




Research Paper

Water access and sanitation facilities in the Johor River Basin, Malaysia: A comparison between indigenous and more modernised communities

Michaela L. Goodson ^{a,*}, Yee Chu Kwa^a, Norlilawati Suboh ^a, Cindy Lee Ik Sing^a, Dominic Kay Shuen Wei^a and Claire L. Walsh ^b

^a Newcastle University Medicine Malaysia (NUMed), No. 1 Jalan Sarjana 1, Kota Ilmu, EduCity@Iskandar, Iskandar Puteri, Johor, Malaysia

^b Newcastle University, Newcastle upon Tyne NE1 7RU, UK

*Corresponding author. E-mail: michaela.goodson@newcastle.edu.my

 MLG, 0000-0003-2481-7704; NS, 0000-0002-4402-3955; CLW, 0000-0002-4047-1216

ABSTRACT

Water access, sanitation and hygiene (WASH) data for Malaysia suggest that almost 100% of the population have access to basic sanitation and basic drinking water, but this data may not include marginalised communities and stateless individuals, indigenous or otherwise. The aim of this study was to evaluate WASH provision for residents of the Johor River Basin and evaluate the disparity in facilities between indigenous Orang Asli and more modernised communities. Questionnaires were distributed to eight communities. In total, 899 questionnaires were completed including 100 from indigenous communities and 799 from more modernised communities. Significant differences existed between communities with regard to education levels ($p < 0.001$), occupation ($p < 0.001$), household income ($p < 0.001$), type of toilet, sewage and sanitation facilities ($p < 0.001$) and perception of health risks and concerns ($p < 0.001$). There is a significant difference in access to water and sanitation facilities between indigenous and modernised communities. Further study is now required to understand behaviours and educate river-based communities on relevant potential health risks from water contamination in the Johor River Basin.

Key words: hygiene, quality, sanitation, water

HIGHLIGHTS

- There is considerable disparity between indigenous and more modernised communities with respect to access to water, sanitation and hygiene facilities in the Johor River Basin, Malaysia.
- Perceptions of health issues and WASH between indigenous and more modernised communities also exist.

INTRODUCTION

In 2016, the United Nations (UN) reported that safe access to drinking water, sanitation and hygiene (WASH) was fundamental to improving standards of living across the world, but it was felt that there were large disparities in WASH globally, particularly in marginalised groups (Hutton & Chase 2016).

Improving access to clean water, sanitation and hygiene facilities is central to achieving Sustainable Development Goals 6 (Clean water and sanitation), 3 (Good health and well-being), and 10 (Reduced inequalities and 11 (Sustainable cities and communities) and also indirectly related to other goals such as 1 (No poverty), 2 (Zero hunger), 5 (Gender equality) and 12 (Sustainable consumption and production) (UN DESA 2022).

With competing demands on water from population growth in some of the most vulnerable countries along with increased industrial and agricultural demands, there is a need for greater investment of time, activities and finance to reduce water pollution and ensure equitable access to water, hygiene and sanitation facilities (Clasen & Smith 2019; Humphrey 2019; McMichael 2019).

Data for Malaysia from WHO/UNICEF (2020) showed that around 99% of Malaysians live in modernised housing and communities with direct household access to water, sanitation, electricity and utilities such as electricity and a gas supply. The remaining 1% of the population does not have access to such facilities; this group would include the indigenous Orang Asli. Orang Asli are the oldest indigenous inhabitants of Peninsula Malaysia. There are around 95 subgroups with their own distinct

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language or dialects and culture. In Johor, they mainly comprise Jakun people, Orang Kuala, Orang Kanaq and Orang Seletar. Historically, most earned a living in agriculture fishing or through trade, but most live in rural areas (Masron *et al.* 2013).

A recent UN study looking at the Orang Asli population (0.7% population of peninsular Malaysia and 60% of East Malaysia) found that their health situation was significantly poorer than the rest of the Malaysian population with a higher prevalence of parasitic infections often related to water supply. A recent systematic (Mahmud *et al.* 2022a, 2022b) found that Orang Asli communities were often excluded in governmental national surveys and recorded WASH data may not be representative. The systematic review found that Orang Asli suffered from a greater number of tropical diseases and non-communicable diseases and had poorer nutritional status than the general population often related to socio-economic factors. Common illnesses related to untreated water included stunted growth, acute diarrhoea illness and chronic enteric infection (Partap *et al.* 2019; Muslim *et al.* 2021; Wong *et al.* 2021).

