other (Partselect.com, 2015), or apply ash, or mud on hands (Eseoghene and Ujiro, 2013).

3. **Rub hands together well and all over:**
Areas to focus on:
- Rub palm to palm thoroughly (away from water), until make a soapy lather.
- Rub back of hands and between fingers: right palm over the other hand with interlaced fingers and vice versa, and palm to palm with fingers interlaced.
- Rub back of fingers by opposing palms with fingers interlocked.
- Rub around thumbs: rotational rubbing of left thumb clasped in right hand palm and vice versa.
- Rub fingertips and under nails: rubbing forward and backward with clasped fingers of the right hands in left palm and vice versa.
- Rubbing should last for at least 20 seconds.

4. **Rinse hands:**
The soap must be rinsed thoroughly off each area of the hands.

5. **Dry hands:**
Dry hands with clean towel, paper towel or air dryer, or shake off water and dry hands with a clean piece of cloth or in the air (Eseoghene and Ujiro, 2013) (Partselect.com, 2015), (Cdc.gov, 2015b) and (Cairntechnology.com, 2011).
(a) Wet hands under running water
(b) Apply soap and rub palms together to ensure complete coverage
(c) Spread the lather over the backs of the hands
(d) Make sure the soap gets in between the fingers
(e) Grip the fingers on each hand
(f) Pay particular attention to the thumbs
(g) Press fingertips into the palm of each hand
(h) Dry thoroughly with a clean towel
2.7.2 Missed areas while washing hands:

Running hands under tap is not enough, even if soap is quickly used; it’s very easy to miss areas of hands where bacteria and other harmful micro-organisms can congregate. Most of people wash their hands constantly, but only few wash them properly. The image below shows missed parts of the hands where hand washing techniques are not correctly implemented. Areas in purple are frequently missed while red areas are the most frequently missed during hand washing process. Missed Areas include (but not limited to): between fingers, under fingernails, wrists, thumb area, and back of hands (OUTFOX, 2015), (Cairnstechnology.com, 2011), (First Steps 2015, 2015) and (Century Products LLC, 2013).
2.7.3 Duration of hand washing process:

UNICEF, the U.S. Centers for Disease Control and Prevention, and other expert bodies endorse the 20 seconds hand washing recommendation. The World Health Organization recommends 40-60 seconds for hand washing, but this encompasses the entire hand washing process from wetting hands and applying soap until hands are fully dried, whereas the 20 seconds recommendation focuses only on the process of scrubbing hands with soap (GHWO, 2015). CDC officially recommends humming the "Happy Birthday" song twice for an accurate measure of time, or singing ABC (Abrams, 2013) and (CDC, 2015b). The average person spends less than 10 seconds washing their hands (B4 Brands, 2013), scrubbing for 10 seconds is not long enough to achieve a fully effective lather and sufficient friction to properly clean hands (GHWO, 2015). Timing is important in hand washing process as for every 15 seconds spent 10 times more bacteria is removed (B4 Brands, 2013). Studies have shown that despite importance of hand washing, it is rarely practiced properly, especially at critical times:

- Globally, WHO (2008b) noted that observed rates of hand washing with soap at critical moments range from 0 to 34%. People wash their hands only 19 percent of the time after using the toilet or changing a child’s diaper. In some parts of the world, people wash their hands with soap just 1-2 percent of critical times (GHWO, 2015), in fact studies have found that 70% of people wash their hands and only 30% of those people wash their hands with soap (Century Products LLC, 2013). While in developing countries hand washing is still being practiced to a very low extent especially at critical times like before eating and after using toilets (Mbeba, 2010).

- A study conducted by the Global Public–Private Partnership for Hand Washing (PPPHW) which included several sub-Saharan African countries (i.e. Kenya, Senegal, Tanzania, and Uganda) reported that only 17% of participants washed their hands with soap after using the toilet, while 45% used only water (Vivas et al. 2010).

- Another study in Colombia, only 33.6% of school children reported to wash hands with soap always or very often after using the toilet and before eating. However, only 3% of school children followed recommendations of CDC and always wash hands for
at least 20 seconds whenever hands are contaminated. In addition these children reported to wash hands rarely after coughing or sneezing (Lopez-Quintero et al., 2009).

- While in Uganda 54% school children were observed washing hands after using the toilet about only 5% use soap (Mbeba, 2010).

- According to study in Angola, Ethiopia, most of school children reported hand washing before meals (99.0%), but only 36.2% reported using soap, and although 76.7% of students reported that washing hands after defecation was important, only 14.8% reported actually following this practice (Vivas et al., 2010).

- Also in Ghana, results showed that both in schools and at homes most of children observed did not practice proper hand washing with soap. Out of 295 students only 7% observed washing hands with soap before eating and 5% observed washing hand with soap after eating (Steiner-Asiedu et al., 2011).

- On the other hand, findings of an assessment conducted in 540 schools in nine Indian states on the Mid-Day Meal (MDM), scheme revealed that nearly half (49 per cent) of the students washed their hands using water while only 42 per cent students used soap (Unicef.in, 2015).

- Another study conducted in 392 schools in seven Indian states reveals that only one third (32 per cent) of the children wash hands with soap before eating (Unicef.in, 2015).

Such rates implies that hand washing is still a problem among school children.

