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WASH IN DAYCARE CENTERS OF SAIDA: DEVELOPMENT OF APPROPRIATE ASSSESSMENT AND MANAGEMENT TOOLS

by
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ABSTRACT
OF THE THESIS OF

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Title: WASH in Daycare Centers of Saida: Development of Appropriate Assessment and Management Tools

WASH facilities and services were documented in 17 out of 23 licensed child daycare centers (DCCs) in Saida Caza. A survey assessment tool was developed to evaluate WASH profiles through field visits that were administered without prior appointment or notification.

Collected data on WASH facilities and services were compared with the (a) 2012 UNICEF School's WASH Guidelines, (b) 2017 National Physical School Environmental Guidelines and (c) 2019 Guidelines for Early Care and Education Programs of the American Academy of Pediatrics, American Public Health Association, and National Resource Center for Health and Safety in Child Care and Early Education, to determine compliance. Moreover, water samples from all DCCs were collected and analyzed, early December 2020, to determine the physical (electrical conductivity, color, total dissolved solids and turbidity), chemical (PH, alkalinity, total hardness, phosphates, sulfates, nitrates, ammonia, chlorides, sodium and free residual chlorine) and microbiological (total and fecal coliforms) quality. The overall quality profile characteristics were compared to the LIBNOR National Drinking Water Standards to determine compliance and safety. Additionally, swabs were collected from hands of two caregivers and different surfaces (toy, diapering area and food serving table) of each surveyed DCCs to reflect on the overall hygienic conditions.

Water quality analysis showed that 29% and 6% of the samples collected from piped water supplies used by DCCs, for removal of waste and hygienic purposes, were microbiologically contaminated with total and fecal coliforms, respectively. Additionally, the physiochemical properties of the piped water supplies showed inconsistent free residual chlorine levels, high total hardness levels, and color exceeding LIBNOR Standards in 17.64% of the samples. Noncarbonate hardness was also detected at minimal levels (31 -155 mg/L) reflecting on the possible exposure to sources of pollution such as sewage and sea water infiltration. As for samples collected from complementary water dispensers, results showed microbiological contaminants in 24% of samples with total coliforms and 6% with fecal coliforms. Still, all the surveyed

DCCs showed ungrounded trust in this source that is considered a “safe and healthy” option for dinking and food preparation.

Additionally, results of the microbiological swabs showed that 16.5% (14/85) of samples were fecally contaminated. Surveyed DCCs with fecally contaminated surfaces reflect on relatively poor performance of hygienic and sanitation practices. Overall, the average compliance rates did not exceed 70% for the total of five WASH clusters (diaper changing practices- water basins requirements- toilet facilities- onsite food preparation requirements- water storage, disinfection and monitoring) that were evaluated based on the Early Care and Education Programs Recommendations and UNICEF Guidelines. This is serious at a time where maximal precautions must be taken in response to COVID-19 pandemic. However, no significant association was found between scoring of compliant common WASH practices and the microbiological outputs documented by the study due to various limiting factors.

In conclusion, and based on the findings, deficient WASH facilities and services prevail in the surveyed DCCs. As such, we recommend the development of National WASH Guidelines based on the identified indicators for proper monitoring and evaluation. This is critical to plan and implement sustainable evidence-based interventions to promote children health and safety.

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ABBREVIATIONS

APHA	American Public Health Association
AUB	American University of Beirut
AAP	American Academy of Pediatrics
AWWA	American Water Works Association
AFED	Arab Forum for Environment and Development
CDC	Centers for Disease Control and Prevention
DCC	Day Care Center
DHEP	Di-(2-ethylhexyl) Phthalate
DALYs	Disability Adjusted Life Years
EPA	Environmental Protection Agency
EC	Electrical Conductivity
HRC	Human Right Council
IRB	Institutional Review Board
JMP	Joint Monitoring Program
LIBNOR	Lebanese Standards Institution
LMIC	Low and Middle-Income Countries
MENA	Middle East and North Africa
MOPH	Ministry of Public Health
MEHE	Ministry of Education and Higher Education
MDG	Millennium Development Goals
PHE	Public Health of England
SDG	Sustainable Development Goals
SPSS	Statistical Package for Social Sciences
TDS	Total Dissolved Solids
UNICEF	United Nations Children’s Fund
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNGA	United Nations General Assembly
WHO	World Health Organization
WEF	Water Environment Federation

CHAPTER 1

INTRODUCTION

Safe water, adequate sanitation and good hygiene practices are essentials to protect and support health and well-being. As defined by the Joint Monitoring Program, safely managed drinking water is the use of an improved water source that is available and has no fecal and chemical contamination, adequate sanitation facilities ensure hygienic separation of human excreta from human contact and good hygiene practices comprise many behaviors with a top priority for handwashing with soap and water (WHO/UNICEF, 2017). Hence, water, sanitation and hygiene are interdependent and are grouped together to represent a growing public health sector called WASH (UNICEF, 2016).

Access to improved water, sanitation and hygiene is crucial to meet community needs and to insure the provision and sustainability of services. Yet, safe water and sanitation remain beyond the reach of many people in low and middle-income countries (LMIC's). There are around 663million who do not have access to safe drinking water, and 2.4 billion people who do not use safely managed sanitation services, specifically in South Asia and Sub-Saharan Africa (World Bank, 2017). In addition, improper WASH services significantly impact the burden of diarrheal diseases in LMIC's children. According to the United Nations International Children's Emergency Fund (UNICEF), diarrheal diseases are considered as the second leading cause of both mortality and morbidity in children under the age of five (UNICEF, 2016). The US Center for Disease

Control and Prevention (CDC) estimates that 88% of this burden of diarrheal diseases in children is due to poor WASH (CDC, 2015).

Early childhood represents a particularly high-risk period, as children are more susceptible to environmental hazards. Childcare quality at daycare centers (DCCs) is known to influence the health and the development of children throughout childhood period. Pre-school children (< 4-5 years) who attend DCCs have an increased risk for infectious diseases, especially diarrhea and upper respiratory tract infections (Ingrid, 2020). As such, the proper implementation of environmental health interventions, particularly improving access to safe drinking water, having an adequate sanitation system, and training on proper hygiene practices (i.e. handwashing with soap and water after defecation ,wiping runny nose, changing diapers, emptying garbage cans, or using cell phones) are crucial, especially in DCC settings (Gyi, 2019) .

In Lebanon and to date, WASH has not been addressed in terms of neither legislation, assessment tools to be developed, indicators to be monitored, nor guidelines for evaluation to ensure sustainability. Hence; the objectives of this study are to:

1- Develop and pilot an environmental assessment tool to assess water, sanitation and hygiene in DCCs.
2- Use the tool to conduct a field assessment of WASH in DCCs of Saida Caza.
3- Recommend needed WASH interventions to enhance service provision and sustainability.

CHAPTER 2

BACKGROUND INFORMATION

2.1. Overview of the Chapter

Chapter 2 provides a literature review of the work under study. It focuses on water, sanitation and Hygiene (WASH) and the importance of the provision and sustainability of such services to human health, specifically children less than 5 years of age. It further presents children vulnerability in DCCs to contaminants and water related diseases. The review emphasizes the importance of providing safe drinking water, adequate sanitation systems and proper hygiene practices in reducing preventable WASH related diseases.

2.2. Water, Sanitation and Hygiene (WASH) and Health

Safe water supply is essential to human's health and development .Yet, billions of people still lacked access to basic services including improved water sources and safely managed sanitation facilities in 2015(UNESCO,2019). Contaminated water and poor sanitation pose serious health risk resulting in diseases such as diarrhea, cholera, hepatitis A, typhoid and dysentery (WHO, 2019).

Globally, 801,000 children younger than five years of age die from diarrhea as a result of inadequate water supply, improper sanitation facilities and poor hygiene practices (CDC, 2016). Diarrheal diseases are confounded by many factors; including concurrent infections and nutritional status, yet unsafe drinking water, inadequate sanitation and poor hygiene account for 88% of the total disease burden worldwide (CDC, 2016).

In Lebanon, water governance and infrastructure have suffered from neglect and damage through many years. In many areas, water sources are highly contaminated and as such not safe for domestic use drinking. According to UN (2017), “up to 70% of natural water sources in Lebanon are bacterially contaminated”. Hence, people using poorly managed water sources suffer from harmful consequences especially vulnerable groups including children under the age of five. Accordingly, child diarrheal diseases rates are at 13 percent for displaced Syrians, 18 percent for Palestine Refugees and 10 percent for the Lebanese host communities; and incident rates are spiking among children of the vulnerable communities .Thus, it is vital to insure the right to adequate water supply and sanitation services to protect human’s health from preventable diseases (UN, 2017).

2.2.1 Basic Human Rights for Water and Sanitation-UN Initiatives

Access to safe drinking and adequate sanitation has been recognized as a fundamental human right. The United Nations has gradually recognized access to safe water as a human right. In 1972 in Stockholm, the UN released the first document on the environment which indirectly addressed the water theme. This was through the second principle which stated that the “natural resources of the earth, including the air, water, land, flora and fauna and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate” (Oliveria, 2017). From then on a succession of UN efforts culminated in the recognition to the basic right to safe water and sanitation as presented in the following sub-entities:

2.2.1.1. Mar Del Plata Water Conference

The global conference in Mar del Plata recognized the human right to water by in the 1977. The conference resulted in a resolution stating that "all people at any level of development either economically or socially have the right to access healthy drinking water in any quantity and of the best quality equal to their basic health needs" (UN,1977). It led to the development of an action plan that called for what became the "International Drinking Water Supply and Sanitation Decade". The objective was to position the right to safe drinking water and sanitation services in the context of basic human needs. The decade focused activities on the provision of safe water and adequate sanitation for all by 1990. Unfortunately, this decade did not achieve its objectives due to major challenges mainly rabid population growth and urbanization, corrupt political system, underinvestment and lack of awareness at community and national levels (Bartram, et.al, 2014).

2.2.1.2. The Dublin Conference

In 1992, the international conference on water and the environment that was held in Dublin, Ireland readdressed access to water. The inclusion of the conference principles highlighted the importance of water as an important resource for human development and environmental protection. The four Dublin principles are as follows:

Principle 1: Fresh water is a finite and vulnerable resource essential to sustain life, development and the environment.

Principle 2: Water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels. This approach dictates that decisions must be taken by policymakers with full public consultation and involvement of users at all levels starting from the planning phase to the implementation phase (Hall, et.al, 2014).

Principle 3: Women play a central part in the provision, management and safeguarding of water. This principle was intended to empower the role of women as decision-makers and implementers in development and management of water resources programs.

Principle 4: Water has an economic value in all its uses and should be recognized as an economic good. This principle recognizes water as both an economic and a social good and highlights that all people have the right access to safe drinking water at an affordable price (Salman, 2014).

2.2.1.3. The Johannesburg Summit

In 2002, the United Nations held the Johannesburg summit on sustainable development to set out strategies for better implementation of Agenda 21 that was negotiated in Rio ten years ago (Salman,2014). In 2005, the United Nations General Assembly proclaimed the period 2005-2015 as the water for life decade aiming by 2015 to achieve the Millennium development goals (MDGs). Those goals were amplified by the 2002 Johannesburg summit which set the target to halve by 2015, the proportion of population without sustainable access to an improved drinking water source and basic sanitation facilities (WHO/UNICEF, 2005).

2.2.1.4. Resolution 64/292 & Resolution 15/9

In 2010, the United Nations General Assembly (UNGA) voted to adopt resolution 64/292 recognizing the human right to water and sanitation as an essential right for the full enjoyment of life and all human rights (UN, 2014). This resolution was an important milestone in recognition of water and sanitation as an independent human right as it became an extension of other human rights rather than just as a prerequisite for the attainment of other human rights (Hall, et.al, 2014).

In resolution 15/9, the Human Right Council (HRC) also reaffirmed that access to safe drinking water and sanitation is a right to life and human dignity (UN, 2014). Unfortunately, the UNGA and HRC resolutions are mostly “moral statements” that are considered vague and have no clear guidelines for implementation (Baer & Gerlak, 2015).

2.2.1.5. The 2030 Sustainable Development Goal on Water and Sanitation (SDG6)

As indicated before, access to water and sanitation was part of the Millennium Development goals (MDGs) within MDG 7 on environmental sustainability with a targets to “halve the proportion of global populations who do not have access to improved water sources and basic sanitation by 2015” (WHO, 2017). Still, water for life decade targets were not fully met especially for sanitation, and accordingly, WHO and UNICEF became part of the recommended global action known as the Sustainable Development Goals (SDGs) (Nagpal&Radin, 2014).

The sustainable development goal 6 (SDG6) 2015-2030 addresses the need to “ensure availability and sustainable management of water and sanitation for all” (Mills & Cumming, 2016; UNICEF, 2016). The SDG targets on clean water and sanitation call for equitable access for all which means eliminating inequalities in service levels. The two indicators relating to SDG6 are: (1) the proportion of population using safely managed drinking water services, (2) the proportion of population using safely managed sanitation services and handwashing facility with soap" (UNICEF, 2018). Meeting these targets by 2030 would (WHO/UNICEF, 2019):

1. Eliminate open defecation
2. Achieve universal access to basic WASH for households, schools and health facilities
3. Have the proportion of the population without access at home to safely managed drinking water and sanitation
4. Progressively eliminate inequalities and access to WASH services

Still, this remains a major challenge specifically for developing countries to deliver and sustain.

2.2.2. Water Related Disease Burdens

Inadequate water supply and sanitation services, specifically in DCCs can increase the risk of gastrointestinal diseases such as diarrhea. Poor WASH infrastructures and services are considered as major contributors to the worldwide burden of infectious diseases especially diarrheal diseases; the second leading cause of both mortality and morbidity among children under the age of five, and the number one cause of mortality in sub-Saharan Africa (Walker, et.al, 2013; UNICEF, 2016). The US Center for Disease Control and Prevention (CDC) estimates that 88% of the burden of diarrheal diseases in children is due to poor WASH (CDC, 2015). According to the World Health Organization (WHO), 829,000 people die annually from diarrheal diseases worldwide because of inadequate water, sanitation, and hygiene (WASH) services (WHO, 2019). In 2017, diarrheal disease accounted for approximately 1.6 million deaths around the globe with one third of of deaths in children under the age of five years, as presented in figure 1 (Dadonite, 2019).

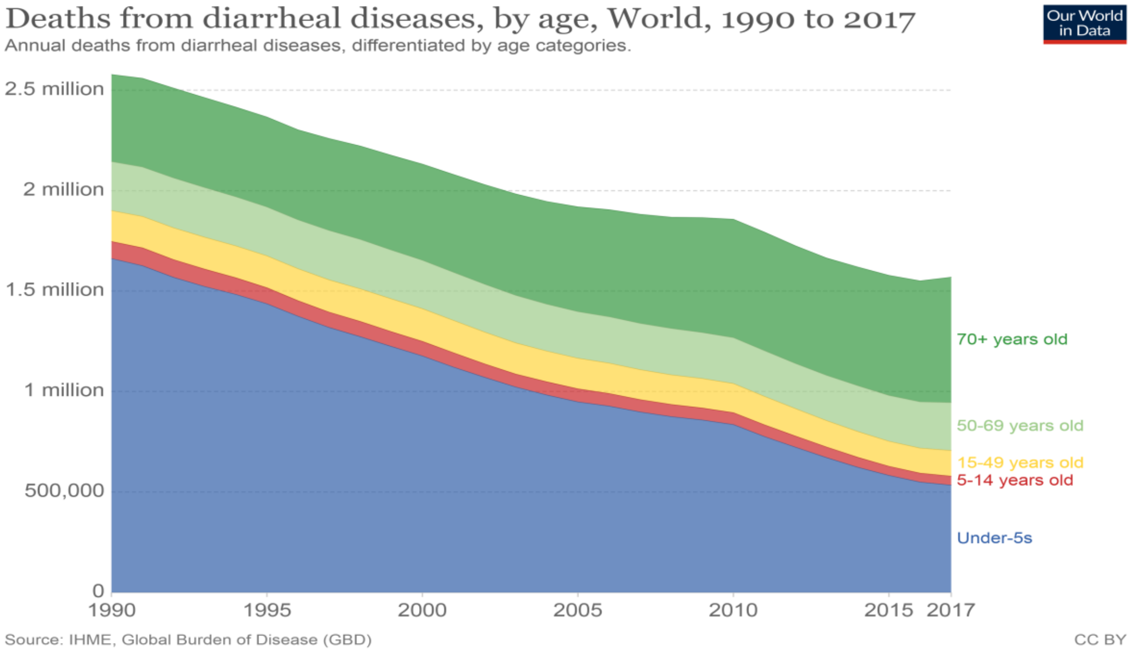

Figure 1: Global Deaths from Diarrheal Diseases by Age, 1990 to 2017 (Dadonite, 2019)

Unsafe drinking water, inadequate sanitation and poor hygiene (WASH) are important risk factors especially in low and middle income countries (LMIC's).Poor conditions of WASH conditions are associated with an average of 2.9 diarrheal episodes per year among children under the age of five in low and middle income countries (LMIC's) (Walker, et. al, 2012). Mostly, diarrhea among children in LMIC's results from the ingestion of pathogens as a result of improper sanitation and lack of appropriate hygienic practices such as hand washing. Figure 2 presents an illustration of the various feco-oral transmission routes In addition, diarrheal diseases may contribute to malnutrition and stunting, according to WHO (2017) "Diarrhea is a leading cause of malnutrition in children under five years old". Hence, diarrhea and malnutrition are highly correlated, for example, diarrhea leads to malabsorption of nutrients and decrease appetite in children that can impair the child's nutritional status (Dewey & Mayers, 2011).

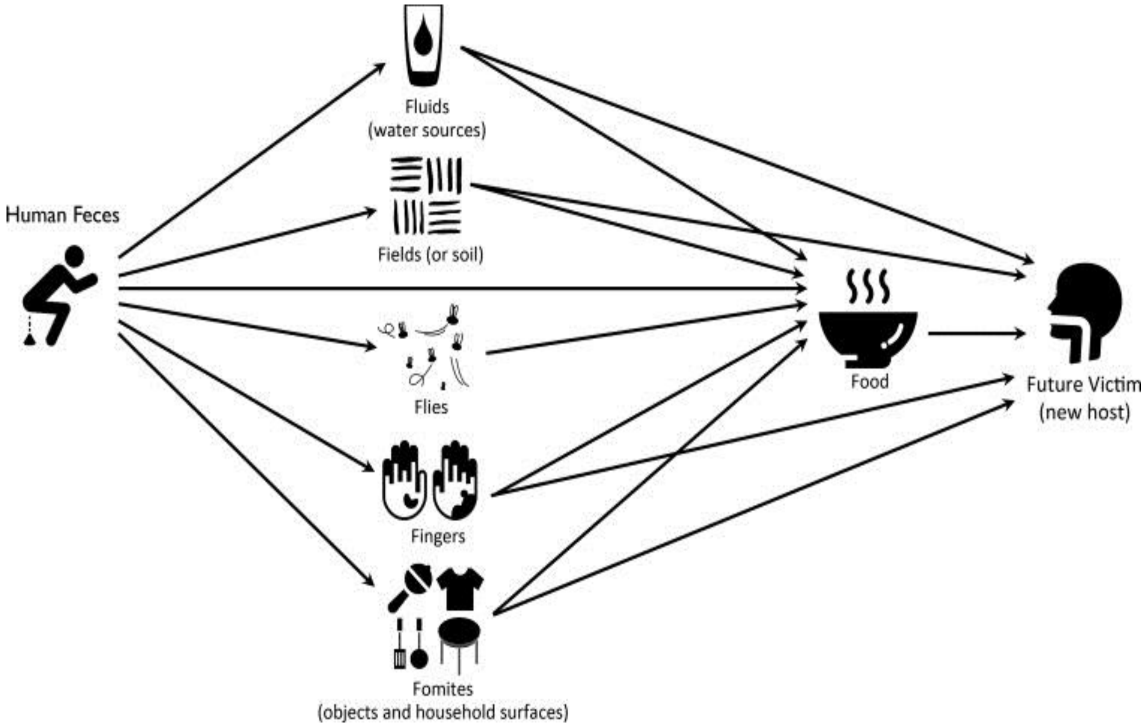

Figure 2: The F diagram illustrating feco-oral transmission routes (Penakalapati, et al, 2017)

In addition to the health impacts, poor WASH can negatively impact the social and economic development of families and societies. Economic costs of diarrhea can affect household resources and provisions including education, food, and productive investments (Rheingans, 2012). Families would be financially affected when having an ill child by spending more money on medications and physician visits and possibly losing their jobs in case of regular absence or earn fewer wages (Nesti, et.al, 2007). Besides, diarrheal diseases can financially affect the DCCs, for example additional costs of disinfecting and cleaning agents would be incurred. Based on a survey conducted on 379 parents of children having diarrhea, it was estimated that one episode of vomit, diarrhea and cold in DCCs cost an average of $ 260.70 per child (Carbin, et. al, 1999). Therefore, poor water, sanitation and hygiene can intensify poverty by elevating health-care costs and reducing productivity (Ready, 2010).

However, sufficient access to appropriate water, sanitation and hygiene practices allows the prevention of diarrheal diseases that negatively affect public health worldwide. According to the Centers for Disease Control and Prevention, improved water sources reduce diarrheal episodes by 21%, improved sanitation reduces diarrhea cases by 37.5%, and good hygiene practices can reduce diarrhea morbidity by 35% (CDC, 2016). Moreover, for every dollar spent on improved water and sanitation, a major return of $2.00 and $5.50 can be expected, leading to $60 billion in total global return (Hutton, & WHO, 2012).

2.3. Water, Sanitation and Hygiene (WASH) in Schools

Schools were identified as a priority setting for global WASH monitoring post-2015. Schools should have adequate water, sanitation and hygiene (WASH) services meaning the availability of water from an improved water source, proper sanitation facilities, and hand washing facilities with water and soap (WHO/UNICEF, 2018). To follow up on the progress towards meeting the SDG targets by 2030, UNICEF proposed 44 child related tracking indicators. The two indicators for progress towards SDG6 are : " (1)the proportion of population using safely managed drinking water services ,(2) the proportion of population using safely managed sanitation services and hand washing facility with soap "(UNICEF, 2018). Research has documented that WASH interventions in schools contribute to healthy and safe learning environment for teachers and students to have good hygiene behaviors (Babalobi, 2013; Patel, et.al, 2012; Reilly, et.al, 2008; Reeves, et.al, 2012). Globally, school-based WASH interventions aim to: (i) improve school enrolment and attendance; (ii) reduce the incidence of diarrhea and other hygiene related diseases; (iii) influence hygiene practices of parents and their children (McMicheal, 2019).

2.3.1. Effectiveness of School-Based WASH Interventions on Health

Improving water, sanitation, and hygiene (WASH) in schools is associated with improved health among school-aged children and reduced absence. School based WASH interventions aim to improve health of children and protect them from infections. WASH interventions can improve health among schoolchildren through two primary pathways. Firstly, these interventions may lead to fostering in the adoption of hygiene practices and change in hygienic behaviors. Reported studies have shown how school WASH interventions lead to an improvement in both knowledge and practices of hygiene (Patel, et.al, 2012; Reilly, et.al, 2008).

Secondly, these interventions interrupt pathogen transmission by reducing exposure to harmful pathogens in the school setting (Eisenberg,et.al, 2007).