Most studies looking at disparities of health in indigenous communities in Malaysia have been taken in Selangor, Perak and Pahang. To our knowledge, no studies have been undertaken on WASH facilities for Orang Asli living around the Johor River Basin in Johor State.

The aim of this study was, therefore, to evaluate WASH provision for residents of the Johor River Basin and evaluate the disparity in facilities between indigenous Orang Asli and more modernised communities.

METHODS

Following ethical approval and informed consent from Newcastle University, residential communities around the Johor River Basin (Figure 1) were contacted through village heads and housing associations to seek participation in the study. In each community ($n = 8$), a data collector was appointed from the village by the village head to collect the questionnaires digitally from the community between October 2021 and June 2022. Questionnaires were completed and collected using the ArcGIS Survey123™ platform with data anonymously uploaded to a secure cloud-based database. A copy of the questionnaire adapted from the United Nations Children's Fund and World Health Organization (2020) questionnaire is shown in the Supplementary Information Appendix A.

Data were analysed with descriptive statistics using SPSS 2 (IBM®) Software. Comparisons between Orang Asli and more modernised communities were undertaken using Chi-Square analysis. Tests for the normal distribution of data were undertaken with a Kolmogorov–Smirnov test.

RESULTS

Demographics of the populations

Eight hundred and ninety-nine respondents completed questionnaires in this study comprising 799 from more modernised communities and 100 from indigenous communities (Supplementary Information, Table S1). Data were not normally

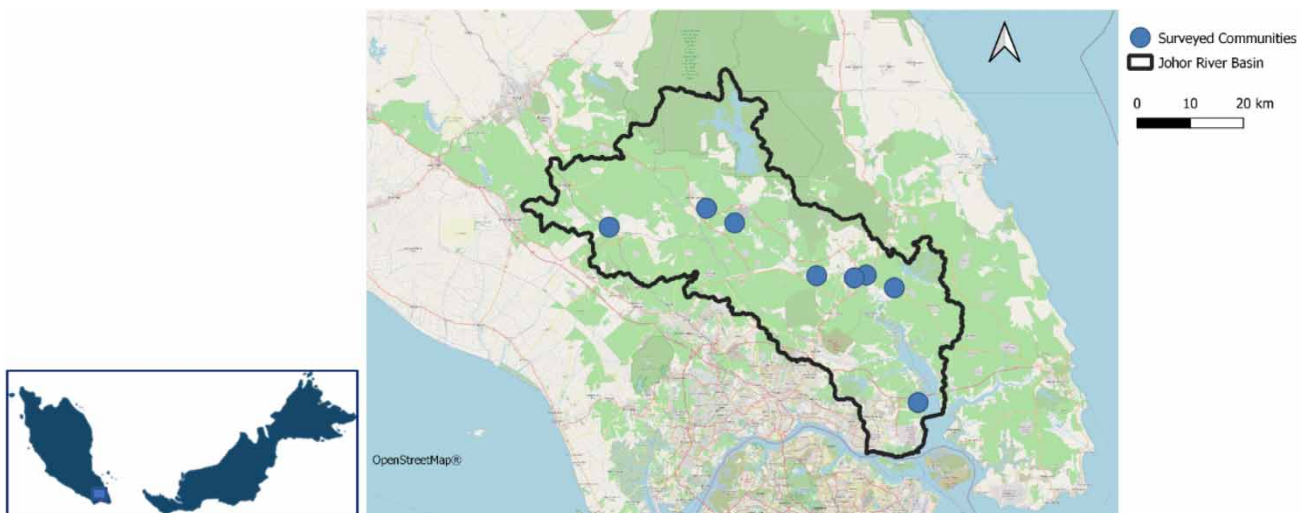


Figure 1 | Map showing the location of surveyed communities within the Johor River Basin. Inlet map indicates location within Malaysia.

distributed in this study ($p < 0.05$). In the indigenous community, 63% of respondents were male, but there was a more even gender balance in the modernised communities (50.4% female). In the indigenous community, 91% were under 55 years of age compared to 80.7% in the modernised community ($p < 0.05$). Most commonly, 4–6 people lived in around 60% of households in both communities. Unemployment affected 38% of respondents in the indigenous community and 36.2% of the modernised communities. With regard to the personal income of respondents, more than half (58%) of the indigenous community had no fixed monthly income when compared to 32.9% ($n = 263$) for more modernised communities. The differences in mean personal income between the communities were statistically significant with the modernised communities earning significantly higher amounts ($p < 0.001$). For household income which included household contributions from people other than the respondent, there was again a significant difference in earnings between the two communities with 58% of indigenous households having no fixed monthly income, but only 11.6% of modernised communities having no fixed income ($p < 0.001$). The most commonly reported household income for the indigenous group (76%) was less than RM 1,000 (around 200 USD) when compared to the modernised community where 43.2% of people reported earning between RM 2,000 and 20,000 (USD 400–4,000).