### 2.8 Factors affect hand washing behavior:

Many factors such as availability of proper hand washing facilities and supplies, granting enough time to wash hands, constant motivating and emphasizing of hand washing behavior, all play important role in whether to boost or hinder compliance to hand washing in schools. Habits and attitudes also have a great impact in such a behavior.
- Hart & Roger (1997) identified Lack of time, poor adult modeling of regular hand washing and unattractive facilities as important barriers to regular hand washing in schools (Eseoghene and Ujiro, 2013).

- In a review of basic school hygiene facilities in a developed country, Reeve & Poore (2012) suggested that the physical quality of any toilet and hand washing facilities is an important determinant of whether and how it is used, especially for school children (Eseoghene and Ujiro, 2013).

- A study done by Chittleborough et al., 2012 reported that lack of time was a big barrier for both teachers and students for not wash hands properly, teachers said they had limited time, and children are in rush in and out and they’re so keen to get out to play or to go and eat their dinner or whatever it is. Designs of Hand washing facilities, accessibility and availability of supplies attractiveness, cleanliness of school hand washing facilities all also influence hand washing practice. The study also mentioned (societal norms), the poor adult modeling of regular hand washing, where seeing other people not properly or at all washing hands may have a great effect on hand washing behavior (children tend to copy behavior of their friends and favorable teachers). Reminders and explanations for the importance of hand hygiene were thought to have a positive impact, and so Teaching and educational interventions of why and how to wash hands (Chittleborough et al., 2012).

- A (KAP) study in Ethiopia suggested that negative attitudes of the school children like laziness, rush to play with friends is the reason for not following hand washing practice after using toilets, and lack of hand washing facilities near toilets as well (Vivas et al., 2010).

- Also, in a study conducted in Senegal, reasons given for not washing hands included stubbornness (not wanting to follow what adults say), laziness, the rush to go to breaks, the time it takes away from playing, and the dirt and smell of the toilets (Vivas et al., 2010).
- Another study in Bogotá Colombia also stated several factors:

  - Availability and accessibility of clean and secure hand-washing facilities, forgetfulness along with laziness, lack or time, were factors to affect hand washing (Lopez-Quintero et al., 2009).

  - Educational programs are also important for an individual's abilities and aptitude to perform the behavior given appropriately (Lopez-Quintero et al., 2009).

  - Attitudes, which reflect the degree to which performance of a behavior is positively or negatively valued by an individual, were also found to be important in predicting hand-washing intentions. Attitudes are shaped by salient beliefs, perception of the expected outcomes, and value of the expected outcomes. Therefore, to reinforce positive attitudes toward hand washing, negative beliefs related to hand hygiene (like the common misperception that diarrhea and respiratory diseases are not harmful and inevitable conditions) need to be modified (Lopez-Quintero et al., 2009).

  - On the other hand, the study opined that students’ perspective of what they need is very valuable that could help improve hand washing practices. Students were asked about what can be done to improve hand hygiene in the school and suggested: Placement of reminders (cues and motivators) in bathrooms and school cafeterias, permanent and visible soap dispensers, and access to hand-washing facilities in and near school cafeterias (Lopez-Quintero et al., 2009).

  - The study also stated the importance of the subjective norms in the development and adoption of the culture of hygiene and self-care within school settings. Subjective norms regarding hand-washing behavior are influenced by expectations of parents, classmates, and teachers and the student's motivation to comply with these expectations (Lopez-Quintero et al., 2009).

- Another study conducted in Ghana to evaluate hand washing practices among school children has reported lack of soap in the school, limited access to clean water, students are often in hurry to play or eat before break time is over, locked hand washing facilities
and the need of students to ask permission prior the use of facilities were the hinders to implement hand washing practices (Steiner-Asiedu et al., 2011).

- Studies by Lopez- Quintero et al., (2009) revealed that, unavailability of soap and clean towels, is a negative factor to compliance, and is confirmed by the School Sanitation and Hygiene Education study in which schools in several developing countries consistently reported lack of soap and unavailability of clean water (Steiner-Asiedu et al., 2011).

- In support of Global Hand washing Day, October 15/2011 which promotes hand washing with soap in schools, a survey was conducted by Russell Research for the American Cleaning Institute (ACI). According to the data the number one reason kids don't wash their hands as much as they should in school is that they are not given enough time by teachers to wash hands before eating. Other reasons reported by students for infrequent hand washing are the lack of cleaning supplies, not liking to use school bathrooms as they are being "disgusting" and not clean, not being reminded, or seeing no one else washing hands. The research also demonstrated that home have a great influence in school children behavior. As some children witnessed their parents not wash their hands after using the restroom, some parents have admitted they didn’t taught children how long they should spend washing their hands, and that they themselves don’t usually wash hands after using toilets (CleanLink, 2011).

- According to an online survey, nearly half out of 512 children agreed that time constraints, supply shortages and untidy restrooms are among the top reasons why students say they don’t wash their hands more often during the school day (Eseoghene and Ujiro, 2013).

- On the other hand, a study done by Mbeba, R. M. (2010) in Tanzania indicated that:
  - Attitudes can act as influential factors on hand washing practices among children depending on their belief and expected outcome. This factor was also found highly associated with children’s hand washing behavior in Colombia (Mbeba2010).
The study also indicated that Hygiene facilities which include water, washing stations (basins), soap and accessible toilets influence hand washing, for instance. In Colombia, 18.9% and 16.7% children stated not to wash their hands due to lack of clean water and soap. In Nigeria it was observed that due to inadequate hygiene facilities in schools, children didn’t have the chance to effectively practice the knowledge of hand washing they have acquired. In India, only 10% of the schools had adequate hand washing points with soap (Mbeba, 2010).

