# Diarrhoeal diseases in Soweto, South Africa, 2020: a community survey

**Siobhan Johnstone** ( siobhanjsa@gmail.com )
National Institute for Communicable Diseases, South Africa

**Nicola Page**
National Institute for Communicable Diseases, South Africa

**Shabir Madhi**
South African Medical Research Council: Vaccines and Infectious Diseases Analytics Research Unit, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

**Portia Mutevedzi**
South African Medical Research Council: Vaccines and Infectious Diseases Analytics Research Unit, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

**Nellie Myburgh**
South African Medical Research Council: Vaccines and Infectious Diseases Analytics Research Unit, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

**Carlos Herrera**
South African Medical Research Council: Vaccines and Infectious Diseases Analytics Research Unit, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

**Michelle Groome**
South African Medical Research Council: Vaccines and Infectious Diseases Analytics Research Unit, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

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# Abstract

**Background** In South Africa, there are limited data on the burden of diarrhoea at a community level, specifically in older children and adults. This community survey estimated rates of and risk factors for diarrhoea across all ages and determined the proportion of cases presenting to healthcare facilities.

**Methods** Randomly sampled households were enrolled from an existing urban health and demographic surveillance site. A household representative was interviewed to determine risk factors and occurrence of diarrhoea in the household, for all household members, in the past two weeks (including symptoms and health seeking behaviour). Diarrhoeal rate of any severity was calculated for <5 years, 5-15 years and >15 years age groups. Risk factors for diarrhoea and factors associated with health seeking behaviour were investigated using binomial logistic regression.

**Results** Diarrhoeal rate among respondents (2.5 episodes/person-year (95%CI, 1.8-3.5)) was significantly higher than for other household members (1.0 episodes/person-year (95%CI, 0.8-1.4); IRR=2.4 (95%CI, 1.5-3.7) p<0.001). Diarrhoeal rate was not significantly different between age groups, however younger children (<5 years) were more likely to present to healthcare facilities (OR=5.86 (95%CI, 1.09-31.37), p=0.039). Having a child between 5-15 years in the household was associated with diarrhoea (OR=2.26 (95% CI, 1.32-3.86), p=0.003). While 26.4% of cases sought healthcare, only 4.6% of cases were hospitalised and only 3.4% of cases had a stool specimen collected.

**Conclusion** Diarrhoeal rate was high across all age groups in this community; however, older children and adults were less likely to present to healthcare, and are therefore underrepresented through facility-based clinical surveillance.


# Background

Although progress has been made towards improving water and sanitation globally, diarrhoea has remained in the top ten causes of mortality and morbidity amongst all ages[1,2]. In 2016, diarrhoea was the eighth leading cause of death among all ages (1 655 944 deaths) and the fifth leading cause of death among children under five years of age (446 000 deaths)[1]. Nutritional wasting in young children, unsafe water and poor sanitation were the leading risk factors for diarrhoeal morbidity and mortality[1,3]. Overall, global diarrhoeal illness has decreased in the past 10 years, however, this decrease has not been uniform across age groups or across settings. Improved maternal education, improvement of child growth due to better nutrition and access to rotavirus vaccination has led to large reductions in childhood diarrhoeal illnesses[1]. However specific attention is still required in the elderly where there are large knowledge gaps in terms of aetiology and epidemiology[1,4] and in low-income settings which still bear the brunt of the burden of disease[1]. Estimates show that the vast majority of global diarrhoeal deaths occur in south Asia and sub-Saharan Africa[1,5].

Diarrhoeal pathogens are commonly transmitted through the faecal-oral route, due to poor hygiene and sanitation[6], and through ingestion of contaminated food and water, aided by poor food safety practices[7]. Diarrhoeal morbidity is therefore largely preventable through improved access to safe water and sanitation and ensuring communities are well educated on good handwashing and safe food preparation practices. The WHO has defined five keys to safer food in order to simplify the messaging behind food safety for clear communication and enhanced recall[8]. Diarrhoeal deaths are also largely preventable if dehydration is properly managed[9]. Dehydration can be prevented through a simple, homemade, sugar and salt solution or oral rehydration solution (ORS) as recommended by the WHO[10,11]. ORS is estimated to reduce diarrhoeal mortality by up to 93% at a healthcare level, however less is known about its efficiency at a community level[9]. Many of the interventions required to reduce diarrhoeal mortality and morbidity are relatively simple and can be addressed through community education. This makes diarrhoea one of the most tangible targets for reducing mortality and morbidity from preventable illnesses.

