Prevalence of reproductive tract infections and the predictive value of girls’ symptom-based reporting: findings from a cross-sectional survey in rural western Kenya

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ABSTRACT
Objectives Reproductive tract infections (RTIs), including sexually acquired, among adolescent girls is a public health concern, but few studies have measured prevalence in low-middle-income countries. The objective of this study was to examine prevalence in rural schoolgirls in Kenya against their reported symptoms.

Methods In 2013, a survey was conducted in 542 adolescent schoolgirls aged 14–17 years who were enrolled in a menstrual feasibility study. Vaginal self-swabbing was conducted after girls were interviewed face-to-face by trained nurses on symptoms. The prevalence of girls with symptoms and laboratory-confirmed infections, and the sensitivity, specificity, positive and negative predictive values of symptoms compared with laboratory results, were calculated.

Results Of 515 girls agreeing to self-swab, 510 answered symptom questions. A quarter (24%) reported one or more symptoms; most commonly vaginal discharge (11%), pain (9%) or itching (4%). Laboratory tests confirmed 28% of girls had one or more RTI. Prevalence rose with age; among girls aged 16–17 years, 33% had infections. Bacterial vaginosis was the most common (18%), followed by Candida albicans (9%), Chlamydia trachomatis (3%), Trichomonas vaginalis (3%) and Neisseria gonorrhoeae (1%). Reported symptoms had a low sensitivity and positive predictive value. Three-quarters of girls with bacterial vaginosis and C. albicans, and 50% with T. vaginalis were asymptomatic.

Conclusions There is a high prevalence of adolescent schoolgirls with RTI in rural Kenya. Public efforts are required to identify and treat infections among girls to reduce longer-term sequelae but poor reliability of symptom reporting minimises utility of symptom-based diagnosis in this population.

INTRODUCTION
An estimated half a billion new cases of curable sexually transmitted infections occur each year globally,1,2 with women being more susceptible and bearing the greatest burden of these infections. Reproductive tract infections (RTIs), including those sexually acquired, have historically been labelled a ‘silent’ epidemic among females, contributing to gynaecological morbidity and maternal mortality globally, including low-middle-income countries (LMICs).3 Untreated infections can lead to pelvic inflammatory diseases, ectopic pregnancy, infertility, cervical cancer, foetal loss or infant health complications, with a threefold to fivefold increase in risk of HIV acquisition and transmission.4–6 Bacterial vaginosis is associated with increased risk for acquisition of HIV,7–9 promotes viral shedding among HIV-infected females,4 and increases susceptibility for other infections such as gonorrhoea, trichomoniasis and herpes simplex virus type-2 (HSV-2).3,8–10 Adolescent females are vulnerable to bacterial vaginosis infection,7,10 with an association between human papillomavirus infection, bacterial vaginosis and cervicitis.9 This is compounded by adolescent girls’ heightened susceptibility to HIV, for biological as well as socio-cultural reasons,10 in western Kenya, for example, young females have a sixfold greater risk of contracting HIV compared with young males.11

Although research on the burden of RTI among adolescent females in LMIC is limited, WHO estimates 80–90% of the global burden lies in LMICs.1 In Kenya, one in every five youths 15–24 years report sexual debut before the age of 15 years.12 While HIV prevalence has fallen nationally, it remains static in rural parts of the former Nyanza Province5 and rises among girls during adolescence.11 For the region, RTI prevalence is also high, with a third of urban adolescent girls aged 15–19 years diagnosed with Trichomonas vaginalis,12 and a smaller proportion with other infections (9% Chlamydia trachomatis; 2% Neisseria gonorrhoeae, 3% syphilis).13 However, data are sparse on the prevalence of RTI among post-pubescent girls in rural African settings.

Symptom assessment has commonly been used to prescribe treatment of RTI, and a simplified algorithm to guide health workers in the implementation of syndromic management of RTI has been developed.14–16 This was intended to define cause among the symptomatic rather than a screening tool in the general population. Experts advocate supplementary point-of-care testing because of the poor predictive value of symptoms.
Methods

Study setting

The population under study are resident in the Kenyan Medical Research Institute (KEMRI) and Centers for Disease Control and Prevention’s health and demographic surveillance system (HDSS), \(^{w9}\) in Gem subcounty, Siaya County, western Kenya. This rural population are almost exclusively comprised of the Luo ethnic group who are mainly farmers. \(^{w9}\)

Study design

Cross-sectional, laboratory-supported, RTI survey nested within a menstrual feasibility study.

