

# Health Risk Assessment of Children Exposed to Greywater in Jerash Refugee Camp in Jordan

Sahar Dalahmeh  
and Almoayed Assayed

**Jerash refugee camp is one of the ten official Palestinian refugee camps located in Jordan. It is inhabited by about 28,000 people who originally fled from Gaza, Palestine, in 1968, as a result of the 1967 Arab-Israeli war. Although more than 30 years have passed, the responsible authorities still consider the camp to be a temporary shelter, and investments in services and infrastructure in the camp, except for basic services, have not taken place.**

The camp covers an area of 750,000 m<sup>2</sup> and is situated five km from the famous ancient Roman monument of Jerash. In 1968, the camp was set up as an “emergency” camp for 11,500 Palestinian refugees, and UNRWA set up facilities for mass supplementary feeding, environmental sanitation services, health services and education in tented schools. The original 1,500 tents have been replaced by prefabricated shelters, and over the years many of the camp inhabitants have replaced these prefab structures with more durable concrete shelters.

Jerash camp now consists of 2001 permanent brick/stone building units supplied with piped water for domestic purposes. The main sanitary facility consists of “cesspools”, which are tanks built underground and used to collect toilet wastewater. Cesspool walls are usually sealed with concrete, bricks or stones and they have an un-sealed bottom that allows seepage of wastewater. Greywater from kitchens, showers and washing machines is drained in small pipes through the house walls to small ditches in the roads between the houses, where children walk and play. Part of this water is used for the production of crops.

Agriculture in the area is practiced by both local farmers and refugees. However, the local farmers own the agricultural fields around the camp, and they hire refugees as labourers, who obtain food and income in this way. About 70-100 refugees work in the farms downstream of the camp. In the cultivation season this number increases. The total number of farms is 13, and each covers about 1.6 hectare.

Wastewater has been used for irrigation in Jordan for several decades. Some treated effluent has been used directly on

restricted crops of relatively low value, but the main practice has been to discharge effluent to the environment where it mixes with freshwater flows before being used downstream. More than (70 M cubic metres) of reclaimed water was reported to be annually used in Jordan (McCornick, 2001), either directly (adjacent to wastewater treatment plants) or indirectly (after mixing with natural surface water supplies and freshwater supplies downstream). However, the health aspects and risks related to this reuse have not yet been investigated within a coherent framework.

This article presents the results of an assessment of health risks related to exposure of children in Jerash refugee camp to greywater that runs openly in small ditches in roads between the houses in the camp.

## Risk assessment

The IDRC/WHO/FAO project (also see UAM no. 20) on adapting and implementing the new WHO guidelines for the safe use of wastewater, excreta and greywater in agriculture seeks to investigate optimal modalities for the application of these guidelines in the context of poor urban communities. Under this project, the assessment of risks associated with children being exposed to pathogens in grey wastewater in

*The water is pumped out of the ditches on the fields*  
Photo: Sahar Dalahmeh



Jerash camp was carried out with information gained using qualitative participatory methods (observational checklists and structured interviews), that followed the risk assessment structure as mentioned in the WHO guidelines and include: 1. Hazard Identification; 2. Hazard Characterisation; 3. Exposure Assessment; and 4. Risk Characterisation. Questions in the structured interviews were divided into four main components: family information, exposure information, epidemiological information, and hygiene behaviours and risk perceptions.

The hypothesis used in this risk assessment was that children's exposure to greywater while playing near greywater ditches results in a high incidence of diarrhoea, that faecal contamination of greywater is the agent that causes diarrhoea, and that diarrhoea and hepatitis are caused by direct contact with the contaminated greywater during irrigation or cultivation, and not by the consumption of crops irrigated with greywater.

The impact of greywater exposure and hygiene behaviour on the health of children was studied, including factors like the source of the children's drinking water, whether the children were involved in or exposed to livestock (manure), what sanitation facilities they had access to (cesspools or other), and their personal hygiene behaviour (hand washing after playing and hand washing before eating).

### Farm level

Greywater generated in the households in the camp runs along collection ditches and flows downstream to agricultural sites, where it is stored in small pools for irrigation use. The water is pumped out of the ditches into concrete reservoirs or earthen pools. These pools have different types of reed vegetation (forming a natural wetland). The size of the pools is about 60-100 m<sup>3</sup>.

The crops grown in the fields are ornamental trees, productive trees (olive, citrus, figs, almond, and cactuses), and vegetables (zucchini, lady-fingers, beans, maize, and capsicum). Most of the crops cultivated near the camp are either vegetables that are cooked before eating, shelled fruits or ornamental crops. The fields are located on the sides of the greywater canal just downstream from the camp. Some 39 percent of the farms collect greywater in pools or reservoirs and 62 percent directly pump greywater for irrigation without storage; 15 percent of the farms use drip irrigation systems, 23 percent use buckets, and 62 percent use surface irrigation.

Faecal contamination is the main source of pathogens in the greywater and occurs through activities at the camp, such as the changing of baby diapers in hand-washing basins, through illegal dumping of wastewater from cesspools into greywater ditches, and through animals. In addition, greywater passes through uncontrolled dumps of organic and household waste. The main health impacts associated with the faecal contamination of greywater are bloody diarrhoea and hepatitis A.

### Exposure analysis

Greywater exposure is likely to occur near the collection pools during pumping activities from the ditch to pools (the tubes are manually moved), and frequent contact is probable during manual distribution between the different lines of irrigation. Also the harvesting procedure for olives creates situations in which there is a high likelihood of contact. Vulnerable groups exposed to risk in these farms include farm workers (69 percent), children who work or visit their families at the farms (23 percent) and shepherds who visit farms to graze their animals near the canal.

### Risk characterisation

Five cases of hepatitis in one family were recorded. This family pumps the greywater from the canal to a concrete reservoir near their house and uses the stored greywater for surface irrigation. The agricultural fields studied here are important in the livelihood of Jerash camp refugees. Most refugees do not have an identity card and are not allowed to work in governmental and public organisations. Agricultural labour is important in earning an income. Therefore, the risk of infection is high, and reduction of this risk is crucial for the inhabitants of the camp. This can be achieved by controlling and reducing the contact between humans and the greywater during irrigation and harvesting, which includes the use of mulch and drip irrigation (for farms that already use surface irrigation), and the use of protective clothes, boots and gloves.

The main health impact associated with the faecal contamination of greywater in the camp is diarrhoea. The incidence of diarrhoea during the period August 9–September 9, 2007 was 10 percent. A significant relation was found between hygiene behaviour and infection with diarrhoea. Children who wash their hands after playing in the canals have 44 percent less risk of developing diarrhoea than those who do not wash their hands after playing. Moreover, the risk ratio between diarrhoea and hand-washing before eating is 64 percent. Thus the risk of developing diarrhoea is decreased by 36 percent among those children who wash their hands before eating.

The risk associated with greywater exposure at household level in Jerash refugee camp can be managed by promoting health protection measures and implementing hygiene education and sanitation programmes.

### Sahar Dalahmeh and Almoayed Assayed

Royal Scientific Society - Jordan  
Email: Sahar.Dalahmeh@et.slu.se

*This project was carried out by the Environmental Research Centre of Royal Scientific Society in Jordan under the umbrella of a WHO/IDRC/FAO project on adapting and implementing the WHO Guidelines for the safe use of wastewater, excreta and greywater in agriculture and aquaculture, which was launched in January 2007.*