Current diarrhoeal surveillance studies being conducted at several hospitals throughout South Africa enrol patients of all ages hospitalised for acute, moderate to severe diarrhoea. However, cases enrolled in these studies represent only a fraction of diarrhoea in the community and are biased towards people with good access to healthcare services, and hence do not give a full picture of diarrhoeal disease at a population level. It is also important to understand the healthcare utilization patterns in the community when interpreting the data from hospital surveillance. This cross-sectional, questionnaire-based, community survey was undertaken to estimate the rate of and risk factors for diarrhoea in the community across all age groups in Soweto, South Africa and to determine the proportion of cases presenting to healthcare facilities.

# Methods

### Study area and population

Soweto is a densely populated, urban township in Johannesburg, South Africa with an estimated population of 1.3 million people in 355 331 households (2011 census)[12]. According to the most recent census, 96.8% of residents get their water from municipal water sources with 55.0%

having access to piped water inside the dwelling and 91.6% use flush toilets[12]. Unemployment is high with 18.7% of households not receiving any set income and a dependency ratio of 40.8[12]. The average household size is 3.4 people[12] with an average household income of R6500 per month[13]. Soweto is served by Chris Hani Baragwanath Academic Hospital, a large, secondary-tertiary care hospital, and Bheki Mlangeni District Hospital as well as several public clinics and private practitioners[13].

The Soweto health and demographic surveillance site (HDSS) was established in 2017 as part of the Child Health and Mortality Prevention Surveillance (CHAMPS) Network[14] and currently tracks individuals from 20 778 households in eight clusters in Soweto through biannual data collection rounds. This diarrhoeal diseases survey used the Soweto HDSS as a sampling frame.

### Sampling methods and data collection

Probability proportional to size sampling was used to select four of the eight Soweto clusters (due to limited resources and relative size of the clusters) and households were randomly sampled from these clusters. Soweto HDSS data were used to verify that clusters were not significantly different in terms of socioeconomic status.

To obtain a representative sample of each of the four clusters with a 5% precision, 95% confidence level, using an estimated 2-week diarrhoeal prevalence of 6%[15] (amongst all ages), a survey size of 84 was required per cluster. Non-response rate was estimated at 20% hence 500 households were selected (125 in each of the four clusters). Fieldworkers visited the selected households, explained the study to an adult (≥18 years old) representative of the household, and obtained written informed consent. A questionnaire on handwashing practices, food preparation practices, ORS knowledge and number of diarrhoeal episodes (defined as ≥3 loose or liquid stools in 24 hours for any duration) for all member of the household in the past two weeks (including symptoms as per other community studies[16] and health seeking behaviour) was administered in the preferred language of the respondent. Households not available on the first visit were visited on a second occasion and considered a non-response if not available at either visit.

### Statistical analysis

Demographic and socioeconomic information was obtained for enrolled households from HDSS data, using respondent name, surname and age, before being de-identified for the purposes of the analysis. The International Wealth Index (IWI)[18] was used as a composite measure of material wealth for each household. This measure combines assets, housing floor material, toilet facility, number of rooms, access to electricity and water sources.

The number of individuals living with the respondent (as reported by the respondent) was used as the denominator for two-week diarrhoeal prevalence. Respondents only answered questions pertaining to their household; individuals living in a separate dwelling on the same property were excluded. Diarrhoeal rate was calculated as episodes per person-year (PY) using events per person over the 2-week period. Confidence intervals (95%) for diarrhoeal rates were calculated using the Poisson distribution. Incidence rate ratios (IRR) were calculated to compare the diarrhoeal rates among strata. Factors associated with diarrhoeal episodes and health seeking were investigated using binomial logistic regression modelling. Multivariate analysis included all variables significant at p-value<0.15 in the univariate analysis and used backwards, stepwise selection (using likelihood-ratio test) to determine which variables to retain in the multivariate model. Logistic regression included only households matched to HDSS data. Factors associated with ORS knowledge were investigated using $X^2$-test for categorical variables and t-test for continuous variables. Handwashing practices were considered adequate if the respondent reported always washing their hands with both soap and water (and opposed to water only) at critical times, including before eating, preparing food and feeding children as well as after using the toilet and changing children's' nappies. Stata software (version 14) was used for all analyses.

### Ethical considerations

This study was approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (approval number: M190663) and the CHAMPS Soweto HDSS Community Advisory Board.

## Results

### Enrolled households and respondents

During February 2020, 374 households comprising 1640 individuals, were enrolled (Figure 1). Respondents were majority female (67.4%) with a median age of 45 years (IQR: 24-59). A total of 355 (94.9%) respondents could be matched to the CHAMPS HDSS data (some may have relocated between the most recent HDSS round and the current survey).