School children’s hand washing practice can also be related to social demographic characteristics such as sex, age, tribe, residence, grade, and religion and parents education level. In Colombia, mother’s education level was found being associated with school children’s hand washing intentions while age, gender, type of school, and father’s education was not at all related. Furthermore, pete (1987) reported better hand washing practice among female as compared to males children. Another study reported hand washing behavior difference between rural and urban settings (Mbeba, 2010).

Self-efficacy has been found being the most important factors which enables a person to actually do the act of washing hands as required. It was reported by Lopez-Quintero et al., (2009) that a high level of control over behavior predicts a person’s proper hand washing practice. Children can easily adopt a behavior only if they have control over the practice (Mbeba, 2010).

Referents like friends, parents, health professionals, teachers or other adults are considered as important role models for children that can affect children hand washing behavior. For example, in Colombia, parents (88.5%), schools (66.7%) and the media (56.8%) were most sources of hand washing information to children. Furthermore, a study done in Ugandan schools found teachers as barriers to children’s hand washing practice since they were not emphasizing on the importance of washing hands (Mbeba, 2010).

Also, UNICEF has demonstrated that Habits, attitudes and teaching are important in influencing hand washing:
• Remembering to wash hands with soap at critical times often needs changing old habits. A change does not happen after just one lesson as it requires persistent effort on the part of teachers and families. Adopting new hygiene behavior also requires persuasion, which is usually in the form of a so-called ‘triggering’ – an experience, hearing about or seeing something that motivates people to make a change because they suddenly see a real reason for doing so (World Bank, 2005) and (UNICEF, 2011).

• Negative Attitudes of children is a serious factor that stumble efforts to promote hand washing. For example, when they know they should wash their hands but don’t do so, for a variety of reasons like: hands don’t look dirty, or no one else will notice if they didn’t wash their hands (UNICEF, 2011).

• Teaching children how to wash their hands correctly and why it’s important to adopt this practice helps to encourage hand washing practices (UNICEF, 2011).

2.9 Hand washing facilities and supplies:

Sustaining hand washing is very important, unlike other health interventions such as vaccines; hand washing must be practiced consistently to work. It must be a habit that people automatically and regularly perform at critical times. Accepting and adopting of hand washing behavior as a daily routine in a community vitally depends on availability and accessibility to tools necessary to wash hands like clean water and soap (GHWO, 2015). WFP, UNESCO and WHO in 1999 has stated that:

Basic hygienic measures, hand washing in particular should not be compromised by lack of water or lack of access to hand washing basins or suitable alternatives (Adams et al., 2009). Unfortunately, in developing countries with low –middle income, it’s a continuous struggle to overcome lack of proper hand washing stations and supplies (Eseoghene and Ujiro, 2013).

2.9.1 Hand washing supplies:

1. Soap and water:

The belief that washing with water alone to remove visible dirt is sufficient to make hands clean is a commonplace in most of countries. Water alone is inefficient skin cleanser because fats and proteins which are components of organic soil are not readily dissolved in water. Using soap is
important as it contains ingredients that help breaks down the grease and dirt that carry most of germs, while the mechanical action of lathering and rubbing soap cause friction which helps to pull dirt and germs free from the skin, soap binds to them, and then they are washed out by water (Mayoclinic.org, 2014), (Floridahealth.gov, 2015), (Better Health Channel, 2015), and (Microbeworld.org, 2014).

1.1 Antibacterial soap:
Antibacterial soaps (sometimes called antimicrobial or antiseptic soaps) contain certain chemical ingredients that plain soaps do not. These ingredients are added to many consumer products in an effort to reduce or prevent bacterial contamination (Fda.gov, 2015). Antibacterial soaps have been heavily promoted to the health-conscious public, but yet, studies have shown that there is no added health benefit for consumers (this does not include professionals in the healthcare setting) using soaps containing antibacterial ingredients compared with using plain soap (Cdc.gov, 2015a), a comprehensive analysis from the University Of Oregon School Of Public Health indicated that plain soaps are as effective as anti-bacterial soaps containing triclosan in preventing illness and removing bacteria from the hands (Wikipedia, 2015a). However, using antibacterial soap might even lead to the development of bacteria that are resistant to the products with antimicrobial agents, which making it harder to kill these germs in the future (GHWO, 2015) and (Mayoclinic.org, 2014).

1.2 Problems with Solid soap:
The problem with solid soap, it usually sits in pools of water and become contaminated with many harmful germs, and people are less likely to use bar soap if it is messy from sitting in water, this may prevent people from washing their hands when needed (Better Health Channel, 2015). Solid soap, also because of its reusable nature, may hold bacteria acquired from previous uses, yet, it is unlikely that any bacteria are transferred to users of the soap, as they are rinsed off with the foam (Wikipedia, 2015a) and (Marturana, 2014).

1.3 Water temperature for hand washing with soap:
Warm soapy water is more effective than cold soapy water at removing the natural oils on your hands which hold soils and bacteria. However, contrary to popular belief,
scientific studies have shown that using warm water has no effect on reducing the microbial load on hands (Wikipedia, 2015a).

