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Systematic Review

Diarrhoea in children under five years of age in South Africa (1997–2014)

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Abstract

OBJECTIVE To present evidence from available reliable published data on the prevalence, incidence and severity of diarrhoea in children aged under five years in South Africa.
METHODS We searched seven electronic databases. Two reviewers assessed the studies independently and extracted outcome data. The heterogeneity of the studies did not allow for a meta-analysis.
RESULTS We found only one nationally representative study conducted in 1998 reporting a diarrhoea prevalence of 13% in children under five. Other studies were conducted in smaller settings across the country. Diarrhoea incidence was 10.13 per 1000 person years in children admitted to a tertiary hospital. Three studies reported severity of diarrhoea; however, they differed across study settings and time period.
CONCLUSION The paucity of nationally representative prevalence data for SA necessitates more national surveys with standardised data-collection methods to allow for more effective comparisons.

keywords Diarrhoea, Prevalence, Incidence, Severity, Dehydration, Children under five, South Africa

Introduction

Diarrhoea remains one of the leading causes of death, ill health and disability among children aged under five years in developing countries [1–3]. In Africa, an estimated 696 million cases and 9.6 million severe episodes of diarrhoea occur among children in this age group [1]. Diarrhoea accounts for 19% of deaths of under fives in South Africa and for 46% on the African continent [1, 4]. Globally, diarrhoea is the 2nd leading infectious cause of death, accounting for 9.2% deaths in under fives [5]. In the initial National Burden of Disease (NBD) study for South Africa conducted in 2000, diarrhoea accounted for 8.8% of the total years of healthy life lost (DALYs)[6] and was ranked the third leading cause of death preceded only by HIV and low birthweight [6, 7]. In 2010, diarrhoea was the second leading cause of death in under fives [4]. One DALY can be thought of as one lost year of 'healthy' life. It combines the years of life lost due to premature deaths (YLLs) and years of life lived with disability (YLDs). YLLs due to diarrhoeal disease can be estimated from adjusted cause-of-death data from vital registration. Estimates are available for South Africa [6, 8]. However, the available YLDs due to childhood diarrhoea in South Africa were derived from the modelled estimate by the first Global Burden of Disease (GBD) Study [9]. If good-quality prevalence data for diarrhoea in South Africa can be found, then YLDs can be estimated directly. However, it is important to have prevalence for a full calendar year to minimise seasonal bias and, preferably, nationally representative estimates.

WHO defines a case of diarrhoea as the passage of three or more loose or liquid stools per day, or more frequently than is normal for the individual. An episode of diarrhoea is one or more diarrhoea days occurring closely in time; and a new episode is one with an onset at least 3 days after the last day of the previous episode [10, 11]. Diarrhoea occurrence can be measured as prevalence or incidence. Diarrhoea prevalence is the proportion of the population that has diarrhoea at a specific point in time (point prevalence) or over a pre-defined time period (period prevalence). Diarrhoea incidence is the number of diarrhoea episodes per person-time (incidence density) or over a defined period of time (cumulative incidence). Prevalence estimates are preferred to incidence in nonclinical studies. Furthermore, measuring diarrhoea incidence could pose certain challenges, such as studies defining an episode of diarrhoea differently, overestimation as a result of counting episodes of diarrhoea rather than persons, recall error and the logistics of close follow-up [10, 12, 13].

The incidence of diarrhoeal diseases varies greatly with the seasons and child's age [14]. In South Africa, diarrhoea is mostly due to either bacterial or viral pathogens (those caused by protozoan pathogens are more frequently seen in people with HIV infection) with a high number of cases due to bacterial enteropathogens in the summer months and rotavirus in the winter months. Rotavirus is a major cause of acute diarrhoea in children below five years of age in both developed and developing countries and is responsible for about 40% of all hospital admissions in this age group worldwide [1, 15–17]. In South Africa, rotavirus vaccination at 6 and 14 weeks of age was introduced into the Expanded Program on Immunization (EPI) in 2009.