There is an increased attention on how schools based WASHs interventions can reduce rates of absence and improve educational outcomes among school children. A cluster-randomized study conducted in Pennsylvania evaluated school-based handwashing program and found that absences were reduced by 50.6% over a period of three months among children who were mandatorily required to hand wash twice per day compared to control group (Guinan, 2002). Similarly, another study conducted in 60 Egyptian schools assessed the effectiveness of hand hygiene campaigns on reducing the incidence of absenteeism among school children. Results showed that students who were required to wash their hands experienced 30% reduction in diarrhea-related absence and 40% reduction in influenza-related absence when compared to control schools (Talaat, et.al, 2011).

2.3.2. WASH in Schools of Lebanon

In Lebanon, WASH guidelines for schools have been developed by UNICEF in collaboration with the Lebanese Ministry of Education (MEHE) and the Swiss Agency for Development and Cooperation since 2012. The objectives of the WASH guidelines are to reduce preventable water and hygiene and sanitation related diseases, increase-learning abilities of students, and improve water, sanitation and hygiene services in all Lebanese schools (UNICEF, 2012). Still, the developed guidelines mainly reflect on water quality and safety but are not in line with national LIBNOR/WHO standards. Additionally, the availability of facilities in terms of basic numbers is not in compliance with the newly adapted guidelines by the Ministry of Public Health (MOPH) and Ministry of Education and Higher Education (MEHE) developed by Jurdi in 2017.The WASH guidelines reflects just on general entities to be addressed in schools with minimal indicators to monitor, especially for sanitation and hygienic conditions as presented in table 1.

Table 1. Components of the WASH Program (UNICEF, 2012)

Component	Indicators
Water	Functional, near, sufficient quantity, safe for consumption, accessible.
Sanitation	Functional, adequate quantity, gender specific, clean, accessible.

Hygiene	Functional handwashing facilities, availability of sanitary services, hygiene education.

Hence, achieving equitable access to water, sanitation and hygiene facilities and services requires special attention to the most vulnerable population groups within our communities.

2.4. Water, Sanitation and Hygiene (WASH) in Child Daycare Centers: Routes of Exposure and Control Measures

DCCs childcare quality at is known to influence the health and the development of children throughout childhood period. Pre-school children (< 4-5 years) who attend DCCs have an increased risk for infectious diseases, especially diarrhea and upper respiratory tract infections (Ingrid, 2020).

Children vulnerability to pathogens relates to their decreased level of immunity, lower body weight, immature protective structural barriers and environmental exposures. Children are highly susceptible to environmental hazards because their immune systems are not well developed, and this makes them more prone to contact infection, and take more time to recover from it. Early childhood represents a particularly high-risk period, as children are more susceptible to environmental hazards than adults, as they drink more water, eat more food and breathe more air per body weight. In addition, they are more likely to put things in their mouth and share toys with other children at a time where their bodies cannot get rid or breakdown the harmful environmental contaminants (CDC, 2019).

2.4.1. Disease Transmission in Child Daycare Centers

Young children attending DCCs are on an increased risk of infections. Infectious agents in the DCC can be transmitted through direct person-to-person contact between children and childcare providers or indirectly via contact with contaminated surfaces for example; toys and other classroom objects where surfaces can be contaminated with saliva, urine or aerosol particles (Thackeray, & Magnusson, 2016). In addition, children have limited understanding of proper hygienic practices and toilet training, for instance; children are more likely to put things in their mouth and this place them at an increased risk of infections because “children engage in frequent hand to mouth behaviors, as much as 64 times an hour”(Thackeray, & Magnusson,2016). The various routes for infection transmission are presented accordingly in the following subsections:

2.4.1.1. Diapering

Diaper changing is a major practice at DCCs; it is an important part of caring for children. However, diapering can be a route of transmission for fecal contamination if childcare providers are not careful about proper diapering procedures. During diaper changing , the diaper changing surface may get contaminated if it comes in contact with fecal matter and dirty diapers , this make it easier for germs to spread and contamination of children’s clothes and hands to occur (Miller, et.al, 2013). Hence, the diapering area should be selected and managed properly to ensure safe and clean environment for the child, for example it must be covered in a non-porous surface that can be sanitized and cleaned easily to reduce the spread of germs (EABCC, 2019). In addition, caregivers who change diapers should be trained on proper diapering practices.

Separation of diapering area from food preparation area, using disposable gloves, disinfecting the diaper pad after every single use and storing diaper supplies at a distance from the diapering area are the appropriate practices to reduce the spread of germs (EABCC, 2019). According to CDC, "there can be a trillion germs in one gram of poop" (CDC, 2016), so it is important for DCCs to be aware of proper diapering procedures to prevent and control infections that might occur from fecal contact.

2.4.1.2. Toileting

Toileting is an important routine in DCCs. Childcare providers play a major role as in training children to use the toilet facilities. Childcare providers can support the process of training through helping children practice toileting by themselves, planning the toilet learning process with parents and watching for signs of readiness (EABCC, 2019). Toilets can be germ-ridden places if hygienic practices are not practiced properly as bacteria microorganisms, like E-coli, can be found on the toilet seat, the flush, the floor and the door handle (Bhatia, 2017). There are set of hygienic procedures that can minimize the spread of pathogens associated with toileting practices. These relate mainly to disinfecting of tall high touch areas like toilet-flush handles, using toilet seat sanitizer, washing hands with soap and water after every time of using the toilet, and providing a good ventilation system (Bhatia, 2017).

2.4.1.3. On Site Food Preparation

Food preparation is a common practice at child daycare facility. Improper food handling is a common route for pathogens to spread. According to WHO "an estimated 600 million (almost 1 in 10 people in the world) fall ill after consuming contaminated food, and 420 000 die every year, resulting in the loss of 33 million healthy life years (DALYs)" (WHO, 2019). Young children are at increased risk of foodborne diseases because of their underdeveloped immunity. According to American Academy of Pediatrics, and the Center for Foodborne Illness (2014), children under the age of five have higher incidence of foodborne infections .In their comprehensive review, Lee and Grieg (2008) found that 29% of the bacterial outbreaks in childcare centers were transmitted through food. Cross- contamination is enhanced if the food preparation area is not separated from the diapering area. Fecal contamination can lead to diarrheal diseases on short term exposure, however long term exposure to fecal contamination can increase the risk of stunting; malnutrition and environmental enteric dysfunction (Wang, 2018) .Thus, exposure to fecal contamination negatively impact the health and the growth of children. Accordingly, food hygiene and proper food handling are essentials for the health of children, who are more vulnerable to diseases than other age groups. As children enrollment is increasing in DCCs, good hygiene must be a priority in these centers. Childcare providers must have good personal hygiene practices while handling or preparing food , As recommended by the US center of disease and control , hands must be washed for 20 seconds with soap and water before, during, and after preparing food and before eating (CDC, 2019).

2.4.2. WASH Preventive Measures to Reduce Pathogens Transmission in DCCs

2.4.2.1 Adequate Water Supply

Water should be safe and available in sufficient quantities whether it is used for drinking, food preparation, personal hygiene and removal of waste (WHO, 2019). Yet, developing countries face major challenges in securing sufficient to safe water supply mostly due to water scarcity and improper sanitation leading to water pollution (Vairavamoorthy,& Sempewo, 2011).Twelve out of the 17 countries that face high levels of water stress are countries in the Middle East and North Africa (MENA) (Hofste,et. al,2019; Zafar,2020). Water scarcity in this region is mostly aggravated by dependency on shared/ transboundary water sources, burgeoning population growth, climate change and increased exposure to pollution. In Lebanon, the 2015 estimates showed that only 48 percent of the population has access to safely managed water (WHO/UNICEF, 2018). The equitable access to safe and affordable drinking water indicator reflects on the "percentage of people using drinking water from an improved source that is accessible on premises, available when needed and free from fecal and priority chemical contamination" (WHO, 2019). Hence, it is important to insure the safety of water in terms of the physical, chemical and microbiological characteristics and to insure that sufficient amounts are provided to meet the basic water requirements to sustain human health.

- Water Quality

Safe drinking water is essential for the health of children to prevent waterborne diseases that affect their cognitive and health development. Exposure to waterborne diseases and outbreaks is linked to unsafe water supplies (UNICEF, 2012). A safe water supply is characterized with physical, chemical and microbiological characteristics in compliance with international/ national water standards, such as LIBNOR 2016 in the case of Lebanon.

That is why water quality should be monitored on regular basis; the physical, chemical and microbiological characteristics of water should be evaluated frequently to ensure the compliance to the set standards/guidelines. This is crucial to protect children from diarrhea, which accounted worldwide to 8% of deaths among children under five years of age in 2017 (UNICEF, 2018).

2.4.2.2 Appropriate Sanitation Facilities

Toileting and diapering are common practices in DCCs .Thus the availability of proper and well maintained sanitary facilities is a must to reduce the spread of germs .Based on WASH guidelines for schools proposed by UNICEF in 2012 in Lebanon**,** toilets should be sufficient, easily accessible, gender specific,, secure, clean, properly ventilated, and should have water-basins equipped with soap, running hot and cold water and tissue paper (UNICEF, 2012). This should be also applied in preschool settings; preschools must have adequate toilets with proper ventilation and easily to reach water basins with the availability of soap and running hot and cold water.

- Availability of Running Hot and Cold Water, Soap and Tissue papers

Hygienic materials such as soap, tissue paper, running hot and cold water should always be available to insure good hygienic practices for caregivers and children.

- Proper Ventilation of Toilets

To control odors, toilets and diaper changing areas should be properly ventilated. One form of ventilation is by using suction fans; other forms such as windows are considered ineffective as it might help in the quick spread of vector-borne diseases. (UNICEF, 2012)

- Availability of Water Basins for Hand Washing

Water basins should be in appropriate height to be reachable by children and allowing them to practice proper hand washing with appropriate adult supervision. Childcare providers should supervise the regular washing of children's hands especially after using the toilet, before and after eating, after blowing their nose, coughing and sneezing (Messing, 2020; Hodgson, 2019). Children would feel motivated to practice voluntary hand washing when they can easily reach the sink. Additionally, the availability of automatic faucets prevents the spread of germs because children do not have to touch the faucet to turn on the water (EABCC, 2019). According to the American Academy for pediatrics, American Public Health Association and National Resource Center for Health and Safety in Childcare and Early Education (2014), handwashing facilities should be located at the place that meets the developmental level of the children for example, toddlers toilets and handwashing sinks should be located in or adjacent to toddler rooms .

- Properly Arranged Diapering Area

Diapering is an important routine in infant and toddler areas of the DCC, thus it is important to have a safe and properly arranged diapering area to reduce the spread of germs and cross contamination of surfaces. The diapering area should be located near a handwashing sink and covered in a non-porous surface that can be sanitized and cleaned easily to reduce the spread of germs (EABCC, 2019). To reduce the risk of contamination, proper diapering procedures must be followed by the caregiver as recommended by the Guidelines for Early Care and Education Programs (AAP, APHA, NRC, 2019). This relates to:

Washing hands before diaper changing and prepare all the needed materials for a diaper change (i.e. disposable gloves, empty plastic bag, wet wipes, etc.)

a) Covering diapering surface with disposable paper that is enough to cover the child from his shoulders to beyond their feet.

b) Getting rid of the soiled diaper and its contents by placing them in a plastic bag and then dispose in hands-free covered trash can.

c) Washing the child's hands after a clean diaper is put on them and they are fully dressed

d) Washing and disinfecting the diapering area after every use

e) Washing hands after diaper changing.

2.4.2.3 Hand Hygiene

Contaminated hands are considered as a main source for pathogen transmission. According to Vishwanath, et.al (2019), the transmission of pathogenic organisms through feco-oral route was common among children who fail to wash their hands properly. Hand washing is an important measure to prevent the transmission of disease agents. Childcare providers should wash their hands many times during the day. The extension alliance for better childcare, stresses on the need of caregivers to wash their hands in association with the following activities (EABCC, 2019):

(1) Upon arrival for the day, after breaks, or when moving from one child-care group to another

(2) Before and after giving medications

(3) Before preparing food or handling food

(4) After using the toilet or helping children using the toilet; diaper changing; handling bodily fluids such as diarrhea, mucus, blood, vomit; touching animals or cleaning up animal waste; playing in sand and outdoor, and eating.

Additionally, CDC recommends the use of water and soap for washing hands to get rid of germs (CDC, 2019). The proper way is to decontaminate hands using soap and water takes about as long as 20 sec (singing "happy birthday" twice) (WHO, 2020). Studies have also showed that alcohol-based hand rubs (ABHRs) are an effective means of decreasing the transmission of bacterial pathogens and can be used instead of hand washing (Jabbar, et.al, 2010). However, alcohol-based hand rubs (ABHRs) or hand-sanitizer has some limitations. CDC found that Sanitizers cannot kill all types of germs and might not remove harmful chemicals from hands like heavy metals (CDC, 2019).

Hand washing could be made simpler and more accessible by having an easy-to-use handwashing area for children when they start to practice independent hand washing with adult supervision. Hand washing sinks should be at low height to be reachable by children and must be separated from sinks used for food washing and preparation. In case the low height washing sinks are not available, a stable stool must be equipped to make the sink reachable by children. Also, each sink should be equipped with a liquid soap dispenser to remove waste in addition to paper towel dispensers, it is better to choose dispensers that dispense only one paper towel at a time to prevent contamination (EABCC, 2019).

And, as childcare providers play an important role in protecting the health of children and in preventing communicable diseases in childcare facility, it is crucial to be trained on general hygiene and sanitation practices. Education of caregivers and children on hand hygiene would provide a healthy and safe environment for children by reducing the transmission of disease agents (AAP, APHA, NRC, 2019).

2.4.2.4. Cleaning and Sanitizing Environmental Surfaces

Pathogens can be transmitted indirectly via the interactive environment of DCCs. Loads of microbial pathogens have been detectable in samples collected from toys. For example, lee, et.al (2008) identified 29 viable bacterial species on the surfaces of toys in DCC over a period of six months. Another study conducted by Ibfelt, et.al (2015) reported that the highest prevalence of bacterial species, such as E coli, were present on pillows and sofas followed by changing diaper mats and toys. Published literature shows that disinfecting all types of surfaces, facilities, and objects such as floors, toilet areas toys can decrease the transmission of diseases in DCCs. In a study conducted by Krilov, et.al (1996), results indicated that disinfecting environmental surface in DCC can reduce the incidence of enteric viral diseases from 0.70 times /child/month to 0.53 /child/month. However, some studies reported conflicting results. To study the effect of washing and disinfection of toys, an intervention was conducted by Ibfelt, et.al (2015) showed no significant difference in the number of days of absence due to sickness between the intervention groups and control groups was reported. In addition, a hygiene intervention study conducted by Gudnason et al. (2012) showed no significant difference in the incidence ratios of diseases between the hygiene intervention and control childcare centers. However, the scoop of these studies was limited in literature and although observational studies provide meaningful results in posing hypotheses on causal relationships, they alone without clinical or microbiological testing can seldom establish clear causality.

As such, DCC structure easily provides pathogen transmission environment. Children are at higher risk of exposure to contaminated surfaces. Thus, it is crucial to disinfect and clean surfaces to reduce on pathogen transmission. For example, according to the American Academy for pediatrics, American Public Health Association and National Resource Center for Health and Safety in Child Care and Early Education (2014), contaminated toys by body secretion or excretion should be cleaned with water and detergent, rinsed, sanitized and then air dried, however, toys that cannot be cleaned or sanitized should not be used. Moreover, contaminants found on shared objects such as toys provide the opportunity for ingestion of enteric pathogens which may contribute to frequent illness in young children due to their frequent mouthing behaviors (Ngure, et.al, 2014).Therefore, routine cleaning and disinfection of surfaces is important for prevention of disease transmission in DCC settings (Brady, 2005; Mink & Yeh, 2009).

CHAPTER 3

METHODOLOGY

3.1. Overview of the Chapter

This chapter describes the methodology used for the thesis work. It presents an overview of the study design, questionnaire development and data collection. Additionally, sampling and laboratory analysis are elaborated, and limitations of the study are highlighted.

3.2. Study Design

This study assessed WASH facilities and services in child daycare centers (DCCs) in Saida Caza. An assessment survey tool was developed to evaluate WASH facilities and services through a cross-sectional field study of licensed DCCs in Saida Caza (Appendix 1).

The list of all licensed DCCs was obtained from the Ministry of Public Health (MOPH) and presented in table 2. The total number of identified DCCs is twenty-three (23); these centers cater children of pre-school age (from 40 days to 5 years).

Prior to field visits, an introductory letter to all licensed DCCs in Saida Caza was obtained from the Mother and Child Health unit at the Ministry of Public Health late in September 2020 through the World Health Organization (WHO)-Lebanon office to facilitate the easy access to the DCCs in Saida Caza (Appendix 2).

A total of seventeen DCCs accepted inclusion in the study (74%) and the remaining six DCCs (26%) refused participation. It is to be noted that participation was voluntary, and participants were informed of their rights to refuse to participate or to withdraw from the study without being penalized. All directors who agreed to participate were asked to sign a consent form to confirm their participation prior to data collection (Appendix 3). The consent form was reviewed verbally with participants and all their questions were answered and addressed. By signing consent form, directors agreed to participate and allowed access to their DCCs to conduct the walk-in survey and collect samples.

Table 2: List of Licensed Child Daycare Centers in Saida Caza

Child Daycare Centers Reference Number	**Decree Number**	**Capacity (Number of children)**	**Date of Establishment**
DCC 1	2/1049	25	5/7/2010
DCC 2	1/2051	35	11/7/2016
DCC 3	1/394	25	13/3/2019
DCC 4	1/1072	26	6/11/2019
DCC 5	1/1672	20	22/8/2019
DCC 6	1/604	41	19/5/2012
DCC 7	1/2000	35	12/5/2013
DCC 8	1/877	15	21/5/2015
DCC 9	2/1849	40	25/9/2008
DCC 10	1/167	40	30/1/2019
DCC 11	1/1719	25	29/10/2012
DCC 12	1/185	23	18/7/2012
DCC 13	1/1656	25	28/8/2015
DCC 14	1/664	25	16/4/2019
DCC 15	1/146	25	23/1/2018
DCC 16	1/794	15	30/4/2015
DCC 17	1/805	15	11/7/2016
DCC 18	1/1603	46	19/5/2012

DCC 19	1/1720	25	29/10/2012
DCC 20	1/720	25	22/4/2015
DCC 21	1/1683	25	9/6/2018
DCC 22	1/1485	45	30/7/2015
DCC 23	1/145	25	23/1/2018

The study design is divided into three main sections (1) WASH survey tool development (2) environmental sampling (water and environmental swabs collection and laboratory analysis) and (3) statistical analysis to determine situation and variability in settings.

All data collection protocols for this study were reviewed by Institutional Review Board (IRB) at the American University of Beirut to ensure that all requirements for this human-based research project were met (Appendix 4). IRB approved this thesis work on July 29, 2020, using expedited review procedures.

3.2.1. WASH Survey Tool Development

The survey tool that was used for the assessment of the environmental health profile of the licensed DCCs in Saida caza was developed under the supervision of the thesis advisor and after an extensive literature review in reference to national and international guidelines (AAP, APHA, NRC, 2019; CDC, 2019; Jurdi, 2017; UNICEF, 2012). Questions on WASH facilities and services in childcare settings were mostly adopted from Centers for Disease Control and Prevention, Environmental Protection Agency, American Academy of Pediatrics, American Public Health Association and National Resource Center Research Guidelines, in addition to examining documents and publications of health risk projects and international study interventions.

(AAP,APHA,NRC,2019;CDC,2015; EPA,2021; EABCC,2019;Gyi,2019; Ibfelt,2015; Ingrid,2020; Kotch,2007; Singth,2017; Vinay,et.al,2011; Zomer,et.al,2013). Additional questions on overall assessment of WASH profile were adapted from the National WASH Survey of Public Schools in Lebanon that was conducted in 2008-09 (Jurdi, 2009). The developed survey tool was pilot tested through field visits to three DCCs that were not included in the provided list by MOPH. This is mainly to reduce on the bias in reporting and behavioral changes when collecting the data from the licensed DCCs. The surveyed tool was pretested to observe and assess the different WASH facilities and services in DCCs setting, and accordingly some questions were added or modified based on the preliminary field visit and on the feedback provided by WHO – Lebanon office on pre and post COVID 19 WASH Measures.

All the questions were synthesized in English and then translated into Arabic to make it easier for participants to understand the context of the study. The final version of the survey tool was approved by IRB on July 29, 2020.

3.3. Measurements

The developed tool was used to evaluate WASH facilities and services in DCCs. The tool consists of the following sections and sub-sections:

3.3.1 Potable Water Quality and Management

Water supplies in the surveyed child daycare centers were assessed using proxy-indicators relating to : (a) Types and sources of drinking water (b) Quality of drinking water (c) Daily consumption patterns (d) Onsite water treatment (disinfection)

(e) Conditions of onsite water storage tanks (f) Water quality perception and monitoring and (g) Reported waterborne diseases during the last 2 weeks/year.

3.3.2. Sanitation

Sanitary services and facilities were assessed using the following categories: (a) Sanitation facilities (number of water basins, suitable child-sized hand washing sinks , availability of running hot and cold water, safe diapering area, proper toileting area, etc.) (b) Types of Sanitation practices (disposal of diapers, disposal of single use paper towels, cleaning and disinfecting potty chairs, etc.) (c) Types of Sewage disposal systems (septic tanks, cesspools, sewage system).

3.3.3. Hygiene Practices

Hygiene practices and activities were assessed using proxy indicators relating to: (a) Availability of hygiene materials (soap, tissue papers, etc...) (b) Hygiene practices (hand washing sinks location and showering) (c) Housekeeping activities (daily, weekly and monthly) and (d) Hygiene training programs and activities.

3.4. Data Collection and analysis

Data was collected in two phases. Phase one consisted of a walk-in survey of the facilities and phase two was for the collection of water samples and swabs.

3.4.1. Walk-in Survey

Field visits for conducting walk-in survey were completed throughout the month of October 2020. Data on number of children and caregivers, perceived water quality, water quality monitoring, water disinfecting method and availability of certified staff were obtained from the directors of the childcare centers, while the other types of data on WASH facilities and services were collected through direct touring, inspection and observation.

No prior appointments or notifications were given to individual DCCs on the date and time of the data collection. This was mostly to reduce on possible bias due to direct behavior.

Data on WASH services and facilities were assessed in reference to National Physical School Environmental Guidelines (developed by M Jurdi) and adopted by the Ministries of Public Health (MOPH) and Education and Higher Education (MEHE) in 2017, and the UNICEF school's WASH Guidelines developed in 2012. Additionally, reference was made also to the Guidelines for "Early Care and Education Programs" developed by the American Academy of Pediatrics, American Public Health Association, National Resource Center for Health and Safety in Child Care and Early Education in 2019.

3.4.2. Water Samples Collection, Analysis, Transportation and Storage

Water sampling was performed in accordance with standard methods recommended by American Water Works Association (AWWA), American Public Health Association (APHA) and Water Environment Federation (WEF) (APHA, AWWA & WEF, 2017) as presented in table 3.

Water sampling was conducted once between December 3 and December 10. Water samples were collected from all potable water outlets (drinking, cooking, hygiene, and removal of waste) (68 samples). The quality and safety of samples was determined in compliance with national standards for drinking water (LIBNOR, 2016).

All collected samples were collected and transferred to the laboratory in ice boxes and analysis of the parameters that are nonstable was done in the same day sample collection (free residual chlorine, ammonia, alkalinity, total hardness, chloride, nitrate, phosphate and sulfate). And, all the samples were stored at 4°C prior throughout the entire analysis period (APHA/AWWA/WEF, 2017).

