Hygiene in early childhood development centres in low-income areas of Blantyre, Malawi

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ABSTRACT

Diarrhoeal disease remains a leading cause of death in children in sub-Saharan Africa, attributed to environmental health factors such as inadequate water, sanitation and hygiene (WASH) and food hygiene. This formative study in low-income areas of Blantyre focussed on the practices in Early Childhood Development Centre (ECDCs) environments where children spend a significant amount of time. A mixed-methods approach was applied to identify key hygiene behaviours in ECDCs through; checklist and structured observations (n = 849 children; n = 33 caregivers), focus group discussions (n = 25) and microbiological sampling (n = 261) of drinking water, food handler’s hands, and eating utensils. ECDCs had inadequate WASH infrastructure; coupled with poor hygiene practices and unhygienic environments increased the risk of faecal-oral disease transmission. Presence of E. coli in drinking water confirmed observed poor water handling habits by staff and children. Addressing undesired hygiene practices in ECDCs has the potential to improve the health outcomes of children in low-income settings.

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Introduction

Children under the age of five are exposed to environments with widespread faecal contamination in low-income countries (Pickering et al. 2012; Ngure et al. 2013). This occurs as a result of poor water, sanitation and hygiene (WASH) practices in both domestic and public settings (Medgyesi et al. 2018a; Holcomb et al. 2020), leading to a high prevalence of diarrhoeal disease, and associated acute and chronic health outcomes; approximately 424,000 deaths annually (WHO 2017) and 29.7% of children suffering from under nutrition (Development Initiatives 2018). In Malawi, childhood diarrhoea remains high with an average prevalence of 22% in children under the age of 5 years, which contributes to the high under-five mortality rate of 63 deaths per 1000 births (Government of Malawi 2016). Interventions which address child health and water, sanitation and hygiene are key to the attainment of the UN Sustainable Development Goals (SDGs), particularly SDGs 3 (Good Health and Well-being) which aims at ending all preventable deaths under 5 years and SDG 6 (Clean water and sanitation) which aims at achieving adequate and equitable access to safe water, sanitation and hygiene (United Nations 2018). On a national level, these areas are also priorities of the Malawi Growth and Development Strategy III (Afidep 2019).
Diarrhoeal disease in this low-income setting has been associated with a range of direct and indirect exposures to faecal oral transmission, including contaminated food (Ehiri and Prowse 1999; Motarjemi 2000), contaminated household and public playground environments (Pickering et al. 2012; Hurd et al. 2017), and contact with domestic animals (Ngure et al. 2019). To date, efforts to reduce these exposures for under five children have focussed in the domestic environment (Luby et al. 2018; Morse et al. 2020). However, recent large intervention trials at household level have failed to demonstrate a reduction in diarrhoeal disease or improved nutritional status from routine WASH interventions (Luby et al. 2018; Null et al. 2018). This has led to call for a more transformational and One Health approach to reducing faecal oral routes of disease transmission for under five children (Cumming et al. 2019). This includes the need to examine and address environments outside of the domestic setting where children may be exposed to infection.

Over 1.6 million children aged between 2 and 5 years in Malawi attend 11, 600 Early Childhood Development Centres (ECDCs) on a daily basis. Early Child Development (ECD) is vital for a child’s social, mental and psychological growth, as such the Malawi Government established community-based ECDCs for children aged 2–5 across the country. With a primary focus on providing both education and nutritious meals, ECDCs are run by volunteers, and serve rural and low-income urban areas. Being an environment that accommodates young children who are prone to numerous communicable diseases including diarrhoea, ensuring WASH facilities and associated good hygiene practices in ECDCs is essential. Thus, there is a need to understand hygiene practices and behaviours in these settings that include what, and how children eat, access and use of WASH facilities, and the microbiological quality of drinking water provided to children. By assessing these factors, we can design an intervention to effectively improve WASH and food hygiene in ECDC settings. As such, this study aimed to: (a) understand hygiene practices in target ECDCs, and (b) identify key recommendations for future environmental health-related interventions in ECDCs.