To our knowledge, there have been no systematic reviews on nationally representative prevalence, incidence and severity estimates of diarrhoeal diseases in South Africa. A recent systematic review by Lamberti *et al.* [2] estimated the severity of diarrhoea in low and middle income countries. However, the results were not specific to South Africa. Routine data on new cases of diarrhoea presenting at health facilities are reported as grey literature in the form of national publications of health statistics, but have several limitations.

The aim of this review was to present evidence from available, reliable, peer-reviewed publications on the prevalence, incidence and severity (assessed by degree of dehydration) of diarrhoea in under fives in South Africa. The findings from our review may be used in the disease modelling of diarrhoea to estimate its morbidity burden (YLDs/DALYs) in South Africa, and they should help decision-makers to prioritise resource allocation for prevention and treatment of diarrhoea, and also guide policy.

Materials and methods

Search strategy and selection criteria

We formulated a comprehensive search strategy with the help of an information specialist and librarian to identify as many relevant studies as possible reporting on the prevalence, incidence or severity of diarrhoea in South Africa. Table 1 shows the search strategy used to search PubMed on 29 August 2014 for studies published between 1997 and 2014. This search period was guided by the availability of mortality data for South Africa from 1997 to 2013. The search strategy was adapted to identify relevant articles in Scopus, ScienceDirect, JSTOR, Web of Science, CINAHL and Popline on 15 August 2014. The included studies were also searched for additional relevant references, and experts in the field were contacted to identify further potentially eligible studies. We did not include grey literature.

Table 1 PubMed search strategy

Search	Query
#4	Search ((#3 NOT (animals[mh] NOT humans[mh]))) AND ("1997/01/01"[Date - Publication]: "2014/08/29"[Date - Publication])
#3	Search (#1 AND #2)
#2	Search (South Africa[mh] OR South Africa*[tiab] OR RSA[tiab] OR Africa, Southern[mh:noexp] OR Southern Africa[tiab])
#1	Search (diarrhea[mh] OR diarrh*[tiab] OR gastroenteritis[tiab] OR dysentery[tiab] OR Intestinal Diseases, Parasitic[mh])

We included population-based surveys, prospective or retrospective cohort studies, case–control studies and cross-sectional studies with more than 100 participants that included children under five years, reported the age band of the participants and were conducted in South Africa (general population, community based and facility based) between 1997 and 2014. The following studies were excluded: randomised controlled trials; studies that focused exclusively on patients with HIV; those that used eligibility criteria that limited the representativeness of the sample to the target population; or reported on outbreak of diarrhoea.

The protocol was registered under PROSPERO CRD42015016940.

Data extraction and management

Two authors independently reviewed the titles and abstracts from the search output to identify potentially eligible studies. Full-text articles for all citations identified as potentially eligible were obtained and inspected to establish the relevance of the article using the pre-specified criteria. We resolved all disagreements by discussion. A standardised data extraction form was designed in Microsoft Excel and two authors independently extracted onto this the following relevant information from each included study: administrative details such as study title, name of author(s), year(s) in which study was conducted, and year of publication; details of the study including study design or data source, population characteristics, study setting and geographic location; details of outcomes; and details necessary for risk-of-bias/methodological quality assessment. Where nationally representative outcome data were not available, data from smaller settings were considered for extraction as this could allow for modelling or pooling of the data if and when possible. Authors were contacted for additional information as required.

Quality assessment

A modified checklist [18] (Appendix S1) was used independently by two reviewers to assess the risk of bias and methodological quality for each study. We systematically reviewed the literature to identify any checklist or quality assessment tool that assessed the risk of bias and methodological quality of observational studies. The reference lists of the articles retrieved were also screened and experts in the field (including the GBD group) contacted. Three relevant quality assessment tools were obtained from our search: the risk-of-bias tool for population-based prevalence studies described by Hoy *et al.* [19], the Newcastle–Ottawa scale for assessing the quality of non-randomised studies[20] and the methodological evaluation of observational research checklist [21]. Two of these tools [19, 20] were adapted for our review: pretested and modified to suit our context. Our tool assessed both internal and external validity, and, depending on the question, each item was assigned a maximum score of four or minimum score of zero. The overall quality score ranged from 1 to 20 (high risk = 1 to 6; moderate risk = 7 to 13; low risk = 14 to 20). Differences were resolved by consensus.