Menstrual feasibility study

The ‘parent’ study, conducted August 2012 to November 2013, was a randomised controlled pilot examining the feasibility of menstrual solutions for girls in rural primary schools in western Kenya. In total, 30 of 62 schools participating in a baseline water, sanitation and hygiene survey reached eligibility for participation. \(^{w7}\) No schools withdrew. All girls in study schools were enrolled if resident in the study area, were aged 14–16 years at enrolment, in classes 5–8, had no debilitating precluding participation and had experienced three or more menses. We estimated 669 participants followed to outcome provided 76% power to detect a 50% reduction in outcome (dropout), with an intra-cluster correlation coefficient of 0.01 and design effect of 1.21. Of 1005 target girls screened, 766 were enrolled and 40 (4%) refused, with the remaining 199 ineligible. Of the 766, 542 were in school for the cross-sectional RTI survey conducted in November 2013. Attrition (224 girls; 29.2%) prior to the RTI survey was due to withdrawal (2.1%), migration (12.4%), dropout (7.9%) and participants in class 8 exiting after their exams in October (6.8%).

RTI cross-sectional survey methods

Study nurses, trained by a gynaecologist, privately questioned participants on a list of RTI-associated signs and symptoms before sample collection (see online supplementary form S1). All survey tools were pilot tested and nurses explained symptoms when interviewing. Symptoms covered urinary complaints, pain or bleed during sexual intercourse, vaginal discharge, malodorous or fishy smell, genital itching/irritation, lower abdominal or vaginal pain or both, and abnormal bleeding (heavy or between periods). \(^{w8}\) Nurses trained participants to obtain their own vaginal swab. \(^{w9}\) Samples were transported daily to the KEMRI laboratory, prepared and analysed for Candida albicans, bacterial vaginosis, T. vaginalis, C. trachomatis and N. gonorrhoeae using standard methods. \(^{w10}\) Bacterial vaginosis was defined as a Nugent Score of 7–10. Girls with a laboratory-confirmed diagnosis were treated by study nurses according to Kenyan national guidelines.

Statistical analysis

Laboratory-confirmed infections were the measured outcome, and signs and symptoms the predictor variables, with age, socioeconomic status (SES), age at menarche and prior use of sanitary pads also assessed as potential confounders. Data on SES were missing for 78 participants and were excluded from specific SES-related analysis. The prevalence of girls with individual infections and the 95% CI were calculated, then aggregated into all RTI. The prevalence of girls reporting symptoms were calculated, then aggregated into any symptom reported. Girls’ ages were collapsed into younger (<16 years) and older (≥16 years) age groups. SES of participants was available from routine household surveys in the HDSS, \(^{w9}\) dichotomising quintiles into the poorest (1–2) and least poor (3–5). Differences due to age, SES, age of menarche and any prior sanitary pad use were assessed using Pearson’s \(\chi^2\) test. The specificity, sensitivity, positive predictive value (PPV) and negative predictive value (NPV) of symptoms alone, and then pooled, were computed for predicting each laboratory-confirmed (gold standard) infection, along with their 95% CI. Data analysis was performed using SPSS v.21.0.

Results

Of 542 adolescent schoolgirls present in school and approached for this study, 515 (95%) participated in the vaginal swabbing; 25 declined saying they were menstruating (including at a second follow-up) and 2 refused. Age at survey ranged from 14 to 17 years, with a mean of 15.2 years (SD 0.6 year). Participants’ median SES index was 4 (range 1–5), with 17% falling into the poorest two quintiles. Girls’ mean age of menarche was 13.6 years (SD 0.9 year), with 83.5% reporting some prior use of sanitary pads. Less than 1% of girls reported they were currently sexually active (past month), while 46 (9%) answered the question on symptoms occurring during sex. Of 515 girls who self-swabbed for laboratory confirmation of RTI diagnoses, 510 (99%) answered questions on symptoms.