Water samples for the chemical and physical analysis were collected in polyethylene bottles that were presoaked overnight in 10% nitric acid and later rinsed with water and for microbiological testing water were collected in sterile borosilicate 300 ml bottles. Sodium thiosulfate was added to the glass bottles (APHA, AWWA & WEF, 2017).

The overall physical, chemical and microbiological quality was determined based on the methods indicated in table 3. All physical, chemical and microbiological analysis was performed in accordance with standard methods recommended by American Water Works Association (AWWA), American Public Health Association (APHA) and Water Environment Federation (WEF) (APHA, AWWA & WEF, 2017).

3.4.2.1. Physical Parameters

Color, turbidity, electrical conductivity, and total dissolved solids (TDS) were the quality physical parameters that were analyzed to reflect on the physical characteristics of the collected water samples. Color of the water samples was determined by Platinum-Cobalt Standard method using the DR 2800 HACH Spectrophotometer. Turbidity of water was determined by using Nephelometric

Method. And, Electrical Conductivity Method was used to determine electrical conductivity and TDS levels.

3.4.2.2. Chemical Parameters

To reflect on the chemical quality and characteristics of the water supplies, several chemical parameters were analyzed. The hydrogen ions (pH) was determined by using Electrometric method. Alkalinity, total hardness and chlorides were analyzed using the burette titration method. Spectrophotometric methods were used for determining the levels of nitrate, phosphate, sulfate, ammonia. The Cadmium Reduction Method, PhosVer 3 Ascorbic Acid Method, SulfaVer 4 Turbidimetric Method, Nesslerization Method were used to determine the levels of nitrate, phosphate, sulfate and ammonia, respectively. Additionally, sodium levels were determined using the flame photometer technique.

Free residual chlorine was tested immediately upon arrival to the laboratory as this is highly unstable parameter; the DPD method was followed for this determination.

3.4.2.3. Microbiological Parameters

In addition to the physical and chemical analysis, microbiological quality of water was determined. Water collected from tabs and bottled cooler dispensers were tested for total and fecal coliforms by using the membrane filtration method. The filter pads were placed on petri dishes, grid side up. Petri dishes contained m-Endo medium for total coliform testing which were incubated at 35˚C for 24 hour and m-Fc medium incubated at 44.5˚C for 48 hours for fecal coliforms (APHA, 2017).

Table 3. Standard Analytical Methods for the Determination of the Physical, Chemical and Microbiological Quality Parameters

Analytical parameter		**Standard analytical method**	**Type of analytical equipment**
physical	Electric Conductivity	Electrical Conductivity Method	Senslon 7HACH,Conductivity Meter
	Color	Platinum-Cobalt Standard Method	DR 2800 HACH Spectrophotometer
	Turbidity	Electrometric Method	2100P HACH turbidimeter
Chemical	PH	Electrometric Method	Senslon 7HACH , PH Meter
	Free residual chlorine	DPD Method Powder Pillows	DR 2800 HACH Spectrophotometer
	Alkalnity	Titration Method using Sulfuric Acid Standard Solution(0.02N)	Buret Titration
	Nitrates	Cadmium Reduction Method	DR 2800 HACH Spectrophotometer
	Phosphates	Phos Ver 3(Ascorbic Acid) Method	DR 2800 HACH Spectrophotometer
	Sulfates	SulfaVer 4 Turbidimetric Method	DR 2800 HACH Spectrophotometer
	Ammonia	Nessler Method	DR 2800 HACH Spectrophotometer
	Sodium and Potassium	Flame Photometry	JENWAY Flame Photometer
	Chlorides	Mercuric Nitrate Titration Methods	Buret Titration
	Calcium and Magnesium	EDTA Titration Methods	Buret Titration
Microbiological	Total Coliform, *Escherichia coli.*	Membrane Filter Technique	Millipore Filtration

3.4.3. Swab Samples Collection, Transportation and Storage

Overall microbiological screening was performed using swab analysis method. Samples were tested for fecal contamination (*E coli*) using the National Infection Service Food Water and Environmental Microbiology Standard method (PHE, 2017).

Random sampling for hand swabs was conducted from two childcare providers in each facility without pre-identification.

Prior to sample collection, childcare providers who agreed to participate in this study were asked to sign a consent form that would be kept with the data collector (Appendix 5) .A copy of the signed consent form was left to each participant for her record. Additionally, random swab sampling was conducted on three environmental surfaces (diapering surface, feeding surface and a randomly chosen toy) from all the surveyed DCCs.

The swabs were moistened by a sterile diluent (distilled water) and then held at a slight angle across the entire selected surface. The swabs were aseptically replaced into the test tube and transported to the laboratory in ice boxes. In the laboratory, the test tube containing the swab was shacked rapidly and then 3 different volumes of the rinse solution (0.1, 0.5, 1 ml) were added into 3 petri dishes. This was repeated on four different agars (Endo, Macconkey, Deoxycholate Lactose agar and Eosine Methylene Blue Agar) by using the spread plate technique method and then all plates were incubated at 37°C for 24 hours.

3.5. Plan of Analysis

Statistical Package for Social Sciences (SPSS) Version 21 was used to analyze the quantitative data collected to determine situation and variability in settings. Analytically, measured water quality parameters were compared with national drinking water standards (LIBNOR, 2016) using non-parametric testing in order to determine water quality and safety.

3.6. Quality Assurance and Quality Control

All water samples were collected once, during the month of December, 2020, to reflect uniformly on wet seasons conditions. All sampling bottles used for microbiological sampling were properly washed and sterilized in the central departmental autoclave. Sodium thiosulphate was added to the sampling bottles collected from tap water to neutralize the effect of free residual chlorine in case the water was chlorinated.

When collecting samples for microbiological analysis, the bottles were filled after flaming tap and allowing water to flow to insure non-stagnating water flow. Moreover, the bottles were filled to the indicated marked line, without overflowing, to allow the presence of oxygen essential for microbial viability.

Analysis of all physical and chemical parameters (section 3.4.2) was done in duplicates for accuracy. And, a blank cell filled with distilled water was used between samples to standardize spectrophotometer readings.

Moreover, when collecting the microbiological swabs, contact with the mouth of the test tube was avoided to prevent contamination. And, since microorganisms create ubiquitous sources of possible contamination in the laboratory, a sterile field area using a Bunsen burner was created while plating the samples. Additionally, the metal loop used for sample spreading was flamed between different samples using the Bunsen burner flame to minimize possible cross contamination.

CHAPTER 4

RESULTS AND DISCUSSION

4.1. Overview of the chapter

This chapter reports on the analysis of the survey data collected from the 17 surveyed child daycare centers (DCCs) in Saida Caza. The assessment addressed WASH facilities and services and included: water quality and quality monitoring, provision and management of water supplies, onsite water disinfection, sanitation facilities, hygiene practices and services and the overall hygienic profiles. Results are compared to: (a) the UNICEF school's WASH guidelines developed in 2012 (b) the National Physical School Environmental Guidelines (developed by M Jurdi) and adopted by the Ministries of Public Health (MOPH) and Education and Higher Education (MEHE) in 2017, and (c) the 2019 Guidelines for Early Care and Education Programs developed by the American Academy of Pediatrics, American Public Health Association, and National Resource Center for Health and Safety in Childcare and Early Education, to assess compliance and recommend interventions.

4.2. Child Daycare Center Water Supply

4.2.1. Potable Piped Water Supply

Young children are at an increased risk of waterborne diseases because they consume more water per pound of body weight compared to adults (EPA, 2018). Diarrhea, a water-related disease is the second leading cause of both mortality and morbidity among children under the age of five years (UNICEF, 2016). Globally, diarrheal diseases accounted, in 2017, to 8% of deaths among children younger than five years of age due to poor WASH (UNICEF, 2018). In sub-Saharan Africa, diarrhea is considered the number one cause of mortality which contributes, every year, to around 180,000 children deaths (Walker et.al, 2013; UNICEF, 2015). Thus, proper risk assessment and routine water quality monitoring are essential to protect children from exposure to potable water contaminants that impact their health and development.

Data collected shows that all (100%) surveyed DCCs do not use the piped water supply as a source of drinking water and rely on various brands of commercial industrial bottled water (water dispensers) as a source of drinking water. This is mainly because the directors of DCCs' perceive the quality of such sources as safe and controlled. Unfortunately, this might not be the case as the quality of bottled water is not necessarily safer than tap water. Many of the commercial bottled water companies entered the Lebanese market after just acquiring a commercial status but were not licensed based on quality assessment, and as such, mostly, do not comply with LIBNOR standards (Jurdi, et.al, 2018; Semerjian, 2011).

A study conducted in Lebanon documented that bottled water has comparable water quality to the public water supply (Massoud, et.al, 2013). Another study showed that the majority of tested local bottled water brands revealed inconsistency in the labelling information relating to chemical quality parameters which thereby raises doubts about the water quality and impeaches the authenticity of the water brand (Khadra, 2020).

Moreover, commercial bottled water may pose major health risks due to the leaching of Di- (2-ethylhexyl) phthalate (DHEP). DHEP, the most common member of the class of phthalates that is used as plasticizers, has been associated with liver and testicular toxicity (Erythropel, et.al, 2014; Rowdhwal & Chen, 2018). In a study conducted in Greater Beirut Area to determine the quality of commercial bottled industrial water , out of ten screened commercial brands, DHEP was detected in 40% (4 brands), and the levels of this contaminant exceeded the maximum acceptable by LIBNOR and EPA Standards in 30% (3) of the brands (Jurdi, et.al, 2018). Bisphenol-A (BPA) is another commonly used monomer for the manufacturing of plastics including bottled water. BPA is an endocrine disruptor that is associated with immune disorders, neurobehavioral alterations, and secondary sexual developmental changes (Aneck-Hahn, et. al, 2018). In a study conducted to quantify the levels of BPA in commercial polycarbonate (PC) bottled water brands in Lebanese market, results showed that water stored in PC bottles had BPA levels ranging between 50 and 1370 ng/L (Dhaini & Nassif, 2014).

As for the piped water supply in all the surveyed facilities (17 DCCs), it is only used for personal hygiene and removal of waste. As indicated before, this is mostly because the directors of the DCCs perceived the quality of the piped water supply as “unsuitable for consumption”; hence, the reliance is on industrial bottled water as a healthier and safer complementary source for drinking, cooking and formula bottles preparation, as presented in table 4.

Table 4: Type of Water Use by Surveyed DCCs

Types of Uses	**Sources of Water**			
	Piped Water Supply		Commercial Bottled Water Brands	
	N	%	N	%
Drinking	0	0.0	17	100
Cooking	0	0.0	8	100
Baby Formula Preparation	0	0.0	17	100
Personal Hygiene and Removal of Waste	17	100	0	0.0
Dental Hygiene	5	100	0	0.0

So accordingly, as indicated by all respondents, the piped water supply is only used for hygienic and cleaning purposes; children use it to brush their teeth and wash their hands. Still, such uses carry the risk of exposure to pathogenic microorganisms, especially if the microbiological quality is not in compliance with National LIBNOR Standards. It is to be noted that WHO emphasizes the need to use safe water supply for all types of basic water requirements including drinking, preparation of food, personal hygiene and removal of waste and that using just safe water for drinking and food preparation is not fully protective (WHO, 2017). Thus, children can be exposed through the various indicated water uses, and as such, the risk remains evident. This issue of the restricted use of safe water quality for drinking and food preparation is a major misconception in communities and exposes children to the risk of disease (Jurdi, 2018).

To conclude, the reliance on complementary water sources for drinking, cooking and formula milk preparation is the common profile for all the surveyed DCCs considering that it is the safer option that does not present a risk of exposure to agents of disease. Mostly, consumers are satisfied by the aesthetic characteristics of the water and could mistakenly conclude that this source is safe and presents no health risks (Addisie, 2012; Nasr, 2005). Other factors that might affect consumer's water quality perception are knowledge and shared experiences about specific water sources and the occurrence of any health problems relating to these sources (Doria, et.al, 2009). So, the entire surveyed DCCs showed a non-satisfactory response to the quality of piped water supply. The opinions expressed and the justifications given might be justified by the inadequacy of quantities supplied by water distribution systems, intermittent water provisions, and the minimal available data on water quality published/provided to the end-users (WHO/UNICEF, 2016). Therefore, continuous water quality monitoring is the key to ensure safe piped water supply that could be used for all types of basic water requirements (drinking, food preparation, personal hygiene, and removal of waste). Moreover, Regional Water Establishments in collaboration with Ministry of Public Health and various NGOs should conduct awareness campaigns on the importance of safe water quality and communicate with end users in transparent manner to reinstate trust and confidence in the quality and use of the piped water supplies.

4.2.2. Onsite Water Storage Tanks

The characteristics of the water storage tanks in the surveyed DCCs are summarized in table 5. All onsite water storage tanks were appropriately covered in all the surveyed DCCs. This is a positive aspect of major importance, as improperly covered tanks could be subjected to contaminants such as bird feces and dirt that might enhance the growth of fecal coliforms (Chalchisa, et.al, 2017). However, all the surveyed DCCs have water storage tanks that are made of plastic. This is very critical as the choice of the plastic material should be approved by international agencies such as the U.S. Food and Drug Administration (FDA). This is important to safeguard the water quality and prevent migration of chemical contaminants into the water. This issue was of no major concern to DCCs directors as they had no knowledge on the importance of safe water storage, and on how to manage it starting with the choice of the material, to the onsite location, maintenance and management.

Onsite water storage in Lebanon is very crucial due to intermittent water distribution, which by itself can increase the risk of exposure of the water supply to contamination throughout the distribution network (Chambers, et. al, 2004; Korfali & Jurdi, 2007; WHO/UNICEF, 2016).

Table 5: Location and Characteristics of Water Storage Tanks

Storage Tank Characteristics	**Reported Cases**	
	N	**%**
Material		
Plastic	17	100
Location		
Roof	14	82.4
Playground	2	11.8
Parking	1	5.9
Design		
Covered	17	100
Uncovered	0	0.0

As noted during the field visits, almost 82.4% (14) of DCCs have their storage tanks installed on the top roof, while 70.6% (12) of DCCs have their water storage tanks exposed directly to sunlight as presented in figure 3. According to the National Physical School Environmental Guidelines, all potable water storage tanks should be in an easily accessible area away from direct sunlight (Jurdi, 2017). Extended exposure to sunlight can affect the physiochemical properties of the water and can encourage algae growth which renders the water quality unsafe (Asad, 2015; Firth, 2017).

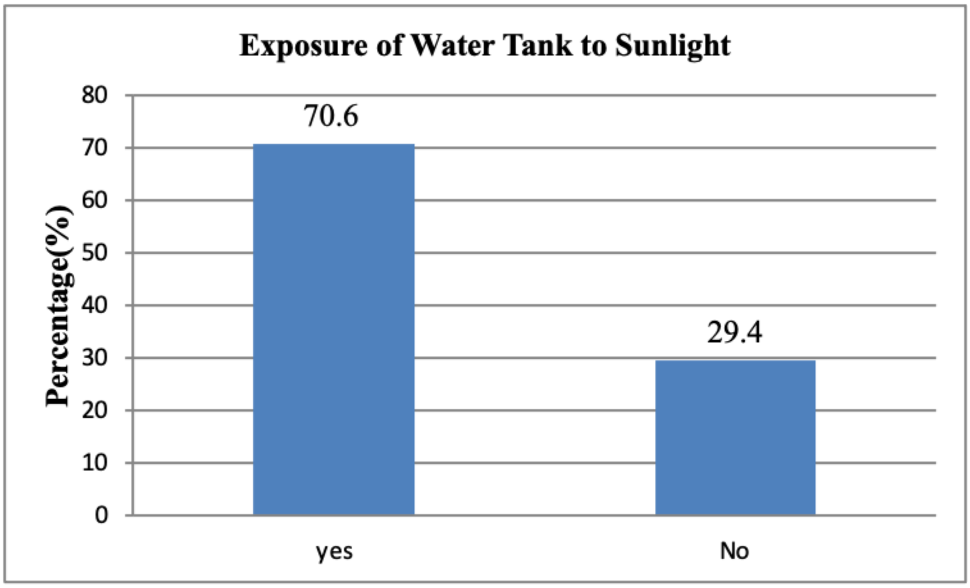

Figure 3: Exposure of Onsite Water Storage Tanks to Direct Sunlight

Additionally, onsite storage tanks made of plastic age and break down under the effect of UV light causing potential leaching of chemicals such as phthalates. Public health concerns related to leaching of phthalates due to their potential endocrine-mediated adverse effects have been raised (Xu, et.al, 2020). These concerns are mostly on its potential impact as an endocrine disruptor. Phthalates may cause endocrine disruption in males through its action as an anti-androgen. Thus, it can adversely affect human reproductive outcomes, in both childhood and adult exposure (Jeng, 2014; Jurdi, et.al, 2018). For this, plastic water storage tanks that can be used are those that are made approved food safe polyethylene resin (e.g. U.S. FDA approved) should be used (Jurdi, et.al, 2018).

As for the cleaning the water storage tanks, analysis of the data collected showed that tanks are never cleaned in all surveyed DCCs except for one that cleans the water tank once per year. This is highly unsatisfactory as UNICEF School's WASH Guidelines require water storage tanks to be cleaned ideally 4 times a year (UNICEF, 2012). Storage tanks require regular cleaning and maintenance as this will greatly reduce the risk of microbiological contamination that renders the water unsafe and can change the aesthetic characteristics of the water resulting in undesirable odors and bad taste (Jurdi, et.al, 2018; Schafer, et.al, 2012).

So, in developing countries, water-related diseases are not only the result of contaminated sources of water supplies, deficient treatment, poor water distribution networks, but also end-user onsite storage and handling (Fewtrell et.al, 2005; Trevett et.al, 2005; Jurdi. et.al, 2018). Thus, poor maintenance and cleaning practices of onsite storage tanks can negatively affect the water quality and safety of use. Several studies reported that the household storage practices are widely linked to the high possibility of fecal contamination at the storage point (Jensen, et.al, 2004; Jurdi, et.al, 2018; Shrestha, et.al, 2006; Tumwine, 2005). For example, in a study conducted in Greater Beirut area to assess the overall quality of water in storage at the household level, investigators found that the microbiological profile of the tested samples was alarming. On average, 12-15% of samples were fecally contaminated. Investigators suggested that exposure to pollution of water in storage could be one of the different factors impacting the microbiological safety of household supplies (Jurdi, et.al, 2018). Therefore, safe storage practices, such as cleaning and properly closing containers should be practiced to reduce the risk of exposure to contaminates, and to ensure the provision of safe water quality for household use (Brauer, et.al, 2012; Clasen, 2009).

Hence, the lack of storage tank cleaning practices in the surveyed DCCs is of major concern and suggests the need of awareness and ongoing education about the importance of storage tank cleaning and maintenance. Additionally, lack of knowledge on the types of proper water tank materials and how to properly locate the storage tank in an accessible and shady location away from direct sunlight are major concerns that must be addressed to reduce the likelihood of physical, chemical and microbiological contamination of the stored water.

4.2.3. Perceived Quality of the Water Supplies

Furthermore, when questioned additionally on the perceived quality of the piped water supply, most of the surveyed DCCs (70.6%, 12 DDCs) considered that it is as unsafe; except for four DCCs (23.5%) that perceived the water quality as “safe” as presented in figure 4. Additionally, one of the directors when questioned about the perceived quality of the piped water supply answered by “don’t know”. This is in line with the indicated limited use of the piped water supply as presented in table 4; the piped water supply is not used for drinking, cooking , nor for infant’s food preparation including formula milk and cereals; its use is limited to hygiene and overall cleaning.

Major reported water complaints leading to the rejection of drinking water in DCCs related to turbidity, color, and unsafe quality “bad to health” as illustrated in figure 5. The “bad to health” complaint reflects on trust issues in relation to the piped water supply provided by the public sector. This negative perception justifies the need for water quality control and quality monitoring in DCCs at a time were no actions are taken to address concerns of this perceived “poor water” quality.

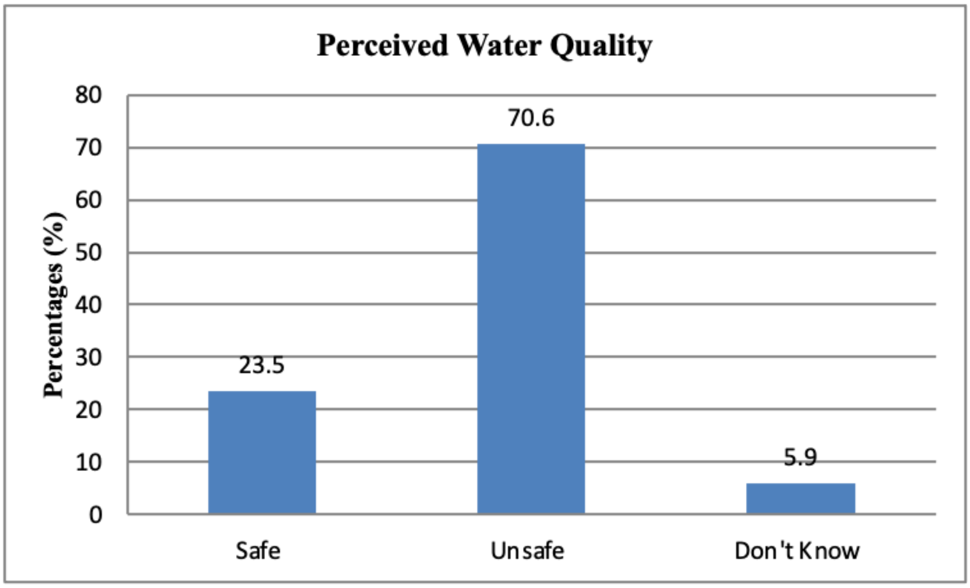

Figure 4: Perceived Piped Water Supply Quality by Surveyed DCCs

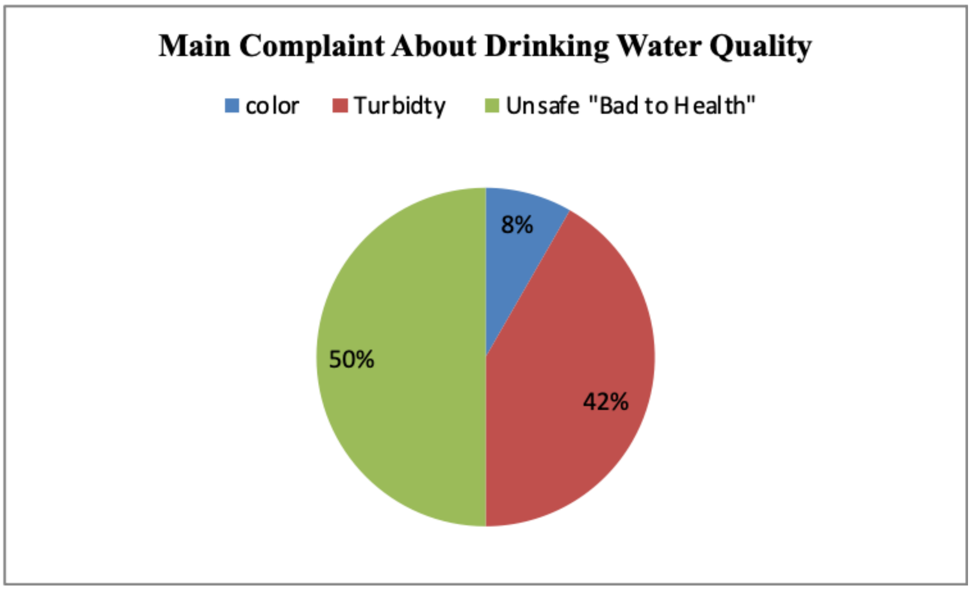

Figure 5: DCCs Major Reported Complaints on Piped Water Supply

4.2.4. Onsite Disinfection

Data on onsite water disinfection showed that it is practiced minimally in 23.5 % (4) DCCs. Onsite water disinfection is an unquestionable important practice that can ensure mostly microbiological safety of water in storage, given the intermittent water distribution profile, as indicated before.