Methods

Study setting

The study was conducted in Blantyre City, Malawi, which has a population of 800, 264 (National Statistical Office 2018), and 89% coverage of improved drinking water sources. Improved sanitation in the city remains low (37%), and diarrhoea prevalence (18%) and stunting (33%) in under-5 children remain high. At an institutional level, sanitation coverage for primary schools sits at 96%, however these figures are misleading as they do not reflect if schools have met the 1 toilet: 60 children ratio or the quality required (Ministry of Education, Science & Technology 2009). Only 18% of schools have handwashing facilities (Ministry of Education, Science & Technology 2009). There are no WASH service coverage figures available for ECDCs. Blantyre city has 900 registered ECDCs, which represents 7.8% of all the ECDCs in Malawi (Gelli et al. 2017; Namadzunda 2017 Nov 21). These are based within the informal settlements that constitute 65% of the city (World Bank and National Statistical Office 2018). In general, ECDCs are characterised by provision education (100%) and meals (91.2%); boreholes are the common source of water (65%) and they have limited availability of kitchens for food preparation (18.6%) (Munthali et al. 2014).

Recruitment and participants

Ten randomly sampled centres were included in this study from amongst the list of ECDCs provided by the District Social Welfare Office. Due to the formative nature of the study, only 10 out of the 900 ECDCs were included to maximise observations in each ECDC and provide an in-
depth understanding of practices and behaviours. Inclusion criteria for the recruited ECDCs included the following: should be peri-urban areas of Blantyre, have an enrolment of over 50 children and should provide a daily meal to the enrolled children. Ten eligible centres were then randomly sampled to represent 10 separate locations in Blantyre. The targeted ECDCs were established by either Non-Governmental Organizations ($n = 4$), Faith-based groups ($n = 5$) or the Government’s District Social Welfare Office ($n = 1$). Daily running of the centres was done by a local committee comprised community members. Study participants included: all enrolled children present during the time of observations, all caregivers (volunteers that look after the children: 2–6 per ECDC), food handlers (which included; caregivers, parents and employed food handlers) who prepared meals for the children (1–3 per ECDC), at least one committee member (administration team) per ECDC that helped with the daily running of the centre, and 8 to 10 guardians of the enrolled children per ECDC.

**Study design and data collection**

This formative study used mixed methods (qualitative and quantitative techniques) to evaluate food hygiene and WASH practices in the targeted ECDCs. Qualitative data were collected through structured observations and Focus Group Discussions (FGDs) while checklist observations and microbiological samples constituted the quantitative data. As shown in Table 1, data were collected in three phases that included observations, FGDs and microbiological sampling. Overall, the ECDCs were assessed using a Hazard Analysis Critical Control Point (HACCP) framework, whereby phase one and two allowed the identification of critical points at which hygiene practices required improvement, and the microbiological sampling supported validation of these observations. All phases of research were conducted by a trained and qualified research assistant (Bachelor of Science in Environmental Health), with support and supervision from senior researchers in the field of environmental health.

<table>
<thead>
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<th>Table 1. Phases of data collection in the study.</th>
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<td><strong>Data Collection Method</strong></td>
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<td>Phase 1 Observations</td>
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<sup>a</sup>Source: (IDEXX US 2019).
<sup>b</sup>Source: (Hygiena 2016).
<sup>c</sup>Source: (Hygiena 2016).
**Phase 1: observations**
Each ECDC was observed for three consecutive days for the full period of operation, to understand the daily schedules, and the use of WASH and food preparation infrastructure that included direct observation of practices. Participatory observation methods were used to put people at ease and minimize reflexivity.

Checklist observations: Checklist observations were conducted on day one at the beginning of the day’s operation (7:00am). Observations used a guided form to assess the availability of WASH infrastructure through presence of toilets, handwashing facilities and water sources. Hand washing facilities and drinking water sources were also observed to see if they were easily accessible and used by all children to ensure user friendliness. Kitchens and hand washing facilities were also assessed to determine access to adequate utensils, and soap for washing both utensils and hands (food handlers and children) at critical times.

Structured observations: The structured observations were conducted during normal daily operation hours (e.g. 07:00 AM – 12:00PM) of the ECDCs for 3 consecutive days. With the use of an observation log, structured observations were used to carefully observe and record: general child hygiene management, food and utensil hygiene practices (from storage, preparation to consumption), handwashing with soap practices, handling of drinking water and disposal of excreta. The observations also included daily monitoring of food temperatures using a digital food thermometer (Thermapen TM 5, ETI Ltd, Worthing, West Sussex) to determine if the food was being served at or above the recommended 63°C. Structured observations; also included hand hygiene audits using pre-coded forms to specifically record handwashing opportunities and actions for children, food handlers and caregivers at these critical times that included: before food preparation, before eating and after toilet use and after handling human, animal or solid waste. This data was correlated with information on the availability of handwashing facilities and soap captured through checklist observations.

