Prevalence of antibiotic use and household water-sanitation risk factors of acute watery diarrhea among children <5 years: retrospective analysis of multicounty health survey data, 2006-2018

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Research Article

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Abstract

A total 12,69,944 under five year Childs were included in this study among them 1,80,067 Childs were acute watery diarrhea (AWD) and 19,502 Childs were bloody diarrhea respectively. Among them 47,755 Childs were taken antibiotic treatment for AWD. The overall prevalence of acute watery diarrhea ~ 14% (prevalence = 0.142; 95% CI = 0.141, 0.142). On the other hand the prevalence of bloody diarrhea ~ 2% (prevalence = 0.015; 95% CI = 0.015, 0.016). The prevalence of antibiotic treatment for AWD was ~ 27% (prevalence = 0.27, 95% CI = 0.26, 0.27) among the under five years old children in DH survey regions in the world. The prevalence of acute watery diarrhea was higher ~ 17% (prevalence = 0.17, 95% CI = 0.16, 0.17) in the Latin America DHS survey region. The minimum prevalence of AWD was almost equal between South East Asia and Central Asia DHS survey regions ~ 12% (prevalence = 0.12, 95% CI = 0.11, 0.12) and ~ 12% (prevalence = 0.12, 95% CI = 0.10, 0.13) respectively. On the other hand the prevalence of AWD between Europe and West North and Central Africa DHS survey regions ~ 16% (prevalence = 0.16, 95% CI = 0.15, 0.16) and ~ 15% (prevalence = 0.15, 95% CI = 0.14, 0.15) correspondingly. In the central Asia of 15,089 under five Childs were included in the survey. Among them 1,748 Childs were AWD and 967 Childs had taken antibiotic treatment for AWD. The highest prevalence of antibiotic use for AWD in Central Asia ~ 55% (prevalence=(967/1748) = 0.55, 95% CI = 0.52, 0.59) and Europe DH survey region ~ 44% (prevalence=(5483/12502) = 0.44, 95% CI = 0.43, 0.45). The lowest prevalence of antibiotic use for under five child AWD was ~ 23% (prevalence=(11918/51328) = 0.23, 95% CI = 0.22, 0.24) in the DH survey region South East Asia. On the other hand the DH survey region Latin America and West North and Central Africa region the prevalence of antibiotic use for AWD were ~ 30% (prevalence=(7887/26396) = 0.30, 95% CI = 0.29, 0.31) and ~ 24% (prevalence=(21500/88093) = 0.24, 95% CI = 0.23, 0.24). The South East Asia DH survey region countries DHS 2007 (Bangladesh), DHS 2014 and 2010 (Cambodia), DHS 2017 and 2012 (Indonesia), DHS 2009 (Maldives), DHS 2015–2016 (Myanmar), DHS 2012–2013 (Pakistan), DHS 2017 and 2013 (Philippines), and DHS 2009–2010 (Timor-Leste) were higher risk of AWD for drinking unimproved water sources. The prevalence of antibiotic use for u5c AWD was shown highest prevalence in DHS 2007 (~ 44%), DHS 2012 (~ 49%), DHS 2016 (~ 40%), and DHS 2017 (~ 65%) from DH survey 2006 to 2018 in South East & Central Asia. The linear trend analysis showed that upward trend for using antibiotic of AWD in the South East & Central Asia DH survey region.

Introduction

Diarrhea is the state of loose, liquid, or watery bowel engagements three times or more a day. [1] If it will be continue for a few days for a result creates severe dehydration. Among the low- and middle-income countries diarrhea is one of the foremost causes of antibiotic use for children. On the other hand vaccine may prevent diarrhea infections but they often consumed antibiotic treatment. [2] Of 13% prevalence for purchasing antibiotics without a prescription, ~ 2% were preferred by the regulars and ~ 11% were suggested by the pharmacists. [3] Cotrimoxazole was the most commonly prescribed drug (51%), followed by colistin sulfate (15.3%), norfloxacin (11%), and nalidixic acid (0.5%). The average number of antimicrobials per case of inpatients was higher than outpatients (1.15 vs 0.84, p < 0.001). There was a
trend toward prescribing noroxacin in childhood diarrhea. [4] The last 20 years shown that the prevalence of antibiotic resistance has increasing remarkably. [5] It is a serious hazard for health among the global people. [6] The low income and middle income countries are higher threatened than high income countries for depletion of antibiotic, prevalence, and confrontation of antibiotic against the childhood diarrhea or diseases by the record. [7] Aggregate the numbers of peoples for gaining access of antimicrobial resistance not only the formal health care but also increasing the antibiotic treatments by the both formal and informal health care providers. [8, 9] Moderately a 3rd of patients admitted to hospital are specified by the antibiotic treatment according to the report by the worldwide Point Prevalence Survey. [10] Around 21% antibiotic were used by oral pills or syrups and 3% by injections in the Demographic Health Survey (DHS) and Multiple Indicator Cluster Survey (MICS) data. The proportion of antibiotic treatments 3–78% for childhood diarrhea episodes among 38 included studies. [11] The main objective of this paper to estimate the prevalence of antibiotic use for acute watery diarrhea of under five children (u5c), and retrospectives analysis of household water sanitation risk factors of DHS multi country survey from 2006–2018.

Methods

Data sources

In this paper we used 112 Demographic Health Survey (DHS) data. On period of household surveys mothers were asked detailed questions about management of diarrhea episodes. And those under-5children were included whose 2-weeks diarrhea episodes earlier the survey date. Of 112 countries 12,69,944 under five Children (u5c) datasets were collected from Demographic and Health Survey (DHS) programmed surveys from 2006 to 2018 (https://dhsprogram.com/Data/). The cross sectional study design used for the DHS survey data collection. The details sampling strategy and methodology discuss in the DHS website and published reports.

Statistical Analysis Method

The dataset was collected from Demographic and Health Survey (DHS) programmed from 2006 to 2018 survey year. There were 12,69,944 under five Children suffering from acute watery diarrhea (had diarrhea last 24 hours or last two weeks) were analyzed as a study variable or dependent variable. Also analyzed the prevalence of antibiotic use for under five child acute watery diarrhea. The logistic regression was used to estimate crude odds ratio (COR) of household drinking water (Improved as reference category) sources and sanitation (Improved as reference category) risk factors with 95% confidence interval. The $p$-value was estimated for prediction of significant risk factors of under-five childhood watery diarrhea. The multiple logistic regression was used to estimate the adjusted odds ratio (AOR) the age in months and sex of the children with 95% confidence interval. All the statistical analysis implemented using the open sources software R statistical programming language (https://www.r-project.org/). The classification of household sanitation and water risk factors are as follows:

**Improved Sanitation Facility Group:**
i. flush - to piped sewer system
ii. flush - to septic tank
iii. flush - to pit latrine
iv. flush - don't know where
v. pit latrine - ventilated improved pit (VIP)
vi. pit latrine - with slab
vii. composting toilet

**Unimproved Sanitation Facility Group:**

i. flush - to somewhere else
ii. pit latrine - without slab / open pit
iii. bucket toilet
iv. hanging toilet/latrine
v. other

**Improved Drinking Water Sources Group:**

i. piped into dwelling piped to yard/plot
ii. public tap/standpipe
iii. piped to neighbor
iv. tube well or borehole
v. protected well
vi. protected spring
vii. rainwater
viii. tanker truck, cart with small tank
ix. bottled water

**Unimproved Drinking Water Sources Group:**

i. unprotected well
ii. unprotected spring
iii. surface water (river/dam/lake/pond/stream/canal/irrigation channel)
iv. other

**Results**

**Overall Characteristics:** A total 12,69,944 under five year Childs were included in this study among them 1,80,067 Childs were acute watery diarrhea (AWD) and 19,502 Childs were bloody diarrhea respectively.
Among them 47,755 Childs were taken antibiotic treatment for AWD. The overall prevalence of acute watery diarrhea ~14% (prevalence=0.142; 95% CI=0.141, 0.142). On the other hand the prevalence of bloody diarrhea ~2% (prevalence=0.015; 95% CI=0.015, 0.016). The prevalence of antibiotic treatment for AWD was ~27% (prevalence=0.27, 95% CI=0.26, 0.27) among the under five years old children in DH survey regions in the world.