Moreover, when questioned about the type of method used for water disinfection, chlorination was reported to be the predominant practice. Three out of the four surveyed DCCs implement onsite disinfection by adding chlorine manually to the water storage tank. Still, such type of a disinfection technique is difficult to control and must be properly monitored for its effectiveness by measuring the levels of free and combined residual chlorine levels in the disinfected water. Results showed that this quality monitoring is missing and that residual chlorine levels are not measured. As such, the effectiveness of chlorination is still questionable as the dose added may be minimal and does not satisfy the chlorine demand. Moreover, addition of high chlorine dosage might lead to the formation of disinfection-by products such as trihalomethanes that are carcinogenic to health (Jurdi, et.al, 2018; WHO, 2017). According to National Physical School Environmental Guidelines, free residual chlorine levels should be frequently (once/day) measured and recorded to sustain a well-documented monitoring system (Jurdi, 2017). Therefore, the process of onsite water chlorination needs to be controlled to meet the chlorine demand by determining the required chlorine dose, and monitoring the free residual chlorine levels, on regular basis, to ensure the bacteriologic water safety.

In addition, one of the surveyed DCCs for water disinfection uses a water filter; still, the type and maintenance of the installed filter could not be determined, and as such this could be just providing a false sense of security.

Hence, further action is required by DCCs administration to address this deficient pattern of applying onsite water disinfection that is considered of major importance. The application of onsite disinfection is a precautionary measure that could ensure safety of water source and reduce the incidence of waterborne infectious diseases such as diarrhea (UNICEF, 2008). Additionally, onsite treatment systems and regular water storage tanks cleaning can overcome problems of odor and turbidity and destroy pathogenic microorganisms (Jurdi, 2017).

4.2.5. Water Quality Monitoring

As for onsite water quality monitoring needed to secure water quality and safety, results of the surveyed DCCs showed that this activity is highly deficient. Most of the surveyed DCCs (82.4%, 14 DDC) do not monitor the quality of their water supplies. Assessment of the water quality is performed in only three of the surveyed DCCs. Two DCCs reported that only microbiological assessment (total and fecal coliform) is performed through a private company once yearly. One DCC reported that the municipality is responsible for monitoring the water quality and they know nothing about what is being assessed except that the water quality is "safe" (Figure 6). This is a highly unacceptable profile. Based on UNICEF school's WASH Guidelines, potable water quality should be monitored on a routine basis; once every week or once a month in coordination with the Ministries of Public Health and Energy and Water (UNICEF, 2012).

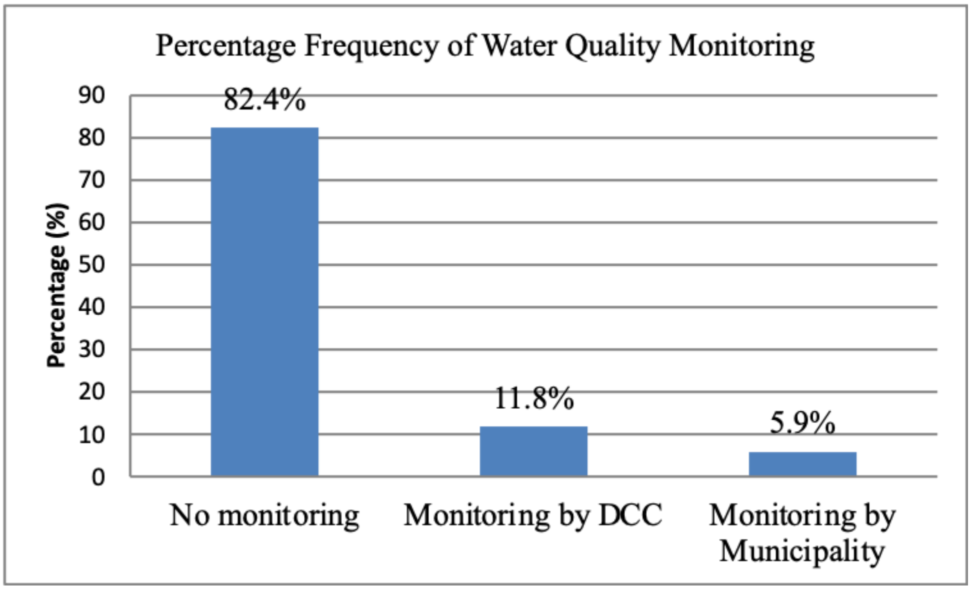

Figure 6: Monitoring Frequency of the Quality of Water Supplies in Surveyed DCCs

A national program was developed for this objective in 2015, but it is evident that it is not being implemented. This is critical and in line with SDG6 that addresses beyond households, safe water provision at schools and healthcare facilities (WHO/UNICEF, 2018). Ensuring the sustainable provision safe potable water supplies remains a major challenge mostly for developing countries. Lebanon, like many developing countries, faces many challenges in providing and sustaining water and sanitation services mostly due to deficient water management aggravated by the influx of Syrian refugees (World Bank, 2012). Besides, water quality monitoring in Lebanon is still deficient, due to poor governance, shortage of data, lack of available and functional water resources monitoring infrastructures (WHO/UNICEF, 2016). Therefore, water quality monitoring is critical for proper risk assessment to ensure safety of water supplies. As such, the deficient water quality monitoring, lack of knowledge and trust in the provided piped water supply and the lack of documentation in DCCs on potable water quality and management is an important issue that needs to be addressed.

4.3. Water Quality Assessment

Samples from both piped water supply (tap water) and commercial industrial bottled water (water dispensers) were collected for physical, chemical, and microbiological analysis. The results of all the collected samples of the surveyed DCCs are presented in tables 6-8. It is to be noted that samples were collected once at the start of the wet season, which would mask some of the physical and chemical water characteristics that would be diluted by rain replenishment. Additionally, it will affect the residence time of pathogenic microorganisms (due to drop in water temperature), and as such the % of positive samples with fecal organisms. Comprehensive water assessment should reflect on water quality variability over the wet and dry seasons of the year to confirm the exposure to sources of pollution and accordingly, variability in water quality and safety.

4.3.1 Physical Water Quality Profile

4.3.1.1. Turbidity

Turbidity of water depends on the quantity of solid mater as suspended particles due to poor source water quality and improper filtration during the treatment process. Proper treatment (sedimentation, coagulation, and sand filtration) will ensure the removal of organisms and undesired solids from the water source (WHO, 2017). Turbidity may shield microbes by protecting pathogens from disinfectants attack and destruction of microbial cells (Sharma & Bhattacharya, 2017). The standard recommended maximum turbidity limit set by LIBNOR is 5 NTU. Results indicate that both tap water and water dispensers have turbidity levels below the standard limit of 5 NTU (ranging from 0.67 to 4.13 NTU for tap water and from 0.49 to 2.21 NTU for water dispensers) as indicated in table 6. Still, the minimal levels which are above 1 NTU, for tap water, could further reflect on exposure to pollution through the intermittent water distribution and conditions of distribution system as indicated before.

4.3.1.2. Color

Undesirable color in water supplies could be the result of several factors. In many cases, chemical contamination can lead to a change in the aesthetic conditions of water supplies including color change. Mainly, dissolved organic matter such as humic and fulvic acids gives water an undesirable color (WHO, 2017). Water must ideally have no visible color. People can notice color in water source only if it is of high concentrations. Levels of color below 15 true colors units (TCU) have no effect on quality and usually are not detectable by consumers (WHO, 2017). Results showed absence of color in all water dispensers' samples, however 17.64% (3) of samples from tap water showed high color levels that exceeded 15 TCU as shown in table 6. This is critical and can reflect on either deficient water treatment, or exposure to sewage and corrosion problems within the distribution network. Intermittent water distribution is of major concern as it is associated with exposure to organic and fecal contaminants in old, corroded networks.

4.3.1.3. Total Dissolved Solids (TDS) and Water Electrical Conductance

TDS levels in water comprise inorganic salts such as sodium, calcium, magnesium, chlorides, bicarbonates and sulfates and some organic minerals (WHO, 2017). Natural factors, seawater intrusions, sewage, industrial wastewater, and urban runoff contribute to TDS levels in water (WHO, 2017; UNESCO/WHO/UNEP, 1996).

High level of TDS in water indicates that water is highly mineralized and although, ingestion of water having high TDS have no direct health impacts, still it can be objectionable to consumers and it may cause irritation of the gastrointestinal tract including laxative and constipation effects (Meride, 2016). According to LIBNOR standards, the desirable limits of TDS are between 100 and 750 mg/L. The levels of TDS of the tap water and water dispensers of all surveyed DCCs were within the set standards (154 to 493 mg/l and 107 to 315 mg/l, respectively) as presented in table 6. These results reflect on the dependence of piped water supplies, mainly, on groundwater sources replenished by rain (springs and wells). However, the sources of the commercial water dispensers are mostly springs (Jurdi, et.al, 2018). Therefore, the reported total dissolved solids levels in the study do not pose any health effects when compared to LIBNOR standards. Still, it is to be noted that these levels reflect on wet season and accordingly will be boasted for the dry season.

Electrical conductivity is an indicator for the mineral content of a water supply. High conductivity does not have direct impact on human health (Jones, 2020). However, water with high conductivity could give an unpleasant mineral taste to the water, thus affecting aesthetic value of water supply that influence the consumer's perception of water quality (Rahmanian, et.al, 2015). According to LIBNOR standards, the EC values should not exceed 1500µS/cm. Electric conductivity of the tap water and water dispensers in surveyed DCCs didn't exceed LIBNOR standard ranging between a minimum of 562 and a maximum of 1000 µS/cm for tap water, and a minimum of 224 and a maximum of 676 µS/cm for water dispensers confirming the type of water sources used, and wet season sampling, as indicated before.

Table 6: Physical Parameters of the Surveyed DCCs

Child Daycare Center Reference #	**Color TCU**		**Turbidity NTU**		**TDS mg/l**		**Electrical Conductivity µS/cm**	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
1	10	2	1.13	1.46	391	117	784	244
2	4	0	1.20	0.97	350	118	719	249
3	6	2	4.13	1.26	338	117	693	246
4	11	0	0.86	1.18	339	155	695	314
5	52	0	0.67	0.71	460	189	932	391
6	14	1	3.46	0.68	332	315	987	676
7	6	4	1.95	0.84	274	130	563	272
8	0	0	1.15	1.04	384	152	775	318
9	8	2	1.81	1.30	378	132	780	276
10	4	0	0.88	0.77	154	153	777	321
11	3	2	1.84	0.49	271	115	562	241
12	14	0	1.71	1.37	356	195	729	406
13	5	1	1.08	1.12	290	107	595	224
14	6	0	1.58	1.55	289	195	593	407
15	14	0	1.68	1.14	493	150	1000	315
16	41	0	1.26	1.21	402	108	823	227
17	57	1	1.20	2.21	379	127	775	266
Mean	15	0.9	1.62	1.13	346	153	752	226
Range	0-57	0-4	0.67-4.13	0.49-2.21	154-493	107-315	562-1000	224-676
Standard	**15**		**5**		**100-750**		**200-1500**	

S1: Water samples taken from taps; S2: Water samples taken from dispensers

4.3.2. Chemical Water Quality Profile

4.3.2.1. pH and Alkalinity

The levels of pH of all water samples were within the acceptable by LIBNOR range of 6.5-8.5. Results showed that the pH of all water samples ranged from 7.3 to 8.56 and 7.55 to 8.44 respectively, for tap water and water dispensers, as shown in table

7. The alkalinity of the tap water ranged between 134 mg/l $CaCO_3$ and 230 mg/l CaCO3 and the alkalinity of water dispenser samples ranged between 110 mg/l $CaCO_3$ and 260 mg/l $CaCO_3$ (table 7). Alkalinity indicates the ability of water to neutralize acids by removing H+ ions, thus it reflects on the buffering capacity of the water body (EPA, 2012). Although no standard level is set by LIBNOR, still water with high alkalinity levels is objectionable by consumers due to the “soda-like taste” or “flat taste” (UNICEF, 2008). The alkalinity of water is mainly determined by rocks and soil through which it passes that contains compounds such as carbonates, bicarbonates, and hydroxides. Water alkalinity has no direct health effect on consumers, but strongly alkaline water can cause skin dryness. On the other hand, low alkalinity levels cannot protect water from fluctuations in pH, which means water quality can be changed from acidic to basic very rapidly. This might decrease the effectiveness of chemical disinfection by chlorine which is optimal at pH levels of 6.5 to 8.5 (WHO, 2017).

4.3.2.2. Total Hardness

The total hardness of all tap water collected was higher than that set by LIBNOR of 200 mg/l $CaCO_3$, except for only one DCC that had a total hardness level of 165 mg/l $CaCO_3$ as presented in table 7. This is expected due to the type of sources indicated that are impacted by the karstic aquifers (mainly limestone). On the other hand, the total hardness of all water dispensers was in line with LIBNOR standard level, except for one DCC with a water hardness level of 250 mg/l $CaCO_3$.

Moreover, comparing the levels of water alkalinity and water hardness for tap water and water dispensers indicated the presence of non-carbonate hardness varying between 31 -155 mg/L as $CaCO_3$ for tap water samples and minimally at insignificant levels in samples from water dispensers. This further confirms exposure of the water sources feeding the distribution networks to sources of pollution confirmed by the presence of low to moderate levels of chlorides and sulfates. These mostly relate to sewage and minimally seawater infiltration given that the samples were collected during the wet season and this profile is masked by dilution.

Generally, problems resulting from hard water include excessive soap consumption and the subsequent formation of "scum". Moreover, depending on alkalinity and pH, very hard water supply can cause scale deposition in storage tanks within heaters, household appliances and plumbing systems. On contrary, soft water with a hardness level of less than 100 mg/l can be corrosive for metal water pipes due to the low buffering capacity of softened water (WHO, 2017).

4.3.2.3. Sulfates

Sulfates occurs naturally in water originating from sedimentary rocks and is also used in the chemical industries that discharge industrial effluents into water bodies (WHO, 2017). According to LIBNOR Standards, sulfate levels should not exceed 250 mg/l. Results revealed that sulfate levels from both tap water and water dispensers were far below recommended levels and varied between 3.5 to 21.5 mg/l and 1 to 8 mg/l, respectively (table 7). Accordingly, water supplies in all of the surveyed DCCs are in compliance, for the wet season, with LIBNOR standard level.

There is no proposed health-based guideline for sulfates in water. However, high sulfate concentration in water can cause gastrointestinal disorders, in addition to odor impairment as sulfate can be reduced to hydrogen sulfite giving a "rotten-egg odor" under the action of bacteria and in the absence of oxygen and free chlorine even at low sulfate concentrations (0.05mg/L) (WHO, 2017).

4.3.2.4. Phosphates

Phosphates are chemical compounds that originate from phosphorous. High concentration of phosphate reflects on source of contamination known as eutrophication that can be caused by extensive algal growth (EMS, 2017). Phosphate is used as a major component of detergents and fertilizers (WHO, 2017). Phosphate level ranged between 0.5- 2.07 mg/l and 0.13-2 mg/l in tap water and water dispensers, respectively as shown in table 7. There are no health-based guideline values for phosphates set by LIBNOR standards. However, sewage infiltration might be the major source contributing to high phosphorous level in water distribution systems (WHO, 2011).

4.3.2.5. Ammonia and Nitrates

Ammonia (NH_3 or NH_4^+) is found in low level in nature and it is a component of animal and human waste. In the environment, ammonia originates from agricultural and industrial processes and from disinfecting water with chloramine (WHO,2017). Because of its lower toxicity to humans, no health-based guideline value is documented for ammonia since toxicological effects are observed when exposure level exceeds 200 mg/kg body weight (WHO, 2017). High levels of ammonia in water can be an indicator for fecal contamination resulting from sewage, animal, and microbial waste pollution. Results show that all water supplies had levels of ammonia less than 0.5 mg/l NH3N, which is within LIBNOR recommendation, as shown in table 7.

Nitrate is a naturally occurring ion that can be reduced to reactive nitrite ion under bacterial action. Sewage, animal excreta and fertilizers are considered as the major sources of nitrate. High level of nitrate is associated with infant methemoglobinemia (blue baby syndrome). Methemoglobinemia occurs when the body converts nitrate to nitrite which reacts with hemoglobin, forming methemoglobin that cannot carry oxygen molecules (Galan, 2018; Rizk, 2009). According to LIBNOR standards, Nitrate NO3- -N levels (as total nitrogen) should not exceed 10mg/L. Results show that the nitrates levels were minimal in all the analyzed water samples and did not exceed the standard of 10mg/L as nitrate-nitrogen for the wet season.

4.3.2.6. Sodium and Chloride

Sodium and chloride induce a salty taste to the water body. All water supplies in the surveyed DCCs bear a level of sodium less than 200 mg/l .Additionally, chloride levels were below the LIBNOR standard of 250 mg/L; the highest detected concentrations were 149 mg/l and 70 mg/l for tap water and water dispenser, respectively as shown in table 7. High levels of chlorides exceeding the taste threshold concentration of 250 mg/L are associated with a salty taste that raise complaints by consumers. Although short term studies show a relation between high sodium intake and hypertension, still this association remains controversial and no firm conclusion was drawn. Therefore, no health-based guideline values are documented for both sodium and chloride (WHO, 2017).

4.3.2.7. Free Residual Chlorine

High levels of free residual chlorine may lead to objectionable tastes and odors in the stored water. On the other hand, insufficient amount of free chlorine might fail to inactivate disease-causing organisms and can lead to fecal contamination in the distribution network. Thus, it is important to adequately measuring and frequently monitoring the amounts of free chlorine in water distribution system (WHO, 2017). LIBNOR recommends levels of free residual chlorine between 0.2 to 0.5mg/l within a water pH range of 6.5 to 8.5. Findings show that residual chlorine levels of tap water in 88.25 % DCCs (15 DCCs) ranged between 0 to 0.06 mg/L, while two DCCs had free residual chlorine levels that exceeded LIBNOR maximal standard level of 0.5 mg/l as presented in table 7. This is expected as onsite chlorination was reported to be minimal.

Table 7: Chemical Parameters of the Surveyed DCCs Water Supplies

Child Daycare Center Reference #	**PH**		**Alkalinity mg/l as $CaCO_3$**		**Chlorides mg/l as CL-**		**Ammonia mg/l as NH3N**		**Nitrates mg/l as NO3N**	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
1	8.19	8.44	180	150	100	50	0.36	0.35	0.25	0.30
2	7.79	8.02	160	110	50	20	0.31	0.23	0.20	0.30
3	7.69	8.21	200	114	49	39	0.34	0.24	0.70	0.20
4	7.71	7.90	134	130	25	15	0.35	0.38	0.90	0.40
5	7.45	7.71	176	140	136	15	0.34	0.31	0.30	0.15
6	8.56	7.73	184	260	150	70	0.45	0.41	0.75	0.50
7	7.3	7.80	174	170	140	17	0.42	0.38	0.60	0.90
8	7.68	7.82	170	154	75	15	0.37	0.37	0.65	0.35
9	8.10	8.08	186	160	125	10	0.45	0.50	0.30	0.20
10	8.09	8.24	210	130	99	15	0.40	0.39	0.70	0.50

11	8.20	7.81	230	170	62	27	0.40	0.38	1.60	0.70
12	8.22	7.55	230	136	28	13	0.42	0.31	0.90	0.30
13	7.73	8.03	210	148	47	15	0.37	0.40	1.05	1.10
14	7.90	7.83	194	142	142	13	0.50	0.37	0.90	0.30
15	7.67	7.90	178	166	109	20	0.34	0.30	1.25	0.45
16	7.66	7.94	194	150	87	32	0.35	0.35	1.00	0.50
17	7.76	8.00	190	156	87	27	0.37	0.36	0.65	0.55
Mean	7.86	7.94	188	152	89	24	0.38	0.35	0.74	0.45
Range	7.3-8.56	7.55-8.44	134-230	110-260	25-150	10-70	0.31-0.5	0.23-0.50	0.2-1.6	0.15-1.1
Standard	**6.5-85**		**NA**		**250**		**0.5**		**10**	

Child Daycare Center Reference #	**Phosphate mg/L as $PO4^{3-}$**		**Sulfates mg/L as SO_4^{2-}**		**Total Hardness mg/L as $CaCO_3$**		**Sodium mg/L as Na+**		**Free Residual Chlorine mg/L**	
	S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
1	0.55	0.8	13	2.5	265	75	69	45	0	0.03
2	1.95	0.9	16	1	275	130	57	15	0.56	0.03
3	0.5	0.4	17	3	250	50	57	51	0.01	0.01
4	0.6	0.39	15	2	290	130	51	15	0.67	0.00
5	0.81	1.30	21.5	7	220	175	87	15	0.05	0.01
6	1	0.70	14	5	350	250	45	33	0.1	0.01
7	0.99	0.75	3.5	2	385	95	21	15	0	0.00
8	2.07	0.88	14	2	275	110	75	15	0.06	0.03
9	0.65	0.13	13	3	240	110	75	15	0.03	0.01
10	0.89	0.29	14	1.5	255	120	76	15	0.01	0.02
11	0.75	0.24	17	2	165	135	33	33	0.04	0.03
12	0.55	1.33	16	8	285	165	57	15	0.03	0.03
13	1.15	0.83	18	8	260	75	33	27	0.04	0.02
14	0.95	2.00	9	8	275	165	27	9	0	0.00
15	0.84	0.24	21.5	2	330	150	100	15	0.01	0.00
16	1.96	0.87	16.5	3	245	75	69	27	0.04	0.015

17	0.57	0.86	14.5	3	285	60	69	45	0.04	0.01
Mean	0.98	0.75	15	4	273	122	59	23	0.09	0.015
Range	0.5-2.07	0.13-2	3.5-21.5	1-8	165-385	50-250	21-100	9-51	0-0.67	0-0.03
Standard	**NA**		**250**		**200**		**200**		**0.2-0.5**	

S1: Water samples from taps; S2: Water samples taken from the dispensers

4.3.3. Microbiological Water Quality

Water is unsafe for consumption when it is contaminated with pathogens that could originate from animal and human excreta. Total coliforms can be an indicator of fecal and non-fecal contamination as they can be naturally occurring in wastewater, natural water, and soil in the presence of biofilms (WHO, 2017). Yet, their presence can be an indicator of poor cleanliness and inappropriate disinfection, as they should not be detected in the water distribution systems. However, the presence of fecal coliforms is considered a health threat because it can cause infections such as diarrhea, dysenteries, enteric fevers, and cholera if the water is used for drinking, food preparation and hygiene (Bain, et.al, 2014). Fecal coliforms are indicators for the presence of Escherichia coli, which is a bacteria found in human and animal feces that can be transmitted to water bodies through possible leaching and discharge of improperly treated wastewater (EPA 2012; Mahmud, 2019; Payment, et.al, 2003). Findings showed that 29% (5) of DCCs and 24% (4) of DCCs samples collected from tap water and water dispensers were contaminated with total coliforms, respectively. Moreover, fecal coliforms were detected in one tap water sample (6%) and in one water dispenser sample (6%) of the surveyed DCCs (table 8).