**Phase 2: focus group discussions (FGDs)**
Following the observations, and initial data analysis, the research team conducted FGDs with stakeholders involved in daily running of the ECDCs (both caregivers and food handlers) using a structured, facilitation guide. The interviews were conducted at the ECDCs and discussions were recorded for transcription. FGDs with ECDC caregivers and food handlers focused on food hygiene and WASH practices, ECDC administration and community participation. The FGDs also highlighted issues that were noted during observations and sought to understand the principles behind those practices. FGDs with guardians/parents of the enrolled children sought to assess parents’ commitment and participation towards running of the ECDCs. Reasons for selection of an ECDC for their child and level of satisfaction with WASH facilities were also assessed with the use of a Schutte scale (Rippon et al. 2018). Lastly, 10 FGD’s with ECDC committee members were conducted to understand the daily administration and community involvement in running the ECDCs.

**Phase 3: microbiological sampling**
With the application of the Hazard Analysis Critical Control Point (HACCP) approach (Codex Alimentarius Commission 1999), data collected from the observations and FGDs informed which critical points were potential sources of pathogen transmission. As such, the following critical areas were identified for microbiological sample collection: drinking water, utensils, children and food handler’s hands. Thus, samples were collected from source water, stored water, utensils (plates, spoons and cups) before use, and the hands of food handlers and children. Microbial sampling and initial analysis were conducted by qualified laboratory personnel.

Hand and utensil swabs: Levels of organic residue on sampled hands and utensils were assessed using Adenosine Triphosphate (ATP) swabs. The swabs were used to obtain Relative Light Units (RLU – a measure of bioluminescence); the luminometer reading is directly proportional to the
amount of ATP in the sample. As there is no direct correlation between dirtiness and the presence of bacteria, the results only gave an indication of hygiene; a high RLU reading indicated a high level of dirtiness and hence, an unhygienic environment. This analysis provided a more robust assessment of the critical control points within ECDCs to support the observation findings and recommendations delivered by the study. A sterile ATP swab (Ultrasnap surface swabs, HYGIENA, Camarillo CA, US2020) was used to sample a surface area through swabbing (Table 1) and was then placed directly into an ATP luminometer (Hygiena SystemSURE Plus, HYGIENA, Camarillo CA, SS3) to give an indication of cleanliness through RLU readings in real time. Reading and interpretations of the Hygiena™ SystemSURE Plus results used the general pre-programmed limits for food contact surfaces by Hygiena™ (Hygiena 2013). Hand hygiene RLU limits were adopted from the Hygiena hand hygiene experiment on health-care workers (Hygiena 2013, 2015). Caregivers were advised to wash the utensils before use after swabbing.

Water sampling and analysis: Water samples were collected directly from the drinking water source used by the ECDC, and from the drinking water storage container within the ECDC to test for presence of coliforms and E. coli using the IDEXX Colilert™ system (IDEXX US, Westbrook, Maine 04092 USA). These were collected in sterile 100 mL containers and transported back to the laboratory in cooler boxes where they were processed on the day of sampling. The Colilert reagent was then added to the water samples and placed in IDEXX Colilert™ Quanti-Tray for 24 hours incubation at 35°C. Positive wells (yellow and fluorescing) were then counted, and the Most Probable Number (MPN) per 100 mL was determined.

**Data analysis**

Quantitative data were entered and analyzed using Microsoft Excel (2016) and Stata 14.0 (College Station, TX: StataCorp LP). Univariate analysis (means and percentages) were used to describe the data.

Qualitative data from observation logs and FGDs were transcribed and analysed using Constant comparison analysis (Onwuegbuzie et al. 2009). Collected data were divided into small units and allocated codes, after which the units were grouped into categories. Thematic areas of interest were then identified, and the results were triangulated with the quantitative findings to assess the food hygiene and WASH status in the ECDCs.

**Ethical approval**

In order to ensure privacy, confidentiality and anonymity of the study participants, ethical approval was obtained from the National Health Sciences Research Committee (Protocol # 18 April 2017). Further approval was sought from Blantyre District Social Welfare Office. Written informed consent for adult participants in the study was received from caregivers, food handlers, guardians/parents and ECDC chairperson. Caregivers at the ECDC provided assent for the children that participated in the study (Mangochi et al. 2019).

**Results**

Observations and FGDs were conducted in all ten ECDCs, however one ECDC (#2) did not consent to microbial sampling.

**Demographics**

All observed child caregivers at the ECDCs were female with an average of two caregivers per centre. Level of education among the child caregivers varied with 70% having attended primary school while 30% had attended secondary school. Few caregivers (30%) and committee members
(20%) had received training that focused on childcare, ECDC lessons, food preparation (including safety) and basic WASH training on how to keep surroundings clean. Children enrolled in the ECDCs were between 2–6 years of age. Enrolment of children ranged from 50 to 187 across the ECDCs with a daily attendance that ranged from 27 to 150 learners; an average ratio of 1 caregiver: 77 children. A total of 849 children in 10 ECDCs were observed in the study.