Data analysis

Measures of disease occurrence with confidence intervals were described and the results of individual studies were presented narratively because the studies varied significantly in terms of study population, setting and outcome reporting, precluding any meta-analysis. The 95% CI for estimates was computed using the following formula: [22]

$$95\%\ \mathrm{CI} = p \pm 1.96\sqrt{p(100-p)} \div \sqrt{n}$$

where p is the percentage of diarrhoea cases, and n is the sample size.

Results

A total of 4921 titles and abstracts were obtained after de-duplication of references. Of these, 58 articles were deemed potentially eligible and full-text articles were obtained. The five studies [23–27] that met our inclusion criteria and their characteristics are described in Table 2. The study flow including reasons for excluding any potentially eligible studies, [13, 15, 28–78] are summarised in Figure 1.

Included studies

The five included studies were conducted between 1997 and 2014. Only one was a population-based survey [23]. Three were cross-sectional surveys of which two were facility based [24, 25], and one was community based [26]. One study was a secondary data analysis involving a cohort of children enrolled into a vaccine efficacy trial [27]. The settings varied from national to rural and poor, urban communities, primary health care (PHC) and tertiary healthcare facilities. The largest study had a sample size of 6328, and the smallest study had a sample size of 115. All included studies reported data on children aged 0–59 months. The outcomes of interest reported in the included studies were prevalence [23, 25, 26], incidence [27] and severity [24, 25, 27]. Different sampling methods and case definitions were used in the studies. For this review, the WHO case definition of diarrhoea, which is passage of three or more loose or liquid stools per day (24 hours), was used. This case definition was used in all but one [23] of the included studies. Furthermore, the definition of diarrhoea episodes/recall period varied: 'diarrhoea in the previous 2 weeks'[23, 26] and 'diarrhoea occurring not <30 days after a previous episode' [27]. Severity (degree of dehydration) was assessed clinically in the three studies [24, 25, 27] that measured the outcome, but was categorised differently by Horwood *et al.* [25]. Case-identification methods included the administration of questionnaires [23, 26]; interviews and clinical examination [25]; questionnaire and medical examination [24]; medical record and medical examination [27]. ICD-9 classification of disease was used in one study for coding all hospital diagnoses [27].

Risk of bias in included studies

Judgements for assessing the methodological quality focused both on external and internal validity. Of the five included studies, three [23, 24, 27] were considered to have a low risk of bias and two [25, 26] a moderate risk (Table 2). Random sampling was performed in three [23–25], and non-random sampling in two studies [26, 27]; sample size was justified in one study [27]; sampling frame was considered adequate in all but one study [25]; and response rate was satisfactory in two studies [24, 26] but not reported in three studies [23, 25, 27]. Only two studies [23, 25] reported adjusting for potential