A quarter of participants reported one or more symptoms (table 1). Most common among these was vaginal discharge, followed by pain or itching. There was no difference in overall symptoms reported by age, SES, age at menarche or prior use of sanitary pads. However, younger (<16 years) girls were twofold less likely to report vaginal discharge than girls aged ≥16 years (p=0.002; table 1). Overlapping of symptoms was common, with two-thirds of girls reporting two or more symptoms in addition to itching or sore vagina, malodorous smell, burning urine or bleeding between menses (see online supplementary table S2).

Laboratory tests confirmed 28% of participants had at least one RTI, with bacterial vaginosis the most common diagnosis among 18% of girls (table 2). T. vaginalis was threefold higher in older compared with younger girls (p=0.03). A higher proportion of girls in the poorest SES quintiles were diagnosed with bacterial vaginosis or C. albicans (p=0.076).

Three-quarters of girls with bacterial vaginosis and C. albicans infections were asymptomatic, with slightly higher proportions of girls with T. vaginalis, C. trachomatis and N. gonorrhoeae reporting at least one symptom (table 3). In the analysis of sensitivity and PPV, between girls’ reporting symptoms and laboratory-confirmed bacterial vaginosis, malodorous smell achieved a PPV >50%, while vaginal itching was 32%. There was a low sensitivity and PPV for girls’ reporting symptoms
associated with *C. trachomatis*. Pain or bleed during intercourse was predictive for *T. vaginalis* among the few infected girls acknowledging sexual intercourse. The low prevalence of girls with *N. gonorrhoeae* (<1%) limited analysis. Burning urine had a low PPV (table 3).

**DISCUSSION**

This study demonstrates over a quarter of young adolescent schoolgirls in a rural African setting had a laboratory-diagnosed RTI. One-third of older aged (16–17 years) girls were infected. The largest contribution to the infection pool was from bacterial vaginosis. The predictive value of reported symptoms was generally very low. Despite this, there remains inadequate data on laboratory-confirmed cases of RTI among school-aged girls in Africa.

This study was nested in a cluster randomised controlled pilot study examining the feasibility of girls’ use of menstrual care products in schools. Sampling bias may have occurred as schools were not representative of the population. The larger contribution of individuals was conducted, thus, the presence of a laboratory-conducted examination of other RTI such as syphilis and HSV-2 was not possible and we recommend that studies include these also to ensure comprehensive mapping of infection, and healthcare needs of adolescent girls.

Synonymous with our findings, a study conducted in South Africa reported symptomatic vaginal discharge among high-risk girls and women was a poor predictor of RTI and genital tract inflammation (sensitivity of 12.3% and specificity of 93.8%), with 87.7% of laboratory-diagnosed infections having no accompanying clinical symptoms. With a high reliability of AH self-obtained swabs for RTI diagnosis has been demonstrated elsewhere, we note girls in our endline focus groups reported a minority of their peers avoided swabbing by spitting on the swabs. Such swabs were processed in the denominator and would have also possibly lowered the prevalence of girls with detected infections. Less than 1% of girls said they had sexual intercourse in the past month, and 9% answered a question on symptoms occurring during sex at face-to-face interview. This is an underestimate, as in a private self-completed survey 28% reported sexual exposure (unpublished). Studies in Kenya and Tanzania estimated up to a threefold higher prevalence of sexual exposure (including coerced) when girls self-completed surveys, for example, by computer. No clinical examination of individuals was conducted, thus, the presence of a lesion (ulcer) relied on girls’ reporting an itchy/sore vagina. We cannot rule out that girls when faced with intimate questions about vaginal discharge or pain may have been too embarrassed, or too scared, to disclose symptoms face-to-face in the nurses’ interview. They may also be less familiar with their bodily ‘norm’ so symptoms may have gone unnoticed. Moreover, due to financial constraints, examination of other RTI such as syphilis and HSV-2 was not possible and we recommend that studies include these also to ensure comprehensive mapping of infection, and healthcare needs of adolescent girls.