### Diarrhoeal rate

Of the 374 households surveyed, 78 (20.9%) reported at least one diarrhoeal episode in the past two weeks. Seventy-one (91.0%) of these had a single episode per household, six (7.7%) had two diarrhoeal episodes, and one (1.3%) had four episodes. Hence, a total of 87 diarrhoeal episodes were reported, 36 (41.4%) of which were self-reported by the respondent and 51 (58.6%) were reported on behalf of someone else in the household.

The overall 2-week diarrhoeal prevalence for the surveyed population was 5.3% which translates to a rate of 1.4 episodes/PY (95% CI, 1.1 – 1.7) (Table 1). Acute diarrhoea (<14 days) was common (1.3 episodes/PY (95% CI, 1.0-1.6)) while persistent diarrhoea was rare (0.1 episodes/PY (95% CI, 0.0-0.2)). Reported 2-week prevalence for respondents was 9.6% (rate of 2.5 episodes/PY (95% CI, 1.8-3.5)) which was significantly higher than reported for other household members (2-week prevalence of 4.0% and rate of 1.0 episodes/PY (95% CI, 0.8-1.4)) as shown by the IRR of 2.4 (95% CI, 1.5-3.7, p<0.001). Rates between age groups were similar (1.1 episodes/PY (95% CI, 0.4-2.2) in <5 years; 1.3 episodes/PY (95% CI, 0.8-2.2) in 5-15 years; 1.4 episodes/PY (95% CI, 1.1-1.8) in >15 years).

Table 1: Rate of diarrhoeal disease reported for different groups

| | Events (N) | Denominator (number of people) | 2-week prevalence (%) | Person-years | Rate (episodes per person-year (95% CI)) |
|---|---|---|---|---|---|
| Overall | 87 | 1640 | 5.3 | 62.9 | 1.4 (1.1-1.7) |
| Acute (<14 days) | 81 | 1640 | 4.9 | 62.9 | 1.3 (1.0-1.6) |
| Persistent (≥14 days) | 6 | 1640 | 0.4 | 62.9 | 0.1 (0.0-0.2) |
| Respondents | 36 | 374 | 9.6 | 14.3 | 2.5 (1.8-3.5) |
| Other household members | 51 | 1266 | 4.0 | 48.6 | 1.0 (0.8-1.4) |
| <5 years | 7 | 169 | 4.1 | 6.5 | 1.1 (0.4-2.2) |
| 5-15 years | 16 | 310 | 5.2 | 11.9 | 1.3 (0.8-2.2) |
| > 15 years | 64 | 1171 | 5.5 | 44.9 | 1.4 (1.1-1.8) |

### Risk factors for diarrhoeal episodes

Multivariate analysis found that having children aged 5-15 years in the household resulted in a higher odds of having had diarrhoea in the last 2 weeks (OR=2.26 (95% CI, 1.32-3.86), p=0.003), (Table 2). Inadequate handwashing (OR=1.69 (95% CI, 0.97-2.95), p=0.065) and having a flush toilet in the house compared to a flush toilet in the yard (OR=1.72, (95% CI, 0.98-3.02), p=0.059) were also associated with increased diarrhoeal episodes in the household however these did not reach statistically significance. Number of people in the household, dwelling type, IWI, eating habits, where food was purchased (formal or informal traders) and stored (availability of cold storage), knowledge on separation of raw and cooked food, and water treatment, interruptions and storage were not associated with increased diarrhoeal episodes.

Table 2: Risk factors associated with occurrence of diarrhoeal episodes in the household in the preceding two weeks