**Socio-economic and Demographic characteristics:** The wealth index is a significant measurement of socio-economic status. The median (robust measures of central tendency with 50% outliers tolerate) prevalence of antibiotic use for acute watery diarrhea (AWD) were almost equal among the poorest (~22%) and poorer (~22%) group Childs respectively. But among the richest people prevalence of antibiotic use was ~14% for AWD. Therefore, from the box plot (Figure-1(A)) showed that the prevalence of antibiotic use trend was decreasing from poorest to richest (Supplementary Table-1).

The mother education plays significant roles for under five childhood acute watery diarrhea. The prevalence of AWD among the primary and secondary education child mother were higher ~31% (median) and ~28% (median) respectively. Comparatively lower prevalence of AWD among the no education child mother group ~20% (median) than the primary and secondary education child mother. However, prevalence of AWD remarkably lowers ~2% among the higher education mother (Figure-1(B) and Supplementary Table-2).

The prevalence of AWD was higher among the age group 6-12 months and 12-18 months ~19% (median) and ~18% (median) respectively. The very low prevalence of AWD among the age group 42-48 months and 48-54 months were ~5% (median) and ~5% (median) respectively (Supplementary Table-3). From the box plot (Figure-1(C)) showed that the prevalence of AWD was decreasing trend from age group 6-12 months to 48-54 months.

**Prevalence of acute watery diarrhea (AWD):**

The prevalence of acute watery diarrhea was higher ~17% (prevalence=0.17, 95% CI=0.16, 0.17) in the Latin America DHS survey region. The minimum prevalence of AWD was almost equal between South East Asia and Central Asia DHS survey regions ~12% (prevalence=0.12, 95% CI=0.11, 0.12) and ~12% (prevalence=0.12, 95% CI=0.10, 0.13) respectively. On the other hand the prevalence of AWD between Europe and West North and Central Africa DHS survey regions ~16% (prevalence=0.16, 95% CI=0.15, 0.16) and ~15% (prevalence=0.15, 95% CI=0.14, 0.15) correspondingly (Table-1).

**South East Asia:** In Afghanistan 2015 demographic health survey (DHS) 30,951 Childs were included in this survey. Among them 7990 Childs were AWD. It is the highest prevalence ~26% (prevalence=0.26, 95% CI=0.25, 0.26) in the DH survey region South East Asia. The DH survey 2012-2013 and 2017-2018 in Pakistan were higher prevalence of AWD ~21% (prevalence=0.21, 95% CI=0.20, 0.22) and ~18% (prevalence=0.18, 95% CI=0.17, 0.18). But the Maldives 2009 and 2016-2017 DH survey showed that the lowest prevalence of AWD ~5% (prevalence=0.05, 95% CI=0.04, 0.06) and ~4% (prevalence=0.04, 95%
CI=0.03, 0.05) respectively (Table-1). The details prevalence of AWD in South Asia was shown in the global mapping Figure-2(A).

Central Asia: The highest prevalence of AWD was ~15% (prevalence=0.15, 95% CI=0.14, 0.16) in Tajikistan DH survey 2012. On the other hand the lowest prevalence of AWD was ~5% (prevalence=0.05, 95% CI=0.05, 0.06) in Kyrgyz Republic DH survey 2012 (Table-1 and Figure 2(B)) in the DH survey region Central Asia.

Europe: In the DH survey 2015-2016 and 2017-2018 in Albania was lowest prevalence of AWD ~4% (prevalence=0.04, 95% CI=0.03, 0.15) and ~5% (prevalence=0.05, 95% CI=0.05, 0.06). The highest prevalence of AWD ~31% (prevalence=0.31, 95% CI=0.30, 0.32) in Yemen 2013 DH survey (Table-1 and Figure-2(C)) in the DH survey region Europe.

Latin America: The demographic and health survey 2008 in Bolivia and 2005-2006 in Haiti were highest prevalence of AWD ~25% (prevalence=0.25, 95% CI=0.24, 0.26) and ~22% (prevalence=0.22, 95% CI=0.21, 0.23) respectively. The lowest prevalence of AWD was ~10% (prevalence=0.10, 95% CI=0.09, 0.11) in Guyana 2009 DH survey in the Latin America region (Tabel-1 and Figure-2(D)).

West North and Central Africa: The lowest prevalence of AWD was ~6% (prevalence=0.06, 95% CI=0.06, 0.07) in Benin 2011-2012 DH survey. The demographic health survey 2006 and 2011 in Uganda and Burundi 2010 DH survey were highest prevalence of AWD ~26% (prevalence=0.26, 95% CI=0.25, 0.27), ~23% (prevalence=0.23, 95% CI=0.22, 0.24), and ~25% (prevalence=0.25, 95% CI=0.24, 0.26) respectively (Table-1 and Figure-2(E)) in the West North and Central Africa.

Prevalence of Antibiotic use for AWD:

In the central Asia of 15,089 under five Childs were included in the survey. Among them 1,748 Childs were AWD and 967 Childs had taken antibiotic treatment for AWD. The highest prevalence of antibiotic use for AWD in Central Asia ~55% (prevalence=(967/1748)=0.55, 95% CI=0.52, 0.59) and Europe DH survey region ~44% (prevalence=(5483/12502)=0.44, 95% CI=0.43, 0.45). The lowest prevalence of antibiotic use for under five Child AWD was ~23% (prevalence=(11918/51328)=0.23, 95% CI=0.22, 0.24) in the DH survey region South East Asia. On the other hand the DH survey region Latin America and West North and Central Africa region the prevalence of antibiotic use for AWD were ~30% (prevalence=(7887/26396)=0.30, 95% CI=0.29, 0.31) and ~24% (prevalence=(21500/88093)=0.24, 95% CI=0.23, 0.24) (Table-1).

South East Asia: The demographic health survey 2017-2018 in Pakistan and 2007 in Indonesia were highest prevalence of antibiotic use for AWD in the South East Asia. The estimated prevalence were ~47% (prevalence=0.47, 95% CI=0.44, 0.50) and ~44% (prevalence=0.44, 95% CI=0.41, 0.46) respectively. The lowest prevalence of antibiotic use for AWD in the Maldives DH survey 2016-2017 was ~5% (prevalence=0.05, 95% CI=0.18, 0.27) and Timor-Leste DH survey 2009-2010 was ~5% (prevalence=0.05,
95% CI=0.0, 0.11) respectively (Table-1) and the details prevalence shown in the global mapping Figure-3(A).

Central Asia: In the Central Asia DH survey region more than ~40% prevalence of antibiotic use for AWD. The DH survey 2017 in Tajikistan highest prevalence ~65% (prevalence=0.65, 95% CI=0.61, 0.69) of antibiotic use for Child AWD in the Central Asia region (Table-1 and Figure-3(B)).

Europe: In the DH survey 2012 in Jordan and 2006 in Azerbaijan were highest prevalence of antibiotic use for AWD ~54% (prevalence=0.54, 95% CI=0.50, 0.57) and ~49% (prevalence=0.49, 95% CI=0.40, 0.58). On the other hand the lowest prevalence of antibiotic use for AWD ~15% (prevalence=0.15, 95% CI=-0.01, 0.30) in the Europe DH survey region (Table-1 and Figure-3(C)).