Table 1 | Prevalence of girls with reported symptoms by age group at survey

<table>
<thead>
<tr>
<th>Prevalence (95% CIs) of girls with reported symptoms</th>
<th>14–15 years</th>
<th>16–17 years</th>
<th>Total</th>
<th>Ratios</th>
<th>Age comparison χ², p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any symptom</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>82/370</td>
<td>22.2 (18.0 to 26.4)</td>
<td>40/140</td>
<td>28.6 (21.1 to 36.1)</td>
<td>122/510</td>
<td>23.9 (20.2 to 27.6)</td>
</tr>
<tr>
<td>Heavy menstruation</td>
<td>25/370</td>
<td>6.8 (4.3 to 9.4)</td>
<td>8/140</td>
<td>5.7 (1.9 to 9.5)</td>
<td>33/510</td>
</tr>
<tr>
<td>Between menses bleeding</td>
<td>15/370</td>
<td>4.1 (2.1 to 6.1)</td>
<td>5/140</td>
<td>3.6 (0.5 to 6.7)</td>
<td>20/510</td>
</tr>
<tr>
<td>Burning urine</td>
<td>9/370</td>
<td>2.4 (0.8 to 4.0)</td>
<td>2/140</td>
<td>1.4 (−0.6 to 3.4)</td>
<td>11/510</td>
</tr>
<tr>
<td>Frequency of urine</td>
<td>11/370</td>
<td>3.0 (1.3 to 4.7)</td>
<td>2/140</td>
<td>1.4 (−0.6 to 3.4)</td>
<td>13/510</td>
</tr>
<tr>
<td>Abdominal/vaginal pain</td>
<td>30/370</td>
<td>8.1 (5.3 to 10.9)</td>
<td>15/140</td>
<td>10.7 (5.6 to 15.8)</td>
<td>45/510</td>
</tr>
<tr>
<td>Pain during intercourse</td>
<td>1/35</td>
<td>2.9 (−2.7 to 8.5)</td>
<td>1/11</td>
<td>9.1 (−7.9 to 26.1)</td>
<td>2/46</td>
</tr>
<tr>
<td>Itchy/sore vagina</td>
<td>16/365</td>
<td>4.4 (2.3 to 6.5)</td>
<td>6/139</td>
<td>4.3 (0.9 to 7.7)</td>
<td>32/504</td>
</tr>
<tr>
<td>Malodorous smell</td>
<td>5/364</td>
<td>1.4 (0.2 to 2.6)</td>
<td>4/139</td>
<td>2.9 (0.1 to 5.7)</td>
<td>9/503</td>
</tr>
<tr>
<td>Vaginal discharge</td>
<td>29/367</td>
<td>7.9 (5.1 to 10.7)</td>
<td>34/139</td>
<td>17.3 (11.0 to 23.6)</td>
<td>53/506</td>
</tr>
</tbody>
</table>

*Five participants reporting ‘don’t know’ for all symptoms are excluded.
†Sample limited to girls responding to symptoms of pain or bleeding during sexual intercourse (n=46).
‡4–6 girls did not answer questions on vaginal itching, smell and discharge.

Table 2 | Prevalence of girls with laboratory-confirmed infections by age group

<table>
<thead>
<tr>
<th>Prevalence (95% CIs) of girls with laboratory diagnoses*</th>
<th>14–15 years</th>
<th>16–17 years</th>
<th>Total</th>
<th>Ratios</th>
<th>Age comparison χ², p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial vaginosis</td>
<td>61/374</td>
<td>16.3 (12.2 to 20.4)</td>
<td>33/141</td>
<td>1.12 (0.58 to 2.15)</td>
<td>94/515</td>
</tr>
<tr>
<td>*Candida albicans</td>
<td>33/373</td>
<td>8.8 (5.8 to 11.8)</td>
<td>11/139</td>
<td>0.75 (0.56 to 1.02)</td>
<td>44/512</td>
</tr>
<tr>
<td>*Chlamydia trachomatis</td>
<td>10/371</td>
<td>2.7 (1.1 to 4.4)</td>
<td>3/140</td>
<td>0.32 (0.11 to 0.93)</td>
<td>13/511</td>
</tr>
<tr>
<td>*Trichomonas vaginalis</td>
<td>6/373</td>
<td>1.6 (0.3 to 2.9)</td>
<td>7/139</td>
<td>0.76 (0.07 to 8.26)</td>
<td>13/512</td>
</tr>
<tr>
<td>*Neisseria gonorrhoeae</td>
<td>2/371</td>
<td>0.5 (−0.2 to 1.2)</td>
<td>1/140</td>
<td>0.55 (0.26 to 1.15)</td>
<td>3/511</td>
</tr>
<tr>
<td>All reproductive tract infections</td>
<td>98/374</td>
<td>26.2 (21.7 to 30.7)</td>
<td>47/141</td>
<td>0.70 (0.48 to 1.02)</td>
<td>145/515</td>
</tr>
</tbody>
</table>