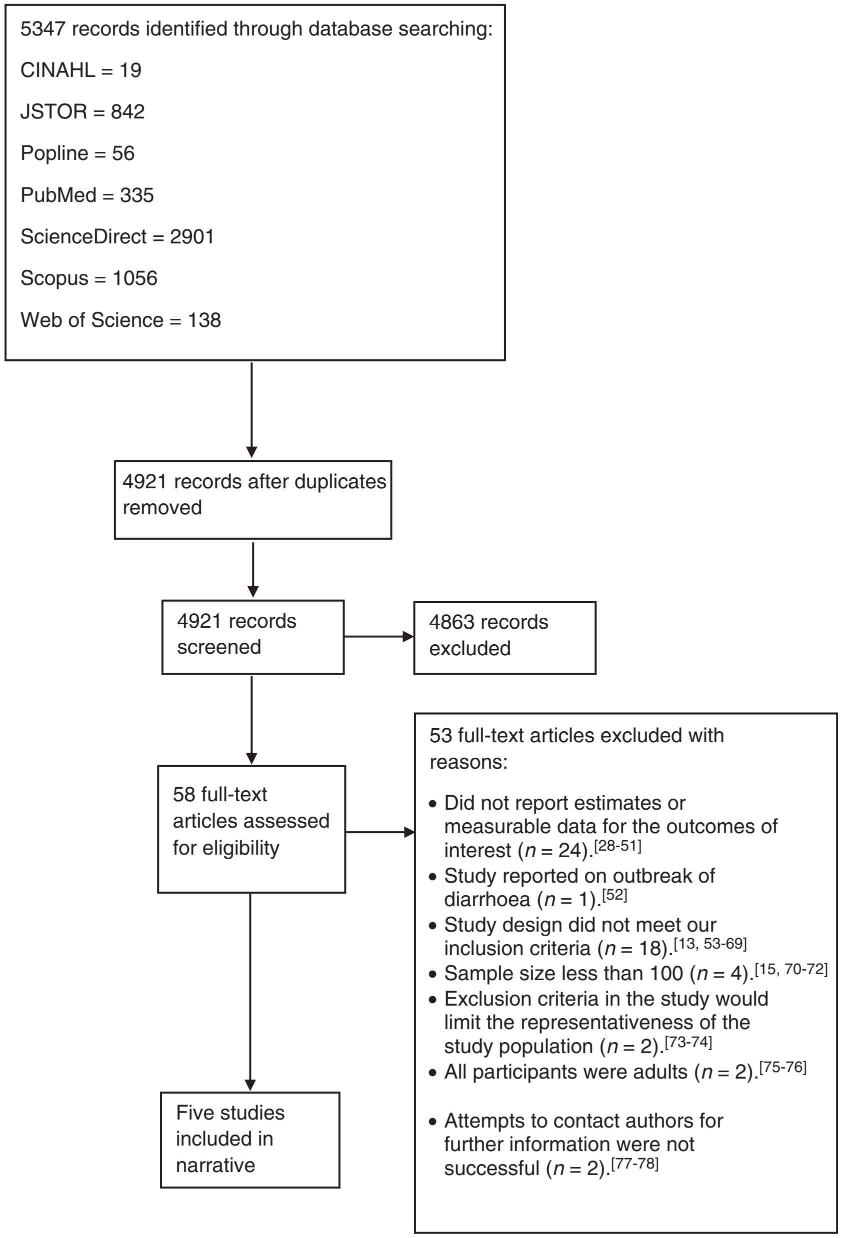

Figure 1 Study flow diagram.

confounders. Groome *et al.* [27]. could not adjust for some potential risk factors in their analysis because they were not measured in the original study. Please see Appendix S2 for assessment results.

Prevalence

Three studies (Table 3) reported data on prevalence of diarrhoea [23, 25, 26]. Choi [23], using data from the 1998 South African Demographic Health Survey (SADHS), reported a national-level prevalence of 13% among under fives. In the study by Horwood *et al.* [25], of a total of 1357 under fives that presented at primary healthcare clinics, 310 (22.8%) had diarrhoea. One study [26] evaluated the prevalence of diarrhoea in a community setting. About 15.9% of the 115 children aged 6 months to 2 years reported an episode of diarrhoea in the 2 weeks prior to the survey.

Table 2 Characteristics of included studies

Author (year)	Study location	Study period	Study design	Sampling method	Sample size	Age band	Case definition	Sources of data	Outcome of interest	Quality assessment score
Choi (2003)[23]	South Africa	1998	Nationally representative cross-sectional survey (SADHS)	Multistage sampling	4437	0 month–59 months	Passing of liquid, watery or loose stools in previous 2 weeks	Questionnaire	Prevalence	14 (low risk)
Johnson (2000)[24]	Chris Hani Baragwaneth Hospital, Soweto	1996–1997	Cross-sectional facility based survey	Systematic	172	3 months–4 years	Occurrence of 3 or more loose stools in the preceding 24 h, as reported by the parent	Questionnaire; medical examination	Severity	16 (low risk)
Horwood (2011)[25]	74 PHC clinics (29 in Limpopo and 45 in KZN)	2006–2007	Cross-sectional facility based survey	Simple random	1357	2 months–59 months	IMCI guideline was used. Three or more loose or watery stools in a 24-hour period	Interviews; clinical examination	Proportion of admissions Severity	13 (moderate risk)
Faber (1999)[26]	Rural community (Ndunakazi) in KZN	1997	Cross-sectional community based survey	Non-random	115	4–24 months	Passing 3 or more loose watery stools per day, during the last 2 weeks	Questionnaire	Prevalence	11 (moderate risk)
Groome (2012)[27]	Chris Hani Baragwaneth Hospital, Soweto	1998–2005	Secondary data analysis, involving a cohort of children enrolled into a vaccine efficacy trial	Non-random	6328	6 weeks–59 months	Three or more loose stools in any 24-hour period with duration < 14 days, occurring not <30 days after a previous episode of diarrhoea	Medical record; medical examination	Incidence Severity	14 (low risk)