Latin America: The DH survey region Latin America the highest prevalence of antibiotic use for AWD in Guatemala 2014-2015 survey ~42% (prevalence=0.42, 95% CI=0.39, 0.45). Also in the Bolivia DHS 2008, Peru DHS 2009, Peru DHS 2011, Peru DHS 2012 were high prevalence of antibiotic use for AWD. The estimated prevalence for those DHS countries were ~40% (prevalence=0.40, 95% CI=0.37, 0.43), ~40% (prevalence=0.40, 95% CI=0.36, 0.44), ~39% (prevalence=0.39, 95% CI=0.35, 0.44), and ~38% (prevalence=0.38, 95% CI=0.34, 0.43) respectively. The lowest prevalence of antibiotic use for AWD was ~10% (prevalence=0.10, 95% CI=0.05, 0.15) in Haiti 2012 DHS in the DH survey region Latin America (Table-1 and Figure-3(D)).

West North and Central Africa: The lowest prevalence of antibiotic use for AWD in the DH survey region West North and Central Africa in Burundi DHS 2016-2017 and Zimbabwe DHS 2005-2006 were ~6% (prevalence=0.06, 95% CI=0.02, 0.09) and ~6% (prevalence=0.06, 95% CI=-0.02, 0.14) respectively. The higher prevalence of antibiotic use for AWD in Congo DHS 2011-2012 and Liberia DHS 2013 were ~59% (prevalence=0.59, 95% CI=0.56, 0.63) and ~59% (prevalence=0.59, 95% CI=0.56, 0.62) respectively. On the other hand, Sierra Leone DHS 2013 and 2008, DHS 2010 in Tanzania were also higher prevalence of antibiotic use for AWD of under five children. The estimated prevalence were ~48% (prevalence=0.48, 95% CI=0.44, 0.52), ~44% (prevalence=0.44, 95% CI=0.38, 0.50), and ~47% (prevalence=0.47, 95% CI=0.43, 0.52) correspondingly (Table-1 and Figure-3(E)).

Household water and sanitation risk factors analysis of under five children AWD:

The multiple logistic regression was used to estimate the odds ratio for measuring water sanitation risk factors of under five children AWD.

Drinking water sources and sanitation toilet risk factor:

South East Asia: The South East Asia DH survey region countries DHS 2007 (Bangladesh), DHS 2014 and 2010 (Cambodia), DHS 2017 and 2012 (Indonesia), DHS 2009 (Maldives), DHS 2015-2016 (Myanmar), DHS 2012-2013 (Pakistan), DHS 2017 and 2013 (Philippines), and DHS 2009-2010 (Timor-Leste) were higher risk of AWD for drinking unimproved water sources.
The DH survey 2007 in Bangladesh was ~1.10 times (aOR=1.1, 95% CI=1.09, 1.11) higher risk of u5c AWD for using unimproved drinking water sources. The DHS 2014 ~1.4 times (aOR=1.40, 95% CI=1.39, 1.42) and 2010 ~1.11 times (aOR=1.11, 95% CI=1.10, 1.12) more risk of u5c AWD in Cambodia for using unimproved drinking water sources. Similarly, ~1.26 times in DHS 2017 and ~1.18 times in 2012 (Indonesia), ~1.65 times in DHS 2009 (Maldives), ~1.21 times in DHS 2015-2016 (Myanmar), ~1.11 times in DHS 2012-2013 (Pakistan), ~1.24 times in DHS 2017 and ~1.18 times in 2013 (Philippines), and ~1.18 times in DHS 2009-2010 (Timor-Leste) higher risk of u5c AWD due to use unimproved drinking water sources respectively (Table-2 and Supplementary Figure-1 (a)).

Most of the countries in the South East Asia region were higher risk of u5c AWD for using unimproved sanitation toilet. On the other hand, DHS 2015 in Afghanistan, DHS 2015-2016 in Myanmar, and DHS 2016 in Timor-Leste were lower risk of AWD (Table-2 and Supplementary Figure-3(a)).

Central Asia: The DH survey 2012 in the Tajikistan was ~1.4 times (aOR=1.14, 95% CI=1.13, 1.15) higher risk of u5c AWD for drinking unimproved water sources (Table-2 and Supplementary Figure-1(b)). On the other hand, the DHS 2012 in Tajikistan was ~4% (aOR=1.04, 95% CI=1.03, 1.04) more risk of AWD using unimproved sanitation toilet (Table-2 and Supplementary Figure-3(b)).

Europe: The DHS 2010 in Armenia, DHS 2016 in Azerbaijan, and DHS 2008 in Egypt were ~2 times (aOR=1.90, 95% CI=1.85, 1.95), ~5 times (aOR=4.54, 95% CI=4.35, 4.73), and ~1.31 times (aOR=1.31, 95% CI=1.28, 1.33) were higher risk of AWD for drinking unimproved water sources (Table-2 and Supplementary Figure-1(c)).

The risk of AWD for using unproved sanitation toilet was higher among Armenia (DHS-2010), Azerbaijan (DHS-2006), and Jordan (DHS-2012). The estimated adjusted odds ratio (aOR) was aOR=2.54 (95% CI=2.47, 2.61), aOR=1.42 (95% CI=1.39, 1.46), and aOR=1.47 (95% CI=1.45, 1.48) respectively (Table-2 and Supplementary Figure-3(c)).

Latin America: The DHS 2008 in Bolivia (aOR=1.69; 95% CI=1.67, 1.71), DHS 2010 in Colombia (aOR=1.23; 95% CI=1.22, 1.24), DHS 2014-2015 in Guatemala (aOR=1.31; 95% CI=1.29, 1.33), DHS 2016-2017 (aOR=1.16; 95% CI=1.29, 1.33) and DHS 2012 (aOR=1.76; 1.71, 1.80) in Haiti, DHS 2012 (aOR=1.49; 95% CI=1.45, 1.48), DHS 2009 (aOR=1.59; 95% CI=1.57, 1.61), DHS 2007-2008 (aOR=1.55; 95% CI=1.53, 1.57), and DHS 2004-2006 (aOR=1.40; 95% CI=1.38, 1.41) in Peru were highest risk of u5c AWD for drinking unimproved water sources (Table-2 and Supplementary Figure-1(d)).

All the DH survey in the DH survey region in Latin America was higher risk of AWD for using unimproved sanitation toilet. But the DHS 2016-2017 in Haiti was lower risk of AWD (aOR=0.99; 95% CI=0.99, 0.99) for using unimproved sanitation toilet (Table-2 and Supplementary Figure-3(d)).

West North and Central Africa: Most of DH survey countries were higher risk of AWD of u5c for using unimproved drinking water sources and unimproved sanitation toilet in the West North and Central Africa.
DH survey regions. The details results were shown in the Table-2 (drinking water sources & sanitation toilet), Supplementary Figure-2 (drinking water sources) and Supplementary Figure-4 (sanitation toilet).

Trend of Antibiotic use for AWD

**South East & Central Asia:** The prevalence of antibiotic use for u5c AWD was shown highest prevalence in DHS 2007 (~44%), DHS 2012 (~49%), DHS 2016 (~40%), and DHS 2017 (~65%) from DH survey 2006 to 2018 in South East & Central Asia. The linear trend analysis showed that upward trend for using antibiotic of AWD in the South East & Central Asia DH survey region (Figure-4 (A)).

**Europe:** The prevalence of antibiotic use for u5c AWD was shown highest prevalence in DHS 2007 (~50%), DHS 2012 (~54%), DHS 2014 (~47%), and DHS 2018 (~32%) from DH survey 2006 to 2018 in Europe DH survey region. The linear trend analysis showed that downward trend for using antibiotic of AWD in the Europe DH survey region (Figure-4 (B)).

**Latin America:** The prevalence of antibiotic use for u5c AWD was shown highest prevalence in DHS 2006 (~37%), DHS 2008 (~40%), DHS 2009 (~40%), and DHS 2015 (~32%) from DH survey 2006 to 2018 in Latin America DH survey region. The linear trend analysis showed that downward (decreasing pattern) trend for using antibiotic of AWD in the Latin America DH survey region (Figure-4 (C)).