2. Hand antiseptic:
Washing hands with soap and water is the best way to reduce germs. In areas where they are not available, an alcohol-based hand sanitizer that contains at least 60 percent alcohol should be provided as an alternative. The CDC recommends users apply sanitizers to the palm of one hand and then rub hands together for at least 30 seconds, or until hands and fingers are dry. Alcohol-based hand sanitizers will not eliminate all types of germs, but they can quickly reduce the number of germs on hands in some situations (Bock, 2015).

3. Ash and mud/soil:
Many people in low-income communities cannot afford soap and use ash or soil instead. Ash or soil may be more effective than water alone, but may be less effective than soap. One concern is that if the soil or ash is contaminated with microorganisms it may increase the spread of disease rather than decrease it. Like soap, ash is also a disinfecting agent (alkaline).WHO recommended ash or sand as alternative to soap when soap is not available (Wsp.org, 2005) and (Wikipedia, 2015a). A number of studies suggested that hand washing with soap is the critical component in this behavior and that hand washing only with water provides little or no benefit. Hoque and Briend (1991) showed that when using a rubbing agent, such as soap, mud or ash, some reductions in contamination were found, more than when washing with water alone, and that using of alternative rubbing agents like (mud or ash) provided the same benefits as soap. Hoque et al. (1995) also found that the use of mud, ash and soap all achieved the same level of cleanliness. It was suggested that the action of rubbing hands was more important than the agent used (Wsp.org, 2005).

2.9.2 Hand washing facilities:
A. Definition:
The term "hand washing facility" means a facility providing a basin, container, or outlet with an adequate supply of potable water, soap and single use towels (Steiner-Asiedu et al. 2011) and (Maine.gov, n.d.), it is a device may be fixed or movable to contain, transport or regulate the flow of water to facilitate hand washing (wssinfo.org, n.d.). A hand washing facility, even with
soap, on a communal basis, where the same water is used by more than one person, does not constitute an adequate hand washing facility (Steiner-Asiedu et al. 2011).

Hand-washing facility is also defined as:

1. Provision of prepackaged, single use moist towelettes, in quantity sufficient for use every day (Maine.gov, n.d.).

Or

2. Provision of waterless soap and single use towels, both in quantity sufficient to enable clean hands several times each day (Maine.gov, n.d.)

3.

**B. Standards of hand washing facilities:**

1. Hand washing facilities should be accessible and sufficient for the maximum anticipated attendance (Adams et al., 2009).

2. They must be configured and at a suitable height for users like children (low enough or equipped with a seat for them to reach), adults and those with disabilities, to encourage them to use water as often as required (Adams et al., 2009).

3. Hand washing facilities should be accessibly and close to users, located within or adjoined to each toilet room and all critical points within the school (a water point close to classrooms is useful to encourage children wash their faces which help prevent eye diseases (Adams et al., 2009).

4. The hand washing station should be designed so that both hands are free for hand washing by having operation with a foot pedal or water that stays on after turning on hand faucets (Cdc.gov, 2007).

5. Washing facilities should have an adequate supply of hot and cold water, hot water is preferable, but if the hand washing stations are supplied with only cold water, a soap that emulsifies easily in cold water should be provided (Cdc.gov, 2007). When there is no direct supply by pipe, a tap or pump, a vessel should be provided to scoop water which should be stored close to the facility (Eseoghene and Ujiro, 2013).
6. Water provided for hand washing and other purposes should be separated from drinking water even if it is from the same supply. If possible, all water provided to the school should be of drinking water quality (Adams et al., 2009).

7. Reliable hand washing facilities should have adequate supply of soap or suitable alternative and towels, preferably papers, hot air hand drying devices may be used (Adams et al., 2009).

8. Communal basins, where water is used by more than one person, do not constitute adequate hand-washing facilities (Cdc.gov, 2007) and (Steiner-Asiedu et al., 2011).

9. Ratio of hand washing facilities to number of students:
   - Hand washing basins: 1 per 50-100 students (Portal.unesco.org, n.d.)
   - The SHEP program regulation under WFP/UNESCO (1999) standards specifies that, schools must have a minimum of one operating hand washing facility and a cubicle or a drop hole for every 25 school girls, and every 40 to 60 school boys, for good access. This regulation makes no reference to the availability of soap and also assumes that every toilet facility at least has one hand washing facility (Steiner-Asiedu et al., 2011).

   - Some regulations stated that washing facilities could be related to ages and number of students, as younger children tends to have greater needs than those for older ones:
     - Toilet and washbasin for every ten pupils under 5 years old would be adequate (gov.uk, 2015).
     - For pupils aged 5-11 ratio could be doubled, one toilet and washbasin for every 20 pupils (gov.uk, 2015).

   - According to Colombian regulation NTC (Columbian technical norm) 4595 (1999), all schools must have a minimum of 1 operating sink and toilet or urinal for every 25 children. This regulation makes no reference, however, to the availability of supplies such as toilet paper and soap or to hand-washing facilities in school cafeterias or lunchrooms (Lopez-Quintero et al., 2009).
C. Designs of Hand washing facilitates:

Hand washing stations can vary in sophistication and design, but they should always have water and soap and be conveniently located (GHWO, 2015). Hand washing stations should not necessary to include a tap-water, where tap-water and/or soap is not available, a simple and low-cost hand washing points can be made in various ways such as:

- A pitcher of water and a basin, one person can pour the water for another to wash their hands, the wastewater falls into the basin (Adams et al., 2009).