*2–4 tests spoiled.
<table>
<thead>
<tr>
<th>Clinical</th>
<th></th>
</tr>
</thead>
</table>

**Table 3** Disease prediction of symptoms against laboratory diagnosis (95% CI) of reproductive tract infections

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>% (95% CI)</td>
<td>n</td>
<td>% (95% CI)</td>
<td>N</td>
</tr>
</tbody>
</table>

**Bacterial vaginosis**

- **Heavy menstruation**
  - 7/93 7.5 (3.1 to 14.9)
  - Between menses bleeding
    - 4/93 4.3 (1.2 to 11.0)
  - Burning urine
    - 2/93 2.2 (0.3 to 7.6)
  - Frequency of urine
    - 4/93 4.2 (1.2 to 10.4)
  - Abdominal/vaginal pain
    - 10/93 10.7 (5.3 to 18.9)
  - Pain during intercourse
    - *Pain or bleed during intercourse* 1/6 16.7 (0.5 to 64.1)
  - Itchy/sore vagina
    - 7/92 7.6 (3.1 to 15.1)
  - Malodorous smell
    - 5/91 5.5 (1.8 to 12.4)
  - Vaginal discharge
    - 11/93 11.8 (6.1 to 20.2)
  - **Any symptoms**
    - 26/93 28.0 (19.1 to 38.2)

**Candida albicans**

- **Heavy menstruation**
  - 4/44 9.1 (2.5 to 21.7)
  - Between menses bleeding
    - 1/44 2.2 (0.1 to 12.0)
  - Burning urine
    - 0/44 0.0 (0.0 to 8.4)
  - Frequency of urine
    - 0/44 0.0 (0.0 to 8.0)
  - Abdominal/vaginal pain
    - 6/44 13.6 (5.2 to 27.9)
  - Pain during intercourse
    - 0/8 0.0 (0.0 to 36.9)
  - Itchy/sore vagina
    - 1/44 2.3 (0.1 to 12.0)
  - Malodorous smell
    - 0/42 0.0 (0.0 to 8.4)
  - Vaginal discharge
    - 3/43 7.0 (1.4 to 19.1)
  - **Any symptoms**
    - 11/44 25.0 (13.2 to 40.3)

**Chlamydia trachomatis**

- **Heavy menstruation**
  - 0/13 0.0 (0.0 to 24.7)
  - Between menses bleeding
    - 0/13 0.0 (0.0 to 24.7)
  - Burning urine
    - 1/13 7.7 (0.2 to 36.0)
  - Frequency of urine
    - 0/13 0.0 (0.0 to 24.7)
  - Abdominal/vaginal pain
    - 2/13 15.4 (1.9 to 45.5)
  - Pain during intercourse
    - 0/1 0.0 (0.0 to 97.5)
  - Itchy/sore vagina
    - 1/13 7.7 (0.2 to 36.0)
  - Malodorous smell
    - 0/13 0.0 (0.0 to 24.7)
  - Vaginal discharge
    - 2/13 15.4 (1.9 to 45.3)
  - **Any symptoms**
    - 4/13 30.8 (9.1 to 61.4)

**Trichomonas vaginalis**

- **Heavy menstruation**
  - 1/12 8.3 (0.2 to 38.5)
  - Between menses bleeding
    - 0/12 0.0 (0.0 to 26.5)
  - Burning urine
    - 1/12 8.3 (0.2 to 38.5)
  - Frequency of urine
    - 0/12 0.0 (0.0 to 26.5)
  - Abdominal/vaginal pain
    - 2/12 16.7 (2.1 to 48.4)
  - Pain during intercourse
    - 2/2 100 (15.8 to 100)
  - Itchy/sore vagina
    - 1/12 8.3 (0.2 to 38.5)
  - Malodorous smell
    - 2/12 16.7 (2.1 to 48.4)
  - Vaginal discharge
    - 2/12 16.7 (2.1 to 48.4)
  - **Any symptoms**
    - 6/12 50.0 (21.1 to 78.9)