Table 8: Microbiological Characteristics of the Surveyed DCCs Water Supplies

Child Day care Center Reference #	**Total Coliforms /100 ml**	**Fecal Coliforms/100ml**

	S1	S2	S1	S2
1	0	28	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	2	0	0	0
7	17	11	9	0
8	0	18	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	20	0	0	0
13	0	0	0	0
14	0	0	0	0
15	11	0	0	0
16	4	32	0	16
17	0	0	0	0
% Positive Samples	29%	24%	6%	6%
Standard value	**0**		**0**	

S1: Water samples from taps; S2: Water samples taken from the dispensers

The presence of microbiological contaminants in DCCs potable water supplies is alarming. Microbiological contamination of piped water supply within the study area showed that 29 percent and 6 percent of the samples were positive for total coliforms and fecal coliforms, respectively. So even in the wet season (lower water temperatures) the microbiological profile reflected is questionable and this would be more evident for the dry season. So, although all the surveyed DCCs indicated that they don't use piped water for drinking or cooking purposes, still indirect water uses of the microbioligically contaminated water (personal hygiene practices and tooth brushing) can expose children to health risks .The detorieration in the quality of the piped water supply could be either due to the lack or improper treatment of water sources feeding network or poor conditions of the distribution networks and the intermittent water distribution. As such, it is important to apply onsite water disinfection in the surveyed DCCs as indicated in section 4.2.4.

Effective onsite chlorination with continuous monitoring of free residual chlorine levels should be practiced. Still, as indicated before, results showed that treatment by chlorination is deficient in the surveyed DCCs and this is further confirmed by the minimal levels of free residual chlorine of less than 0.2 mg/l in most (88.25%) of the surveyed DCCs.

However, it is to be re-iterated that water sampling was conducted once during the wet season which could mask the detection of seasonal variations in the microbiological water quality by altering the percentages of positive samples for total and fecal coliforms (Yassin, et.al, 2006).

The microbiological findings of the water dispensers are comparable to that of piped water supply. Microbiological contamination of water dispensers showed that 24 percent and 6 percent of the samples were positive for total coliforms and fecal coliforms, respectively. This can be associated with lack of hygiene standards and quality management practiced at the bottled water industries or improper handling and storage of bottled water at consumer point. Hence, the magnitude of the health risks associated with the consumption of bottled water by surveyed DCCs as a safe source might be underestimated. Therefore, quality control of bottled water industries is a must to provide products that are reliable and safe.

As such, microbiological water quality monitoring of all potable water sources should be conducted on routine basis by the surveyed DCCs to ensure safe water utilization. Hence, further action is required by the DCCs with the support of the

Ministry of Public Health and local NGOs to conduct all year continuous monitoring as the results reflect on one round of analysis (wet season).

4.4. Sanitation Services

The sanitation part of the developed survey targeted the availability of facilities and conditions of utilization including the availability of appropriate water basins and personal hygiene requirements, usage of towels for wiping, proper toilet ventilation, cleaning and sanitizing practices and accessibility to toilet area. Analysis of the collected data of the surveyed DCCs showed the following:

4.4.1. Water Basins Height and Location

Handwashing with soap remove germs from hands and reduces disease transmission. Thus, having child-sized handwashing sinks in DCC settings would make it simpler, easy- to -use, and effective. In the surveyed DCCs, only 64.7% (11) of DCCs have sinks that are low to the ground with a height of 0.5 meters as shown in figure 7. This agrees with Guidelines for Early Care and Education Programs, recommending that sinks should be placed at the child’s height with a maximum elevation of twenty-two inches (0.55 meters). When children can easily reach the sink, this would encourage practicing handwashing, by themselves, under the supervision of the childcare providers. Additionally, it will give them a sense of accomplishment, and as such, they are more likely to practice voluntary hand washing (EABCC, 2019).

Moreover, results of the survey showed that water-basins for handwashing are located inside toilets in most of the surveyed DCCs (82.4%). However, this is not in line with the recommended Guidelines for Early Care and Education Programs and the

National Physical School Environmental Guidelines because handwashing sinks must be located in a room leading to the toilets in close proximity to the toilet cabin and accessible without barrier such as doors to each childcare area (AAP, APHA, NRC, 2019; Jurdi, 2017).

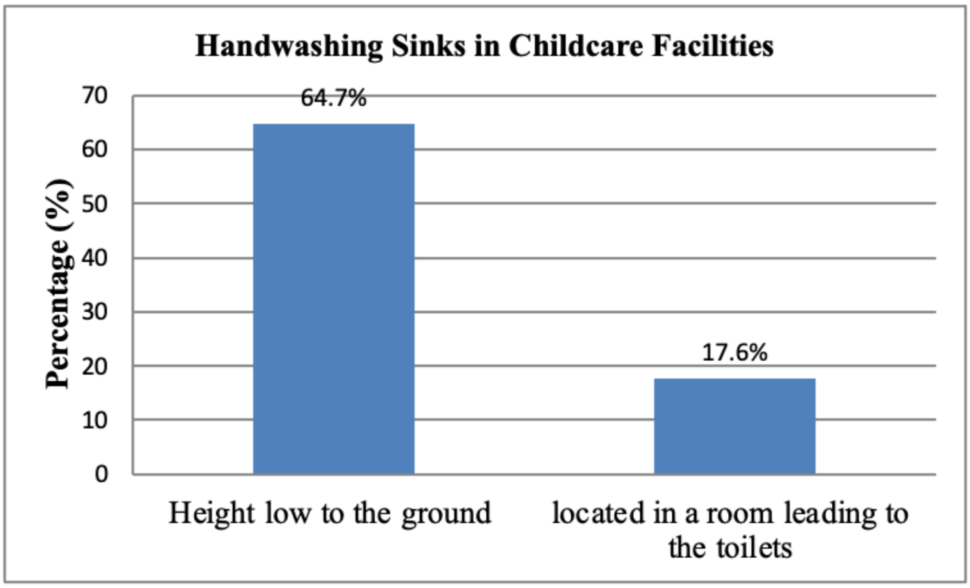

Figure 7: Percentage Compliance of Handwashing Sink Requirements in the Surveyed DCCs

4.4.2. Availability of Personal Hygiene Requirements

Availability of hygiene supporting features such as running hot and cold water, soap and tissue papers are essential to promote hygiene in childcare facilities. According to the Guidelines for Early Care and Education Programs, and the National Physical School Environmental Guidelines (AAP, APHA, NRC, 2019; Jurdi, 2017), hand washing basins should be equipped so that users have access to: running warm water, hand-cleansing non-antibacterial, unscented liquid soap, automated faucets to provide water flow (at least thirty seconds without the need to reactivate the faucet), and disposable paper towels. Analysis of the collected data indicated that running cold water and liquid soap, on all water basins, are available in all the surveyed DCCs; however hot water is not available in 17.6% (3) of DCCs at a time of data collection which was during a cold season of the year.

Automated faucets are not available in any of the surveyed facilities. Moreover, availability of disposable paper towels was noted in 76.5% (13) of the surveyed DCCs during the field visits (Figure 8). As such, the availability of proper water basins hygiene requirements in the surveyed DCCs can be considered of a satisfactory profile, but still the issues of access to hot water and the installment of automated faucets should be taken into consideration to encourage handwashing and reduce the contact of children with uncleaned surfaces.

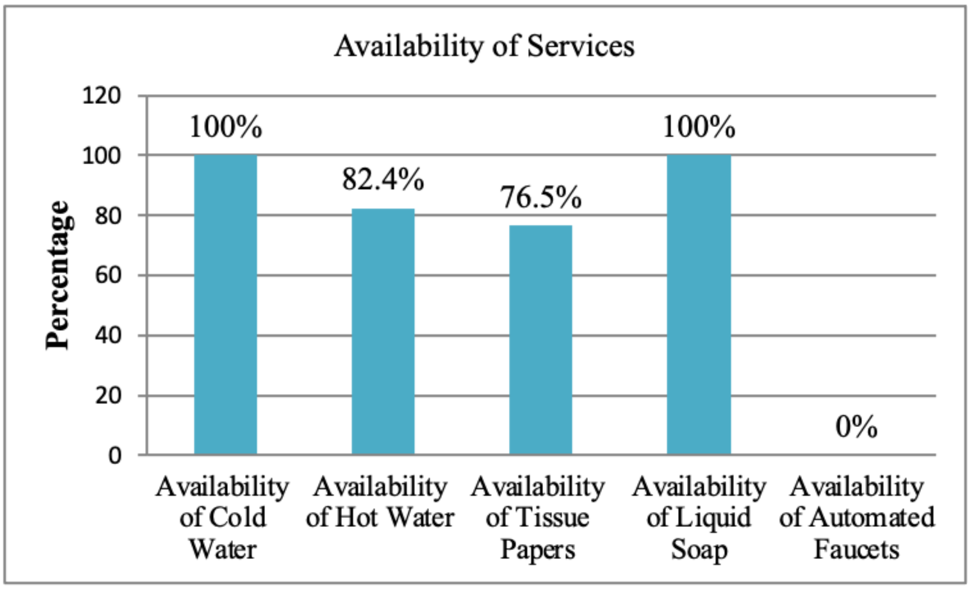

Figure 8: Provision of Proper Water Basin Hygiene Requirements

4.4.3. Multiple-Use Cloth Towels

Additionally, the usage of cloth towels for hand drying purposes was observed as a common practice in most of the surveyed DCCs. Results showed that in 58.8% (10) of DCCs cloth towels are used for drying purposes as illustrated in figure 9. However, according to the Guidelines for Early Care and Education Programs, using cloth towels is not recommended as preventing shared use of towels is difficult in DCC settings even if the cloth towel is solely for that child's use (AAP; APHA; NRC, 2019).

Cloth towels can increase the risk of infectious diseases among children in DCCs. For example, a study conducted by St. Sauver et.al (1998) to assess hygienic practices in DCCs showed that sharing cloth towels to dry hands increased the risk of illness when compared to children who used paper towels to dry their hands (Odd Ratios= 2.47) (Sauver, et.al, 1998). In a more recent study conducted by Gerhardets, et.al (2015), investigators used fabric-skin models to assess the role of skin and fabrics in the transmission of the impetigo pathogen *Staphylococcus aureus* and the strain *Streptococcus equi* in kindergarten settings. Investigators used technical artificial skin to simulate children's skin-to-skin transfer as well as skin-to-fabric-to-skin transmissions to obtain insight into the transmission factors for impetigo infections. Results showed that the joint use of cotton towels and other used fabrics led to notable transfer of impetigo pathogens to recipient skins (Gerhardets, et.al, 2015). Thus, fabrics including cloth towels imply a high risk for infection in DCCs and should be replaced by disposable paper towels to reduce the risk of disease among children DCCs (AAP; APHA; NRC, 2019).

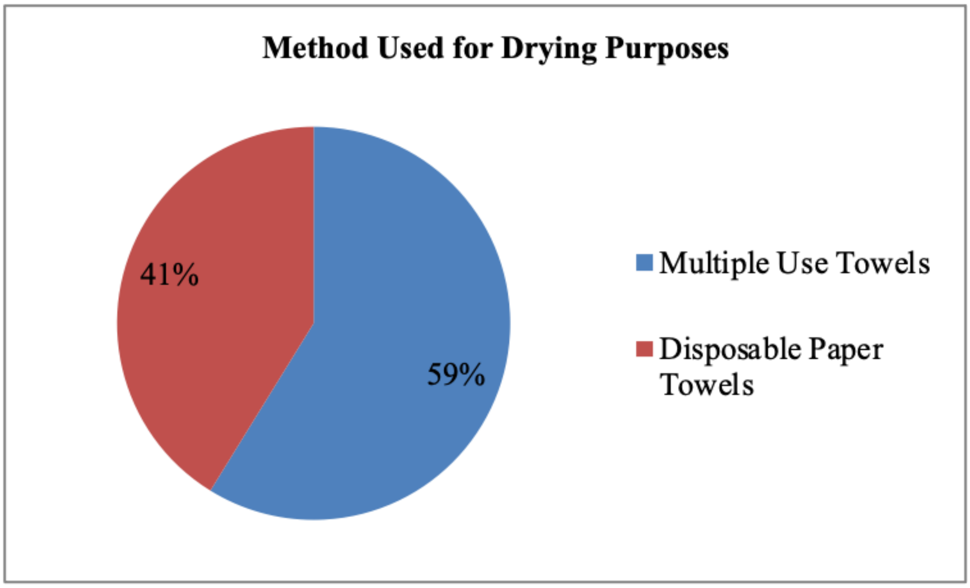

Figure 9: Usage of Multiple-Use Cloth Towels in the Surveyed DCCs

4.4.4. Toilets and Potty-Chairs

Learning how to use the toilet is an important routine for young children in DCC settings. Thus, a properly safe and accessible toileting area is an important part of the DCC facility. Results of the survey revealed that all toilets of the surveyed DCCs are in separate bathrooms with a closed door.

Additionally, toilet cabins are low to the ground with a height of approximately 0.3 meters from the ground in 88.2% (15) of the surveyed DCCs as illustrated in figure 10. This makes it easier for young children to use the toilets independently under the supervision of childcare providers through the toilet- use training process.

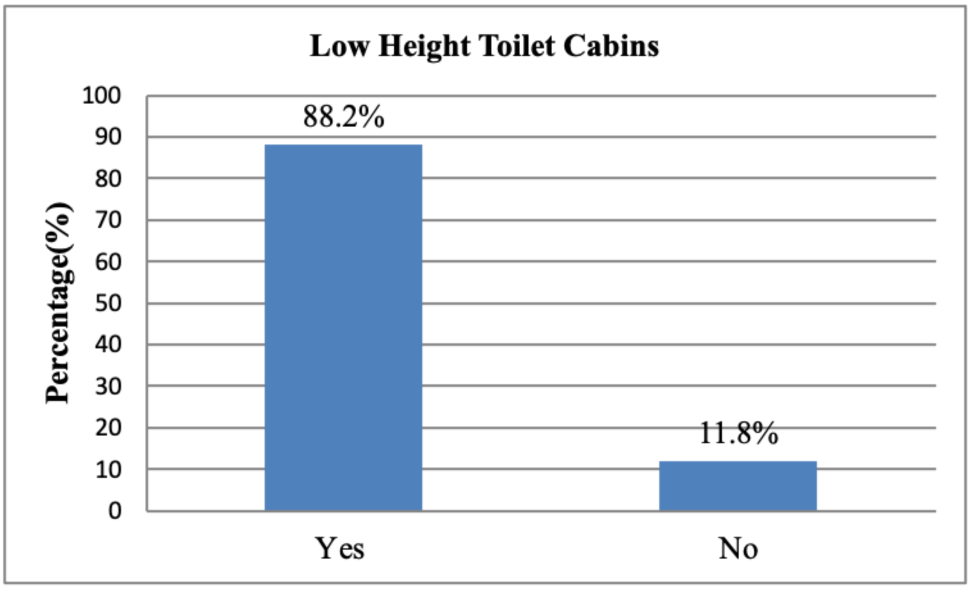

Figure 10: Availability of Low height Toilet Cabins in Surveyed DCCs

Toilet facilities should be always clean. According to UNICEF school's WASH Guidelines, toilets should be cleaned three times per day (UNICEF, 2012). Results of the survey showed that only 35.3% (6) of the surveyed DCCs meet this guideline as presented in figure 11. Therefore, the frequency of daily toilet cleaning is not sufficient and needs to be increased to meet set guidelines.

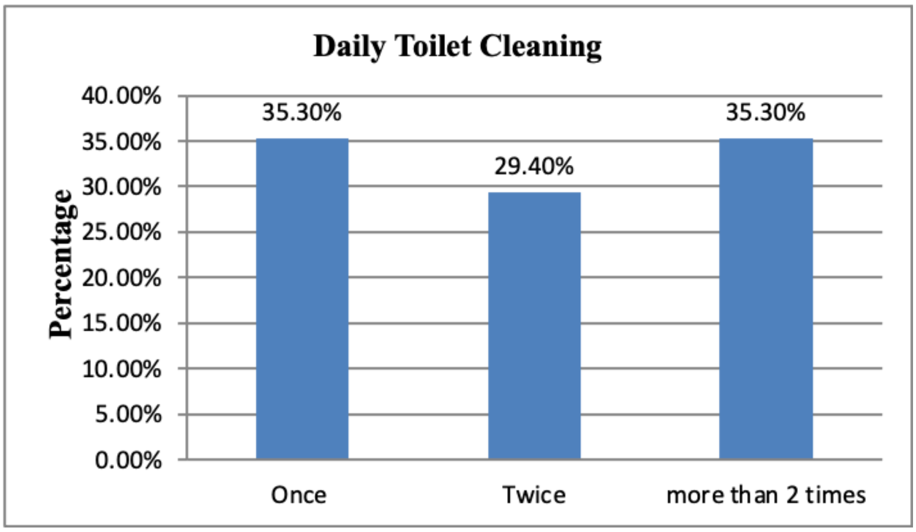

Figure 11: Daily Toilet Cleaning Schedule in the Surveyed DCCs

Moreover, potty-chairs are considered as a distinct risk of the child daycare environment. It can be a major source of pathogens as it is difficult to keep clean, and accordingly, must be handled with proper attention. Results showed that potty-chairs are used in only one of the surveyed DCCs. The use of non-flushing potty-chairs is highly discouraged and small-sized flushable toilets or modified toilet seats are recommended as shown in figure 12 (AAP, APHA, NRC, 2019).

Figure 12: Preschool’s Low Height Toilet Cabins

4.4.5. Toilet Doors

Toilet doors should be secured and easily opened by the children so that their privacy is ensured when using the toilet. At the same time toilet doors should be able to open from outside by staff in case adult assistance and supervision is needed. Toilet doors and door handles are hot spots for bacteria and disease transmission, thus self-closing doors should be installed to prevent the spread of pathogens from direct contact (Bahatta, et.al, 2018; UNICEF, 2012). Among the surveyed DCCs only 17.6% (3 DCCs) have proper self-closing doors as shown in figure 13. As such, the availability of self-closing doors is relatively minimal and not in compliance with the National Physical School Environmental Guidelines (Jurdi, 2017).

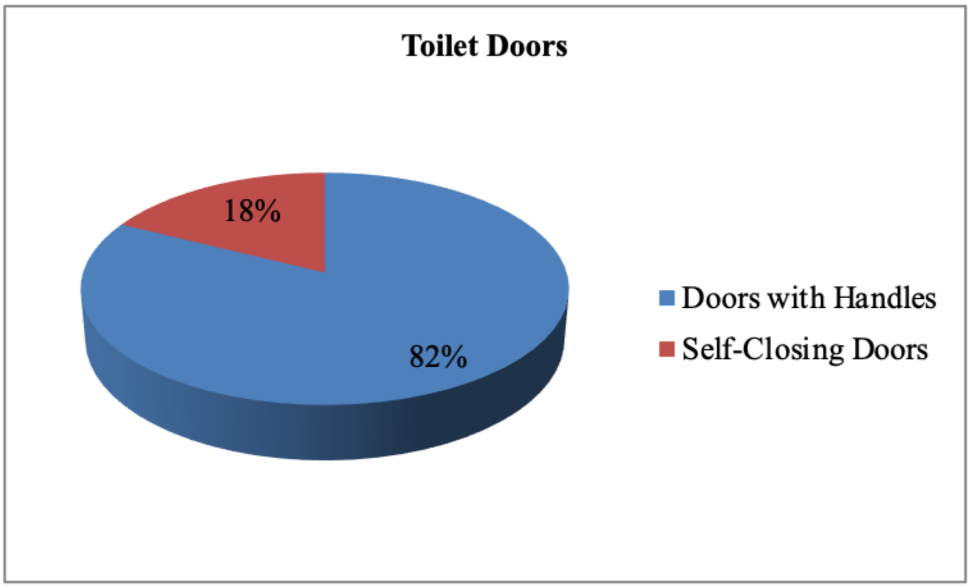

Figure 13: Percentage of Surveyed DCCs Having Proper Self-Closing Toilet Doors

4.4.6. Proper Toilet Ventilation

Odors in toilets should be controlled by appropriate ventilation. To add to indicated concerns, the toilet facilities of most of the surveyed DCCs are not adequately ventilated. One of the surveyed DCCs has no toilet ventilation, 56.3% (9 DCCs) have only small windows for venting, and 43.8% (7 DCCs) use suction fans (Figure 14). Using windows as the main method for ventilation is not an acceptable WASH indicator because odors will not be removed effectively. Thus, based on UNICEF School's WASH Guidelines, toilets should be properly vented through suction fans because proper ventilation can control and prevent the spread of diseases (UNICEF, 2012).

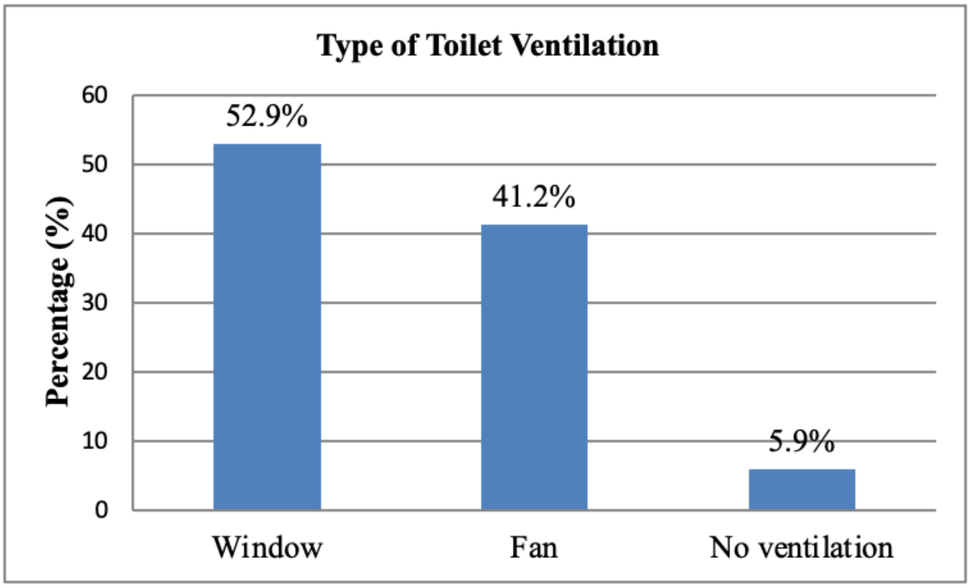

Figure 14: Type of Toilet Ventilation Systems in the Surveyed DCCs

4.4.7. Wastewater Disposal

All the surveyed DCCs are connected to public sewerage systems for wastewater collection and conveyance. Based on UNICEF school's WASH Guidelines, this is considered as a good WASH indicator to protect children from health hazards and prevent offensive odors (UNICEF, 2012). Therefore, properly discharged wastewater in sanitary piped sewer systems is critical to ensure that children and caregivers are not exposed to pathogens.

Additionally, it is also important to note that advanced sanitation services in schools should include "per toilet ratios, menstrual hygiene facilities, cleanliness, accessibility to all users, and excreta management systems" (JMP, 2018).

4.5. Hygiene Services

4.5.1. Hygiene Promotion and Training Hygiene Program

Maintaining good hygiene in child DCCs is necessary for children development. Caregivers should plan activities and programs that teach young children about hygiene rules and practices. One of the most important hygiene practices that children should master is hand washing which is a critical practice in the fight of pathogens including COVID-19 virus (Singth, 2017; UNICEF, 2020). All the surveyed DCCs reported that they are educating children on proper hygiene practices including hand washing and tooth brushing, demonstrating it twice per week during the morning cycle.