- Pouring water from a hanging jerrycan or gourd with suitable holes (Wikipedia, 2015a) and (Danielsson, n.d.).

- A small tank (e.g. an oil drum) fitted with a tap, set on a stand and filled using a bucket, with a small soakaway or a basin under the tap to catch the wastewater (Adams et al., 2009).

- In situations with limited water supply (such as schools or rural areas in developing countries), there are water-conserving solutions, such as "tippy-taps". A tippy-tap is a simple technology using a jug suspended by a rope, and a foot-operated lever to pour a small amount of water over the hands and a bar of soap (Wikipedia, 2015a), (Adams et al., 2009) and (Danielsson, n.d.).

- The punched pipe or tube system is a low-cost hand-washing facility where up to 20 children can wash their hands at the same time using just 2 liters of water. It is made from wood, galvanized iron and PVC piping – and does not rely on piped water or a constant water pressure. Water is stored in a covered container with a tap to attach the pipe to. Small holes are made along the pipe where the water will flow out (UNICEF, 2011).

- The Super Jaboncín hand washing device. A private company DURAPLAST in Peru designed the device to address a main barrier to hand washing with soap (convenient access to water and soap) at critical times. The device consists of two plastic (3-liter) soda bottles (commonly found), one for water and one for home-made liquid soap, and can be mounted on walls (Devine and Peschiera, 2010).
Chapter three
Materials and Methods

3.1 Study area:
Basic schools in Al Hag Yusuf (Al Wehda), East Nile Locality, Khartoum State, Sudan.

3.2 Study population:
The study population chosen was basic school pupils of grade (1) to (5) both males and females, East Nile Locality, Khartoum State, Sudan.

3.3 Study design:
Analytical cross-sectional study.

3.4 Sample size:
The sample size obtained was 189 samples, randomly selected from 3 basic schools in East Nile Locality, Khartoum State, Sudan.

3.5 Data collection:
Data was collected using a questionnaire, observational check list, and hand swabs.

1- Questionnaire:
A structured questionnaire consists of 11 multiple choice and open questions was used to evaluate school children’s knowledge, and their attitudes toward hand washing.

2- Observational check list:
The check list aimed to inspect availability and sufficiency of hand washing facilities and supplies in schools, to observe students’ hand washing practices at critical times before and after eating/playing, and their implementation of the right hand washing steps and techniques.

3- Hand swabs:
Hand swabs were collected at different times during school day to assess the hand hygiene among school children, through detecting presence of pathogens.
3.6 Experimental work:

1. Collection of samples:
Hand swabs were collected from randomly selected students at different times during school day. A number of 189 sterilized cotton swabs were used to take samples from both right and left hand’s fingertips, between fingers, under nails, palm and back of the hand. Swabs dampened in sodium chloride 0.9% solution prior to use to create a growth environment. Samples were taken into collections, each collection transported at the same day to Microbiology laboratory in Ribat University Hospital to be cultured and analyzed.

2. Culturing of samples:
   - Prepared plates of Sabouraud and MacConkey agar were used at room temperature after refrigerated. Each plate was divided into four quadrants (four samples in one plate).
   - Plates were inoculated using swabs by streaking patterns across agar surface, each swab rubbed first in Sabouraud agar then MacConkey agar while sterilizing near incinerator.
   - Plates incubated at 35 C, for 24-48 hours. After incubation plates were ready to be examined.

3. Identification of pathogens:
The research aimed to identify fungi and bacteria presence, accordingly growth in plates was examined as the following:

   - **Colonial morphology:**
     Identification of growth first conducted through describing the appearance of bacterial colonies and yeast cells based on size, color and shape.

   - **Gram stain test:**
     Gram’s Stain test used to differentiate bacteria into two types: Gram-Positive and Gram-Negative. The test was processed as following: Smear of the growth applied on a slide, air dried and then heat fixed by passing it through a flame. Drop of Crystal violet stain added for 1 minute (bacteria stained purple) and washed briefly with water. Iodine solution poured over the slide for 30 seconds then rinsed with running water, (acetone-alcohol solution) solvent added for
decolorizing about 5 seconds until purple color stopped running then washed with water. The smear counterstained with saffranin solution for 1 minute and washed off with water. The slide air dried, drop of oil added to the smear and examined under light microscope.

- **Biochemical tests:**
  Biochemical tests then conducted to have a precise identification of bacterial species exist on hands’ of school children.

1. **Catalase test:**
   A sterilized wooden stick used to take sample from the growth and immersed in test tube containing (2-3 ml) of hydrogen peroxide solution. Tubes that showed bubbling are positive catalase test which indicate to *Staphylococcus* species, non-bubbling tubes are negative catalase test which indicate to *Streptococcus* species.

2. **Coagulase test:**
   Drop of distilled water placed on each end of a slide, smear of the growth emulsified in each drops to make suspensions, then a loopful of plasma added to one suspension and mixed gently. Positive test resulted in clumping appearance within 10 seconds which indicate to *Staphylococcus aureus*.