Regarding the level of education, there were significant differences in education level between the indigenous group and modernised populations ($p < 0.001$). About 98% of indigenous respondents were educated up to the end of secondary school, with 2% having achieved diplomas, whereas 74.2% were educated up to secondary school in the more modernised community and 25.7% ($n = 206$) acquired diplomas and/or a university degree.

Water use and sanitation facilities

A significant difference existed in access to toilets between the indigenous group and the modernised communities ($p < 0.001$), as summarised in Table S2 (Supplementary Information). Almost all (99%) of the indigenous community used buckets and only one respondent had a mechanical toilet. In the modernised community, 38.9% ($n = 311$) used a mechanical toilet with a flush that drained to a piped sewer system, 26.2% ($n = 209$) used a bucket, and 24.4% ($n = 195$) used toilets with mechanical sewage leading to a septic tank.

When asked about using shared toilet facilities, all indigenous respondents shared their toilet facilities with people outside of their household, whereas only 24.9% ($n = 199$) of the modernised respondents shared their toilet facilities with outsiders on a daily basis ($p < 0.001$). Unsurprisingly, there was also a significant difference in the number of toilets in each household between the indigenous and the modernised communities ($p < 0.001$); 98% of the indigenous people had only one toilet in the household ($n = 98$) and 2% ($n = 2$) of them had two toilets, compared to the modernised group where 87.8% had more than two toilets in the household ($n = 789$). When asked about toilet and sewage systems in the household, 52% of the indigenous people did not know where flush toilets are connected to, compared to 40.9% ($n = 327$) of respondents from modernised communities ($p < 0.001$). When asked about the condition of the toilet in the household, almost all (92%) of the indigenous population did not know the condition of the toilet basement (tank or plumbing) in their households, the other 8% said that their facilities are in very good condition. For the modernised population, most (57%, $n = 455$) think that their toilets were in very good condition, followed by 35.2% ($n = 281$) who do not know the condition of their toilets, 6% ($n = 48$) have damaged plumbing that needs repair, and the remaining 1.9% ($n = 15$) have damaged and leaking toilet facilities.

Regarding the main source of drinking water for household members, while all houses had a tap with water, this water was not necessarily considered safe to drink. Table S2 (Supplementary Information) compares the water usage between the indigenous and modernised community. About 62% of the indigenous respondents depended on their spouse (no gender differences, $p > 0.05$) to bring drinking water in the household either as bottled or boiled drinking water from the tap, but this responsibility was taken on by all family members for 19.0% of the indigenous households. For the modernised group, 56.7% ($n = 453$) relied on their spouse (no gender differences, $p > 0.05$) to bring drinking water to the household, 20.4% relied on parents ($n = 163$) and 5.3% relied on children ($n = 42$).

For cooking and washing, there was a significant difference in the main source of water for household usage between indigenous and the modernised groups ($p < 0.001$). About 96% of the indigenous population had tap water as the main source of water which may have come directly from the river, a local pond or public water supply. For the modernised community, 86.2% ($n = 689$) used tap water from the municipal water supply as the main household water source.

There was a significant difference in the recent household water supply shortage between indigenous and modernised groups ($p < 0.001$). About 15% of the indigenous community said there had been household water supply shortages in the past month. For the modernised population, 22.8% ($n = 182$) had experienced a household water supply shortage.

There was a significant difference in hand-washing between the indigenous and the modernised communities ($p < 0.001$). In the indigenous community, 97% used a kitchen sink. For the modernised population, 98% ($n = 783$) used either kitchen sinks, bathroom sinks, or both to wash their hands.

Regarding the use of soap for hand-washing, there was a significant difference in the routine use of soap and detergent between the indigenous people and the modernised people ($p < 0.001$). About 18% of the indigenous people did not use soap/detergent when washing their hands, compared to 5.8% of the modernised community respondents.

For showering or bathing, 92% ($n = 92$) of the indigenous people showered two times per day, but for the modernised population, 62.1% ($n = 496$) showered two times per day and up to 36.8% showered three times or more each day, as a matter of routine ($P < 0.001$).