| | No diarrhoeal episode in the household n/N (%) | Diarrhoeal episode in the household n/N (%) | Total n/N (%) | Univariate [C] OR (95% CI) | p-value | Multivariate [C, d] OR (95% CI) | p-value |
|---|---|---|---|---|---|---|---|
| **Dwelling type** | | | | | | - | - |
| Formal | 234/281 (83.3) | 56/74 (75.7) | 290/355 (81.7) | Referent | - | | |
| Informal | 47/281 (16.7) | 18/74 (24.32) | 65/355 (18.3) | 1.62 (0.87-3.01) | 0.126 | | |
| **Structure main material** | | | | | | - | - |
| Brick | 253/280 (90.4) | 66/74 (89.2) | 319/354 (90.1) | Referent | - | | |
| Metal sheets | 27/280 (9.6) | 8/74 (10.8) | 35/354 (9.9) | 1.17 (0.51-2.71) | 0.706 | | |
| **Home ownership** | | | | | | - | - |
| Owned by residents | 164/278 (59.0) | 38/74 (51.4) | 202/352 (57.4) | Referent | - | | |
| Rented | 69/278 (24.8) | 27/74 (36.5) | 96/352 (27.3) | 1.69 (0.96 – 2.99) | 0.070 | | |
| Government issued | 45/278 (16.2) | 9/74 (12.2) | 54/352 (15.3) | 0.85 (0.38-1.89) | 0.695 | | |
| **Power source for cooking** | | | | | | - | - |
| Electricity | 280/281 (99.6) | 74/74 (100.0) | 354/355 (99.7) | | | | |
| Paraffin | 1/281 (0.4) | 0/74 (0) | 1/355 (0.3) | Omitted | | | |
| **Toilet type** | | | | | | | |
| Flush toilet in yard | 120/280 (42.9) | 22/74 (29.7) | 142/354 (40.1) | Referent | **-** | Referent | - |
| Flush toilet in house | 158/280 (56.4) | 52/74 (70.3) | 210/354 (59.3) | 1.79 (1.03-3.11) | **0.039** | 1.72 (0.98-3.02) | 0.059 |
| Ventilated pit latrine | 2/280 (0.7) | 0/74 (0) | 2/354 (0.6) | - | - | - | - |
| **International Wealth Index** | | | | | | - | - |
| Median (IQR) | 86.2 (79.1 – 92.3) | 85.6 (79.1-92.1) | 86.1 (79.1–92.3) | 1.00 (0.97-1.03) | 0.827 | | |
| **Number of people living in the household** | | | | | | - | - |
| Median (IQR) | 4 (2-5) | 5 (3-7) | 4 (2-6) | 1.13 (1.03-1.24) | **0.004** | | |
| **Children under 5** | | | | | | - | - |
| No | 205/296 (69.3) | 42/78 (53.9) | 247/374 (66.0) | Referent | **-** | | |
| Yes | 91/296 (30.7) | 36/78 (46.1) | 127/374 (34.0) | 2.04 (1.21-3.44) | **0.008** | | |
| **Children between 5-15** | | | | | | | |
| No | 171/296 (57.8) | 29/78 (37.2) | 200/374 (53.5) | Referent | **-** | Referent | - |
| Yes | 125/296 (42.2) | 49/78 (62.8) | 174/374 (46.5) | 2.29 (1.35-3.89) | **0.002** | 2.26 (1.32-3.86) | **0.003** |
| **Handwashing [a]** | | | | | | | |
| Adequate | 134/296 (54.7) | 24/78 (30.8) | 158/374 (42.3) | Referent | **-** | Referent | - |
| Inadequate | 162/296 (54.3) | 54/78 (69.2) | 216/374 (57.8) | 1.76 (1.02-3.04) | **0.043** | 1.69 (0.97-2.95) | 0.065 |
| **Consume fresh fruit and veg [b]** | | | | | | - | - |
| Never | | | | | | | |
| Occasionally | 6/294 (2.0) | 3/77 (3.9) | 9/371 (2.4) | Referent | - | | |
| Often | 90/294 (30.6) | 24/77 (31.2) | 114/371 (30.7) | 0.46 (0.10-2.05) | 0.307 | | |
| | 198/294 (67.4) | 50/77 (64.9) | 248/371 (66.9) | 0.42 (0.10-1.82) | 0.245 | | |
| **Consume meat [b]** | | | | | | - | - |
| Never | 15/295 (5.1) | 3/78 (3.9) | 18/373 (4.8) | Referent | - | | |
| Occasionally | 95/295 (32.2) | 28/78 (35.9) | 123/373 (33.0) | 1.43 (0.38-5.36) | 0.594 | | |
| Often | 185/295 (62.7) | 47/78 (60.3) | 232/373 (62.2) | 1.17 (0.32-4.26) | 0.808 | | |
| **Consume dairy [b]** | | | | | | - | - |