**West North and Central Africa:** The prevalence of antibiotic use for u5c AWD was shown highest prevalence in DHS 2008 (~44%), DHS 2010 (~47%), DHS 2012 (~59%), DHS 2013 (~48%), and DHS 2018 (~8%) from DH survey 2006 to 2018 in West North and Central Africa DH survey region. The linear trend analysis showed that downward (decreasing pattern) trend for using antibiotic of AWD in the West North and Central Africa DH survey region (Figure-4 (D)).

Discussion And Conclusions

Antibiotic use for acute watery diarrhea among the under five children are common phenomenon in the low and middle income countries. The overall prevalence of diarrhea among the South East Asia and Central Asia are equally distributed among the under child watery diarrhea. The highest prevalence of antibiotic use of under five children diarrhea among the Central Asia on the other hand the lowest prevalence of antibiotic use among the West North and Central Africa DH survey region. According to the trend analysis shown that the prevalence of antibiotic use for under five children diarrhea was the increasing trend among the South East and Central Asia DH survey regions. However all the other DH survey regions (Europe, Latin America, and West North and Central Africa) were decreasing trend of antibiotic use for under five children diarrhea.

Declarations

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The author is cordially grateful to the DHS for making the data access available for analysis and publications. This work was done by author won interest, there no funding for this study. The authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

**Author contributions**

All the statistical analysis and write & revised the manuscript and provided important intellectual content. The author approved the final version of the manuscript.

**Competing interests**

The author(s) declare no competing interests.

**Data Availability**

The study data are available upon request from the Demographic and Health Surveys program (https://dhsprogram.com/).