Table 3 Summary of results

Study	Age band	Study location	Study period	Unit of measure	Numbers	Estimates	95% CI (%)
Prevalence							
Choi (2003) [23]	0–59 months	South Africa	1998	%	577/4437	13	12 to 14
Horwood (2011) [25]	2–59 months	74 PHC clinics (29 in Limpopo and 45 in KZN)	2006–2007	%	310/1357	22.8	21 to 25
Faber (1999) [26]	4–24 months	Rural community in KZN	1997	%	18/115	15.9	9 to 22
Incidence							
Groome (2012) [27]	6 weeks–59 months	Soweto	1998–2005	per 1000 person years	1949/192 454	10.13	9.68 to 10.58
Severity (degree of dehydration)							
Johnson (2000) [24]	3 months–4 years	Chris Hani Baragwanath Hospital, Soweto	1996–1997	Severe (>5% dehydrated)	59/172	34.3	27 to 41
Horwood (2011) [25]	2 months–59 months	74 PHC clinics (29 in Limpopo and 45 in KZN)	2006–2007	Some dehydration	37/310	11.9	8 to 15
				Severe dehydration	3/310	0.97	−0.1 to 2
Groome (2012) [27]	6 weeks–59 months	Soweto	1998–2005	Mild (≤2.5%)	1107/1885	58.73	57 to 61
				Moderate (>2.5–≤5%)	527/1885	27.96	26 to 30
				Severe (>5%)	251/1885	13.32	12 to 15

Incidence

One study (Table 3) reported data on incidence of diarrhoea [27]. Of the 9108 hospitalisations for children aged under five years in this study (representing 6328 children), there were 1949 hospitalisations for acute gastroenteritis per 192 454 total person years in the age interval 6 weeks to 59 months involving 1761 patients. An overall incidence of 10.13 (95% CI 9.68–10.58) per 1000 person years was reported.

Severity (degree of dehydration)

Three studies [24, 25, 27] evaluated the degree of dehydration in both primary and tertiary health facilities (Table 3). Horwood *et al.* [25]. reported 37 (11.5%) of the 310 children with diarrhoea had some dehydration and 3(0.97%) had severe dehydration in PHC facilities. Johnson *et al.* [24]. classified 59 (34.3%) of 172 under 4-year-old children admitted for gastroenteritis as being severely dehydrated. Groome *et al.* [27]. estimated degree of dehydration in 1885 of the 1949 hospitalisations. They reported 1107 (58.73%) with mild dehydration, moderate dehydration in 527 (27.96%) and severe dehydration in 251 (13.32%).

Discussion

The evidence obtained from this review is sparse. Our results show only one nationally representative study conducted in 1998 reporting a 2-week diarrhoea prevalence of 13% in under fives. Other studies were conducted in smaller settings across the country varying from primary and tertiary healthcare facilities to rural communities. The heterogeneity of the studies did not allow for a meta-analysis. Nonetheless, the frequency estimates of three studies were of a similar order of magnitude and translated into an average incidence of 3.4 diarrhoea episodes per child per year nationally [23], 4.1 episodes per child per year in rural KwaZulu-Natal [26] and 3.8 episodes per child per year in Soweto [27]. South Africa was in the midst of a growing HIV/AIDS epidemic, and antiretroviral therapy (ART) was not the standard of care at the time these studies were conducted. The higher incidence observed in KwaZulu-Natal can be attributed in part to the younger age range of the study participants, but may also be associated with high prevalence of HIV in that province.