Moreover, educative hygiene posters on handwashing technique, toilet flushing after use, and tooth brushing were identified in the toilet facilities in 47% (8) of the surveyed DCCs as illustrated in figure 15.

Additionally, promoting caregiver hygiene behaviors and conducting ongoing hygiene training are crucial as childcare providers come in direct contact with children. Still, results of the survey showed that the availability of training hygiene programs in the DCCs is minimal. Only 35.3% (6) of DCCs reported that they receive annual ongoing training on proper hygiene practices provided by either private organizations or experienced in-house childcare providers (Figure 16).

Several reported studies show the importance and efficacy of training childcare providers on hygiene practices to approach a safe environment (Azor-Martinez, et. al, 2018; Ponka et.al, 2004; Roberts, et.al, 2000; Zomer et.al, 2013). For example, a study conducted by Ponka et.al (2004) in the city of Helsinki showed that hygiene training of child-care staff resulted in enhanced practices and led to a decrease in the incidence of absenteeism due to infections for 26% of children under the age of three. Another cluster randomized, controlled study conducted by Azor-Martinez, et. al (2018) assessed the effectiveness of an educational and hand hygiene program in DCCs and homes in reducing the incidence of respiratory infections and antibiotic prescriptions.. Investigators found that educational hand hygiene programs that include measures to be taken by DCC staff, children and parents reduced absent days, episodes of respiratory infections and antibiotic prescriptions (Azor-Martinez, et.al, 2018). As such, childcare providers should be knowledgeable about hygiene and sanitation practices as they play a major role in controlling communicable diseases that might occur and spread in a childcare facility (Alkon, et.al, 2010).

Moreover, all the surveyed DCCs reported that they received a training session on required hygiene practices to face COVID-19 pandemic. These training programs were delivered by the Lebanese Red Cross in collaboration with the Ministry of Public Health. Hence, further action is required by DCCs directors, with the support of the Ministry of Public Health to provide environmental health training programs for all childcare providers. This is important because although COVID-19 is respiratory in nature, contaminated hands can transfer the novel coronavirus from one surface to another (AFED, 2020). For this the US Center for Disease Control and Prevention (CDC) recommends intensive cleaning and disinfection efforts especially on objects and surfaces that are frequently touched, like toys and games (CDC,2021). Additionally, WHO called for increasing access to sanitation services to support healthy hygiene practices to minimize the risk of COVID-19 transmission (AFED, 2020). Information about COVID-19 among children is minimal, however available data suggests that some children might develop severe symptoms when infected (CDC, 2021). Therefore, maintaining the recommended hygiene practices is of utmost importance to reduce the spread of COVID-19 and to protect children's health and wellbeing.

Figure 15: Samples of Educative Hygiene Posters in the Surveyed DCCs

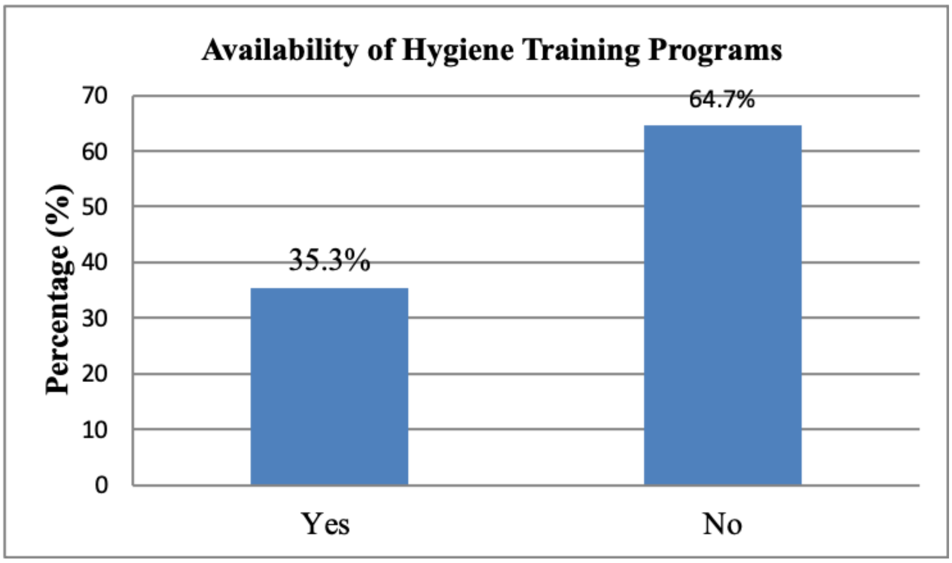

Figure 16: Availability of Hygiene Training Programs in the Surveyed DCCs

4.5.2. Dental Hygiene

Childhood is a critical period in which children acquire new knowledge and habits that may be reflected on their future health related behaviors.

All the surveyed DCCs reported that they conduct educative oral hygiene programs to teach children the importance of tooth brushing. Early onset of dental carries is an important health issue for preschool children. For this, it is relevant to promote oral health education in DCCs as an opportunity for acquisition of knowledge on dental hygiene. Several interventional studies have been conducted to assess the importance of oral health programs for children in the childcare environments (Bhoopathi et. al, 2018; Sigaud, et. al, 2017). For example, Sigaud, et.al (2017) conducted a study in a nursery in the city of São Paulo to assess the frequency of tooth brushing by children before and after the implementation of a playful learning intervention. Results showed a significant increase in the adoption of appropriate behaviors for tooth brushing after the intervention with a mean number of 8.5 compared to a mean of 4.4 before the intervention. Therefore, DCCs can easily enhance oral health promotion actions by preschoolers using playful and educative learning programs.

As such, childcare providers play a vital role in imparting good oral hygiene practices and preventing occurrence of dental caries, especially as pre-scholars fall into susceptible age range for dental caries (Bhoopathi et.al, 2018; Vinay, 2011). Childcare providers are responsible for helping and supervising children in brushing their teeth, monitoring their eating habits while at the facility and accompanying them to regular dental visits especially when children eat at least two meals during their time at the DCC (Gerreth, et. al, 2019).

Still, oral health activities are not frequently practiced in the surveyed DCCs. Results of the survey showed that tooth brushing activities is practiced at a very minimal level, in only 29.4% (5) of the surveyed DCCs. Children practice dental hygiene once after having their lunch meal by using tap water for rinsing after tooth brushing as presented in figure 17. According to the Guidelines for Early Care and Education Programs, all children with teeth should brush their teeth at least once during their time spent in the facility under the supervision and assistance of childcare providers. Every child should have his/her own toothbrush and toothpaste tube stored in an individualized rack or labeled cup to prevent contamination with infectious agents (AAP, APHA, NRC, 2019).

Moreover, microbiological analysis of tap water indicated that 5 samples (29%) were contaminated with total coliforms and 1 sample (6%) was fecaly contaminated as discussed in section 4.3.3. Thus, children using this water for tooth brushing can be at risk for acquiring diseases such as diarrhea. As such a, and as part of enhancing dental hygiene, the water quality should be carefully monitored to ensure its safety.

Accordingly, this unsatisfactory profile of tooth-brushing must be addressed. However, in DCCs where tooth brushing is practiced, all toothbrushes and toothpastes were separated for every child in individualized labeled cups in DCCs which is highly encouraging as an entry point.

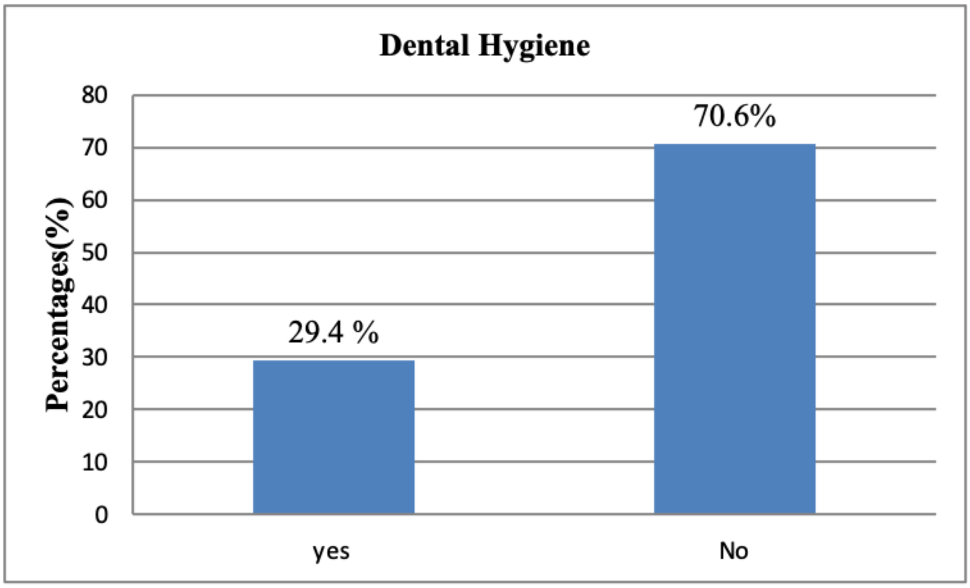

Figure 17: Tooth Brushing Practices in Surveyed DCCs

4.5.3. Diapering

Results of the survey showed that only 11.8% (2) of DCCs use disposable papers on the diapering surface when they change diapers, and only 17.6 % (3) of DCCs reported washing the child's hands after diaper changing. It is recommended to wash the child's hands with soap and water after diaper changing as children's hands often stray into the diaper area.

Most of the surveyed DCCs (76.5%, 13 DDC) have their diapering area close to a hand- washing sink. Moreover, it was observed during the field survey that 64.7% (11) of DCCs place the supplies needed for diaper changing away from the diapering surface.

Additionally, diaper-changing surfaces should be disinfected after every diaper change between children, and sinks should be adjacent to diaper-changing areas to facilitate handwashing routine (AAP, APHA, NRC, 2019). Figure 18 illustrates the percentages of diapering area requirements in the surveyed DCCs that meet the Guidelines for Early Care and Education Programs.

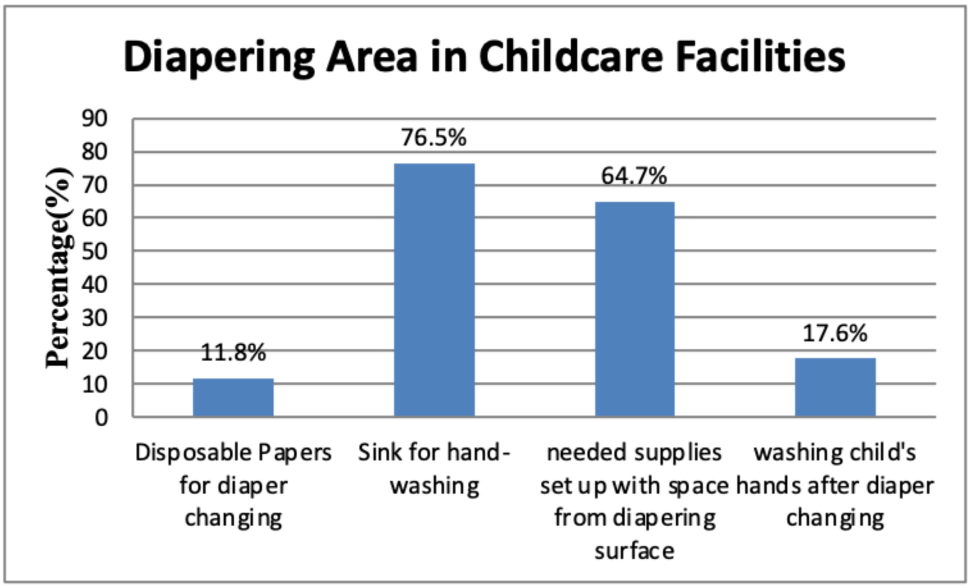

Figure 18: DCCs that Meet Guidelines for Early Care and Education Programs

Diapering is a common practice that increases the risk of pathogen transmission in DCCs. It can also increase the likelihood of pathogen transmission between children and providers or between children themselves as it is considered a hot spot for fecal matter (Arvelo et.al, 2009). Therefore, childcare providers who change diapers should be well trained to prevent contamination and disease transmission. Childcare providers must keep diaper-changing areas clean and safe by following proper diaper changing procedures, starting by proper handwashing and organization of the needed supplies that must be set away from the changing surface to avoid contamination. Disposable paper that is large enough to cover the area likely to be contaminated during diaper changing must be used. The use of disposable sheet on diaper-changing surface can minimize the chance of contamination of clean surface while changing for the children (Fiene, 2002).

Additionally, soiled diapers and wipes must be discarded into a plastic-lined, hands-free covered can.

As such, most of the surveyed DCCs have a low diaper-changing compliance with the recommended practices of the Early Care and Education Programs. Child-care providers in only two DCCs (11.8%) use disposable sheets on the diaper-changing surface. Additionally, most of the surveyed DCCs (82.4%) reported that they do not wash child's hands after changing diapers, which could potentially increase risk of the transmission of enteric pathogens within the DCCs. These noncompliant practices must be addressed by DCCs directors and training on proper diapering practices should be emphasized in DCCs to better control and prevent the spread of pathogens. Additionally, the wide variations in sanitation practices for changing diapers among DCCs, emphasis the need for national hygiene and sanitation guidelines on proper diaper-changing.

4.5.4. Toys Disinfection

Surfaces such as toys are among the fomites with the highest pathogen load. Contaminated shared toys can transmit enteric pathogens to children via ingestion, where children, due to their age, are more likely to put their fingers or any objects in their mouths. The transmission of bacteria and viruses between toys and children's hands is well documented in literature (Ledwaba, et.al, 2019; Merriman et.al, 2002).

Thus, routine cleaning and disinfection is important to reduce microbial load on environmental surfaces including toys (EABCC, 2019; Ibfelt, 2015; Mink & Yeh, 2009). According to Early Care and Education Programs Standards, cleaning should be done in two steps, washing with soap and water and disinfecting using a fragrance-free

EPA registered disinfectant. Toys that cannot be cleaned and sanitized should not be used (AAP; APHA; NRC, 2019).

The disinfection methods used for children's toys in the surveyed DCCs are presented in figure 19. Nine of the surveyed DCCs (52.9%) reported using a "known effective detergent" for disinfecting purposes mixed with water. Two DCCs (11.8%) reported the use of bleach concentrate and water for disinfection but showed no knowledge when asked about the required procedure for diluting a bleach solution. Moreover, 5 DCCs (29.4%) indicated the use of a professional disinfecting product from Boeker public health Company; while one DCC (5.9%) use alcohol for disinfection. Additionally, all the surveyed DCCs indicated the use of disinfectants multiple times per day on toys; however, none of the DCCs mentioned the use of soap and water for cleaning purposes before disinfecting.

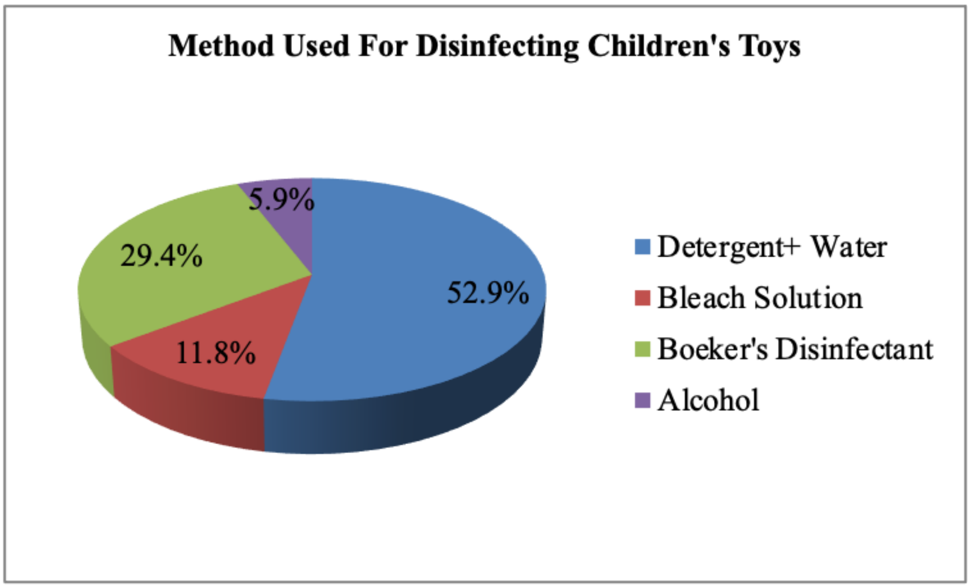

Figure 19: Method Used for Disinfecting Children's Toys in Surveyed DCCs

Therefore, the reported methods used to disinfect toys varied widely among the surveyed DCCs. Because of the minimal availability of hygiene training programs as indicated in section 4.5.1, the effectiveness of the sanitization procedures followed by DCCs could be questionable. This is partly confirmed by not knowing the concentration of the disinfection solutions prepared from the bleach concentrate. Therefore, standardized procedures for toys disinfection is needed with the purpose of preventing the spread of non-communicable diseases in child-care environments. Moreover, the results indicate the need for continued effective training for childcare providers on proper sanitization standard procedures.

4.5.3. On site Food Preparation

Food is prepared onsite in only 47% (8) of the surveyed DCCs. Two DCCs (11.8%) reported that they stopped food preparation inside the facility since the beginning of COVID-19 pandemic. However, only 35.3% (6) of DCCs have set programs to promote healthy and safe food preparation and consumption as shown in figure 20. Moreover, only two DCCs had acquired the food safety certificate provided by Boeker.

Contaminated food is considered of high concern especially in DCCs as children are more susceptible to foodborne pathogens due to their immature immune systems (Buzby, 2001; Enke et.al, 2007). Hence, if food is stored, prepared, and handled in DCCs, employees should receive adequate training in safe food handling practices (AAP; APHA; NRC, 2019). Results of the survey revealed that only 11.8% (2) of DCCs have onboard certified food handlers.

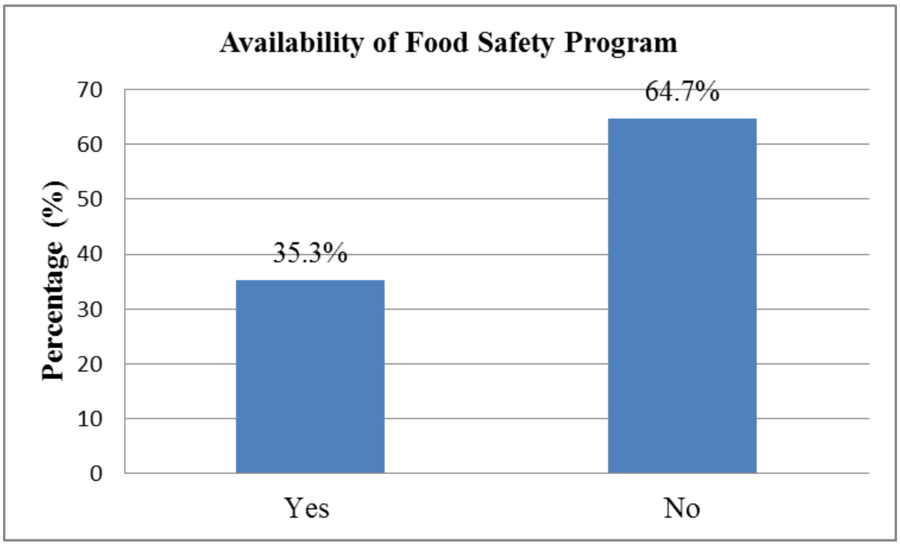

Figure 20: Implementation of Food Safety Programs in Surveyed DCCs

This is an unacceptable performance indicator which raises concern on food safety that is considered critical to reduce foodborne diseases. As such, DCCs should provide on-going training on food safety to their employees, as recommended by National Physical School Environmental Guidelines. Hazard Analysis of Critical Control Points (HACCP) should be implemented in managing raw and prepared food products and food handlers should be trained on HACCP to ensure food safety and reduce the risk of exposure to foodborne diseases (Jurdi, 2017).

4.6. Overall Hygienic Profile

Results of the microbiological swabs taken from the seventeen surveyed DCCs to assess the overall hygienic conditions showed evidence of fecal contamination as indicated in table 9. E-coli organisms were detected in 16.5% (14/85) of swab samples analyzed. To confirm the presence of fecal organisms, and as indicated in the methodology, four different culture media (Endo, MacConkey, Deoxycholate Lactose agar and Eosine Methylene Blue Agar) were used to increase sensitivity of the results. The most commonly contaminated surfaces were the diapering area and the table used for feeding. Evidence of fecal contamination was confirmed in 29.4% (5/17) of swab samples from both diapering area and table used for feeding. Examining the toys surfaces, only one swab sample showed a positive result for E coli (5.8%). As for childcare providers, out of the 34 random swab samples taken from hands, 3 sets of hand swabs (3/34) were contaminated with E-coli (8.8%) as shown in table 9.

In the DCC environments there are frequent opportunities for the transmission of microbes. Poor hygiene practices of childcare providers followed by direct physical contact with children and environmental surfaces could be potential risk factors for the transmission of enteric pathogens in the DCC environment (Lee & Grieg, 2008; Nesti & Goldbaum, 2007; Sullivan et.al, 1984).

Contamination of various environmental surfaces with enteric pathogens is well documented in literature. For example, Ekanem, et. al, (1983), identified fecal coliforms in 36% (23/64) of environmental samples and 32% (42/131) of hand samples taken from five DCCs after an AGI outbreak. In a prospective study to determine risk factors for AGI, researchers found that the incidence of diarrhea was two-fold higher in classrooms with fecal contamination compared to classrooms without. This was attributed to the frequent hand washing and disinfection practiced (Laborde et. al, 1993). Moreover, a study conducted by Petersen and Bressler (1986) showed that hands constitute the major foci of fecal contamination in which fecal coliform bacteria were detected in 54% (35/65) of hand samples of child-care providers. Additionally, an intervention study conducted by Batidas, et.al, (2014) to investigate the contamination of children's toys and hands during play revealed that both toys and children's hands were contaminated with fecal coliforms.

Table 9: Detection of E-coli from Surfaces in Surveyed DCCs by Microbiological Swabbing

Types of Surface Swabbed	Number of Collected Samples	Detection of E-Coli among Collected Samples	
		N	%
Caregivers' hands	34	3	8.8
Diapering Surfaces	17	5	29.4
Toys	17	1	5.8
Tables	17	5	29.4
Total	85	14	16.5

Results showed a relatively poor performance of proper hygiene and sanitation practices in the surveyed DCCs due to fecally contaminated surfaces. Detection of E-coli can increase the likelihood of acquiring diarrheal illness. Therefore, hygiene interventions are needed to provide a safe healthy environment for young children. Several observational study designs have been used to assess hygiene interventions in the child-care environment (Bronson-Lowe, 2006; Gudnason, et.al, 2013; Kotch et.al ,1994; Sandora, et.al, 2005; Shrestha, et.al, 2015). For example, a study conducted by Sandora et.al (2005) determined whether a multifactorial campaign centered on hand-hygiene education and on increasing alcohol-based hand sanitizer use can reduce illness transmission. For this purpose, a controlled trial was conducted of the homes of 292 families with children enrolled in 26 DCCs. Intervention families received biweekly hand-hygiene educational materials and a supply of hand sanitizers for 5 months; control families received only materials promoting good nutrition. Caregivers were phoned biweekly and asked about respiratory and gastrointestinal (GI) infections in family members. Results showed that the transmission of AGI diseases was reduced within intervention families when compared to control families. Another reported hygiene intervention study by Shrestha, et.al, (2015) found that the mean knowledge score of personal hygiene among school children increased from 53.86 and to 77.54, and the mean practice score of personal hygiene increased from 41.43 to 60.87 after implementing health education interventions.