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**Tables**

**Table-1**: Prevalence of diarrhea of under-five child (u5c) among 112 DHS national survey 2006-2018
| DHS Survey Countries | Total No. of u5c | No. of u5c diarrhea | Diarrhea of u5c Prevalence (95% CI) | No. of u5c antibiotic use for AWD | Antibiotic use for AWD Prevalence (95% CI) |
|----------------------|----------------|---------------------|------------------------------------|----------------------------------|-----------------------------------------|
| South East Asia      |                |                     |                                    |                                  |                                         |
| Afghanistan (2015)   | 30951          | 7990               | 0.26 (0.25, 0.26)                  | 1522                             | 0.19 (0.17, 0.21)                       |
| Bangladesh (2007)    | 5789           | 560                | 0.1 (0.09, 0.1)                    | 56                               | 0.1 (0.02, 0.18)                       |
| Cambodia (2014)      | 6970           | 855                | 0.12 (0.11, 0.13)                  | 45                               | 0.05 (-0.01, 0.12)                     |
| Cambodia (2010)      | 7820           | 1135               | 0.15 (0.14, 0.15)                  | 83                               | 0.07 (0.02, 0.13)                      |
| India (2015-2016)    | 247743         | 22500              | 0.09 (0.09, 0.09)                  | 5464                             | 0.24 (0.23, 0.25)                      |
| Indonesia (2017)     | 17263          | 2440               | 0.14 (0.14, 0.15)                  | 306                              | 0.13 (0.09, 0.16)                      |
| Indonesia (2012)     | 17323          | 2505               | 0.14 (0.14, 0.15)                  | 321                              | 0.13 (0.09, 0.16)                      |
| Indonesia (2007)     | 17891          | 2536               | 0.14 (0.14, 0.15)                  | 1104                             | 0.44 (0.41, 0.46)                      |
| Maldives (2016-2017) | 3055           | 126                | 0.04 (0.03, 0.05)                  | 6                                | 0.05 (-0.18, 0.27)                     |
| Maldives (2009)      | 3759           | 188                | 0.05 (0.04, 0.06)                  | 20                               | 0.11 (-0.04, 0.25)                     |
| Myanmar (2015-2016)  | 4596           | 550                | 0.12 (0.11, 0.13)                  | 219                              | 0.4 (0.33, 0.46)                       |
| Nepal (2016)         | 4861           | 336                | 0.07 (0.06, 0.08)                  | 102                              | 0.3 (0.21, 0.39)                       |
| Nepal (2011)         | 5054           | 679                | 0.13 (0.12, 0.14)                  | 93                               | 0.14 (0.07, 0.21)                      |
| Nepal (2006)         | 5457           | 659                | 0.12 (0.11, 0.13)                  | 61                               | 0.09 (0.02, 0.17)                      |
| Pakistan (2017-2018) | 11985          | 2107               | 0.18 (0.17, 0.18)                  | 985                              | 0.47 (0.44, 0.5)                       |
| Pakistan (2012-2013) | 10935          | 2298               | 0.21 (0.2, 0.22)                   | 829                              | 0.36 (0.33, 0.39)                      |
| Philippines (2017)   | 10297          | 652                | 0.06 (0.06, 0.07)                  | 171                              | 0.26 (0.2, 0.33)                       |
| Country                        | 2013          | 2016          | 2008          | 2012          |
|--------------------------------|---------------|---------------|---------------|---------------|
| Philippines (2013)             | 7012          | 6950          | 6382          | 9294          |
| Philippines (2008)             | 551           | 700           | 571           | 1390          |
| Timor-Leste (2016)             | 194           | 124           | 139           | 74            |
| Timor-Leste (2009-2010)        | 0.08 (0.07, 0.08) | 0.1 (0.09, 0.11) | 0.09 (0.08, 0.1) | 0.15 (0.14, 0.16) |
| Total                          | 441387        | 51328         | 4834          | 15089         |
| Central Asia                   |               |               |               |               |
| Kyrgyz Republic (2012)         | 4236          | 4834          | 4236          | 1748          |
| Tajikistan (2017)              | 223           | 802           | 6019          | 519           |
| Tajikistan (2012)              | 95            | 519           | 4934          | 353           |
| Total                          | 15089         | 1748          | 15089         | 967           |
| Europe                         |               |               |               |               |
| Albania (2017-2018)            | 22            | 149           | 2755          | 312           |
| Armenia (2015-2016)            | 68            | 128           | 1709          | 4934          |
| Armenia (2010)                 | 22            | 41            | 1450          | 353           |
| Azerbaijan (2006)              | 231           | 113           | 2196          | 967           |
| Egypt (2014)                   | 2010          | 15465         | 2196          | 10475         |
| Egypt (2008)                   | 979           | 949           | 10595         | 312           |
| Jordan (2017-2018)             | 968           | 390           | 10475         | 0.09 (0.09, 0.1) |
| Jordan (2012)                  | 1540          | 830           | 10128         | 0.15 (0.15, 0.16) |
| Jordan (2007)                  | 1659          | 836           | 10237         | 0.16 (0.15, 0.17) |
| Yemen (2013)                   | 4770          | 1968          | 15326         | 0.31 (0.3, 0.39) |
| Country                  | Year      | Value 1  | Value 2  | Value 3  | Value 4  |
|--------------------------|-----------|----------|----------|----------|----------|
| **Bolivia (2008)**       |           | 8193     | 2055     | 0.25     | 825      | 0.4     |
| **Colombia (2010)**      |           | 17443    | 2495     | 0.14     | 549      | 0.22    |
| **Dominican Republic (2013)** |       | 3605     | 637      | 0.18     | 125      | 0.2     |
| **Dominican Republic (2007)** |       | 10796    | 1773     | 0.16     | 294      | 0.17    |
| **Guatemala (2014-2015)** |         | 12068    | 2239     | 0.19     | 946      | 0.42    |
| **Guyana (2009)**        |           | 2105     | 213      | 0.1      | 36       | 0.17    |
| **Haiti (2016-2017)**    |           | 6120     | 1235     | 0.2      | 202      | 0.16    |
| **Haiti (2012)**         |           | 6744     | 1415     | 0.21     | 141      | 0.15    |
| **Haiti (2005-2006)**    |           | 5596     | 1217     | 0.22     | 182      | 0.15    |
| **Honduras (2011-2012)** |           | 10592    | 1919     | 0.18     | 684      | 0.36    |
| **Honduras (2005-2006)** |           | 10506    | 1797     | 0.17     | 360      | 0.2     |
| **Peru (2012)**          |           | 9445     | 1254     | 0.13     | 479      | 0.38    |
| **Peru (2011)**          |           | 8950     | 1312     | 0.15     | 518      | 0.39    |
| **Peru (2009)**          |           | 10041    | 1475     | 0.15     | 586      | 0.4     |
| **Peru (2007-2008)**     |           | 16730    | 2680     | 0.16     | 980      | 0.37    |
| **Peru (2004-2006)**     |           | 16730    | 2680     | 0.16     | 980      | 0.37    |
| **Total**                |           | 155664   | 26396    | 0.17     | 7887     | 0.30    |
| Country                      | Code     | Year(s)     | Total Cases | Deaths | Death Rate | Total Deaths | Death Rate |
|------------------------------|----------|-------------|-------------|--------|------------|--------------|------------|