There was a significant difference in showering time between the indigenous and the modernised communities ($p < 0.001$). About 78% of the indigenous people said that they would take a quick shower (< 10 min), and the remaining 13% showered within 10–20 min. However, for the modernised group, 50.1% ($n = 400$) showered within 10–20 min, 45.9% ($n = 367$) showered for less than 10 min, and up to 4% of them showered more than 20 min at a time.

There was a significant difference in the frequency of weekly household laundry undertaken between the indigenous group and the modernised communities ($p = 0.016$). About 70% of the indigenous people did laundry 1–4 times per week, and 30.0% did laundry 5–8 times per week. For the modernised group, 59.2% ($n = 473$) of laundry was undertaken 1–4 times per week, followed by 28.7% ($n = 229$) doing laundry 5–8 times per week. The remaining 12.1% ($n = 97$) said that they did laundry 9–12 times per week. When asked about car washing, 62% of the indigenous community found this question not applicable because they did not own a car. About 18% of the indigenous people answered ‘once a week’, 1% answered ‘once every 2–3 weeks’ and the other 19% answered ‘once a month’. For the modernised community car owners, 14.1% ($n = 113$) washed their cars once a week, 23.0% ($n = 184$) washed their car once every 2–3 weeks, and 30.7% ($n = 245$) washed their car once a month. When asked how water was stored in this study, 89% ($n = 89$) of indigenous respondents boiled their water from the tap which may have come from the municipal supply or the river. About 9% of the indigenous community did not treat their water at all from the tap or river and the remaining 2% ($n = 2$) used an electronic water filter. In the modernised communities, 45.7% boiled tap water ($n = 366$) and 34.3% ($n = 274$) used an electronic filter. The difference in water storage methods was significantly different between the two communities ($p < 0.001$). Given the greater water usage by the more modernised community, it is perhaps not surprising that there was a significant difference in monthly water bills between the indigenous group and the modernised group ($p < 0.001$). In the indigenous community, 91% of respondents paid less than RM 100 (USD 20) per month compared to the modernised community where only 81% paid less than RM 100 per month.

A comparison of WASH practices related to income status irrespective of community type is presented in Table S3 (Supplementary Information).

This study showed that a greater proportion of households with lower household incomes lived within walking distance of the Johor River Basin (53.6%) than those requiring transport to get into the river basin (46.4%), whereas a greater proportion (65.8%) of higher-income households lived at a distance from the Johor River Basin requiring transport. This difference was significant at the $p < 0.001$ level.

There was not much of a difference between lower- and higher-income households with respect to the main source of household drinking water. In both groups, the majority of respondents had tap water in the house (86.7% in the $< \text{RM}2\text{K}$ group versus 86.8% in the higher-income group). There was a similar small difference in the main source of water for household water. In both the lower (89.3%) and higher-income groups (90.3%), tap water was used for household water requirements.

Interestingly, in the lower-income households, female spouses were more often, responsible for ensuring that there was clean drinking water in the house (61.7% in the lower-income group and 56.1% in the higher-income group). In the higher-income group, a greater proportion of parents were enlisted to ensure clean drinking water for the household (21.9%) compared to the lower-income group (14.8% households). In all cases, these differences, however, were non-significant ($p > 0.05$).

There was no significant difference in the experience of water shortage between lower- and higher-income households in this study ($p > 0.05$). With regard to water storage, both household income groups stored water most commonly in open buckets and plastic bottles to store water and the refrigerator. A greater proportion of lower-income households, however, used glass containers to store water.

This study showed that higher-income households had higher water bills than the lower-income households with 47.3% paying less than RM 50 per month versus higher-income households with 51.8% paying RM 51–100 monthly ($p < 0.001$).

Health risks and perception of risk

When asked about health concerns of contaminants in drinking water, a significant difference ($p < 0.001$) existed between indigenous and modernised communities with regard to the nature of the concerns (Supplementary Information, Table S4). Indigenous respondents were most concerned about metals (62%; $n = 62$) polluting water, whereas modernised communities were more concerned about chemicals such as arsenic and petrochemicals (42.9%; $n = 343$). Only 1% ($n = 1$) of indigenous respondents were concerned about bacteria or sewage contamination, whereas 9% ($n = 72$) of the modernised community were concerned about bacteria. Concern for bacteria, however, was significantly higher ($p < 0.001$) within the modernised community group for respondents with higher educational levels. Chemical concern was conversely higher in those with lower levels of education, i.e. primary or secondary school level ($p < 0.001$). These patterns were also reflected in the household income level compared with those of no fixed income and less than RM 1,000/month (USD 200) concerned primarily about chemicals and the higher earners (RM 2,001–5,000/month) concerned about bacteria. Interestingly, the predominant health concern in both communities was diarrhoea (69% in the indigenous population and 82.9% in the modernised community), and both communities felt those under five years old were most vulnerable. In both communities, the lack of access to water and the contamination of water were said to affect mood, but a greater number (91.1%) of the modernised community respondents felt that water contamination was a health concern compared to only 78% of indigenous respondents ($p < 0.001$).