| Never | 34/292 (11.6) | 10/77 (13.0) | 44/369 (11.9) | Referent | - | | |
| Occasionally | 82/292 (28.1) | 28/77 (36.4) | 110/369 (29.8) | 1.19 (0.50-2.82) | 0.689 | | |
| Often | 176/292 (60.3) | 39/77 (50.7) | | 0.77 (0.34-1.76) | 0.539 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | 215/369 (58.3) | | | | |
| **Consume eggs** [b] | | | | | | - | - |
| Never | 46/293 (15.7) | 16/77 (20.8) | 62/370 (16.8) | Referent | - | | |
| Occasionally | 94/293 (32.1) | 26/77 (33.8) | 120/370 (32.4) | 0.74 (0.36-1.53) | 0.420 | | |
| Often | 153/293 (52.2) | 35/77 (45.5) | 188/370 (50.8) | 0.67 (0.34-1.32) | 0.248 | | |
| **Consume ready-to-eat meat products** [b] | | | | | | - | - |
| Never | 94/291 (32.3) | 21/77 (27.3) | 115/368 (31.3) | Referent | - | | |
| Occasionally | 97/291 (33.3) | 28/77 (36.4) | 125/368 (34.0) | 1.39 (0.72-2.68) | 0.325 | | |
| Often | 100/291 (34.4) | 28/77 (36.4) | 128/368 (34.8) | 1.36 (0.71-2.62) | 0.358 | | |
| **Consume takeaways** [b] | | | | | | - | - |
| Never | 129/289 (44.6) | 28/77 (36.4) | 157/366 (42.9) | Referent | - | | |
| Occasionally | 133/289 (46.0) | 39/77 (50.7) | 172/366 (47.0) | 1.34 (0.77-2.35) | 0.942 | | |
| Often | 27/289 (9.3) | 10/77 (13.0) | 37/366 (10.1) | 1.76 (0.76-4.09) | 0.782 | | |
| **Eat at restaurants** [b] | | | | | | - | - |
| Never | 181/294 (61.6) | 48/78 (61.5) | 229/372 (61.6) | Referent | - | | |
| Occasionally | 107/294 (36.4) | 28/78 (35.9) | 135/372 (36.3) | 1.02 (0.60-1.75) | 0.942 | | |
| Often | 6/294 (2.0) | 2/78 (2.6) | 8/372 (2.2) | 1.26 (0.25-6.45) | 0.782 | | |
| **Purchase meat** | | | | | | - | - |
| Informal | 14/296 (4.7) | 2/78 (2.6) | 16/374 (4.3) | Referent | | | |
| Commercial | 282/296 (95.3) | 76/78 (97.4) | 358/374 (95.7) | 1.62 (0.36-7.42) | 0.532 | | |
| **Purchase veg** | | | | | | - | - |
| Informal | 161/295 (54.6) | 39/76 (51.3) | 200/371 (53.9) | Referent | - | | |
| Commercial | 134/295 (45.4) | 37/76 (48.7) | 171/371 (46.1) | 1.06 (0.63-1.78) | 0.835 | | |
| **Fridge/freezer storage** | | | | | | - | - |
| No | 9/295 (3.1) | 2/78 (2.6) | 11/373 (3.0) | Referent | - | | |
| Yes | 286/295 (96.9) | 76/78 (97.4) | 362/373 (97.0) | 1.21 (0.26-5.72) | 0.811 | | |
| **Separate raw and cooked food** | | | | | | - | - |
| No | | | | | | | |
| Yes | 10/291 (3.4) | 1/78 (1.3) | 11/369 (3.0) | Referent | - | | |
| | 281/291 (96.6) | 77/78 (98.7) | 358/369 (97.0) | 2.77 (0.35-21.96) | 0.336 | | |
| **Treat drinking water** | | | | | | - | - |
| No | 271/296 (91.6) | 67/78 (85.9) | 338/374 (90.4) | Referent | - | | |
| Yes | 25/296 (8.5) | 11/78 (14.1) | 36/374 (9.6) | 1.58 (0.72-3.46) | 0.251 | | |
| **Water storage** | | | | | | - | - |
| None (straight from tap) | 180/292 (61.6) | 47/78 (60.3) | 227/370 (61.4) | Referent | - | | |
| Closed container | 106/292 (36.3) | 29/78 (37.2) | 135/370 (36.5) | 1.13 (0.66-1.93) | 0.658 | | |
| Open container | 6/292 (2.1) | 2/78 (2.6) | 8/370 (2.2) | 1.56 (0.29-8.33) | 0.600 | | |
| **Interruptions to water supply in the past 2 weeks** | | | | | | - | - |
| No | | | | | | | |
| Yes | 258/295 (87.5) | 69/76 (90.8) | 327/371 (88.1) | Referent | - | | |
| | 37/295 (12.5) | 7/76 (9.2) | 44/371 (11.9) | 0.67 (0.27-1.67) | 0.393 | | |