| Angola (2015-2016)            | 282      | 2015-2016   | 13619       | 1891   | 0.14       | 406          | 0.21       |
| Benin (2017-2018)             | 282      | 2017-2018   | 12651       | 1342   | 0.11       | 101          | 0.08       |
| Benin (2011-2012)             | 282      | 2011-2012   | 12679       | 816    | 0.06       | 163          | 0.2        |
| Burkina Faso (2010)           | 282      | 2010        | 13716       | 2031   | 0.15       | 576          | 0.28       |
| Burundi (2016-2017)           | 282      | 2016-2017   | 12472       | 2664   | 0.21       | 151          | 0.06       |
| Burundi (2010)                | 282      | 2010        | 7231        | 1787   | 0.25       | 384          | 0.21       |
| Cameroon (2011)               | 282      | 2011        | 10713       | 2078   | 0.19       | 372          | 0.18       |
| Chad (2014-2015)              | 282      | 2014-2015   | 16837       | 3292   | 0.2        | 474          | 0.14       |
| Comoros (2012)                | 282      | 2012        | 3022        | 480    | 0.16       | 91           | 0.19       |
| Congo (2011-2012)             | 282      | 2011-2012   | 8857        | 1531   | 0.17       | 908          | 0.59       |
| Congo (2005)                  | 282      | 2005        | 4435        | 627    | 0.14       | 203          | 0.32       |
| Congo Democratic Republic (2013-2014) | 282 | 2013-2014 | 17188 | 2818 | 0.16 | 939 | 0.33 |
| Congo Democratic Republic (2007) | 282 | 2007 | 7987 | 1287 | 0.16 | 336 | 0.26 |
| Cote d'Ivoire (2011-2012)     | 282      | 2011-2012   | 7052        | 1276   | 0.18       | 163          | 0.13       |
| Eswatini (2006-2007)          | 282      | 2006-2007   | 2537        | 347    | 0.14       | 75           | 0.22       |
| Ethiopia (2016)               | 282      | 2016        | 10006       | 1090   | 0.11       | 150          | 0.14       |
| Ethiopia (2011)               | 282      | 2011        | 10808       | 1620   | 0.15       | 251          | 0.15       |
| Gabon (2012)                  | 282      | 2012        | 5747        | 981    | 0.17       | 299          | 0.3        |
| Gambia (2013)                 | 282      | 2013        | 7788        | 1340   | 0.17       | 325          | 0.24       |
| Country (Year)          | Population | Deaths | Death Rate | Deaths Per 100k | Death Rate Per 100k |
|------------------------|------------|--------|------------|-----------------|--------------------|
| Ghana (2014)           | 5593       | 671    | 0.12 (0.11, 0.13) | 243              | 0.36 (0.3, 0.42)   |
| Ghana (2008)           | 2794       | 553    | 0.2 (0.18, 0.21)  | 201              | 0.36 (0.3, 0.43)   |
| Guinea (2012)          | 6396       | 1071   | 0.17 (0.16, 0.18) | 226              | 0.21 (0.16, 0.26)  |
| Kenya (2014)           | 20069      | 2953   | 0.15 (0.14, 0.15) | 505              | 0.17 (0.14, 0.2)   |
| Kenya (2008-2009)      | 5706       | 946    | 0.17 (0.16, 0.18) | 217              | 0.23 (0.17, 0.29)  |
| Lesotho (2014)         | 2915       | 328    | 0.11 (0.1, 0.12)  | 52               | 0.16 (0.06, 0.26)  |
| Liberia (2013)         | 7058       | 1675   | 0.24 (0.23, 0.25) | 989              | 0.59 (0.56, 0.62)  |
| Liberia (2007)         | 5305       | 1072   | 0.2 (0.19, 0.21)  | 148              | 0.14 (0.08, 0.19)  |
| Madagascar (2008-2009) | 11750      | 1006   | 0.09 (0.08, 0.09) | 260              | 0.26 (0.2, 0.31)   |
| Malawi (2015-2016)     | 16462      | 3402   | 0.21 (0.2, 0.21)  | 979              | 0.29 (0.26, 0.32)  |
| Malawi (2010)          | 18360      | 3105   | 0.17 (0.16, 0.17) | 717              | 0.23 (0.2, 0.26)   |
| Mali (2012-2013)       | 9582       | 844    | 0.09 (0.08, 0.09) | 140              | 0.17 (0.1, 0.23)   |
| Mali (2006)            | 12388      | 1450   | 0.12 (0.11, 0.12) | 335              | 0.23 (0.19, 0.28)  |
| Mozambique (2011)      | 10291      | 1071   | 0.1 (0.1, 0.11)   | 313              | 0.29 (0.24, 0.34)  |
| Namibia (2013)         | 4805       | 810    | 0.17 (0.16, 0.18) | 156              | 0.19 (0.13, 0.25)  |
| Namibia (2006-2007)    | 4841       | 576    | 0.12 (0.11, 0.13) | 112              | 0.19 (0.12, 0.27)  |
| Niger (2012)           | 11602      | 1591   | 0.14 (0.13, 0.14) | 199              | 0.13 (0.08, 0.17)  |
| Niger (2006)           | 8209       | 1669   | 0.2 (0.19, 0.21)  | 590              | 0.35 (0.31, 0.39)  |
| Nigeria (2013)         | 28596      | 2968   | 0.1 (0.1, 0.11)   | 1121             | 0.38 (0.35, 0.41)  |
| Nigeria (2008)         | 25273      | 2645   | 0.1 (0.1, 0.11)   | 849              | 0.32 (0.29, 0.35)  |
| Country (Year)                      | Total Revenue | Total Expenses | Total Net Income | Revenue Growth | Expense Growth |
|------------------------------------|---------------|----------------|------------------|---------------|---------------|
| Rwanda (2014-2015)                 | 7556          | 905            | 0.12 (0.11, 0.13) | 106           | 0.12 (0.06, 0.18) |
| Rwanda (2010)                      | 8484          | 1109           | 0.13 (0.12, 0.14) | 116           | 0.1 (0.05, 0.16)  |
| Sao Tome and Principe (2008-2009) | 1851          | 230            | 0.12 (0.11, 0.14) | 61            | 0.27 (0.15, 0.38) |
| Senegal (2017)                     | 11605         | 2212           | 0.19 (0.18, 0.2)  | 336           | 0.15 (0.11, 0.19) |
| Senegal (2016)                     | 6417          | 1062           | 0.17 (0.16, 0.17) | 164           | 0.15 (0.1, 0.21)  |
| Senegal (2015)                     | 6602          | 1359           | 0.21 (0.2, 0.22)  | 195           | 0.14 (0.09, 0.19) |
| Senegal (2014)                     | 6526          | 1272           | 0.19 (0.19, 0.2)  | 186           | 0.15 (0.1, 0.2)   |
| Senegal (2012-2013)                | 6540          | 972            | 0.15 (0.14, 0.16) | 201           | 0.21 (0.15, 0.26) |
| Senegal (2010-2011)                | 11633         | 2196           | 0.19 (0.18, 0.2)  | 494           | 0.22 (0.19, 0.26) |
| Sierra Leone (2013)                | 10618         | 1214           | 0.11 (0.11, 0.12) | 581           | 0.48 (0.44, 0.52) |
| Sierra Leone (2008)                | 5043          | 590            | 0.12 (0.11, 0.13) | 258           | 0.44 (0.38, 0.5)  |
| South Africa (2016)                | 3413          | 350            | 0.1 (0.09, 0.11)  | 37            | 0.11 (0, 0.21)    |
| Tanzania (2015-2016)               | 9707          | 1125           | 0.12 (0.11, 0.12) | 369           | 0.33 (0.28, 0.38) |
| Tanzania (2010)                    | 7526          | 1015           | 0.13 (0.13, 0.14) | 478           | 0.47 (0.43, 0.52) |
| Togo (2013-2014)                   | 6530          | 1042           | 0.16 (0.15, 0.17) | 251           | 0.24 (0.19, 0.29) |
| Uganda (2016)                      | 14710         | 2923           | 0.2 (0.19, 0.21)  | 666           | 0.23 (0.2, 0.26)  |
| Uganda (2011)                      | 7355          | 1684           | 0.23 (0.22, 0.24) | 589           | 0.35 (0.31, 0.39) |
| Uganda (2006)                      | 7593          | 1956           | 0.26 (0.25, 0.27) | 579           | 0.3 (0.26, 0.33)  |
| Zambia (2013-2014)                 | 12698         | 2045           | 0.16 (0.15, 0.17) | 670           | 0.33 (0.29, 0.36) |
| Zambia (2007)                      | 5844          | 909            | 0.16 (0.15, 0.17) | 221           | 0.24 (0.19, 0.25) |
| Country              | Sample Size | Total | Risk Factor | Confidence Interval | Risk Factor | Confidence Interval |
|---------------------|-------------|-------|-------------|---------------------|-------------|---------------------|
| **Zimbabwe (2015)**| 5807        | 72    | 0.16 (0.15, 0.17) | 0.08 (0.01, 0.14)  |
| **Zimbabwe (2010-2011)** | 5203        | 116   | 0.13 (0.12, 0.14) | 0.17 (0.1, 0.24)  |
| **Zimbabwe (2005-2006)** | 4867        | 35    | 0.13 (0.12, 0.14) | 0.06 (-0.02, 0.14) |
| **Total**           | 577468      | 21500 | 0.15 (0.14, 0.15) | 0.24 (0.23, 0.24) |
| **Grand Total**     | 1269944     | 47755 | 0.142 (0.141, 0.142) | 0.27 (0.26, 0.27) |