When asked where they mostly received information from regarding water pollution, the indigenous community mostly relied on television programmes (54.0%; $n = 54$), whereas the modernised communities mostly received information from the internet (42.3%; $n = 338$) and then from television (38.8%; $n = 310$), with the remainder getting information from newspapers, the community, advertisements and friends ($n = 151$). This difference between the two community types was significant ($p = 0.003$).

Additional questions and responses are tabulated as Supplementary Information (Table S5 and Appendix).

DISCUSSION

The communities involved in this study provided a proportionally representative sample of people living in the Johor River Basin. While the study did not capture every village and riverside community, access provided by village heads and the Johor Orang Asli Association allowed the study to be undertaken with a relatively large sample size. There is a disparity in sample sizes between the modernised and Orang Asli communities, but this is reflective of the relative population ratios of people living in the area of the river basin sampled. More men were proportionally higher respondents in the Orang Asli communities than women, this is compared to a more equal divide in the modernised communities. It likely this is because the village head of the Orang Asli communities were male as were the data collectors and sampling was probably more convenient than random in those communities based on where data collectors decided to undertake their questionnaires. Women were often at home while men were sitting out in social areas. In the modernised communities, due to the larger population, it was easier for data collectors to sample equal numbers of men and women. The electronic questionnaire used in this study was beneficial in the sense that it could be used by data collectors in the community to obtain information and data could be uploaded to secure cloud-based storage, minimising contact between the researchers and vulnerable communities during and immediately after the COVID-19 pandemic. Data collectors found the electronic questionnaire easy and convenient to use.

This study has shown significant differences between Orang Asli and modernised communities in almost all variables measured in this study. In the second Malaysian Plan in the 1970s, the Malaysian government attempted to reduce the disadvantage to Orang Asli communities by making plans to increase educational standards and job opportunities. They also made plans for upgrading basic facilities such as utilities, clean water access and sanitation facilities. Attempts were made to improve medical facilities and health too, but the plan involved resettlement programmes and only 0.7% of Orang Asli

were willing to move and live in the urban or semi-urban community (Mohd Shah *et al.* 2018). As a consequence, many Orang Asli are still living without basic facilities that are reflected here in the Johor River Basin.

Water usage was considerably lower in the indigenous communities with the less frequent use of mechanical or flush toilets, showering and car washing. While this questionnaire has not examined every possible use of water in a household, it gives an indication of the differences in community water usage for common activities. In general, the indigenous communities tended to be more conservative about using household water for everyday tasks, which may reflect lower personal and household incomes to pay water bills. Indigenous communities hand-wash laundry using river water or tap water, but electric washing machines were commonplace in more modernised communities. While the Ministry of Rural and Regional Development has implemented a rural electricity supply programme to serve remote rural areas of Peninsula Malaysia and Borneo, there is no universal provision and communities who do not want to live in resettlement areas still do not have a reliable electricity supply (Rahim *et al.* 2012).

Regarding drinking water, it is interesting to note that more of the indigenous community did not treat their water prior to drinking. Several studies have reported increased higher rates of parasitic infection and diarrhoea infection in Orang Asli populations (e.g. Anuar *et al.* 2012; Mahmud & Isa 2022; Minhat & Zakaria 2022). While the current study showed awareness of unclean water causing diarrhoeal-related illnesses, this has not necessarily translated to a behaviour change in terms of maintaining high levels of sanitation. In this study, the Orang Asli community was more worried about chemical contamination in their water supplies. Chemical pollution is episodic and frequently reported in local newspapers or in television, so awareness of chemical pollution is likely to be more common in this group who rely on television more than internet sources for news and information. In addition, it affects more highly populated modernised communities too, so journalists are more willing to report on such issues. Bacterial contamination is a long-standing problem affecting a minority of the population (Afroz & Rahman 2017; See *et al.* 2017), so may not be considered to be newsworthy.