[a] Adequate defined as washing with soap and water at critical times (after using the toilet or changing nappies and before preparing food, eating or feeding young children); [b] Occasionally defined as once/twice per week and often defined as every day or every second day. [C] Univariate and multivariate analysis using only the 355 households that could be matched to HDSS data. [d] The following variables were assessed in the multivariate model: number of people living in the household, dwelling type, home ownership, toilet type, children under 5 years, children between 5-15 years and handwashing. The following variables were retained in the model: toilet type, children between 5-15 years and handwashing.

### Symptoms and health seeking behaviour

The median age for those who reported diarrhoea was 30 years (IQR: 13-53). Episodes lasted between a few hours to 28 days with a median of two days (IQR: 2-5). Cramps were the most commonly experienced symptom (59.8%) followed by headache (31.0%), loss of appetite (31.0%) and fever (31.0%). Some cases (14.9%) experienced no additional symptoms (other than diarrhoea), (Table 3).

Table 3: Frequency of concurrently reported symptoms amongst household members with diarrhoeal episodes (N = 87)

| | Yes - N (%) |
|---|---|
| Cramps | 52 (59.8) |
| Headache | 27 (31.0) |
| Loss of appetite | 27 (31.0) |
| Fever | 27 (31.0) |
| Body ache | 24 (27.6) |
| Respiratory symptoms | 17 (19.5) |
| Nausea | 15 (17.2) |
| Discoloured stool | 15 (17.2) |
| Watery stool | 14 (16.1) |
| Vomiting | 13 (14.9) |
| Blood in stool | 4 (4.6) |
| Stiff neck | 3 (3.5) |

Twenty-three of the 87 people with diarrhoea (26.4%) sought healthcare (Supplementary Figure S1). Fourteen (16.1%) visited a local clinic, while five (5.7%) visited a pharmacy and only four (4.6%) were admitted to hospital. The admitted cases included a 4-month-old baby, two elderly cases (65 and 77 year olds) and a 23 year old with dysentery, body aches, cramps, fever, nausea and vomiting. Fifty-one (58.6%) did not seek healthcare as they had mild symptoms and did not feel it was required, while 12 (13.8%) felt it was required but were unable to access healthcare. Children <5 years and those with body aches were significantly more likely to seek healthcare for diarrhoea compared with older children and adults and those without body aches (OR=5.86 (95% CI, 1.09-31.37), p=0.039; OR=3.44 (95% CI, 1.15-10.23), p=0.027 respectively) (Table 4). The six cases that reported having had blood in the stool or symptoms for an extended time period, all felt they required healthcare, although only three (50.0%) were able to access it. Only three of the 87 cases had a stool specimen collected (3.4%).

Table 4: Predictors for seeking healthcare

| | Univariate | | Multivariate [a] | |
|---|---|---|---|---|
| | OR (95% CI) | p-value | OR (95% CI) | p-value |
| Cramps | 1.09 (0.41-2.90) | 0.858 | - | - |
| Vomiting | 1.26 (0.35-4.58) | 0.722 | - | - |
| Nausea | 2.12 (0.66-6.81) | 0.208 | - | - |
| Blood in stool | 2.90 (0.38-21.93) | 0.301 | - | - |
| Watery | 0.71 (0.18-2.81) | 0.625 | - | - |
| Discoloured | 1.47 (0.44-4.88) | 0.527 | - | - |
| Headache | 0.71 (0.24-2.05) | 0.710 | - | - |
| Respiratory | 0.81 (0.23-2.79) | 0.738 | - | - |
| Fever | 0.71 (0.24-2.05) | 0.523 | - | - |
| Body aches | 2.69 (0.97-7.43) | 0.056 | 3.44 (1.15-10.23) | **0.027** |
| Loss of appetite | 0.94 (0.33-2.65) | 0.908 | - | - |
| Stiff neck | 5.90 (0.51-68.49) | 0.156 | - | - |
| Extended period of time | 5.90 (0.51-68.49) | 0.156 | - | - |
| Age group (years) | | | | |
| <5 | 3.61 (0.73-17.82) | 0.115 | 5.86 (1.09-31.37) | **0.039** |
| 5-15 | 0.387 (0.08-1.88) | 0.239 | 0.45 (0.09-2.30) | 0.339 |
| >15 | Referent | - | Referent | - |
| Female | 0.76 (0.25-2.32) | 0.634 | - | - |
| International Wealth Index | | | | |
| | 1.04 (0.98-1.11) | 0.194 | - | - |

[a] The following variables were assessed and retained in the multivariate model: body aches, age group

Only 44.8% (n=39) of cases used ORS during the episode. Knowledge on ORS was relatively poor in the surveyed population with only 51% (n=192) of respondents having some knowledge on ORS (knew the recipe or were able to name the ingredients) and only 17.9% (n=67) able to

give the correct recipe. Females (p<0.001), respondents with a child less than five years old in the household (p=0.01) or children between the age of five and 15 (p=0.002) were significantly more likely to have some knowledge on ORS (Supplementary Table S1).