**Daily routine in the ECDCs**

All targeted ECDCs provided lessons and meals to the children. All ECDCs followed a daily routine that either operated between 7:30AM-12:00 noon (n = 8) or from 7:30AM-3:30 PM (n = 2). Caregivers in all the ECDCs started their day at 7:00 am where they shared cleaning responsibilities (i.e. cleaning of learning rooms, kitchen, toilets, and sweeping the compound). Either a caregiver or food handler then collected water while 1–2 caregivers welcomed the learners. At 8:00am, children were divided according to their age to begin lessons, at the same time one food handler set a fire to prepare the days meal. ECDCs that operated from 7:30am-12:00 noon only provided porridge (maize based fortified porridge), while those that operated from 7:30am-3:30 pm provided nsima (made of maize flour with a thicker consistency than porridge) and relish (a side dish of stew, beans or vegetables). The whole process of preparing porridge took approximately 2 hours (8:00am-10:00am) while the children were in class. In the eight ECDCs that ended the day at 12:00 noon, the learners broke at 10:00 am to eat porridge and play games, which took approximately 1 hour 30 minutes. The food handler washed the used utensils immediately after use in preparation for the following day. While in the remaining two ECDCs that ended the day at 3:30pm, the learners broke at 10:00 am for 30 minutes, where they ate snacks provided from home (e.g. banana fritters, doughnuts and corn snacks) and played games. At 12:00 noon, the learners broke again for lunch (nsima and relish) which was prepared at the ECDC. The whole process of preparing nsima and relish took 3–4 hours. As the lessons reconvened at 1:30pm, the food handlers cleaned the utensils in preparation for the next day.

All caregivers in the target ECDCs worked on a voluntary basis and were not remunerated for their work. However, food handlers in 50% of the centres were paid. Parents/guardians of the enrolled children made a monthly contribution of MK100–MK2, 000 (1 USD = 740 MK) per month in 70% of the ECDCs to cover the cost of food handlers, soap, firewood, cleaning equipment and cooking utensils. Counterparts from the remaining 30% did not make any monetary contribution since these were Church or NGO sponsored ECDCs. Parents/guardians enrolled their children to the ECDCs for various reasons that included: affordability (100%), convenience (80%), academic preparation (100%) and free meals (70%).

“When children take porridge at the ECDC, they take less nsima when they get home, which saves our food”- Parent ECDC 7

**Food hygiene**

ECDCs were evaluated on a number of components related to food hygiene that included;

Food preparation reported food hygiene practices, food consumption and utensil management.

**Food preparation**

Seven out of 10 selected ECDCs in this study had kitchens available for food preparation. This provided a cooking area that was sheltered from weather, had concrete work surfaces, and earthen floors. Kitchens were used for food preparation and storing water during the day. Three ECDCs that did not have kitchens prepared food on either the veranda of the learning room or in an open outdoor space depending on the weather. Maize flour for preparing porridge, and learning materials were stored on pallets or shelves while utensils were stored in open basins on the floor in secured (lockable) storerooms with concrete floors. Evidence of pests (i.e. rodent droppings and
cockroach casings) were observed in five out of the 10 storage rooms. Classrooms were cleaned on a daily basis while storerooms were not cleaned frequently since they were not considered areas of constant use.

All ECDCs were observed to have adequate pots, plates, spoons and cups to be used for both food preparation and serving, with pots made locally from aluminium, and plates and utensils made of plastic. Utensils were cleaned soon after use, with 70% of the ECDCs using water and soap while 30% used water and sand. Ninety percent subsequently stored items upside down until use the next day. However, cups were not cleaned in between use by different children. In 1 ECDC, utensils were stored on a dish rack.

Food was prepared by dedicated food handlers who were paid in 50% of the ECDCs. In the others, food was prepared by caregivers and committee members, with parents helping in some (30%). Only three ECDCs had handwashing facilities at the food preparation area, of which two handwashing facilities were a bucket with a tap, and one was a tap with running water. Soap was available at one handwashing facility.

During food preparation, none of the food handlers were observed washing hands with soap. While 44% of the food handlers were observed to have washed their hands with water only and 56% did not wash hands at any time. Few food handlers (10%) missed handwashing during food preparation when a HWF was available at the cooking area, as compared to those who missed handwashing when the HWF was not available at the food preparation area (30%).