A striking difference between the two communities was toilet facilities. All but one indigenous respondent was using a single bucket for the whole family and all were sharing their bucket toilet facilities regularly with their communities. This was in contrast to the modernised communities who shared toilet facilities much less frequently and most households had more than one toilet. Due to the smaller size of the indigenous community dwellings and the ability to use toilets in neighbouring properties, it is perhaps not surprising that indigenous communities felt that they did not need more than one toilet, despite having a similar number of people in the household as the modernised communities.

In this study, toilets were felt to be in a better condition in the more modernised communities than the indigenous homes, and while not specifically asked about in this study, it is possible that more of the modernised community homes were owner-occupied, and thus responsibility for maintenance and function was with the owner. While many of the indigenous respondents were homeowners who had purchased basic homes on a government scheme, these homes only included very basic toilets as standard sanitation facilities without adequate connection to any sewage treatment plant. Such responsibility falls to the homeowners. The current practice is either a self-prepared underground wood storage box to contain the sewage, or sewage is directly released into open water. Without proper drainage and sewage management, it is unlikely that the indigenous communities will install such toilets now or in the future (Kong *et al.* 2020).

When WASH data were compared between high- and low-income households irrespective of community, it was found that more households with a higher monthly income were located away from the river. This may be a reflection of the types of employment in these communities. Those in modernised communities were commonly employed in service industries and factories, whereas those living near the river were mainly dependent on retail and fishing for household incomes which are consistent with findings from Masron *et al.* (2013). Interestingly, female spouses were responsible for ensuring clean drinking water supplies in the lower-income communities, a behaviour consistent with findings from other low-income communities in low- and middle-income countries (Graham *et al.* 2016; Caruso *et al.* 2022). In this study, water storage did not differ greatly between higher- and lower-income households, but the use of the refrigerator was more common in the higher-income households and water was probably less likely to be contaminated since the refrigerator is a sealed compartment. Lower-income households did not use the refrigerator due to lack of electricity. While most of Malaysia has electricity readily available, pockets of rural areas have unpredictable access (Mahmud *et al.* 2022a, 2022b).

Unsurprisingly, the lower-income households had lower water bills than the higher-income areas, but this may be not only a reflection of budgeting, but that they use the river water to carry out laundry and washing practices rather than a washing machine or a shower facility. Bathrooms with hand-washing facilities were more common in higher-income households,

but in both higher- and lower-income households there was adequate access to soap and detergent most of the time. Less time was spent showering in this study in lower-income households, but individuals in these households were showering more frequently, so water usage may have been similar for showering. While laundry practices did not vary greatly between lower- and higher-income households, there were higher levels of car ownership and consequently car washing which will have affected water use in higher-income households. Water availability to indigenous communities in Malaysia has been the subject of a long debate. Wook (2021) discussed the case of Orang Asli plaintiffs from a fishing village in Southern Johor, wanting exclusive land and water rights in their settlements where they had lived for more than 50 years. Land reclamation and development had removed resources that communities had previously depended on meaning that livelihoods were being threatened along with water provision. Unfortunately, the High Court ruled that Orang Asli had non-exclusive rights to this land and water through common law. As such, there would not necessarily be any legal protection from these resources being further removed in the future.

From this study, it is clear that there are differences in the perception of risk between the two community types. As such, public health education programmes would need to be tailored to the community in question. Future public health education programmes for the indigenous communities should also be directed towards educating communities about the importance of improving sanitation and hygiene. Both communities had some awareness of bacterial contamination of their water supplies but did not fully understand the consequences. Simple hand-washing hygiene and water preparation information targeting various age groups in the communities are the next step in trying to improve WASH facilities and practices in the Johor River Basin for indigenous communities. In modernised communities there is also work to be done explaining the risks to health with water contamination. While WASH facilities are generally good in this community, knowledge of health risks is variable so public health education in these areas will be better directed to the health consequences of water contamination. Changing behaviours on water treatment and usage is difficult when many of these behaviours have been lifelong and may be cultural or learned from previous generations. Further study into why water is used and treated or not treated will allow investigators to work with communities to modernise some behaviours to improve sanitation and hygiene in vulnerable communities.

CONCLUSIONS

This study confirms the statement by WHO/UNICEF (2020) that in Malaysia, those living in marginalised communities and stateless individuals, indigenous or otherwise may not have access to basic drinking water and sanitation. Significant differences exist between indigenous and modernised communities in their water access and sanitation facilities. Further study is required not only to understand behaviours but also to educate populations on relevant potential health risks from water contamination in the Johor River Basin.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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