## Discussion

This survey found a self-reported diarrhoeal rate of 2.5 episodes/PY (95% CI, 1.8 – 3.5) and 1.0 episodes/PY (95% CI, 0.8 – 1.4) for other household members (as reported by respondent as a proxy). Both the self-reported rate and the rate for other household members were higher than those reported in high-income countries[15,19], which is expected due to poorer living conditions and higher burden of underlying conditions, specifically HIV, associated with increased diarrhoeal morbidity in our setting. Although data for adults in an African setting are rare, a household survey in Zambia reported a diarrhoeal rate of 1.74 episodes/PY for persistent diarrhoea only[20] and a household study in Ethiopia found a diarrhoeal rate of 3.78 episodes/PY for children <5 years of age[21]. These rates from other African studies are higher than reported here, however our reported prevalence for children <5 years was the same as that reported in a community-based study from the same setting (4.0%)[13]. Rates for other household members are also in line with GBD estimates of 1.04 episodes/PY (95% CI, 1.00-1.09) for sub-Saharan Africa[1]. Since community-level data amongst all ages in sub-Saharan Africa are limited, it is possible that the higher estimates of self-reported diarrhoea are accurate, and other estimates (based on healthcare level data) are an underestimation. Of interest, our survey found no significant difference between rates for different age groups as seen in similar population-based studies elsewhere[15,19]. This highlights that diarrhoeal cases in children under five are seen disproportionally at a healthcare level as many older children and adults do not seek healthcare for diarrhoeal episodes. This was supported by the finding that healthcare was most likely to be sought for children under five years. The economic effects of diarrhoea in the community therefore, extend beyond those placed on healthcare systems by reducing economically active days for individuals of working age, as has been suggested by another South African study which found diarrhoeal diseases to have effects on social disturbance and lost economic opportunities additional to health-related costs[22].

Presence of children between 5-15 years in the household was a significant risk factor for diarrhoea. Since the diarrhoeal rate was not higher for this age group than for adults, it is likely that having a child of school going age in the household is a risk factor for others in the household as these children may act as vectors. Having a flush toilet in the house (as compared to in the yard) and inadequate handwashing were also risk factors for diarrhoea (although only marginally significant). Eating habits and food purchasing behaviours were not associated with an increased risk for diarrhoea in the current study. Despite this, establishing patterns of eating and purchasing habits in this community may inform future foodborne outbreak investigations.

Diarrhoeal episodes were relatively mild in the surveyed population, with a median duration of 2 days. The most common accompanying symptoms were cramps, headache, loss of appetite and fever. This is in line with systematic review data from low- and middle-income countries[25]. A French study found a mean duration of 2.9 days with cramps/abdominal pain, vomiting, nausea and headaches being the most common accompanying symptoms[19]. Fever was found in just under a third of cases both in the current and French studies[19]. Only 20.7% of cases required healthcare intervention, which is in line with estimates of 21.0% from the United States[15]. Data from low- and middle-income countries estimate that 35.2% of diarrhoeal cases present to healthcare, however these data are limited to children <5 years[25]. In the present study, of those that sought healthcare, the majority went to a local clinic (60.9%), followed by pharmacy (21.7%) and public hospital (17.4%). This differs to a community-based study from the same setting that looked at diarrhoea in children <5 years only and found that 70.0% of cases sought healthcare at a local clinic, 10.0% at a private practitioner, 10.0% at a pharmacy and 5.0% at a public hospital[13]. This difference is probably due to adults being more likely to seek healthcare at a pharmacy, rather than a clinic, hospital or private practitioner. This study was not powered to determine the difference in health seeking between age groups, however no cases in young children were reported to have sought healthcare at the pharmacy (rather visited a clinic or hospital). The number of individuals seeking healthcare for their illness underrepresents the severity of illness, since 34.3% (12/35) of those that felt they needed healthcare were unable to access it. Reasons for not being able to access healthcare included personal as well as issues with the healthcare system, including being ill-treated at clinics in the past, clinic queues being too long and the clinic being closed. Many of these barriers were also highlighted in the previous Soweto study which showed that people did not seek healthcare for their children due to issues with the health system including deficiencies in healthcare delivery, dissatisfaction with services, medications being out of stock; and for personal reasons such as time, finance and transportation constraints[13]. The data presented here shows that only 4.6% of cases in the community would have been detected through hospital surveillance and 16.1% through clinic surveillance. Analysis of routine diagnostic laboratory data would represent only 3.4% of the cases seen in the community (those that had stool specimens collected).