3. **Indole test:**
   A piece of filter paper was saturated with Kovács reagent (1 to 1.5 ml), smear of the growth was added to the paper using a loop. Positive test resulted in red pink color within 1-3 minutes which indicate presence of *E.coli*. 
4. **Oxidase test:**

The oxidase test is used to identify oxidase-producing bacteria. A piece of filter paper was soaked with oxidase reagent, sample from the growth then smeared on filter paper.

Positive test resulted in deep purple color within 10 seconds, which indicate presence of *Pseudomonas* spp.

**3.7 Data analysis:**

Data obtained from questionnaire, check list and laboratory tests have been statistically analyzed using SPSS software (Statistical Package for the Social Sciences).
Chapter Four

Results

4.1 Questionnaire results

Figure (4.1) shows that 68.3% of study population agreed that bad hand hygiene can cause dermal, abdominal or respiratory infections, 31.2% disagreed, and .5% of study population didn’t know.

Figure (4.1) knowledge of the Study Population about Bad hand Hygiene Cause Dermal, Abdominal or Respiratory Infections in East Nile Locality, Khartoum
Figure (4.2) Frequency distribution of using water enough to clean hands and remove germs,

Figure (4.2) shows that 73% of study population disagreed that water is enough to clean hands and remove germs and only 27% was agreed respectively.

Figure (4.3): Frequency Distribution of the diseases transmit by using multiple same soap

Figure (4.3) reflect that 54% of study population agreed that multiple use of the same soap can transmit diseases, while 45% disagreed, and 1% of study population didn’t know.
Figure (4.4) Clipping nails helps removing germs and maintaining clean hands,

Figure (4.4) shows that 98.4% of study population agreed clipping nails helps removing germs and maintaining clean hands, followed by 1.6% were disagreed.

Figure (4.5) Responses of study population to hand shaking transmit germs

Figure (4.5) shows that 82.5% of study population agreed that hand shaking can transmit germs, and 17.5% were disagreed.
Figure (4.6) Important of washing hands to human health

Figure (4.6) revealed that 98.4% of study population agreed that washing hands is important to human health, while 1.1% disagreed, and only .5% of study population didn’t know.

Figure (4.7) Importance of washing hands with soap after using the toilet

Figure (4.7) shows responses to what is the importance of washing hands with soap after using the toilet. The highest percentage 97.4% was to clean hands, followed by 2.1% to remove germs; the lowest percentage .5% was using soap to get rid of bad smell.
Figure (4.8) Wash hands at eating time

Figure (4.8) shows study population responses to when is best to wash hands at eating time. The highest percentage 82.5% was before eating, followed by 17% before and after eating, the lowest percentage was .5% after eating.

Figure (4.9) Following hand hygiene practices after sneezing or coughing (using tissues, sleeves or washing hands)

Figure (4.9) shows responses to following hand hygiene practices after sneezing or coughing (using tissues, sleeves or washing hands). 55.5% of study population reported they (often) follow hand hygiene practices, followed by (yes) with percentage 37.6%,while 6.9% reported (no) they don’t follow hand hygiene practices after sneezing or coughing.
Figure (4.10) responses of Study population to washing hands with soap after using toilet

Figure (4.10) shows study population responses to washing hands with soap after using toilet. 65.1% reported (yes) they do wash with soap after using toilets, followed by 31.2% who reported they (often) use soap, while 3.7% of study population reported (no) they don’t wash with soap after toilet.
4.1.2 Observational check list results:

Figure (4.11) observations of washing hands before eating (mid-day meal)

Figure (4.11) shows observations of washing hands before eating (mid-day meal). 100% of study population didn’t wash their hands before eating.

Figure (4.12) Observations hand washing after break (eating, playing)

Figure (4.12) shows observations of hand washing after break (eating, playing). 84.7% of study population didn’t wash their hands after break, while only 15.3% did.
Figure (4.13) Observations of hand washing techniques and missed areas while washing hands

Figure (4.13) shows observations of hand washing techniques and missed areas while washing hands among study population. 32.20% of study population only rubbed hands together (palm and back) and missed all other steps, 25.0% missed areas under nails and around thumps, 16.40% missed areas around thumps, 13.20% missed area under nails, 5.30% missed the area between fingers. While only 7.90% of study population followed all hand washing techniques.
Table (4.1) Frequency distribution knowledge about critical times to washing hands

<table>
<thead>
<tr>
<th>Critical times to wash hands</th>
<th>frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before eating, after using toilet</td>
<td>117</td>
<td>61.9%</td>
</tr>
<tr>
<td>Before eating</td>
<td>35</td>
<td>18.6%</td>
</tr>
<tr>
<td>Before eat, after using toilet, after playing</td>
<td>18</td>
<td>9.5%</td>
</tr>
<tr>
<td>After using toilet</td>
<td>7</td>
<td>3.7%</td>
</tr>
<tr>
<td>After eating and playing</td>
<td>3</td>
<td>1.6%</td>
</tr>
<tr>
<td>After playing, eating and cleaning</td>
<td>2</td>
<td>1.1%</td>
</tr>
<tr>
<td>When visible dirty</td>
<td>2</td>
<td>1.1%</td>
</tr>
<tr>
<td>After playing, when visible dirty</td>
<td>1</td>
<td>.5%</td>
</tr>
<tr>
<td>After cleaning and eating</td>
<td>2</td>
<td>1%</td>
</tr>
<tr>
<td>After using toilet, when visible dirty</td>
<td>1</td>
<td>.5%</td>
</tr>
<tr>
<td>After different activities</td>
<td>1</td>
<td>.5%</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