**Neisseria gonorrhoeae**

- **Heavy menstruation**
  - 1/3 33.3 (0.8 to 90.6)
  - Between menses bleeding
    - 1/3 33.3 (0.8 to 90.6)
  - Burning urine
    - 1/3 33.3 (0.8 to 90.6)
  - Frequency of urine
    - 0/3 0.0 (0.0 to 70.6)
  - Abdominal/vaginal pain
    - 1/3 33.3 (0.8 to 90.6)
  - Itchy/sore vagina
    - 1/3 33.3 (0.8 to 90.6)
  - Malodorous smell
    - 0/3 0.0 (0.0 to 70.7)
  - Vaginal discharge
    - 1/3 33.3 (0.8 to 90.6)
  - **Any symptoms**
    - 2/3 66.7 (9.4 to 99.1)

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*P/P bleed during intercourse was limited to 46 girls responding to symptoms of pain or bleeding during sexual intercourse (no data for N. gonorrhoeae).

14–6 girls did not answer questions on vaginal itching, smell, discharge.

PPV, negative predictive value; PPV, positive predictive value.
challenges for diagnosis and treatment among this critically vulnerable group. Adding to the evidence from South Africa and Botswana, our data suggest that the syndromic approach is not a good enough indicator of RTI, and new approaches are needed.

A study among African females found a high prevalence of bacterial vaginosis was associated with recent unprotected sexual intercourse. Among adolescent girls from South Africa and Kenya, 16–17-year-old sexually active girls reported minimal symptoms (2/60; 3.3%) while the prevalence of laboratory-confirmed RTI was very high (in 60 girls, 23 were diagnosed with bacterial vaginosis, 12 with C. albicans, 4 with T. vaginalis and 4 with C. trachomatis).

The relationship between bacterial vaginosis, N. gonorrhoeae, C. trachomatis and genital ulcer disease, and the increase in the risk of HIV transmission, makes early detection and diagnosis of RTI a major public health imperative. Studies in western Kenya among the Luo show a rapid rise in HIV and HSV-2 prevalence during adolescence among girls, suggesting that many of our schoolgirls not already infected with HIV are at further risk of acquiring HIV due to their RTI-infected status. A reduction in prevalence is possible, for example, in Tanzania in areas where women had improved access to laboratory diagnosis and treatment of RTIs, incident HIV infections were reduced by 40%. T. vaginalis infection is a common curable sexually transmitted infection with high prevalences observed in the African continent. However, this vaginal condition may cause substantial morbidity among women in developing countries if untreated. No comparison study was available among adolescents; however, among pregnant women in Botswana, T. vaginalis was found in 19% and bacterial vaginosis in 38% of the study participants. Unless drastic measures are put into place, the high prevalence of infections found in young adolescent girls is likely to remain undetected and untreated, leading to a rising pool of infection in the local population, increasing morbidity and reducing their fertility, as well as increasing their risk of other RTI and HIV.

From our data, we have identified three priority areas for public health intervention among this female adolescent population. First, girls need to learn self-awareness of their own bodies to be able to recognise any changes in order that symptoms are detected as being different from their normal state. Second, girls need to understand that it is possible to have an RTI despite having no symptoms. Third, methods to achieve prevention must be made readily available to adolescent girls. Our data, combined with other findings, point to the urgent need for sexual and reproductive health education, including a focus on personal hygiene, combined with the provision of friendly sexual and reproductive health services including treatment and counselling services. The latter must be easily accessible to girls who have little free time and no resources to travel. Without such interventions, it is difficult to envisage any real progress in reducing the prevalence of RTI, poor maternal health outcomes and HIV acquisition. One solution, in part, may be school-based, through school nurses who, as well as treating and referring girls to specialist services, could educate and counsel girls as they reach menarche and become sexually active.

In summary, our study adds to a sparse body of literature, showing a high prevalence of RTI among school-aged girls in a rural African setting. The majority of infections were asymptomatic, demonstrating a very poor sensitivity of symptom-based reporting. The use of syndromic management to reduce RTI and HIV incidence in this adolescent population would leave most of these very vulnerable girls untreated (even if they would present to a health clinic). Technological advancements that can enable quick, easy and cost-effective diagnosis of RTIs may be a desirable step towards realising effective management of reproductive health in rural African settings.

Key messages

- Adolescent schoolgirls in rural Kenya have a high prevalence of reproductive tract infections.
- Symptom-based reporting has a poor sensitivity missing three-quarters of laboratory-confirmed infections.
- Greater public health efforts are required to diagnose and treat infections among vulnerable girls to minimise long-term sequelae.