This confirmed that increase in knowledge and practice was statistically significant. Therefore, the more the knowledge about the affective and environmental determinants of good hygiene practices of child-care providers and children, the more likely it is that successful interventions, with long-term effects, can be developed to improve hygienic behavior in DCCs.

As such, supervision, and continuous monitoring of DCCs are critical to assess environmental health compliance. All licensed DCCs should receive unannounced inspection, at least one site visit per year, from quality control public health inspectors of the Ministry of Public Health. This would be an efficient way to ensure continued compliance and identify common unsafe practices to be addressed in DCCs.

4.7. WASH Response to COVID-19 by the Surveyed DCCs

Although the novel coronavirus is respiratory in nature, transmission can occur from touching surfaces contaminated with viable virus (Hashikawa, et.al, 2020). Studies showed that children enrolled in DCCs can become infected with the novel coronavirus, and can spread the infection to others (CDC, 2021). Although the COVID-19 transmission in DCCs can pass unrecognized owing to mild or asymptomatic nature of the infections, compared to adults, still children can be silent spreaders. In a retrospective study, the impact of COVID-19 on 2143 children under the age of 18 was evaluated by the Chinese Centers for Disease Control. Investigators found that among the 65.19% (1412) of children suspected to have been infected, 34.1% (731) tested positive. Nearly, 4% of children were categorized as asymptotic, 51% as having mild illness, and 39% with moderate illness. The infants' age group (< 12 months) had the highest proportion of severe disease (11%) compared with 7% of preschool children of ages 1 to 5 years (Murray, et.al, 2020). Another study further found that children can be as infectious as adults. In this study, investigators found that the nasopharyngeal viral loads in 47 German children were similar to those in other age groups (Jones, et.al, 2020). Thus, kids are a possible source of corona virus spread, and prevention strategies should be taken by DCCs and other children settings to reduce the risk of exposure.

The introduced preventive measures by DCCs in response to COVID-19 pandemic are illustrated in figure 21. When asked about the new implemented measures, 9 DCCs (53%) reported that the frequency of disinfecting all touchable surfaces increased since the start of the pandemic, and this is posing a financial burden on the facilities. The remaining 8 DCCs (47%) reported that they are still disinfecting surfaces in the same manner, and at the same frequency used prior to COVID-19 pandemic. Moreover, they reported satisfaction with the regular routine followed for cleaning and disinfection. However, results of the microbiological swabs revealed fecal contamination in 16.5% of swabbed surfaces as illustrated in section 4.6, and it is worth mentioning that the positive enhancing factors to disinfection could have been the additional measures that were being taken. Enchaining such a practice is very important as CDC recommends cleaning and disinfecting all potentially touched surfaces frequently. This suggests the need for a detailed guidance on efficient cleaning and disinfection practices that could effectively kill the viable corona virus and limit its spread in DCCs environment.

Moreover, when questioned on reducing capacity to enhance proper distancing, only one DCC director mentioned that they reduced the number of children in rooms to maintain physical distancing and reduce exposure (Figure 21). CDC guidelines recommend “limiting group size to the extent possible and maintaining adequate ratio of staff to children to ensure safety” but does not give any guidance to group size. Still, decreasing of group size can add challenges to DCCs, as it requires the availability of enough rooms in the facility to keep smaller groups physically spaced, and enough staff to maintain adequate child-to-staff ratios. Still, decreasing group size and maintaining physical space between children is an important intervention to limit the viral transmission. Thus, clear guidance must be provided to DCCs given the challenges and constraints endured.

Additionally, all the surveyed DCCs (100%), and to enhance hand hygiene, had installed alcohol-based hand sanitizers in their facilities for use by staff and children under the supervision of childcare providers (Figure 21). Still, CDC recommendations stress on handwashing with soap and water for 20 seconds as a better and a more effective preventive measure, especially if hands are visibly dirty or greasy (CDC,2021). As such, installing alcohol-based sanitizer units does not replace the need to enhance proper handwashing.

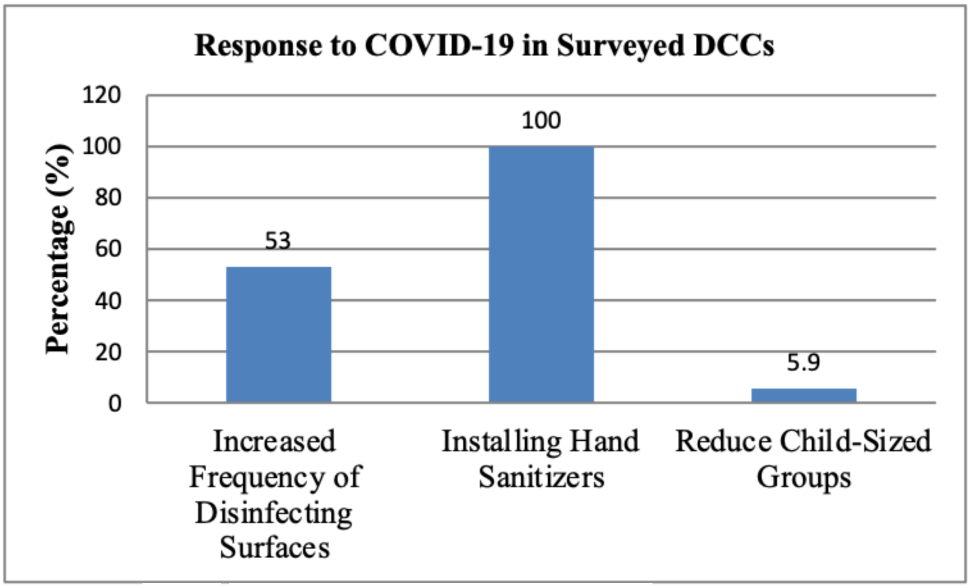

Figure 21: DCCs COVID-19 Preventive Strategies

In conclusion, DCCs should be provided with detailed guidance on efficient cleaning and disinfection to prevent transmission of COVID-19 and other pathogens. As such, facing the COVID-19 pandemic has highlighted the urgency to develop, implement and sustain WASH guidelines and standards, specifically for early childcare, as it is still non-existent at the national level.

4.8. Compliance Rates of WASH Facilities and Services and Microbiological Findings

To provide an aggregate measure of the WASH conditions in the surveyed DCCs, WASH scores were computed based on the national and international guidelines, standards, and recommendations, as shown in table 10.

A total of five (5) clusters of WASH facilities and services were assessed based on the recommended guidelines of the Early Care and Education Programs and UNICEF. The overall average rate for diaper-changing compliance, water-basins compliance, and toilet facilities compliance in the 17 surveyed DCCs was 50.58%, 67%, and 56.5%, respectively. The overall average on-site food preparation compliance in the 8 DCCs who prepare food inside their facilities was 57.5%, while water storage, disinfection and monitoring had the lower average compliance rate of 34%. These low compliance rates mean that WASH facilities and services in the surveyed DCCs are still deficient and not fully in compliance with AAP, APHA, NRC and UNICEF recommended guidelines.

Although no National WASH guidelines are set, cleaning and sanitizing practices should be emphasized in DCCs as many studies showed the effectiveness of these practices in protecting children against infectious diseases especially diarrheal diseases, as discussed throughout the thesis. It is to be noted that given the COVID-19 pandemic, maximal precautions should have been taken by the surveyed DCCs, but still compliance rates were low. This is mostly due to the minimal inspection and the deficient technical support needed to upgrade WASH facilities and sustain services. Thus, this further supports the need to have national regulations that would provide guidance to childcare providers on proper hygiene and sanitation practices based on nationally developed DDC WASH Guidelines.

Table 10: Mean Overall Compliance Rates of WASH Facilities and Services in the Surveyed DCCs

Term	Recommendations	Mean Overall Compliance Rate
Compliant Diaper-Changing Practices	• Disposable sheets are used on diaper-changing surfaces • Needed supplies for changing diapers are set with space from diapering surface • Availability of handwashing sink near the diaper-changing area • Diapering surface is disinfected between every child • Child-care provider wash child's hands after diaper- changing	50.58%
Compliant Water Basins for Handwashing	• Water basins are low to the ground with a height of 0.5 meters • Handwashing sinks are in a room leading to the toilets • Availability of disposable paper towels • Availability of running cold water and liquid soap • Availability of running hot water	67%
Complaint Toilet Facilities	• Toilet cabins are low to the ground • Toilets are vented by suction fans • Toilets have self-closing doors • Toilets are cleaned minimum 3 times daily • Toilets are flushable	56.5%
Compliant On-Site Food Preparation Requirements	• Availability of certified food handlers • Availability of food safety program	57.5%

	• DCC has a food safety certificate • Staff receive adequate training in hygiene and safe food handling practices • Food is prepared in the kitchen	
Complaint Water Storage, disinfection, and Monitoring	• Water storage tank is properly covered • Storage tank is in a shady location • Water storage tank is cleaned ideally 4 times a year • Water is disinfected by DCC • Water quality is monitored regularly by DCC	34%

*Based on Recommendations of Early Care Education Guidelines (AAP, APHA, and NRC) and UNICEF School's WASH Guidelines.

Moreover, WASH score for the common WASH facilities and services (diaper-changing practices, water basin's requirements, and adequate water storage, disinfection, and monitoring) was computed for each surveyed DCC based on the selected criteria as shown in table 11 using SPSS. Bivariate analysis using ANOVA test was conducted to check for the association between the score of each compliant event and variables that relate to (1) the microbiological results of swabs for compliant diapering and handwashing practices, and (2) the microbiological results of water samples for compliant water supply.

Not disinfecting the diaper-changing surface after use between children with the lack of disposable sheets may increase the risk of spreading pathogens. Results of the survey revealed that only 11.8% (2) DCCs use disposable sheets on the diaper-changing surface, and 72% (13) DCCs reported disinfecting diaper-changing surface after use for each child. A study conducted by Barros, et.al (1999), reported that the use of disposable non-absorbent liners on diaper-changing surfaces was significant in reducing the incidence of diarrhea by 23% ($p=0.02$). Still, results of the current survey revealed that although E-coli was detected on the diaper-changing surface in 29.4% (5) DCCs, no significant association between the compliant diaper changing practices and the detection of E-coli on diaper-changing surfaces was found ($p=0.72 > 0.05$). This could be possibly due to a potential bias introduced into the results collected using the question/answer method, in which DCCs might not report the true disinfection frequency, especially because of the prevailing COVID-19 pandemic imposed precautionary measures, and the short observation time spent in the DCCs to document such practices during the field visit. Thus, this could greatly decrease the reliability of collected data and bias compliance of diapering practices. In addition, the small sample size of the study could prevent the production of widely generalizable results.

Availability of handwashing equipment such as handwashing sinks, running cold water and soap, running hot water and disposable paper towels could improve hand washing compliance. Even though soap and running cold water were available and accessible in all the surveyed DCCs (100%), hot water in 82.4% (14 DCCs), and 76.5% (13 DCCs) have handwashing sinks adjacent to diaper-changing areas, still E-coli was detected on hands of three childcare providers. However, no significant association was found between the accessibility of compliant handwashing equipment and the detection of fecal coliforms ($p=0.28 > 0.05$). Several studies found that childcare providers had poor hand hygiene practices (not washing hands after certain contamination events) despite the availability of handwashing equipment in DCCs (Barros,et.al, 1999; Zomer, et.al, 2013) . Moreover, to examine the effectiveness of hygiene training program that is available in 35.3% (6 DCCs), the association between availability of hygiene training program and the detection of E-coli from all tested surfaces as illustrated in section 4.6 (child care provider's hands, table for feeding, diapering area, toys) was also examined . No significance was detected ($p=0.62> 0.05$) and this could be justified by either the low competency of the educators who delivered the training or the comprehensiveness of the delivered training programs. An earlier study conducted by Jones, et.al (2003) found that participants, who received information from a credible source, had more positive behaviors and intentions than participants who received negative communication from a non-credible source. Therefore, training initiatives must communicate positively with the trainees by helping them understand the science behind risk factors and how it can be controlled in DCCs settings through training interventions that can improve competency.

Then, the more that is known about environmental determinants of diaper-changing and handwashing practices to childcare providers, the more the likelihood of the implementation of successful interventions with long-term effects to improving hygiene practices in the childcare environments.

As such, detection of fecal coliforms in DCCs even in few samples is a significant problem that must be adequately addressed by the MOPH. And, more studies are needed to focus on the detailed handwashing and diapering events and techniques used by childcare providers to control and prevent the spread of pathogens.

Water quality should be ensured during storage. Properly covered storage tank, appropriate water disinfection and monitoring, and routine cleaning of storage tanks are precautionary measures that would prevent the microbiological contamination of water in storage. No significant association between compliant water storage and treatment in the surveyed DCCs and microbiological contamination detected in tested samples (total and fecal coliforms) was found (P=0.12>0.05). However, such factors (water treatment and monitoring, the type of storage tanks, and proper covering) are associated with the microbial water quality. Several studies showed that the unsanitary handling practices of water supplies at household level can cause further exposure to pollution (Onabolu, et.al, 2011; Poulous, et.al, 2012). As such, effective water treatment and quality monitoring can reduce the risk of contamination of water supply at household level, thereby decreasing the incidence of waterborne diseases such as diarrhea. For example, in a cluster randomized study, researchers conducted an intervention to study the effectiveness of drinking water disinfection by chlorination in reducing incidence of diarrhea among children under the age of 5 years in rural Dire Dawa, Ethiopia. Sodium hypochlorite solution (1.2%) was provided for the intervention group with demonstration of its proper use, while the control group continued with the usual routine of water collection and water storage. Results showed that the intervention group had a 36% reduction in incidence of diarrhea when compared with the control group with the highest reduction rate in children between 1 and 2 years (Solomon, 2020). Therefore, and according to documented studies, on-site water treatment and good storage practices at the final point of use (household, daycare, school…) are significantly associated with reduced rates of microbiological contamination and exposure to waterborne diseases.

This association is not found in our study results and may be attributed to many factors such as, inaccurate reporting, where water treatment was reported but minimally practiced at 23.5% (4) of DDCs as discussed earlier in section 4.2.4. This could challenge the definite conclusion about the association between onsite water disinfection and microbiological quality. Another reason could be recontamination on-site after treatment or improper treatment procedures followed by DCCs.

As such, it is important for DCCs to understand the proper protocols for onsite water handling, treatment, and storage of water supplies to reduce water contamination at the facility level.

Table 11: Criteria Used to Assess Compliant WASH Facilities and Services in Surveyed DCCs and Association with the Study Microbiological Findings

Microbiological Contamination	Term	Selected Criteria	Compliant Events (%)	P value
Swabs Taken from Diapering Surface	Compliant Diaper-Changing Practices	• Disposable sheets are used on diaper-changing surfaces	11.8%	0.72
		• Diapering surface is disinfected between every child	72%	
Swabs Taken from Childcare Providers' Hands	Compliant Handwashing Tools	• Availability of disposable paper towels	76.5%	0.28
		• Availability of running cold water and liquid soap	100%	
		• Availability of running hot water	82.4%	
		• Availability of handwashing sink near diapering area	76.5%	
Detection of Total/Fecal Coliforms in Water Samples	Complaint Water Storage, disinfection, and Monitoring	• Water storage tank properly covered	100%	0.12
		• Water storage tank cleaned ideally 4 times a year	0%	
		• Water is disinfected	23.5%	
			17.6%	

		by DCC • Water quality monitored regularly by DCC

(1) The Early Care and Education Programs Guidelines (AAP, APHA, NRC, 2019) used to evaluate the compliant diaper-changing practices and compliant handwashing tools.
(2) UNICEF WASH School's Guidelines (2012) used to evaluate compliant water storage, disinfection, and monitoring practices.

4.9. Limitations

The major study limitation related to acceptance to participate. Out of the identified 23 DCCs, only 17 accepted to participate in this study which limits the generalization of this study. This is mostly because participation was voluntary, so participating childcare facilities might have better hygienic and sanitary conditions than those who refused to participate in the study.Thus, results obtained from the surveyed DCCs may not be applied to all DCCs in Lebanon.

Moreover, data was collected at the peak of COVID-19 pandemic, so positive enhancing factors could have been the additional measures that were being taken.

Also, water samples were collected at one point in time during winter 2020; and therefore, the seasonal changes in water quality and its effect on onsite water treatment was not determined.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1. Chapter Overview

This chapter summarizes the main findings and conclusions of the study and presents steps forward to enhance WASH facilities and services in national daycare centers and develop a sustainable national quality control program.

5.2. Conclusion and Recommendations

Overall, WASH facilities and services in the surveyed DCCs in Saida Qadaa are still deficient. This is mainly because WASH in DCCs has not been addressed, nor properly regulated, directly or indirectly, at the national level, as the focus has been, so far, on schools.

5.2.1. Water Supply

Contaminated water would transmit diseases such as diarrhea, the second leading cause of both mortality and morbidity in children under the age of five (UNICEF, 2016). When children utilize unsafe water, it negatively affects their health as they drink more water per body weight than adults drink and are thus at an increased risk of exposure (Ingrid, 2019). Thus, the water source should be safe and available in sufficient quantities to meet basic water requirements of drinking, food preparation, personal hygiene and removal of waste (WHO, 2019).

Findings of the study show that surveyed DCCs rely on two water sources: the piped water supplies for personal hygiene and removal of waste, and complementary sources mainly brands of commercial industrial bottled water (water dispensers) for drinking, food, and formula milk preparation. This pattern of water use was justified by the voiced complaints about the piped water supply that reflect on its unsatisfactory organoleptic characteristics such as color, turbidity and conceived "safety" that further reflects on lack of trust in the public sector systems and services. Moreover, complementary water sources are received as safe for consumption due to absence of color or turbidity and the trust in the commercial sector products.

Collection and analysis of the physical, chemical, and microbiological quality of water samples from all surveyed DDCs, was done during the month of December 2020. The determined quality of both the tap water and the water dispensers was checked based on LIBNOR Standards to determine safety and compliance (LIBNOR, 2016). Sampling was conducted once during the wet season and this could mask some of the physical and chemical water characteristics that would be diluted by rain replenishment. In addition, it would influence the residence time of fecal microorganisms as a result of drop in water temperatures. Results of the analysis showed that:

➢ For piped water samples, the overall physio-chemical analysis showed that levels of all the following quality parameters (turbidity, total dissolved solids, conductivity, pH, alkalinity, sulfates, phosphates, nitrates, ammonia, sodium, chloride) were within LIBNOR standards. Still, the detection of color in 17.64% of samples, and high levels of hardness in most of the samples (94%) exceeding LIBNOR standard levels is important to note. Additionally, the detection of minimal non-carbonate hardness levels (31 -155 mg/L) further reflect on the type water sources (groundwater of karstic aquifers) and possible exposure to sources of pollution such as sewage and seawater infiltration. The overall impacts of exposure to such sources of pollution would be mostly masked by the dilution factor of rain in the wet season as presented in section 4.3.2.2.

Microbiologically, total, and fecal coliforms were detected in 29 and 6 percent of the samples, respectively. This is in line with the reported water complaints relating trust in water “safety”. As mentioned before, drop in water temperatures would affect the detection of fecal organisms in water. And, even if DCCs do not use this water source for drinking and cooking purposes, still indirect uses for personal hygiene practices including tooth brushing would expose children to health risks.

Poor water provision and management is an indication of concern relating to the overall quality and safety of the piped water supplies. Deficient Water quality in surveyed DCCs might be the result of the deficient pattern and low average compliance rate (34%) of water storage, disinfection and quality monitoring and quality control programs in compliance with UNICEF recommended guidelines, as indicated in section 4.8. Thus, this issue should be addressed in order to reduce likelihood of physical, chemical and microbiological contamination of the water in storage.

- For water dispensers, all physio-chemical characteristics (color, turbidity, TDS, conductivity, pH, alkalinity, sulfates, phosphates, nitrates, ammonia, sodium, chloride and free residual chlorine) were within LIBNOR standards. However, microbiologically, 24% (4 DCCs) of samples were contaminated with total coliforms and one sample (6%) with fecal coliforms.

Therefore, the DCCs satisfaction with complementary water sources (water dispensers) is not confirmed experimentally by the actual microbial safety of the water quality. It is rather by the perception that the water is of acceptable quality based on its aesthetic properties. Moreover, as this source is used for the preparation of food and bottle milk feeds, it carries a major risk and should be properly monitored to insure safety. As such, consumer’s water-related misconceptions must be addressed through education and awareness as a general step to protect consumer's safety and public health.

5.2.2. Sanitation

As for sanitation, the characteristics of the available facilities in the surveyed DCCs is relatively in compliance but did not exceed an average compliance rate of 70% as indicated in section 4.8. Findings for toilet facilities and water basins for handwashing are as follows:

- Toilet facilities had an average compliance rate of 56.5%, mainly small windows are used as a main method for ventilation, but such method does not remove bad odors effectively and is considered as an improper method of ventilation to be replaced by suction fans. Moreover, toilet cabins that are low to the ground were commonly found in the surveyed DCCs as it will make easily accessible to children when in the learning process. However, minimal toilet cleaning was reported as only 6 DCCs (35.3%) meet the recommended guideline of cleaning toilets at least 3 times per day. To add to the problem, the presence of self-closing doors is relatively minimal.

- Water basins for handwashing had an average compliance rate of 67%. Child-sized water basins were not available in all the surveyed DCCs, making it hard for children to reach the basin and practice proper hand washing under adult supervision. Water, soap, and disposable paper towels are accessible in most of the surveyed DCCs as indicated before. This is important to promote personal hygiene. Additionally, the use of cloth towels for hand drying purposes is the common practice in the surveyed DCCs (58.8%). This practice can increase the risk of infectious diseases among children in DCCs, and cloth towels should be replaced by disposable tissue papers. However, wastewater is properly discharged in sanitary sewerage systems by all surveyed DCCs and accordingly, is in compliance with a major UNICEF WASH Guidelines requirement. This later is a preventive measure to protect children and care providers against vectors and vector- borne diseases.

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5.2.3. Hygiene Services

- Hygiene Promotion and Training Hygiene Program

Hygiene promotion and on-going hygiene training programs are essential to help children and childcare providers improve their hygienic practices. Results found that all the surveyed DCCs educate their children on activities that relate to personal hygiene such as handwashing and tooth brushing. However, on-going training in food safety, hygiene, and sanitation practices was minimal, and only in a relatively small percent of DCCs (35.3%). Caregivers of these DCCs were exposed to some form of hygiene training provided either by experienced child-care providers through on-the-job training or by private organizations. Modifying this deficient pattern is necessary by conducting and implementing hygiene-training programs in all DCCs.

- Diapering Practices

A Low diaper-changing average compliance (50.58%) was determined in this study. Moreover, although handwashing sinks are adjacent to the diaper- changing area in most of the surveyed DCCs, washing child's hands after diaper changing is relatively a missing practice. Additionally, the use of appropriate disposable paper on the diaper changing surfaces with each diapering, a highly recommended practice to reduce spread of pathogens, is relatively nil. Thus, these non-compliant practices must be addressed The more that it is known about environmental determinants of handwashing and diaper-changing practices to child-care providers, the better is the control and prevention of pathogens spread can be maintained in the DCC environments.

- Dental Hygiene

Implementing the practice of tooth brushing, in surveyed DCCs, is minimal. However, it is important that children brush their teeth at least once during their time spent in the DCCs. Additionally, the tap water used for dental hygiene is minimally treated and monitored, as reported earlier. Moreover, the microbiological quality of piped water supplies show possible exposure to fecal contamination as discussed in section 4.3.3. Thus, children using this water for tooth brushing and other hygiene purposes can be at risk for acquiring diseases such as diarrhea.