profiles responses of study population to what are the critical times to wash hands. The highest percents were (before eating, after using toilet) with percentage 61.9%, followed by (before eating) with percentage 18.6%, (before eating, after using toilet, after playing) with percentage 9.5%, (after eating and playing) with percentage of 1.6%, (after playing, eating and cleaning) with percentage of 1.1%, (after playing, when visible dirty) with percentage of .5%, (after using toilet, when visible dirty) with percentage of .5%, (after using toilet) with percentage 3.7%. Only 1.1% responded with (when hands visible dirty), followed by (after cleaning and eating) with percentage 1%, and .5% said (after different activities).
Table (4.2) Observations of Schools environment, hand washing facilities and water supplies in the schools

<table>
<thead>
<tr>
<th>Observations</th>
<th>School (1)</th>
<th>School (2)</th>
<th>School (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand washing facilities/stations available in the school</td>
<td>yes</td>
<td>yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Type of hand washing station available</td>
<td>Ground built-in tap</td>
<td>Ground built-in tap</td>
<td>Ground built-in tap</td>
</tr>
<tr>
<td>Other sources used as hand washing stations</td>
<td>Drinking clay containers</td>
<td>Drinking clay containers</td>
<td>Drinking clay containers, water barrel</td>
</tr>
<tr>
<td>Enough hand washing stations available in the school</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Hand washing materials (soap) available</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Water available during school day</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Location of hand washing stations</td>
<td>Inside the school</td>
<td>Inside the school</td>
<td>Inside the school</td>
</tr>
<tr>
<td>Hand washing stations far from toilets/classrooms</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Table (2) profiles observations of hand washing facilities and supplies in schools. All schools observed with hand washing stations (ground built- in tap), number of washing stations wasn’t sufficient to meet the uses of those present in schools. Water was available in all schools but no soap supply. All washing facilities were located inside the school. Out of three schools only one had the washing station easily accessed (not far from toilets and
classrooms). Other sources were used by students for hand washing (drinking clay containers and water barrel)

4.1.3 Hand swabs results:

Table (4.3) Bacteriological identification of hand swabs collected from basic school

<table>
<thead>
<tr>
<th>Bacteriological Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gram’s stain</strong></td>
</tr>
<tr>
<td>+ve cocci</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>-ve bacilli</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>+ve bacilli</td>
</tr>
<tr>
<td>Yeast</td>
</tr>
</tbody>
</table>

Table (4.3) illustrates bacteriological identification of hand swabs collected from school children. Out of 189 sample, (93.7%) showed potential pathogens. A Gram-positive cocci
bacterium was recovered from 64% of samples, followed by Gram-negative bacilli recovered from 13.8% of samples, and gram-positive bacilli recovered from 10.6% of samples, while yeast found in 5.3% of samples. The highest prevalence was *Staphylococcus aureus* with percentage 30.7%, followed by *Staphylococcus non-aureus* 19.0%, while the lowest prevalence was Yeast cells recovered from 5.3% from samples.
Chapter Five  
Discussion

Knowledge and attitudes are important factors to influence human behavior. In this study, student’s basic school have shown fairly adequate knowledge and positive attitudes toward hand washing, fig (4.1) showed that (68.3%) of basic school students agreed with bad hand hygiene can cause dermal, abdominal or respiratory infections. In regard to importance of water on clean hands and remove germs, the study in fig (4.2) showed that, (73%) of studied basic school students disagreed, that water was enough to clean hands and remove germs this is a good indicator and these findings are in consistent with the result reported by (CDC, 2013) who mentioned that, importance of Hand-washing with soap manifested as one of the most effective and inexpensive ways to remove germs. The data on clipping nails in Fig (4.4) indicated that, the majority of study group (98.4%), were agreed, clipping nails helps removing germs and maintaining clean hands. This study in fig (4.5) revealed that majority of participants (82.5%) were agreed hand shaking can transmit germs. And though 97.4% of students fig (4.7) responded that hand washing with soap is important to clean hands, but not to remove germs which is more accurate, still an acceptable though which reflects their positive attitude and understanding of importance to wash hands when dirty. In spite of small family size but in fact they were aware of critical times to wash hands, in table (4.1) the study cited critical times mentioned by students were before eating and after using toilet with percent of 61% , and this agree with what the Global Public-private Partnership of Hand Washing (PPPHW, 2008) has mentioned. Moreover, they understood the importance of hand washing to health, and relation between hands, germs and diseases. Fig (4.6) revealed that 98.4% of school children agreed that hand washing is important to maintain human health. On the other hand, multiple use of the same soap don’t transmit diseases, the finding in fig (4.3) revealed that (54%) of participants agreed that, multiple use of the same soap can transmit diseases, this could be a reason that prevent students from washing hands with soap when needed.