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ContributorsEK, NO, CO, EN and KOO collected the data and were involved with writing the manuscript. KFL, LM, JV, CZ and PAP-H designed the study and obtained the funding. NO and PAP-H analysed the data. EK, CO, AB and PAP-H wrote the manuscript. All authors reviewed and approved the manuscript.

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Competing interests None declared.

Patient consent Written informed consent and assent from parents and girls, respectively, were required for participation.

Ethics approval The study was approved by KEMRI’s National Ethical Review Committee (ethics number: 2198) and the Liverpool School of Tropical Medicine’s Ethics Committee (ethics number: 12.11). The Institutional Review Board of the US Centers for Disease Control and Prevention approved a non-engaged waiver.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement All study data are presented in the paper.

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REFERENCES


SECTION 1: CLINICAL CHECK-(SCREENING FOR ILLNESS)

1. Be isebedo kiwinjo maber/kingima e dwe mokalo ni?  
   (Have you been feeling well this last month?)
   ○ Ee (Yes)  ○ Ooyo (No)

2. Ka ooyo, nitimang’o? (If no, what did you do)
   ○ Dhi ei osiptal (Go to hospital)
   ○ Dhi ei od thieth (Go to health facility)
   ○ bara skul (Miss school)
   ○ Mamoko (Other)

3. If any health problems that are not menstrual/RTI/TSS, write in this box what the problem was, how you advised care and what services are signposted:
   ———————————————————————————————————————————
   ———————————————————————————————————————————
   ———————————————————————————————————————————
   ———————————————————————————————————————————
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4. Be isebedo kichuero remo mang’eny e kinde manidiyiye e dwe mogik? (Have you been bleeding very heavily during your recent monthly period?)
   ○ Ee (Yes)  ○ Ooyo (No)

5. Be isebetie kineno remo bang dwe mogik kapok ichako dwe manyien? (Have you had any bleeding in between one period and the next period?)
   ○ Ee (Yes)  ○ Ooyo (No)

6. Saa asaya e dwe mokalo-Bende iwinjo rem kata lit sama iolo pi/layo? (Do you have pain or burning during urination?)
   ○ Ee (Yes)  ○ Ooyo (No)

7. Saa asaya e dwe mokalo-Bende isebedo kilayo sate sate/saa ka saa(layo mothingo kaka pile)? (Do you have more frequent urination (pass urine more than usual)?)
   ○ Ee (Yes)  ○ Ooyo (No)

8. Saa asaya e dwe mokalo-Be iwinjoga rem e piny iyi, kata e duong’ni? (Do you have any pain in your abdomen, or vagina?)
   ○ Ee (Yes)  ○ Ooyo (No)

9. Saa asaya e dwe mokalo-Be duong’ni ili? (Any time last month-Are you at all itchy, sore in your vagina?)
   ○ Ee (Yes)  ○ Ooyo (No)

10. Saa asaya e dwe mokalo-Be nitie tik moro amora mawuok e duong’ni? (Is there any smell coming from your vagina?)
   ○ Ee (Yes)  ○ Ooyo (No)

11. ka kamano ,ler ni en tik machal nadi (If yes, describe type of smell)
   ○ Dirty  ○ Fishy  ○ Blood  ○ Other

12. Saa asaya e dwe-Be nitiega gik mawuok/machuer kowuok e duog’ni? (Is there any discharge coming from your vagina?)
   ○ Ee (Yes)  ○ Ooyo (No)

13. ka kamano ,en (If yes, is it:)
   ○ Machal go othinyo (Mucusy)  ○ Motimo byoyo (Frothy)  ○ Mong’inore (curd-like)  ○ NA  ○ Other

14. ka kamano ,no chal nadi (If yes, what color:)
   ○ Rachar (White)  ○ Majan (Green)  ○ Raton’g (Yellow)  ○ Motimo remo (Bloody)  ○ NA

15. Bende ne iriwrie gi ng’ama dichuo e dwe mokalo? (Did you have sex in the past month?)
   ○ Ee (Yes)  ○ Ooyo (No)

16. Ka kamano, be neniitere chuer, rem kata chandruok moro amora kaluwore gi riwruok? (If yes, was there any bleeding, pain or other problem with sex?)
   ○ Ee (Yes)  ○ Ee, rem (Yes), pain  ○ Ee, chuer (Yes, bleed)  ○ Mamoko, (Other)  ○ NA