- Toys Disinfection

Result of the survey showed that no uniform procedures for cleaning and disinfecting purposes are in place across DCCS. This questions the effectiveness of the methods is use. Shared toys are hot spots for enteric pathogens that could be transmitted from one child to another. Hence, routine cleaning and disinfection is important to prevent this transmission. As such, standardized procedures for the cleaning and disinfection of toys is necessary to prevent the spread of pathogens in child-care environments. Additionally, continued effective training for childcare providers on proper standard sanitization procedures and proper monitoring is necessary to ensure sustainability.

- Onsite-Food Preparation

The average compliance rate for food safety requirements in DCCs was relatively low (57.5%). Most of the surveyed DCCs do not have set programs to promote healthy food preparation and consumption. Additionally the presence of certified food handlers is minimal and highly deficient. This makes food safety a serious concern in these DCCs. Thus, it is important to manage and conduct food safety training for both directors and staff in DCCs with the need to have certified food handlers.

5.2.4. Overall Hygienic Profile and Average Compliance Rates

Furthermore, to reflect on the overall hygienic profile of the surveyed DCCs, samples of microbiological swabs from different surfaces (childcare providers' hands, diapering, toys, tables for feeding) were tested. The presence of E-coli was detected in 16.5% (14/85) of the samples analyzed. Collection of these swab samples happened at the time marking the completion of training programs provided by the Lebanese Red Cross in collaboration with the Ministry of Public Health in face of the COVID-19 pandemic. Still, low mean compliance rates in the surveyed DCCs of five clusters of WASH facilities and services (diaper changing practices- water basins requirements- toilet facilities- onsite food preparation requirements- water storage, disinfection and monitoring) with recommended Guidelines of the Early Care and Education Programs and UNICEF was found, as indicated in section 4.8. As such, detection of E-coli on surfaces even in minimal percentages raises a concern on the effectiveness of hygiene practices of childcare providers.

Additionally, scoring of compliant common WASH practices was used to determine if these practices are associated with the positive microbiological findings from swabs and water samples. No association was found, however and as determined earlier in section 4.8, this might be due to several limitations, such as the small sample size (17 DCCs) and information bias like inaccurate reporting. Another reason could be the low competency of the educators who delivered the training, and the comprehensiveness of the delivered training programs. Moreover, recontamination on-site after treatment or improper treatment procedures followed by DCCs could also be another factor for the "no-association" findings.

5.3. Recommendations for Future Work

Findings of this study reflect on, relatively, deficient WASH facilities and services prevail in the surveyed DCCs. As such, the following is recommended:

1. Develop National WASH Guidelines that will enable policymakers to regulate WASH in Child Daycare Centers.

2. Identify set of indicators (from the data collected) to be monitored and evaluate WASH facilities and services in order to tailor intervention plan for DCCs based on needs identified and the provision of resources.

3. Develop a national WASH quality-monitoring program to be implemented by Public Health Inspectors of the Ministry of Public Health (MoPH). Implementation and sustainability of this program is a must to enhance WASH and accordingly reduce exposure of children to disease.

4. Empower DDCs by on-going training WASH programs to improve childcare providers understanding of proper water, sanitation and hygiene management and practices to control risk factors in DCC settings. Additionally, training initiatives can help staff become more credible in identifying problems and gaps in the delivery of WASH services.

APPENDIX 1

Survey Questionnaire

1. **Daycare Center Area and Location**

Q1. Daycare center Area	**Q2.** Number of children (Total):	**Q3.** Number of boys	**Q4.** Number of girls	**Q5.** Number of childcare providers	**Q6.** Supportive staff

1. **Water services**
    a. **Access to safe water**

Q7.Is there a piped water system in the area?	**Q8. If yes, is the daycare center connected to the water network?**	**Q9. Indicate for what purpose do you use piped water?**	**Q10. Specify the water authority that provides the water**	**Q11. If no ,indicate the reason (s) for not having a piped water supply**	**Q12.Type of complementary water sources used**	**Q13. Indicate for what purpose do you use complementary water sources**
01.Yes 02.No	01. Yes 02. No	01.Drinking 02.preparaton of food and Cooking 03.Removal of waste 04.Hygiene			01.Vended water 02.Water cisterns 03. Industrial water brands ,	01. Drinking 02. Preparation of food and Cooking 03. Removal of waste 04. Hygiene

		05. Other, specify 06. All			specify 04. Well water	05. (1)&(2) 06. Other, specify

Q14.Does your daycare center have onsite water storage facility?	**Q15. Type of storage facility**	**Q16. Water tank covered tightly(if applicable)**	**Q17. location of the water tank**	**Q18. Is the water tank exposed to sunlight**
01. Yes 02. No	01.poly tank .02Metal 03. Concrete 04. Other, specify	01.Yes 02.No		01.Yes 02.No

b. **Onsite water disinfection**

Q19. Is water disinfection practiced onsite?	**Q20.** Type of disinfection technique	**Q21. Chlorine addition technique**	**Q22. If no, why?**	**Q23. Who does the monitoring?**	**Q24. Residual level of chlorine**
01. Yes	01- UV light	01- Chlorine added		01.childday care	……mg/l

02. No (go to question 22)	02- Solar disinfection 03- Chlorination (if yes go to question 21 and 24) 04- Filtration 05- Reverse Osmosis 06- Other , specify	manually in water tank 02- Chlorine added automatically in the water tank		center 02.Municipality 03. Water authorities 04. NGO's 05. Other , specify	

c. Type of water quality monitoring and perception

Q25. Is the main water source compliant with LIBNOR standards? (YES/NO)				
Type of water quality	Indicators measured	Frequency of monitoring	Results available for last monitoring	Compliant
Physical	Color (Yes/No)		YES/NO	YES/NO
	Turbidity (Yes/No)		YES/NO	YES/NO
	TDS(Yes/No)		YES/NO	YES/NO
	Electrical Conductivity (Yes/No)		YES/NO	YES/NO
Chemical	PH(Yes/No)		YES/NO	YES/NO
	Alkalinity (Yes/No)		YES/NO	YES/NO
	Nitrates ,sulfates, phosphates (Yes/No)		YES/NO	YES/NO
	Chlorides (Yes/No)		YES/NO	YES/NO
	Hardness (calcium and magnesium) (Yes/No)		YES/NO	YES/NO
	Free residual chlorine (Yes/No) .		YES/NO	YES/NO
	Other, (Yes/No) If yes, specify………...		YES/NO	YES/NO
Microbiological	Total fecal contamination (Yes/No)		YES/NO	YES/NO
	E coli(Yes/No)		YES/NO	YES/NO

Q26. Water quality perception	**Q27. For what type of uses?**	**Q28. Reasons for not safe**	**Q29. Water user groups**	**Q30. Has any child in your daycare center had unusual water-related disease syndrome such as diarrhea during the last 15 days/ month?**
01- Safe (go to question 27) 02.Not safe (go to question 28) 03.Just used for cleaning 04.Do not know	01. Drinking 02. Preparation of food and cooking 03. Removal of waste 04. Hygiene 05. Other , specify 06. All	01- Color 02- Turbid 03- Tasty 04- Unsafe 05- Saline 06- Other , specify	01.children 1.yes 2.No 02.Childcare providers 1.yes 2.No 03.staff 1.yes 2.No	01- 15 days (Yes /No) 02- Month (Yes/No)

2. **Sanitation Services**

Q31. Total number of water-basins	**Q32. Water basin location**	**Q33. Number of water-basins for kindergarten boys**	**Q34. Number of water-basins for kindergarten girls**	**Q35. Water basin placed at low height for children**	**Q36. Height of the water basin**	**Q37.Availability of running cold water**	**Q38. Availability of running hot water**	**Q39. Availability of tissue papers**	**Q40. Towels used for drying (if applicable)**	**Q41. Frequency of towels washing**
	01.toilets 02. Food consumption area 03. Classrooms 04. other, specify			01- Yes 02- No	…… m	01.Yes 02.No	01.Yes 02.No	01- Yes 02- No(go to question 40 and 41)	01. Single use 02. Multiuse	01.daily 02.weekly 03.other, specify

Q42. How many child latrines/ toilets are currently usable?	**Q43. Separate for boys and girls? (above the age of 2)**	**Q44.Separate for toddlers?**	**Q45.Are there tissue papers for wiping?**	**Q46.Are toilets flushable?**	**Q47. Latrines placed at low height for children**	**Q48. Toilet self-close doors**	**Q49. Toilet ventilation**	**Q50. Type of toilet ventilation**	**Q51.Cleaning toilets/latrines daily**	**Q52.Frequency of cleaning/day**	**Q53.Type of cleaning method**

	01.Yes 02.No	01.Yes 02. No	01.Yes 02.No	01. Yes 02.No	01-Yes 02-No	01- Yes 02- No	01- Yes 02- No	01- Window 02- Fan 03- Other … … … …	01.Yes (go to question 52and 53) 02.No		

Q54.Is there specific personnel allocated	**Q55. What is the disposal method of the sewage?**
01.yes 02.No	01.septic tanks-water tights 02.cesspols 03.sanitary sewage system

3. **Hygiene**
   a. **Hygiene promotion**

Q56. Hygiene education.	**Q57. On average, how many times per day do you wash your hands?**	**Q58. When do you use to wash your hands?**	**Q59. Do you wear disposable gloves to prevent the spread of germs?**	**Q60.When do you wear gloves**
01.Yes 02.No		01.before using the toilet (yes/no) 02.after using the toilet (yes/no) 03.before food-handling (yes/no) 04.before eating (yes/no) 05. after eating(yes/no) 06.before and after diaper changing(yes/no)	01.yes (go to question 60) 02.No	01. Before food handling (Yes/No) 02.Before diaper changing (Yes/No) 03.other, specify

b. **Dental Hygiene**

Q61.Do children practice dental hygiene (age group above 2 years)	**Q62.How often young children (above 2 years) brush their teeth?**	**Q63.Type of water source used for tooth brushing**
01.yes (go to question 62and 63) 02.No	01.twice a day 02. in the morning 03. bedtime 04. other , specify	01.Vended water 02.Water cisterns 03.Industrial water brands , specify 04.Well water 05.Other, specify

c. Diapering

Q64. Type of surface used for diaper changing	Q65. Is the surface used washable?	Q66. Method used for cleaning	Q67. Frequency of cleaning	Q68. Method of disinfection	Q69. Frequency of disinfection	Q70. Is the diapering area close to a hand washing sink?	Q71. Location of supplies needed for diaper changing
01.rubber mat 02.disposable paper 03.other , specify	01.yes 02.No		01. daily 02. once per week 03. twice per week 04.other, specify			01.Yes 02.No	01. On the diapering surface 02. set up with space from diapering surface 03.other, specify

Q72.method used for wiping	Q 73. Do you wash the child's hands after diaper changing	Q74. Method used for diaper and wipes disposal

1.wiping from front to back 2. wiping from back to front 03. Do Not Know	01.Yes 02.No	

d. Toileting

Q75.Do children above the age of 3(from 3to 5) use toilet by themselves?	**Q76.Who supervises the proper usage of toilet**	**Q77. Type of toileting area**	**Q78. Do children use potty chairs**	**Q79. How do you clean it (describe)**	**Q80. style of waste disposal basket**
01.Yes 02.No	01.caregiver 02.housekeeper 03.specific person allocated 04.other, specify	01.Separate bathrooms 02. open toilets in the classroom 03.other, specify	01.Yes (go to question 79) 02.No		01.Hand free 02.Self-closed 03.Other, specify

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e. **Hygiene services**

Q81. Do you have a training hygiene program?	**Q82. If yes, when the last training was held?**	**Q 83. Do children wash their hands by themselves (above the age of 3)**	**Q84.after what practice(s) children are taught to wash their hands?**	**Q85. Who supervises good handwashing practices?**
01.yes 02.no	01.during the last one month 02.during the last two months 03.since 6 months 04. from 6-12 months 05. Do not know	01.yes 02.No	01. before and after eating 02. after using the toilet 03. after sneezing or coughing 04. all 05.other, specify	

Q86. How often do you wash the bedding material used by children for bedtime routine?	**Q87.Method used for cleaning**	**Q88. Frequency of cleaning the floor and surfaces**	**Q89. Method used for cleaning**	**Q90. Do you disinfect toys and outdoor playing equipment that children play with?**	**Q91.Method used for disinfection**	**Q92. Frequency of disinfection**
01. Multiple times daily 02. once a week 03. twice a week 04. other, specify		01.multiple times per day 02.once daily 03. twice daily 04.other, specify		01.yes (go to question 91 and 92) 02.No		01.Multiple times daily 02.once a week 03.twice a week 04.other, specify

Q93. Is there on site food preparation?	**Q94. If yes, where food is prepared?**	**Q95. Is there a food safety program**	**Q96.if yes ,who is involved in running this program**	**Q97. Is there food safety certifications for daycare center?**	**Q98. Has any food-borne disease outbreak occurred during the last month?**
01.Yes 02.No	01. inside the classroom 02. kitchen 03.other , specify	01.yes 02.No		01. Yes, specify 02. No	01.yes 02.No 03. Do not Know

Q99. Is the daycare center inspected routinely?	**Q100. Who does the monitoring?**	**Q101. What type of inspection does daycare center have?**	**Q102. Frequency of inspection**
01.Yes (go to question 100, 101 and 102) 02.No			

4. **Availability of specialized staff**

Q103. Certified nurse	**Q104.** Certified health care adviser	**Q105.** Certified food handler	**Q106.** Other
01- Yes 02- No	01- Yes 02- No	01- Yes 02- No	01.yes (specify) 02.no

AdditionalRemarks:..
....

APPENDIX 2

الجمهورية اللبنانية

وزارة الصحة العامة

جانب مدير دار حضانة -----------------------------

الموضوع:دراسة تقييمية لحالة المياه والأصحاح و النظافة في دور الحضانة (WASH)

المرجع:دائرة صحة الأم و الولد و المدارس

بناءاً على الموضوع والمرجع المبينين اعلاه، تفيدكم وزارة الصحة العامة انها وبالتعاون مع منظمة الصحة العالمية والجامعة الأميركية في بيروت تقوم بدراسة حول حالة المياه والأصحاح والنظافة في دور الحضانة لتقييم وضع البيئي لها.

لذلك نطلب تسهيل مهمة الباحثة السيدة تغريد زكريا في تعبئة استمارة خاصة بالتعاون مع إدارة دار الحضانة .مذكرين بأن المعلومات الواردة في الاستمارة تبقى سرية وتستعمل للهدف الذي وضعت لتحقيقه .

نشكر لكم تعاونكم

رئيس دائرة صحة الأم والولد والمدارس بالتكليف

باميلا منصور

٢٠٢٠-٩-٢٨

Access Letter by MOPH

APPENDIX 3

Consent Form of Participation

WASH in Daycare Centers of Saida: Development of Appropriate Assessment and Management Tools

Investigator: Dr. Mey Jurdi
Address: American University of Beirut
Bliss Street
Beirut, Lebanon
Phone: (01) 350000 Ext 4624

You are being asked to participate in a research study conducted at the American University of Beirut. Please take time to read the following information carefully before you decide whether you want to take part in this study or not. Feel free to ask any question if you need more information or clarification about what is stated in this form and on the study as a whole.

This study aims to evaluate the environmental conditions, specifically water, sanitation and hygiene facilities and services in child daycare centers and accordingly, recommend needed interventions.

You can stop filling the survey at any time or you can refuse to give analytical samples (water and microbiological screening) and it is okay to say “No” if you don’t want to be in the study.

There are no risks imposed on you when participating in this study. In addition, there are no direct benefits from participating in this study; however, data collected will be used to towards developing the WASH guidelines for daycare centers that would be used to protect and enhance the health of pre-school children.

Data will be collected personally by the researcher from 29 child daycare centers in Saida region. The physical facility will be surveyed, and questions will be asked relating to WASH premises, programs and activities.

A walk-in of survey of the WASH facility will be conducted and you will be asked to respond to few questions; total allocated is 25 to 30 minutes. Additionally, samples will be collected during the study period of one to three months.

If you agree to participate in this research study, the information will be treated at utmost confidentiality with no reference to the unit. The location and the name of the daycare center will not be mentioned nor communicated as the major objective is service improvement.

A copy of this form will be given to the participant.

For questions about the study you may contact Dr. Mey Jurdi: 03916580, email: mjurdi@aub.edu.lb or Ms. Taghrid Zakaria: 70232707, email: tbz00@mail.aub.edu

To discuss other study-related questions about rights or concerns about the study, you may contact the AUB Social& Behavioral Science Institution Review board at 00961-1-350000, ext: 5445

Investigator's Statement:

I have explained the objectives and the benefits of the study before requesting the signature of the participant. I have answered to all the participant's questions clearly. I will inform the participant in case of any changes to the research study.

Name of Investigator **Signature**

____

Date & Time

Signing the consent form:

I have read and understood all aspects of the research study and all my questions have been answered. I voluntarily agree to be a part of this research study and I know that I can contact **Ms.** Taghrid Zakaria **or Dr.** Mey Jurdi in case of any questions**.** If I feel that my questions have not been answered, I can contact the Institutional Review Board for human rights at **AUB.** I understand that I am free to withdraw this consent and discontinue participation in this project at any time, even after signing this form. I know that I will receive a copy of this signed informed consent.

______________________________ ________________________________

Name of person obtaining consent **Signature**

____

Date & Time

APPENDIX 4

IRB Approval

Institutional Review Board | لجنة الأخلاقيات

www. aub.edu.lb

APPROVAL OF RESEARCH

July 29,2020

Mey Jurdi, PhD
American University of Beirut
mjurdi@aub.edu.lb

Dear Dr. Jurdi,

On July 29, 2020, the IRB reviewed the following protocol:

Type of Review:	Initial, Expedited
Project Title:	WASH in Daycare Centers of Saida: Development of Appropriate Assessment and Management Tools
Investigator:	Mey Jurdi
IRB ID	SBS-2020-0066
Funding Agency:	None
Documents reviewed:	Received July 8,2020: • IRB application • Proposal • Consent document for biological samples (English and Arabic versions) • Consent document (English and Arabic versions) • Survey tool (English and Arabic versions)

The IRB approved the protocol from July 29, 2020 to July 28, 2021 inclusive. Before May 28,2021 or within 30 days of study close, whichever is earlier, you are to submit a completed "FORM: Continuing Review Progress Report" and required attachments to request continuing approval or study closure.

If continuing review approval is not granted before the expiration date of July 29, 2021 approval of this research expires on that date.

Please find attached the stamped approved documents:

- Proposal (received July 8,2020),
- Consent document for biological samples (English and Arabic versions, received July 8,2020),
- Consent document (English and Arabic versions, received July 8,2020),
- Survey tool (English and Arabic versions, received July 8,2020).

Only these IRB approved consent forms and documents can be used for this research study.

Thank you.

The American University of Beirut and its Institutional Review Board, under the Institution's Federal Wide Assurance with OHRP, comply with the Department of Health and Human Services(DHHS) Code of Federal Regulations for the Protection of Human Subjects ("The

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New York 3 Dag Hammarskjold Plaza, 8th floor | New York, NY 10017-2303, USA | Tel: +1-212-583-7600 | Fax: +1-212-583-7651

Common Rule") 45CFR46, subparts A, B, C, and D, with 21CFR56; and operate in a manner consistent
with the Belmont report, FDA guidance, Good Clinical Practices under the ICH guidelines, and applicable national/local regulations.

Sincerely,

Lina El-Onsi Daouk, MSc, CIM
SBS/IRB Administrator

Cc: Michael Clinton, PhD
IRB Vice Chairperson
Social & Behavioral Sciences

Fuad Ziyadeh, MD, FACP, FRCP
Professor of Medicine and Biochemistry
Chairperson of the IRB

Ali K. Abu-Alfa, MD, FASN, FAHA
Professor of Medicine
Director, Human Research Protection Program

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APPENDIX 5

Consent Form for Microbiological Hand Swabs

Consent to participate in giving hand swab samples

WASH in Daycare Centers of Saida: Development of Appropriate Assessment and Management Tools

Investigator: Dr. Mey Jurdi
Address: American University of Beirut
Bliss Street, Beirut, Lebanon
Phone: (01) 350000 Ext 4624

You are being asked to participate in a research study conducted at the American University of Beirut. Please take time to read the following information carefully before you decide whether you want to take part in this study or not. Feel free to ask any question if you need more information or clarification about what is stated in this form and on the study.

This study aims to evaluate the environmental conditions, specifically water, sanitation and hygiene facilities and services in child daycare centers and accordingly, recommend needed interventions.

We are asking for your permission to participate in this study. One of the current research project objectives is to evaluate hygiene conditions in the daycare center. The study will involve the recruitment of 3 to 4 participants recruited randomly. If you are asked and agreed to participate in this study, then we will take a hand swab sample for microbiological testing.

It is important to note that if you decide not to participate in this study, the refusal will not affect your relationship with AUB.

To protect your **privacy**, I will ask you not to use your full name or any identifying information while completing the study. I will also ask you not to use any other people's full names or identifying information. Your participation will be anonymous and all the samples will be de-identified. Proxy indicators will be used to reflect on existing conditions.

This is a **no risk** study. Your employability will not be affected as the microbiological samples will be done randomly and de-identified. In addition, there **are no direct benefits** from participating in this study; however the data collected will be used towards developing the WASH guidelines for daycare centers that would be used to protect and enhance the health of pre-school children. Our ultimate goal is service improvement in Lebanese child daycare centers.

If you agree to participate in this research study, your information will be **kept confidential**. The **sample taken will not identify who you are.** The Principal Investigator and the researcher will have direct access to your records. However, your records will not be displayed to the public, only the summary of the findings of the project will be disseminated to the public.
Participation in this study is **voluntary**. You have the right to decline participation, and if you choose to do so, your decision will not affect you in any way. In addition, refusal of participation or withdrawal from the study will involve no penalty.

All data will be stored on password protected and encrypted electronic devices (laptops) or in locked areas at the Environmental Health Department –AUB accessible only to the study personnel.

A copy of this form will be given to the participant.

For questions about the study you may contact Dr. Mey Jurdi: 03916580, email: mjurdi@aub.edu.lb or Ms. Taghrid Zakaria: 70232707, email: tbz00@mail.aub.edu

To discuss other study-related questions about rights or concerns about the study, you may contact the AUB Social& Behavioral Science Institution Review board at 00961-1-350000, ext: 5445

Investigator's Statement:

I have explained the objectives and the benefits of the study before requesting the signature of the participant. I have answered to all the participant's questions clearly. I will inform the participant in case of any changes to the research study.

______________________ ______________________

Name of Investigator **Signature**

____

Date & Time

Signing the consent form:

I have read and understood all aspects of the research study and all my questions have been answered. I voluntarily agree to be a part of this research study and I know that I can contact **Ms.** _Taghrid Zakaria_ **or Dr.** _Mey Jurdi_ in case of any questions**.** If I feel that my questions have not been answered, I can contact the Institutional Review Board for human rights at **AUB.** I understand that I am free to withdraw this consent and discontinue participation in this project at any time, even after signing this form. I know that I will receive a copy of this signed informed consent. If I screened positive, I agree on a follow up with Ms. Taghrid to learn proper mechanisms on hand washing and hygiene practices. I know that this will be kept between me and the researcher, thus my employability will not be affected at all.

______________________ ______________________

Name of person obtaining consent Signature

____

Date & Time

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