However, knowledge not always translated into practice. In fig (4.8) though 82.5% of study population knew its best to wash hands before eating, fig (4.11) showed that 100% of students observed not washing hands before eating. Washing hands after eating/playing (mid-day break) is as important as washing before eating as children pick up germs from different surfaces and
get in contact with more other students, fig (4.12) showed that 84.7% of students didn’t wash their hands after the break. These findings compare well with the study conducted by Steiner-Asiedu et al., 2011 in Ghana where 91.5% of children reported washing hands before eating, yet only 5% observed washing their hands, and only 7% did after eating. Forgetting, rushing to buy food from canteen or limited time given for the break, could be reasons for not following hand washing practices among school children, and this agrees with what Lopez-Quintero et al., 2009 has cited through study in Colombia that the 3 most frequently given reasons for not washing hands were forgetfulness (78.2%), laziness (43.5%), and lack of time (21.7%). Other reasons cited were lack of clean water (18.9%) or soap (16.7%), bathroom facilities that were dirty (16.5%) or unsafe (5.2%), and lack of interest (6.3%).

Washing hands after sneezing or coughing and after using toilet is important to cut spread of respiratory and diarrheal diseases which claim millions of school age children lives each year in developing countries. Data in fig (4.9) revealed that 55.5% of children reported practicing hand hygiene after sneezing or coughing and in fig (4.10) 65.1% reported washing hands with soap after using toilet. The findings are delightful and far way better than what Lopez-Quintero et al., 2009 and Vivas et al., 2010 revealed through studies in Colombia and Ethiopia, where children have reported rarely following such practices and only 3% of students, met the stricter Centers for Disease Control and Prevention definition, which includes always washing hands for at least 20 seconds upon entering one’s home and after nose blowing, coughing, and other critical episodes of germ contamination.

Knowledge is not enough to achieve goal of hand washing, availability of proper facilities and supplies play a major part in actually practicing and sustain hand washing behavior. In current study, table (4.2) profiled that all schools had washing facilities with running water, but they were insufficient in number, with a total absence of hand washing materials (soap), and improperly located in most of the schools, therefore, don’t meet with the basic standards of washing facilities. This is in consistent with previous studies done in by Steiner-Asiedu et al.,(2011), Eseoghene and Ujiro (2013), and Verma (2012) who also revealed similar shortage of hand washing supplies and improper hand washing facilities in inspected schools.

According to the results, it’s likely that interests and financial resources in these schools are directed into other priorities. In addition, the findings clearly present a barrier to adopt hand
washing among school children; they might be a reason for negligence and lack of interest toward hand washing behavior. This agree with Eseoghene and Ujiro, 2013 who stated that, Earlier studies in developing countries carried by UNICEF and Water Aid, indicated that lack of soap is one of the barriers to hand washing in schools; since most of these schools have neither soap nor appropriate hand washing facilities, and if existed may be poorly located, or have insufficient hand washing materials.

This study in fig (4.13) further revealed that ; the majority of the study population 32.20% only rubbed both of hands together, while areas under nails, between fingers and around thumps were the most frequently missed while washing hands. The findings agree with the study done by Steiner-Asiedu et al., 2011 in Ghana who also asserted that majority of children didn’t demonstrate right hand washing techniques. Hand washing steps and techniques are important to be performed fully and correctly, simply running hands under the tap is not enough even with a quickly use of soap. It is very easy to miss some critical areas of hands where bacteria and other harmful micro-organisms can hide and multiply which increases the risk of health problems.

According to Data in table (4.3), microbiological tests verified that Staphylococcus aureus bacterium 30% is the most common pathogen among school children, along with presence of other different pathogens. The findings are confirmed with the studies done by Tambekar and Shirsat (2009), Verma (2012) and Ray et al.,(2011) who revealed the same. However, disagree with the study done by Tambekar and Shirsat 2013 who reported presence of Escherichia species (27%) as the most common pathogen. Pathogens recovered in the study are known to pose great health problems ranging from food poisoning, respiratory and skin infections, and diarrheal diseases. Thought Staphylococcus aureus bacterium is none harmful nose and skin flora, but plenty amount of it with their ability to survive for a long time can cause serious health issues, and this agrees with Healthdirect.gov.au, 2013 and Health.state.mn.us, 2014.
Chapter Six
Conclusion and recommendations

6.1 Conclusion

This analytical cross-sectional study was carried out in 3 basic schools in East Nile Locality, Khartoum State, Sudan, 2015. Numbers of 189 students were questioned, observed, and hand swabs samples were also collected. The study has revealed as follows,

- 68.3% of basic school students agreed with bad hand hygiene can cause dermal, abdominal or respiratory infections.
- That schools student acquire a good knowledge and attitudes towards hand washing, but their practices at critical times during school day showed contradiction with the knowledge they have.
- The majority of study population 32.20% didn’t know how to wash their hands properly (steps of hand washing were not correctly performed).
- Microbiological swabbing has verified Staphylococcus aureus the commonest pathogen on hands of children, along with presence of other different pathogens.
- Schools observed didn’t meet the standards of hand washing facilities. Improper facilities and lack of supplies believed to be one of factors that affected compliance to hand washing practices.
6.2 Recommendations

1. Ensure a continuous provision of washing materials (soap) or other alternatives to wash hands.
2. Provision of sufficient number of hand washing facilities to meet the uses of students.
3. Proper placement of hand washing stations, near to classes and sanitation facilities to encourage hand washing among school children.
4. Development of educational and practical training programs with the participation of both students and teaching staff, to improve hand washing culture and techniques.
5. Regular monitoring of students’ hand washing practices at critical times during school day.
6. Allocation of signs and other visual aids near facilities and other vantage points in school premises for constant reminding of importance of hand washing practices.
7. Parents and teachers co-operation to support knowledge and practices that students acquire at school.
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