17. Ka kamano, ne en ang’o? (If yes, What?)
   ○ Ee, rem (Yes), pain  ○ Ee, chuer (Yes, bleed)  ○ Mamoko, (Other)  ○ NA

18. SWAB TAKEN: swab_taken
   ○ Yes  ○ No

   TIME:  
   ———————————————————————————————————————————
Table S1 Number and percentage of overlapping symptoms reported by girls

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Heavy menstruation (33)</th>
<th>Between menses bleeding (20)</th>
<th>Burning urine (11)</th>
<th>Frequency urine (13)</th>
<th>Abdominal/vaginal pain (45)</th>
<th>Pain/bleed during intercourse (2)</th>
<th>Itchy/sore vagina (22)</th>
<th>Malodorous smell (9)</th>
<th>Vaginal discharge (53)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy menstruation (33) and</td>
<td>33 (100)</td>
<td>8 (24.2)</td>
<td>3 (9.1)</td>
<td>4 (12.1)</td>
<td>11 (33.3)</td>
<td>1 (3.0)</td>
<td>6 (18.2)</td>
<td>3 (9.1)</td>
<td>8 (24.2)</td>
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<tr>
<td>Between menses bleeding (20)</td>
<td>8 (40.0)</td>
<td>20 (100)</td>
<td>2 (10.0)</td>
<td>3 (15.0)</td>
<td>5 (25.0)</td>
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<td>2 (10.0)</td>
<td>1 (5.0)</td>
<td>6 (30.0)</td>
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<tr>
<td>Burning urine (11) and</td>
<td>3 (27.3)</td>
<td>2 (18.2)</td>
<td>11 (100)</td>
<td>3 (27.3)</td>
<td>7 (63.6)</td>
<td>1 (9.1)</td>
<td>6 (54.5)</td>
<td>2 (18.2)</td>
<td>1 (9.1)</td>
</tr>
<tr>
<td>Frequency of urine (13) and</td>
<td>4 (30.8)</td>
<td>3 (23.1)</td>
<td>3 (23.1)</td>
<td>13 (100)</td>
<td>3 (23.1)</td>
<td>0</td>
<td>5 (38.5)</td>
<td>4 (30.8)</td>
<td>2 (15.4)</td>
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<tr>
<td>Abdominal / vaginal pain (45)</td>
<td>11 (24.4)</td>
<td>5 (11.1)</td>
<td>7 (15.6)</td>
<td>3 (6.7)</td>
<td>45 (100)</td>
<td>1 (2.2)</td>
<td>9 (20.0)</td>
<td>3 (6.7)</td>
<td>12 (26.7)</td>
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<tr>
<td>Pain/bleed during intercourse (2) and</td>
<td>1 (50.0)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1 (50.0)</td>
<td>2 (100)</td>
<td>1 (50.0)</td>
<td>1 (50.0)</td>
<td>1 (50.0)</td>
</tr>
<tr>
<td>Itchy/sore vagina (22) and</td>
<td>6 (27.3)</td>
<td>2 (9.1)</td>
<td>6 (27.3)</td>
<td>5 (22.7)</td>
<td>9 (40.9)</td>
<td>1 (4.5)</td>
<td>22 (100)</td>
<td>7 (31.8)</td>
<td>9 (40.9)</td>
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<tr>
<td>Malodorous smell (9) and</td>
<td>3 (33.3)</td>
<td>1 (11.1)</td>
<td>2 (22.2)</td>
<td>4 (44.4)</td>
<td>3 (33.3)</td>
<td>1 (11.1)</td>
<td>7 (77.7)</td>
<td>9 (100)</td>
<td>6 (66.6)</td>
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<tr>
<td>Vaginal discharge (53) and</td>
<td>8 (15.1)</td>
<td>6 (11.3)</td>
<td>1 (1.9)</td>
<td>2 (3.8)</td>
<td>12 (22.6)</td>
<td>1 (1.9)</td>
<td>9 (17.0)</td>
<td>6 (11.3)</td>
<td>53 (100)</td>
</tr>
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S3 Additional Web References