**Table-2:** Analysis of household water and sanitation risk factors using multiple logistic regression model ofu5c among 112 DHS national surveys 2006-2018 (Improved as reference category)
| DHS Survey Countries | Drinking water sources | Sanitation Toilet |
|----------------------|------------------------|------------------|
|                      | cOR (95% CI)           | aOR (95% CI)     | cOR (95% CI) | aOR (95% CI)     |
| **South East Asia**  |                        |                  |              |                  |
| Afghanistan (2015)   | 0.97 (0.97, 0.97)      | 0.97 (0.97, 0.97)| 0.9 (0.9, 0.9)| 0.9 (0.9, 0.9)  |
| Bangladesh (2007)    | 1.09 (1.08, 1.1)       | 1.1 (1.09, 1.11) | 1.12 (1.11, 1.13)| 1.12 (1.12, 1.13)|
| Cambodia (2014)      | 1.39 (1.38, 1.41)      | 1.4 (1.39, 1.42) | 1.41 (1.4, 1.43)| 1.42 (1.4, 1.43)|
| Cambodia (2010)      | 1.11 (1.11, 1.12)      | 1.11 (1.1, 1.12) | 1.47 (1.45, 1.49)| 1.47 (1.45, 1.49)|
| India (2015-2016)    | 0.81 (0.81, 0.81)      | 0.81 (0.81, 0.81)| 1.12 (1.11, 1.12)| 1.12 (1.11, 1.12)|
| Indonesia (2017)     | 1.26 (1.25, 1.26)      | 1.26 (1.25, 1.26)| 1.41 (1.4, 1.42)| 1.41 (1.4, 1.42)|
| Indonesia (2012)     | 1.17 (1.17, 1.18)      | 1.18 (1.17, 1.19)| 1.18 (1.17, 1.19)| 1.17 (1.17, 1.18)|
| Indonesia (2007)     | 0.7 (0.7, 0.71)        | 0.7 (0.69, 0.71) | 1.17 (1.17, 1.18)| 1.17 (1.17, 1.18)|
| Maldives (2009)      | 1.65 (1.62, 1.68)      | 1.65 (1.61, 1.68)| 1.98 (1.93, 2.02)| 1.97 (1.93, 2.02)|
| Myanmar (2015-2016)  | 1.21 (1.19, 1.22)      | 1.21 (1.19, 1.22)| 0.99 (0.99, 1)  | 0.99 (0.99, 1)  |
| Nepal (2016)         | 1.03 (1.02, 1.03)      | 1.03 (1.02, 1.03)| 1.24 (1.23, 1.26)| 1.24 (1.23, 1.26)|
| Nepal (2011)         | 0.97 (0.96, 0.97)      | 0.97 (0.96, 0.97)| 1.1 (1.09, 1.11) | 1.1 (1.09, 1.11)|
| Nepal (2006)         | 1.09 (1.09, 1.1)       | 1.09 (1.09, 1.1) | 1.32 (1.3, 1.34) | 1.32 (1.3, 1.34)|
| Pakistan (2017-2018) | 1.06 (1.06, 1.07)      | 1.06 (1.06, 1.07)| 1.04 (1.04, 1.05)| 1.04 (1.04, 1.05)|
| Pakistan (2012-2013) | 1.1 (1.1, 1.11)        | 1.11 (1.1, 1.11) | 1.13 (1.12, 1.13) | 1.13 (1.12, 1.13)|
| Philippines (2017)   | 1.24 (1.23, 1.25)      | 1.24 (1.23, 1.25)| 1.22 (1.21, 1.23) | 1.22 (1.21, 1.23)|
| Philippines (2013)   | 1.19 (1.18, 1.2)       | 1.18 (1.17, 1.19) | 1.04 (1.04, 1.05)| 1.04 (1.03, 1.04)|
| Philippines (2008)   | 0.98 (0.98, 0.98)      | 1.41 (1.39, 1.41) | 1.41 (1.39, 1.41)|                  |
| Region                        | Country                | Value 1          | Value 2          | Value 3          | Value 4          |
|-------------------------------|------------------------|------------------|------------------|------------------|------------------|
| Asia                         | Timor-Leste (2016)     | 0.97 (0.97, 0.97)| 0.97 (0.97, 0.97)| 0.9 (0.9, 0.9)  | 0.9 (0.9, 0.9)  |
|                              | Timor-Leste (2009-2010)| 1.09 (1.08, 1.1) | 1.1 (1.09, 1.11) | 1.12 (1.11, 1.13)| 1.12 (1.12, 1.13)|
| Central Asia                 | Kyrgyz Republic (2012) | 0.74 (0.73, 0.75)| 0.74 (0.73, 0.75)| 0.76 (0.75, 0.77)| 0.75 (0.74, 0.76)|
|                              | Tajikistan (2017)      | 0.83 (0.82, 0.83)| 0.82 (0.82, 0.83)| 0.79 (0.78, 0.8) | 0.79 (0.78, 0.8) |
|                              | Tajikistan (2012)      | 1.14 (1.13, 1.15)| 1.14 (1.13, 1.15)| 1.04 (1.03, 1.04)| 1.04 (1.03, 1.04)|
| Europe                       | Albania (2017-2018)    | 0.93 (0.92, 0.94)| 0.94 (0.93, 0.94)| 0.31 (0.3, 0.32) | 0.31 (0.3, 0.32) |
|                              | Armenia (2015-2016)    | 0.93 (0.92, 0.93)| 0.93 (0.92, 0.94)| 0.93 (0.92, 0.93)| 0.93 (0.92, 0.94)|
|                              | Armenia (2010)         | 1.88 (1.83, 1.93)| 1.9 (1.85, 1.95) | 2.57 (2.5, 2.65) | 2.54 (2.47, 2.61)|
|                              | Azerbaijan (2006)      | 4.46 (4.27, 4.65)| 4.54 (4.35, 4.73)| 1.43 (1.39, 1.46)| 1.42 (1.39, 1.46)|
|                              | Egypt (2014)           | 0.93 (0.92, 0.95)| 0.93 (0.92, 0.95)| 0.68 (0.66, 0.71)| 0.69 (0.66, 0.71)|
|                              | Egypt (2008)           | 1.31 (1.28, 1.33)| 1.31 (1.28, 1.33)| 0.53 (0.51, 0.55)| 0.53 (0.51, 0.55)|
|                              | Jordan (2017-2018)     | 0.75 (0.75, 0.76)| 0.76 (0.75, 0.76)| 0.81 (0.8, 0.81) | 0.8 (0.79, 0.8)  |
|                              | Jordan (2012)          | 0.71 (0.7, 0.72) | 0.71 (0.71, 0.72)| 1.47 (1.46, 1.49)| 1.47 (1.45, 1.48)|
| Latin America                | Bolivia (2008)         | 1.69 (1.67, 1.71)| 1.69 (1.67, 1.71)| 1.31 (1.3, 1.33) | 1.31 (1.3, 1.33) |
|                              | Colombia (2010)        | 1.23 (1.22, 1.23)| 1.23 (1.22, 1.24)| 1.31 (1.3, 1.33) | 1.31 (1.3, 1.33) |
|                              | Dominican Republic (2013)| 1 (1, 1)         | 1 (1, 1)         | 1.23 (1.22, 1.24)| 1.23 (1.22, 1.24)|
|                              | Dominican Republic (2007)| 0.97 (0.97, 0.97)| 0.97 (0.97, 0.97)| 1.46 (1.44, 1.47)| 1.45 (1.44, 1.47)|
| Country (Year) | 2014-2015 | 2014-2015 | 2015-2016 | 2015-2016 |
|---------------|-----------|-----------|-----------|-----------|
| Guatemala     | 1.31 (1.29, 1.33) | 1.31 (1.29, 1.33) | 1.2 (1.19, 1.22) | 1.2 (1.19, 1.22) |
| Guyana (2009) | 0.9 (0.9, 0.91) | 0.9 (0.9, 0.91) | 1.28 (1.27, 1.29) | 1.28 (1.27, 1.29) |
| Haiti (2016-2017) | 1.16 (1.15, 1.16) | 1.16 (1.15, 1.16) | 0.99 (0.99, 0.99) | 0.99 (0.99, 0.99) |
| Haiti (2012) | 1.76 (1.71, 1.8) | 1.76 (1.71, 1.8) | 1.31 (1.29, 1.34) | 1.31 (1.29, 1.34) |
| Haiti (2005-2006) | 1.03 (1.03, 1.03) | 1.03 (1.02, 1.03) | 1.25 (1.23, 1.26) | 1.25 (1.23, 1.26) |
| Honduras (2011-2012) | 0.98 (0.97, 0.98) | 0.98 (0.97, 0.98) | 1.07 (1.06, 1.07) | 1.07 (1.06, 1.07) |
| Honduras (2005-2006) | 1.08 (1.07, 1.09) | 1.08 (1.07, 1.09) | 1.07 (1.06, 1.08) | 1.07 (1.06, 1.08) |
| Peru (2012) | 1.46 (1.44, 1.47) | 1.46 (1.45, 1.48) | 1.21 (1.2, 1.22) | 1.21 (1.2, 1.22) |
| Peru (2011) | 0.92 (0.91, 0.92) | 0.92 (0.91, 0.92) | 1.26 (1.25, 1.27) | 1.26 (1.25, 1.27) |
| Peru (2009) | 1.59 (1.57, 1.61) | 1.59 (1.57, 1.61) | 1.34 (1.32, 1.35) | 1.33 (1.32, 1.35) |
| Peru (2007-2008) | 1.56 (1.54, 1.57) | 1.55 (1.53, 1.57) | 1.16 (1.16, 1.17) | 1.17 (1.16, 1.18) |
| Peru (2004-2006) | 1.4 (1.38, 1.41) | 1.4 (1.38, 1.41) | 1.38 (1.37, 1.4) | 1.39 (1.37, 1.4) |