ECDC food handler's hands were swabbed before serving food at a separate time from observations, and they were seen to increase handwashing frequency albeit primarily with water only (Figure 1) after consenting to swabbing. Nevertheless, results showed that those who washed their hands with soap had reduced dirt on hands as compared to those who used water only or missed handwashing.

**Reported food hygiene measures**

Caregivers also highlighted some of the food hygiene measures that were considered to be good practice to ensure safety of food in the ECDCs, however not all reported practices were observed to be carried out during observations. Reported practices included; inspection of food preparation by the committee members (60%), food handlers covering their hair and armpits during food preparation (90%) and handwashing for both children when eating and food handlers during food preparation (80%). However, these practices were observed in 30%, 20% and 40% of the participating ECDCs, respectively.

![Figure 1. Food handler's hand hygiene before serving food. *Result interpretation; <60RLU = safe; 60-100RLU=caution area; >100RLU = contamination. Source: (Hygiena 2015).](image-url)
Food consumption

Food was prepared and served directly to children from the pot soon after it was ready. Porridge was served between a minimum of 56°C and maximum of 99°C with 40% being on or above the recommended 63°C. Visually, utensils used for serving children’s food were clean. ECDC caregivers (90%) commented that having adequate plates, cups and spoons was an important means of preventing cross-contamination among children when eating (i.e. sharing plates). One child caregiver commented:

We make sure that every child has his/her own plate and spoon to make sure that contamination of food is contained within one’s own plate - Caregiver

However, all children used the same cup(s) (1–2 cups per ECDC) for drinking; handling them with visibly dirty hands.

Contamination level of the observed utensils

Utensils were also sampled using ATP swabs before serving food. Results indicated high levels of contamination in shared cups in 88% of the ECDCs as compared to spoons and plates that were not shared among the children (Figure 2). Nevertheless, spoons and plates exceeded the recommended limit of 10 RLU in most of the ECDCs, which may be indicative of dust and debris being present as a result of open overnight storage. All utensils were observed to be washed soon after use and were taken straight from the storage area for the next use.

Since more than half of the ECDCs provided porridge only, spoons were observed to be used, while children used bare hands, as is tradition, in one ECDC to eat nsima. However, there was an observed lack of clean floor surface (e.g. mats) for children to use while eating. During observations, children sat on bare concrete floors (50%) (Figure 3(c)), bare ground (30%) and mats (20%) either indoors or outdoors depending on the weather.

Regardless of the absence of handwashing facilities for food preparation in 70% of the ECDCs, the majority (90%) did have water available for handwashing before eating in buckets and basins. However, access to handwashing was not provided during snack breaks. Out of the 849 children observed, 46% used water only to wash their hands before eating, while 22% used soap for handwashing; and 31% did not wash hands before taking their meals. Methods of handwashing used were; dipping in a communal container (11.11%), running water from bucket with tap (11.11%) and running water by pouring with a cup.

![Figure 2. Utensil hygiene in ECDCs. *Result interpretation: <10RLU = safe; 10-30RLU=caution area; >30RLU = contamination Source: (Hygiena 2015).](image-url)
Children were observed to just wet their hands during handwashing without taking the proper handwashing procedure of taking no less than 20 seconds while rubbing the palm, thumbs, dorsum and interlacing fingers. On some occasions after eating, children were observed drinking already used handwashing water from a communal basin. This was convenient to the children as water allocated for drinking was located away from the eating place (Figure 3(a)).

Before taking food (nsima or porridge), children’s hands were also swabbed at three time points. Unlike caregivers who registered reduced (safe) RLU after handwashing with soap, there were less children in the safe category even after the use of soap for handwashing that may imply the lack of proper handwashing procedure by children. However, results from ECDC 8 indicated an unusual pattern from the rest of the ECDCs as sampling that was conducted soon after handwashing showed an increased level of contamination in all sampled children, which may imply the interference of soap chemicals in the result readings (Figure 4).

Figure 3. (a) Child drinking water from a communal handwashing basin (b) Children and caregivers playing during break time (c) Children taking porridge.

Figure 4. Children’s hand hygiene using ATP swabs. * Result interpretation; <60RLU = safe; 60-100RLU = caution area; >100RLU = contamination Source: (Hygiena 2015).
**Water management**

Approximately 80% of the targeted ECDCs had access to safe water sources that included boreholes (50%) and piped water (50%) located within their premises, while the remaining 20% accessed water from communal boreholes. All ECDCs used containers without taps for storing water for drinking, cooking and any other chores for a period of 1–3 days. However, 80% of these storage containers were visibly dirty (presence of dust, stains, dirt and hair) and 30% were not covered with a tight-fitting lid.

