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Intestinal parasitic infections: Current prevalence and risk factors among schoolchildren in capital area of the Republic of Marshall Islands

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ABSTRACT

Intestinal parasitic infections (IPIs) among schoolchildren in Republic of Marshall Islands (RMI) largely remains unknown, thus investigation on IPIs status to establish the baseline data is urgently needed. This cross-sectional study intended to investigate the current IPIs status and associated risk factors among schoolchildren at capital of RMI. Single stool sample from 400 schoolchildren (207 boys and 193 girls) aged 9.73 ± 2.50 yrs old was examined by employing merthiolate-iodine-formaldehyde concentration method. Demographic characteristics, uncomfortable symptoms and risk factors were obtained by questionnaires investigation. The overall prevalence of IPIs in schoolchildren was 22.8% (91/400), of them 24.2% harbored at least 2 different parasites. Notably, the majority was infected by waterborne protozoan parasites (82.4%, 75/91). Nine different intestinal parasites have been identified, of which six were pathogenic including Hook worm, *Trichuris trichiura*, *Enterobius vermicularis*, *Entamoeba histolytica/dispar*, *Giardia intestinalis* and *Blastocystis hominis*. Schoolchildren who ever complained dizziness or headache showed a significant higher prevalence of pathogenic IPIs than those who did not ($p < 0.05$). Schoolchildren who lived in urban area than rural area had higher chance to acquire pathogenic IPIs ($p = 0.03$). However, none of risk factors were identified to be associated with pathogenic IPIs.

1. Introduction

Helminths and protozoa constitutes the major pathogens of intestinal parasitic infections (IPIs) and pose profound impact to human health worldwide. It was estimated about one-third of the world's populations was influenced by IPIs and the most vulnerable population being children (Hotez et al., 2009). Soil-transmitted helminths (STHs) are the most prevalent helminth parasites in the world. *A. lumbricoides* is the largest and most common helminth that infects about 819 million people globally, followed by *T. trichiura,* which infects about 464.6 million, and hookworm is estimated to infect about 438.9 million people (Ojha et al., 2014). Two most prevalent protozoan parasites i.e., *Giardia intestinalis* and *Entamoeba histolytica* reportedly infect about 200 million and 500 million people, respectively (Barry et al., 2013). Moreover, *Blastocystis hominis* may be considered as another common intestinal protozoa, although its pathogenicity is still under debate (Kurt et al., 2016).

Schoolchildren are the most vulnerable population at greatest risk of IPIs-related morbidity, causing poor growth, vitamin deficiencies, iron-deficiency anemia, and poor educational performance, nonetheless fatal consequences are rarely seen in IPIs (Muller et al., 2016; Pullan et al., 2014). Some studies indicated that polyparasitism seems likely to be associated with higher mortality rates thus possibly enhance susceptibility to other infections e.g., tuberculosis and in addition, substantial studies have indicated that schoolchildren acquired polyparasites may have worse cognitive outcomes than those infected by single parasite

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alone (Supali et al., 2010).

IPIs are some of the most common human infectious diseases endemic in tropical and subtropical countries with poverty (Hotez et al., 2009). Majuro city is the commercial capital of Republic of Marshall Islands (RMI) characterized by substandard housing conditions, poor sanitation and lack of safe drinking water. Because it is largely unknown about the status of IPIs in schoolchildren in RMI, present study aims to investigate on the IPIs status among Marshallese schoolchildren from public schools at Majuro city to help establish the baseline data and further delineate the prevention strategy.

2. Methods

2.1. Geography of the Republic of the Marshall Islands and Majuro City

The RMI is an island nation situated in the central Pacific Ocean between 4° and 14° North latitude and 160° and 173° East longitude. The RMI is divided into 24 municipalities and Majuro, Ebeye, Wotje, and Jaluit are its major district centers. The Majuro atoll, a large coral atoll of 64 islands, is a legislative district of the Ratak Chain of RMI. The Majuro atoll has a land area of 3.7 mi^2 and encloses a lagoon of 114 mi^2. The RMI has a total population of 52,560. The primary population center, named Majuro, is the capital and largest city in the RMI. Its characteristic climate is tropical and the economy primarily relies on agriculture, fishery, and support from the United States. The major ethnic group is Micronesian (Ichiho et al., 2013). This study was conducted on six public primary schools according to the suggestions from Ministry of Health, RMI (Fig. 1).