**West North and Central Africa**

| Country (Year) | 2015-2016 | 2015-2016 | 2016-2017 | 2016-2017 |
|---------------|-----------|-----------|-----------|-----------|
| Angola (2015-2016) | 1.49 (1.48, 1.5) | 1.49 (1.48, 1.5) | 1.36 (1.35, 1.37) | 1.36 (1.35, 1.37) |
| Benin (2017-2018) | 1.49 (1.48, 1.5) | 1.49 (1.48, 1.5) | 1.36 (1.35, 1.37) | 1.36 (1.35, 1.37) |
| Benin (2011-2012) | 0.91 (0.9, 0.91) | 0.9 (0.9, 0.91) | 1.15 (1.14, 1.15) | 1.15 (1.14, 1.15) |
| Burkina Faso (2010) | 1.27 (1.26, 1.28) | 1.27 (1.26, 1.28) | 1.7 (1.68, 1.71) | 1.69 (1.68, 1.71) |
| Burundi (2016-2017) | 1.23 (1.22, 1.24) | 1.23 (1.22, 1.24) | 1.02 (1.01, 1.02) | 1.02 (1.01, 1.02) |
| Burundi (2010) | 1 (1, 1) | 1 (1, 1) | 0.93 (0.93, 0.93) | 0.93 (0.93, 0.93) |
| Cameroon (2011) | 1.02 (1.02, 1.02) | 1.02 (1.02, 1.02) | 1.25 (1.24, 1.26) | 1.25 (1.24, 1.26) |
| Country (Year)                      | 2014-2015  | 2011-2012  | 2013-2014  | 2005       |
|------------------------------------|------------|------------|------------|------------|
| Chad                               | 1.11 (1.1, 1.12) | 1.11 (1.1, 1.12) | 1.31 (1.3, 1.33) | 1.31 (1.3, 1.33) |
| Comoros (2012)                     | 1.28 (1.27, 1.29) | 1.28 (1.27, 1.29) | 1.41 (1.4, 1.43) | 1.41 (1.4, 1.43) |
| Congo (2011-2012)                  | 0.97 (0.97, 0.98) | 0.98 (0.97, 0.98) | 0.97 (0.96, 0.97) | 0.97 (0.96, 0.97) |
| Congo (2005)                       | 0.89 (0.88, 0.9) | 0.89 (0.88, 0.9) | 0.81 (0.8, 0.82) | 0.81 (0.8, 0.82) |
| Congo Democratic Republic (2013-2014) | 0.88 (0.87, 0.88) | 0.87 (0.87, 0.88) | 1.06 (1.05, 1.06) | 1.06 (1.05, 1.06) |
| Congo Democratic Republic (2007)   | 1.19 (1.18, 1.2) | 1.19 (1.18, 1.21) | 1.35 (1.33, 1.36) | 1.34 (1.32, 1.36) |
| Cote d'Ivoire (2011-2012)          | 0.97 (0.97, 0.97) | 0.97 (0.97, 0.97) | 1.2 (1.19, 1.21) | 1.2 (1.19, 1.21) |
| Eswatini (2006-2007)               | 1.2 (1.19, 1.21) | 1.2 (1.19, 1.21) | 1.09 (1.08, 1.1) | 1.09 (1.08, 1.09) |
| Ethiopia (2016)                     | 0.98 (0.98, 0.99) | 0.99 (0.98, 0.99) | 1.06 (1.05, 1.07) | 1.07 (1.06, 1.07) |
| Ethiopia (2011)                     | 1.65 (1.61, 1.69) | 1.62 (1.59, 1.66) | 1.73 (1.69, 1.77) | 1.7 (1.66, 1.75) |
| Gabon (2012)                       | 0.99 (0.99, 0.99) | 0.99 (0.99, 0.99) | 1.2 (1.19, 1.21) | 1.2 (1.19, 1.21) |
| Gambia (2013)                      | 1.12 (1.11, 1.12) | 1.12 (1.11, 1.12) | 1.33 (1.32, 1.34) | 1.33 (1.32, 1.34) |
| Ghana (2014)                       | 1.25 (1.23, 1.26) | 1.25 (1.23, 1.26) | 1.14 (1.13, 1.15) | 1.14 (1.13, 1.15) |
| Ghana (2008)                       | 0.97 (0.97, 0.98) | 0.98 (0.97, 0.98) | 0.77 (0.76, 0.78) | 0.77 (0.76, 0.77) |
| Guinea (2012)                      | 0.8 (0.79, 0.81) | 0.8 (0.79, 0.81) | 1.17 (1.16, 1.19) | 1.17 (1.16, 1.19) |
| Kenya (2014)                       | 1.27 (1.25, 1.29) | 1.27 (1.25, 1.29) | 1.29 (1.27, 1.31) | 1.29 (1.27, 1.31) |
| Kenya (2008-2009)                   | 1.35 (1.33, 1.36) | 1.34 (1.33, 1.36) | 1.24 (1.23, 1.25) | 1.24 (1.23, 1.25) |
| Lesotho (2014)                     | 1.11 (1.11, 1.12) | 1.11 (1.11, 1.12) | 1.16 (1.15, 1.16) | 1.16 (1.15, 1.16) |
| Liberia (2013)                     | 1.29 (1.27, 1.3)  | 1.29 (1.27, 1.31) | 1.26 (1.25, 1.28) | 1.26 (1.25, 1.28) |
| Liberia (2007)                     | 1.17 (1.16, 1.19) | 1.17 (1.16, 1.19) | 1.22 (1.2, 1.24)  | 1.22 (1.2, 1.24)  |
| Country                   | Year 1 | Year 2 | Year 3 | Year 4 |
|--------------------------|--------|--------|--------|--------|
| Madagascar               | 1.29   | 1.29   | 1.14   | 1.14   |
| Malawi                   | 1      | 1      | 1.04   | 1.04   |
| Malawi                   | 0.92   | 0.92   | 0.87   | 0.87   |
| Mali                     | 1.03   | 1.06   | 1.06   | 1.06   |
| Mali                     | 1.07   | 1.13   | 1.13   | 1.13   |
| Mozambique               | 0.71   | 0.72   | 0.88   | 0.88   |
| Namibia                  | 1.21   | 1.04   | 1.04   | 1.04   |
| Namibia                  | 1.01   | 0.99   | 1      | 1      |
| Niger                    | 1.37   | 1.37   | 1.58   | 1.59   |
| Niger                    | 1.26   | 1.16   | 1.16   | 1.16   |
| Nigeria                  | 0.94   | 0.91   | 0.91   | 0.91   |
| Nigeria                  | 1.15   | 1.34   | 1.34   | 1.34   |
| Rwanda                   | 1.3    | 1.06   | 1.06   | 1.06   |
| Rwanda                   | 1.38   | 1.04   | 1.04   | 1.04   |
| Sao Tome and Principe    | 1.05   | 1.06   | 1.43   | 1.43   |
| Senegal                  | 1.19   | 1.18   | 1.17   | 1.17   |
| Senegal                  | 0.85   | 0.84   | 1.16   | 1.16   |
| Senegal                  | 1.05   | 1.08   | 1.08   | 1.08   |
| Senegal                  | 1.22   | 1.02   | 1.02   | 1.02   |
| Senegal                  | 1.23   | 1.26   | 1.26   | 1.26   |
| Country (Year)          | 2005-2006 | 2006-2007 | 2007-2008 | 2008-2009 |
|------------------------|-----------|-----------|-----------|-----------|
| Zimbabwe (2010-2011)   | 0.9 (0.9, 0.91) | 0.9 (0.9, 0.91) | 0.97 (0.97, 0.98) | 0.97 (0.97, 0.98) |
| Zimbabwe (2005-2006)   | 1.17 (1.16, 1.18) | 1.17 (1.16, 1.18) | 1.07 (1.07, 1.08) | 1.07 (1.06, 1.08) |
| Zambia (2007)          | 1.08 (1.07, 1.08) | 1.09 (1.08, 1.09) | 1.06 (1.05, 1.07) | 1.06 (1.06, 1.07) |
| Zambia (2013-2014)     | 1.22 (1.21, 1.23) | 1.22 (1.2, 1.23) | 1.08 (1.08, 1.09) | 1.08 (1.08, 1.09) |
| Uganda (2006)          | 1 (1, 1) | 1 (1, 1) | 1.09 (1.09, 1.1) | 1.09 (1.09, 1.1) |
| Uganda (2011)          | 1.17 (1.16, 1.18) | 1.17 (1.16, 1.18) | 1.84 (1.81, 1.87) | 1.84 (1.81, 1.87) |
| Togo (2013-2014)       | 0.95 (0.95, 0.95) | 0.95 (0.95, 0.95) | 0.87 (0.87, 0.88) | 0.87 (0.87, 0.88) |
| Tanzania (2010)        | 1.24 (1.22, 1.26) | 1.24 (1.23, 1.25) | 1.22 (1.2, 1.23) | 1.22 (1.2, 1.23) |
| Tanzania (2015-2016)   | 1.11 (1.1, 1.12) | 1.11 (1.11, 1.12) | 1.21 (1.19, 1.22) | 1.21 (1.12, 1.22) |
| South Africa (2016)    | 1.24 (1.23, 1.25) | 1.24 (1.23, 1.25) | 1.02 (1.02, 1.02) | 1.02 (1.02, 1.02) |
| Sierra Leone (2008)    | 0.96 (0.96, 0.97) | 0.96 (0.96, 0.97) | 0.91 (0.9, 0.91) | 0.91 (0.9, 0.91) |
| Sierra Leone (2013)    | 1.43 (1.41, 1.45) | 1.43 (1.41, 1.45) | 1.41 (1.39, 1.43) | 1.41 (1.39, 1.42) |
| Senegal (2010-2011)    | 1.03 (1.03, 1.03) | 1.03 (1.03, 1.04) | 0.91 (0.91, 0.92) | 0.92 (0.91, 0.92) |

**Figures**
Figure 1

Box plot for (A) prevalence of antibiotic use by wealth index, (B) prevalence of diarrhea by mother education, (C) prevalence of diarrhea at different age groups of several DHS survey regions.
Figure 2

Global mapping of acute watery diarrhea prevalence in different DHS survey regions (A) South East Asia, (B) Central Asia, (C) Europe, (D) Latin America, and (E) North and Central Asia
Figure 3

Global mapping of antibiotic treatment prevalence for acute watery diarrhea in different DHS survey regions (A) South East Asia, (B) Central Asia, (C) Europe, (D) Latin America, and (E) North and Central Asia
Figure 4

Linear trend analysis of antibiotic use for AWD among (A) South East and Central Asia, (B) Europe, (C) Latin America, and (D) West North and Central Africa

Supplementary Files

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