**Microbial quality of water**

Water samples were obtained from both the source and drinking water storage containers and measured for the presence of coliforms and *E. coli* (MPN/100 mL). Results indicated an increase of coliforms and *E. coli* from source to storage containers, indicating post collection contamination and poor water management. Samples from communal water sources recorded the highest number of coliforms compared with samples from water sources owned by the ECDCs. Notably, ECDC 3 which utilised a primary school borehole, recorded the highest number of *E. coli* in both source and stored water (Table 2), which might be a result of the long distance from the source to the ECDC and improper use of the water source by primary school pupils. While ECDC 7 recorded high levels of coliform and *E. coli* in its stored water compared to the source indicating contamination at point of use.

**Access to toilet and handwashing after toilet use**

All ECDCs had access to toilets with the exception of one which shared toilets with a neighbouring primary school. There were at least two toilets available in 67% of the centres and 33.3% had separate toilets for adults and children but there was no separation of boys and girls toilets in all the targeted ECDCs. Almost half of the observed toilets in the ECDCs were traditional unimproved latrines. Furthermore, no latrine was fitted with a drop-hole cover to minimise smell and flies. When asked about available sanitation facilities in the ECDCs, most parents admitted that they were not aware of the type and number of facilities that were available. Urine and faeces were observed on all the latrine floors, mostly around the drop hole. In addition, faeces were present on the toilet walls.

<table>
<thead>
<tr>
<th>ECDC</th>
<th>Source</th>
<th>Ownership</th>
<th>Coliforms (MPN/100 mL)</th>
<th><em>E. coli</em> (MPN/100 mL)</th>
<th>Coliforms (MPN/100 mL)</th>
<th><em>E. coli</em> (MPN/100 mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECDC 1</td>
<td>Tap</td>
<td>Owned by ECDC</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td>ECDC 3</td>
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<td>&gt;2420</td>
<td>105.9</td>
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<td>1011</td>
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<td>0</td>
<td>1011</td>
<td>0</td>
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</tbody>
</table>

*Maximum count: 2,419 MPN/100 mL.

*63% of the observed water sources in ECDCs were less than the recommended proximity of 30 m from a latrine.
(67%), which could be attributed to lack of training on toilet use among the learners, and unavailability of proper anal cleansing materials. There was no evidence of open defaecation in the ECDC compounds. Committee members and caregivers during FGDs mentioned that sanitation facilities were at times vandalised by the community members thereby affecting the hygiene practices in the ECDCs.

Fifty-five percent of the ECDCs had handwashing facilities positioned near the latrines to enable children to wash their hands after latrine use, of which 44.4% were functional, and only one had both water and soap. One ECDC provided a bucket with a tap that was easily accessed by children; two ECDCs provided buckets with a cup for pouring but children were observed dipping their hands in the whole bucket. One ECDC provided a bucket without a tap which was placed on a stool at a height that made it difficult for the children to reach.

The study observed that 31% and 6% of the learners washed hands with water only and water with soap, respectively, after using the latrine. Further, it was observed that 63% of the learners missed handwashing completely. Children were not assisted by caregivers during handwashing after toilet use, as caregivers were teaching the rest of the children. Observations found that 50% of caregivers washed their hands with soap after toilet use. One child caregiver highlighted that most children miss handwashing due to lack of supervision;

*We sometimes fail to properly follow up children to check if they have washed their hands with soap after latrine use since we do not have adequate caregivers at the ECDC.* – Caregiver.

Sixty percent of the ECDCs had soap available for handwashing. However, the use of soap for handwashing was uncommon as 27% washed their hands with water only compared to 14% that used soap when it was available.

**Discussion**

ECDCs in Malawi are locations where vulnerable under-fives spend a large proportion of their time, and therefore need closer examination to understand their potential role in disease transmission (Gauld et al. 2020). To do this, we must first understand the current standard of infrastructure and hygiene practices before establishing if there are specific needs within these facilities. The findings of this formative study confirmed the availability of basic WASH infrastructure (i.e. safe water sources and toilets) in ECDCs. However, lack of infrastructure such as handwashing facilities, in combination with poor hygiene practices and poorly maintained environments potentially exposed children to pathogens. WASH in ECDCs should go beyond availability of basic water and sanitation structures, to ensure the support and nurturing of long-term and sustained hygiene practices.