2.2. Study population and subject selection

The study population constituted of children attending the six public primary schools, namely, Delap, Laura, Rairok, Rita, Uliga and Woja at Majuro City. Although the total number of schoolchildren enrolled in the six schools was nearly 1000 consent forms were issued, of which 908 were signed and subsequently 400 children (207 boys and 193 girls) voluntarily participated in the study. Since no pilot study was done, the sample size was determined using the general formula, $n = z^2p\ (1 - p)/d^2$ where, n is the sample size, z (1.96) is the standard deviation at a 95% confidence interval (CI), p is the estimated prevalence (50%), and d is the allowed relative error (0.05) (Rutterford et al., 2015). The minimum sample size after calculation was 383 children.

2.3. Diagnostics and assessment of risk factors associated with IPIs

The IPIs status of schoolchildren was determined by examination of stool samples. Participant children were simultaneously interviewed with a structured questionnaire through help of public health nurses to gather demographic, uncomfortable symptoms and personal hygiene practices information. Height and weight of the selected children were also recorded using standard calibrated instruments. Additionally, screw capped containers with wide mouths were given to each participant, with instructions on how much stool should be put inside, and it was emphasized that only fresh, early-morning stool was acceptable. After collection of the stool samples within 2–3 h, they were transported to the Department of Laboratory Medicine, Majuro Hospital for examination. Each sample was processed using the merthiolate-iodine-formaldehyde concentration method (MIFC) method then examined under a microscope. Any sample with eggs, cysts, trophozoites, or oocysts detected by MIFC method was considered positive (Fan et al., 2012).

2.4. Parasitological examination

To examine for parasites in the fecal materials, a thumb-sized stool was taken from each fecal sample and then put into a specially designed stool container (cat. no. ParaQ1, High Skill Inn., Chubei, Taiwan). Thereafter, 5 ml of a MIF solution containing 4.7 ml of a merthiolate-formaldehyde solution and 0.3 ml of an iodine solution (cat. no. ParaQ3, High Skill Inn.) were added to each stool container with a stool sample for at least 4 h. The MIF-stool sample was then filtered through a layer of gauze in the bottom of the container, and the filtered solution in a collection tube (cat. no. ParaQ2, High Skill Inn.) was aspirated to examine helminthic ova, larva and protozoan cysts/trophozoites under a microscope (Olympus BX41, Tokyo, Japan) (Fan et al., 2012).

2.5. Statistical analysis

Differences in the prevalence of infection based on independent

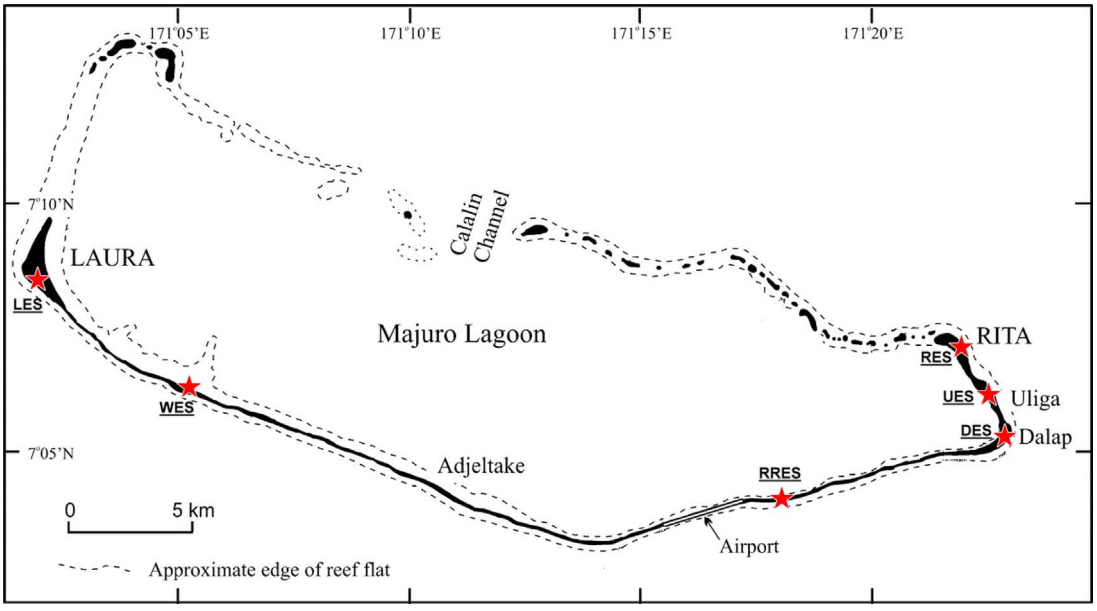

Fig. 1. Map indicated the location of participant schools at Majuro City, Republic of the Marshall Islands. The abbreviation of RES, UES, DES, RRES, WES and LES indicates Rita, Uliga, Dalap, Rairok, Woja and Laura elementary school, respectively.