We found community ORS knowledge to be relatively poor. Women and respondents with children in the household were more likely to have some knowledge on ORS indicating that this information is most likely disseminated through baby and childcare clinics, a finding which has also been made in rural Botswana[26]. There is a gap in information dissemination for men and households without children which should be addressed to improve uptake of ORS.

This study was limited by the reliance on a single household member to answer questions on behalf of other household members. This may have introduced bias, as respondents were less likely to have been able to accurately respond to questions regarding diarrhoeal episodes experienced by others. This method has been used in other similar studies[3,27] and was preferable to collecting data on respondents only as this may have biased results towards those that stay at home during the day.

In conclusion, the diarrhoeal rate for children <5 years of age is lower than reported for other African countries, while the rate for adults is higher than expected (similar to rates in young children). Young children were more likely to present to healthcare than adults and older children, hence the high rate of diarrhoea seen in adults and older children in the community is not reflected at a healthcare level.

## Abbreviations

CHAMPS – Child Health and Mortality Prevention Surveillance network

CI – Confidence interval

GBD – Global Burden of Disease

HDSS – Health and demographic surveillance site

IQR – Interquartile range

IRR – Incidence rate ratio

IWI – International Wealth Index

ORS – oral rehydration solution/salts

PY – Person-years

WHO – World Health Organisation

## Declarations

*Ethics approval and consent to participate*

This study was approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (approval number: M190663) and the CHAMPS Soweto HDSS Community Advisory Board. Written informed consent was obtained from all included participants.

*Consent for publication*

Not applicable.

*Availability of data and materials*

The datasets used and/or analysed during this study are available from the corresponding author on reasonable request.

*Competing interests*

The authors declare that they have no competing interests.

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*Authors' contributions*

SLJ – conceptualised and designed the study; completed and managed fieldwork and data collection; acquired, analysed and interpreted the data; drafted the work.

NAP – assisted in conceptualising and designing the study; assisted in acquiring, analysing and interpreting the data; substantively revised the work.

SAM – assisted in acquiring, analysing and interpreting the data, substantively revised the work.

PM - assisted in conceptualising and designing the study; substantively revised the work.

NM - assisted in acquiring, analysing and interpreting the data, substantively revised the work.

CH - assisted in acquiring, analysing and interpreting the data

MJG – assisted in conceptualising and designing the study; assisted in acquiring, analysing and interpreting the data; substantively revised the work.

All authors read and approved the final manuscript.

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## Figures

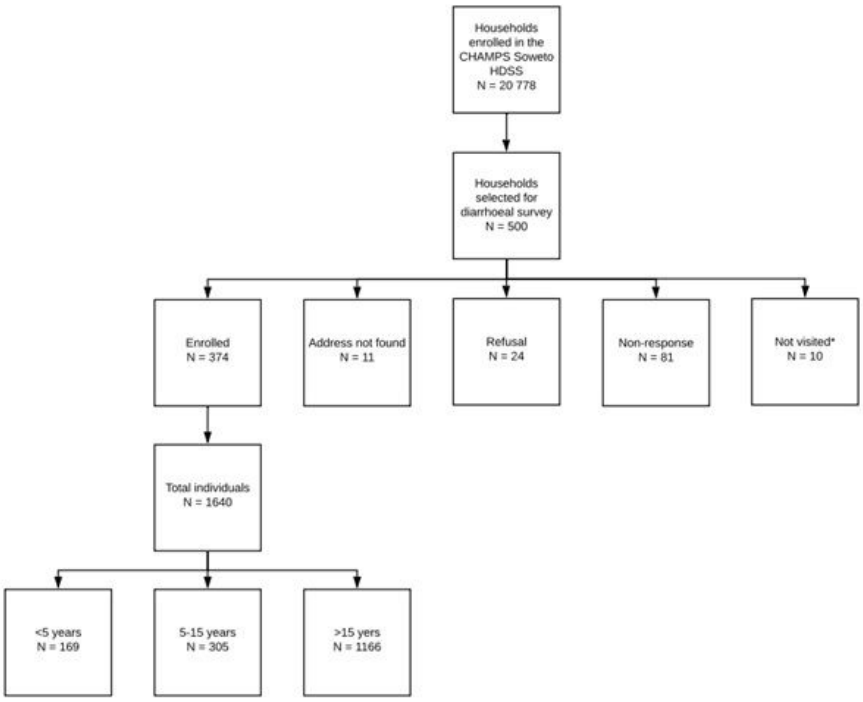


**Figure 1**

Enrolment flow diagram. *10 households were not visited due to strike action which prevented fieldwork for several days. Despite this, the required sample size was reached.

## Supplementary Files

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