The study suggests that the observed poor hygiene practices in ECDCs were associated with insufficient knowledge among the caregivers and food handlers, consistent with previous studies (Kondwani et al. 2019a). Despite receiving limited education, caregivers ably run ECDCs and given the practical food hygiene and WASH skills, they will be able to provide both a safe environment, and transfer these skills to the children in their care. Shallwani et al. (2018) argued that caregivers working on a voluntary basis felt humiliated by the community members as they were considered to have nothing better to do. On the contrary, caregivers in this study drew their motivation from being prioritized as beneficiaries of village funds/donations within their communities and an increased social status. Efforts to increase the public profile of ECDC caregivers could improve both their self-esteem and the educational outcomes in children (Tomlinson et al. 2017; Malolo et al. 2021 Mar 18). Nevertheless, there is need for continued community support in the absence of renumeration, to retain the current caregivers and motivate others to volunteer so as to curb the existing high child–caregiver ratio.

Similar to previous studies in both Ghana and Malawi (Akabanda et al. 2017; Chidziwisano et al. 2020), not all WASH practices reported by caregivers during interviews were observed to be carried out during observations. Moreover, some of the reported practices were not recommended WASH
behaviours, indicating a need for caregivers and food handlers to receive training in practical WASH skills with appropriate tools if they are to effectively sustain WASH behaviours and educate children on the same.

Findings from Parkinson et al. (2018) and Chidziwisano et al. (2020) have shown that implementation of WASH and food hygiene knowledge as well as the adoption of food safety behaviours, is highly dependent on the availability of enabling infrastructure and the proximity to these to point of use. Our findings correspond with these previous indications as handwashing with soap was more frequent among the caregivers who had a handwashing facility within the cooking area compared to those who had them at a distance. ECDCs need to adopt programs which will not only improve caregiver’s knowledge, but also consider the provision and accessibility of enabling WASH infrastructure within the ECDCs.

Availability of infrastructure such as kitchens provides a safe space to reduce the risk of contamination during food preparation (AECDM 2014). The lack of kitchens in some ECDCs was attributed to a lack of resources. Previous involvement of community leaders (i.e. traditional leaders) in ECDC committees in Malawi has shown to improve community commitment and involvement (PumpAid 2018). Since ECDCs are run by communities, future interventions should consider the effective involvement of influential community members and leaders to advocate for the potential benefits of WASH facilities, and in turn facilitate support from parents and community members in contribution towards construction.

Food, hands and object mouthing have been identified as primary sources of faecal-oral transmission of infection in children under 5 years old (Kwong et al. 2016; Wang et al. 2017; George et al. 2020). Food in this formative research was at risk of contamination from use of contaminated utensils. Even though we did not assess the presence of E. coli on utensils like other studies conducted Peru and Zimbabwe (George et al. 2020), the use of ATP in our study showed some level of contamination on a range of utensils with the highest contamination associated with shared cups. Utensils in ECDCs were not rinsed again before use after being washed and stored in open basins overnight, which exposed them to dust and vermin (Chidziwisano et al. 2019b). The shared cups on the other hand, had the highest levels of contamination since were not cleaned in-between use. This is a particular cause for concern, as such practices could increase the spread of diseases including typhoid fever which has been previously reported in peri-urban settings of Blantyre city, with an association with ECDCs (Curtis et al. 2010). As reported elsewhere (Chidziwisano et al. 2019b), it is important to clean the utensils immediately before use, mostly if the storage conditions are hygienically compromised and future research should consider assessing the presence of E. coli on utensils in ECDC settings.

The practice of children sitting directly on a dirt floor during eating and playing has also been observed in several other ECDCs in Malawi (AECDM 2014; Khonje 2017). Comparable studies in Indonesia, Zambia and Haiti (Agustina et al. 2013; Medgyesi et al. 2018a; Reid et al. 2018; Satter 2019) have linked this practice to increased non-dietary hand-to-mouth contacts in the exploratory stage of childhood (i.e. between 3–6 years). As reported by Ngure et al. (2014) and George et al. (2020), non-dietary hand-to-mouth contacts promote the ingestion of faecal pathogens, helminths and roundworms through contact with soil and other contaminated objects leading to environmental enteropathy and diarrhoea in children. However, due to the high caregiver: child ratio in ECDCs (1:77 children), proper supervision of children’s mouthing during both meal and playtimes remains a challenge. The provision of plastic mats which can be easily cleaned could be an effective way to reduce the risk of non-dietary mouthing in these learning environments (AECDM 2014).