In an attempt to compare the findings from our study with diarrhoea estimates reported in the grey literature such as the South African Health Review (SAHR), District Health Barometer (DHB) and General Household Surveys (GHS), we found that comparison was not possible because the study settings and populations were different with a mix of severe and non-severe cases; description of the catchment areas did not provide sufficient information to compare study results to routine health service data; different estimates for diarrhoea occurrence were reported; and measurements of diarrhoea were different between surveys (e.g. the GHS reported diarrhoea on any day in the 30 days prior to the survey).

Data from the GHS of children with diarrhoea a month prior to the survey showed a decline in diarrhoea prevalence from 2006 (1.5%) to 2010 (1.2%) and a peak at 1.9% in 2008 [79]. The low prevalence observed in the GHS might reflect the fact that these data are based on a household schedule, and the child's care-giver might not have been interviewed. However, the data may suggest a decrease in the occurrence of childhood diarrhoea in recent years, most probably as a result of a combination of interventions, namely increase in ART coverage, introduction of rotavirus vaccine, improvement in water, sanitation and food security, and reduction in poverty [80, 81].

The only included study that reported on the incidence of diarrhoea shows an overall incidence of 10.1 per 1000 person years between 1998 and 2005. Data from the District Health Information System (DHIS) have been reported in the SAHR and show that the incidence of diarrhoeal disease in under fives in South Africa steadily declined from 128.7 per 1000 in 2004 to 90.3 per 1000 in 2012, except for 2005 when it doubled to 268.7 per 1000. Furthermore, the national incidence of diarrhoea with dehydration in children in this age group progressively declined from 21.1 per 1000 children in 2009/2010 to 11.2 per 1000 children in 2012/2013, rising to 14.1 per 1000 under fives during 2013/2014 [82–84]. The DHIS diarrhoeal incidence could be a national source of data for diarrhoeal trends. However, the collection of the indicator has changed over time, that is diarrhoea incidence has recently been replaced by diarrhoea with dehydration incidence, posing a challenge in the interpretation of the trends in diarrhoea over time. It is also necessary to assess the order of magnitude difference in the rates obtained from the DHIS.

The proportional distribution of severity among diarrhoeal cases is necessary for the calculation of YLDs. Similar to the findings from a study conducted in low and middle income countries [2], the results from our review suggest that a smaller proportion of children with diarrhoea experience severe episodes. However, degree of dehydration was classified differently across studies, and severity differed across study settings.

Lack of safe drinking water, poor sanitation and hygiene, plus poorer overall health and nutrition are all factors that contribute to the heavier burden of diarrhoea in developing countries including South Africa [1, 14]. According to the Statistics South Africa 2013 report on living conditions, 89.9% of South Africans have access to running water, 77.9% have access to improved sanitation and 77.7% live in formal dwellings [85]. While the South African government post-1994 has made significant achievements with regard to the eight Millennium Development Goals, improvement in basic service delivery and reduction in childhood morbidity and mortality remain a priority. Any further reduction in childhood morbidity and mortality would depend on tackling childhood diseases such as diarrhoea and pneumonia.

Findings from our review suggest that there is a paucity of reliable *nationally* representative prevalence data available for diarrhoea in South Africa. Most studies that estimate the prevalence or incidence of diarrhoea are not population based and may not be generalisable due to the diverse population of South Africa. Furthermore, none of the included studies were conducted since ART roll-out was intensified or the rotavirus vaccine was introduced into the EPI. Although routine data, especially the DHIS, provide information on diarrhoea indicators, they are limited primarily to public healthcare facilities. That said, DHIS provides estimates for diarrhoea indicators by month for each year and should be investigated further.

Conclusions

This review has highlighted the paucity of nationally representative prevalence data. It is crucial to have more national surveys and localised prospective cohort studies with standardised data-collection methods to allow for more effective comparisons.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Risk of bias assessment tool for observational studies.
Appendix S2. Assessment of risk of bias of included studies.

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