The importance of hand hygiene in the prevention of communicable disease transmission cannot be overemphasized (Rabie and Curtis 2006; Prüss-Ustün et al. 2014). The reduced levels of contamination in food handler’s hands that used soap for handwashing highlights the critical role that soap plays in order to achieve effective handwashing. Besides the use of soap, the proper handwashing procedure (WHO 2020) needs to be followed for effective handwashing. We observed less RLU reductions in children regardless of the use of soap for handwashing which could be
attributed to lack of proper handwashing procedure; children waited in line to utilise a single handwashing facility, resulting in rapid and ineffective handwashing as they just wet their hands with running water or dipped them in a communal container. Our findings are similar to an experiment by Hygiena* where high RLU readings after handwashing in workers indicated a lack of proper handwashing procedure despite the use of soap (Hygiena 2015). Introduction of group handwashing facilities is one possible solution, since they have been proven to reduce overcrowding on the handwashing facility, improve soap use, minimize waiting time and missed opportunities to wash hands in Timor-Leste (Madrid et al. 2016; UNICEF 2018). Handwashing facilities could also be implemented with nudges or visual cues that have been proven to be effective in improving hand hygiene behaviour in the school environment (Dreibelbis et al. 2016; Blackwell et al. 2018; Naluonde et al. 2019). Further, the WHO highlights the need for inclusion of hygiene practices in children’s daily routine and ECD curriculum if children are to adopt desired hygiene habits (Kericho and Kabwos 2016).

Availability of improved water sources does not always translate to consumption of safe water in communities. Similar to previous reports from low-income countries (Bain et al. 2014; Heitzinger et al. 2015), our study found E. coli in the water collection points (i.e. boreholes) above the WHO and Malawi Bureau of Standards recommendation of total absence of E.coli and thermotolerant coliform bacteria per 100 ml drinking water sample (Swistock and Sharpe 2018; Jume; Na 2018 Mar). This indicates potential faecal contamination of water being used in the recruited ECDCs. Bain et al. (2014) linked contamination of water sources with their proximity to sanitary facilities. Over half of the water sources observed in our study were situated less than the recommended proximity to a latrine (>30 m), which could explain the contamination. There is need for ECDC establishments to carry out environmental impact assessments and sanitation surveys when instituting and maintaining a water source, particularly in a highly populated urban area, to determine risk of possible contamination. Further, water treatment methods at source such as chlorination should be considered as this would protect against the evident post-collection contamination.

This study confirmed a high coverage of latrines with no visible open defaecation within the premises. However, presence of faeces on toilet walls, and lack of anal cleansing materials indicate poor use of the facilities available in line with previous findings in Kenya (McMahon et al. 2011), and increase the risk of diarrhoeal disease associated with this exposure (Getachew et al. 2018). ECDCs should consider adopting environmental-level latrine cleaning interventions such as the one conducted in Kenya (Caruso et al. 2014) in order to maintain clean latrine environments.

Limitations and future research

This study had three main limitations: first was the Hawthorn effect, whereby volunteers and food handlers changed their actions on the first days of observation. Although our 3 days of participatory observation ensured that caregivers reverted to their normal practices, future research should consider using a more extended observation period to accommodate flexibility of participants. Second was bias, during initial observations some schools did not provide water for handwashing, however during the swabbing exercise, children were required to wash hands to see the difference before and after handwashing, which did not give a true reflection on the level of contamination in children’s hands on their normal days. Future research must also consider swabbing hands of children in their normal routines to give a true reflection on levels of contamination. Lastly, we recognise that different cleaning agents and sanitizers may possibly interfere with ATP readings during swabbing. Therefore, future research should consider the level of contamination in the subject area, and type of cleaning agents used as to whether ATP will be subject to interference. Although this study had a small sample size, we are confident the findings represent the current situation in peri-urban ECDCs in Blantyre. However, further studies would be required to evaluate ECDCs in rural settings.
Conclusion

Although most WASH interventions target adults, the effects of WASH are often measured through child health indicators. However, when examining pathways of disease transmission, it is crucial that we consider not only the caregiver’s responsibility at home, but also institutional settings such as ECDCs. Children under the age of five spend a considerable amount of their time in these settings, and as such they require to have the appropriate WASH and food hygiene infrastructure in place. As they are primarily community or third sector owned, it is important for parents and community members to support ECDCs in setting up innovative and fit for purpose facilities. However, the provision of infrastructure and knowledge alone cannot ensure that adequate and appropriate water, sanitation and hygiene (including food) practices take place. As such, caregivers and food handlers in ECDCs need to be trained appropriately using a behaviour-centred approaches, targeting practical and context appropriate WASH skills if they are to effectively implement WASH behaviours and train children.

Disclosure statement

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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