

Research Paper

Sanitation and water supply in schools and girls' educational progression in Zambia

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ABSTRACT

There is much anecdotal evidence related to the importance of Water, Sanitation and Hygiene (WASH) in schools for girls' educational progression, yet a lack of comprehensive quantitative studies on linkages between WASH and educational indicators disaggregated by gender and grade. This paper aims to fill that gap by testing the hypothesis that the presence of water and sanitation facilities in schools can increase female-to-male enrolment ratios and reduce repetition and drop-out-ratios for girls, especially at ages when they menstruate. Quantitative analyses were undertaken of Education Management Information System (EMIS) data collected from over 10,000 schools in Zambia, to explore relationships between WASH facility provision in schools and enrolment, repetition and drop-out ratios disaggregated by gender and grade. Results indicated that improved sanitation provision in schools was correlated with high female-to-male enrolment ratios, and reduced repetition and drop-out ratios, especially for girls. A *t*-test revealed significant gender differences in grades 5–8 when many girls start to experience their menstrual cycle. Improved water supply in schools, however, did not reveal the same relationship. The findings confirm possible linkages between adequate toilets in schools and educational progression of girls.

Key words | education, gender, sanitation, schools, WASH, Zambia

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INTRODUCTION

Interest in linkages between Water, Sanitation and Hygiene (WASH) and education in low-income countries has gained momentum in the last decade. Recent research indicates that poor WASH is a common barrier to the achievement of good quality education in low-income countries (Chatterley *et al.* 2013; Cotton *et al.* 2013; Dreibelbis *et al.* 2013; Hirve *et al.* 2015; Nzengya 2015) and that the availability and access to toilets, water and other sanitation services can lead to good quality learning, primarily through its positive outcomes on health, hygiene and nutrition (Crofts & Fisher 2012; Jasper *et al.* 2012; Garn *et al.* 2013; Gelaye *et al.* 2014; Fuller *et al.* 2015; Vishnupriya *et al.* 2015).

There are multiple reasons why students drop out of schools and these are often driven by socio-economic,

cultural, political and environmental factors such as poverty, malnutrition, civil war, migration, natural disasters, child orphanage, teenage pregnancy, child marriage and child labour (Case *et al.* 2004; Davis-Kean 2005; Cigno 2012; Sabates *et al.* 2013; Lansford *et al.* 2016; Pal *et al.* 2016). Studies on educational outcomes suggest that the lack of WASH facilities is one key reason for drop-outs (Walker & Black 2010; Mbatha 2011; Klasen *et al.* 2012; Alexander *et al.* 2014; Garn *et al.* 2014; Sahin 2015; Vishnupriya *et al.* 2015) particularly for teenage girls. In particular, such studies highlighted the challenges facing girls with managing menstruation in schools with poor sanitation facilities and the potential risks of dropping out in such environments (Sommer 2010; McMahon *et al.* 2011; Jewitt & Ryley 2014).

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Menstrual Hygiene Management (MHM) is an important aspect of WASH and the lack of it poses an additional learning barrier for girls who often require essential WASH facilities (Crofts & Fisher 2012; Sommer *et al.* 2013; Alexander *et al.* 2014). Research in Kenya and Uganda showed that without adequate WASH facilities, absenteeism was common for girls during their menstrual cycle (Crofts & Fisher 2012; Sommer *et al.* 2013; Alexander *et al.* 2014). This is due to lack of privacy and space for changing, cleaning, drying or discarding MHM materials, as well as insufficient availability of water for personal hygiene (Sommer *et al.* 2013).

In the Eastern and Southern African Region (ESAR), WASH in Schools (WinS) is limited, with access to improved water and sanitation facilities in learning institutions relatively poor. In 2015, only 60% and 51% of the schools had access to water supplies and sanitation respectively, while the level of provision of hand washing facilities was even lower with only 31% of schools reporting adequate facilities (United Nations Children's Fund (UNICEF) 2017). In response, efforts continue to promote WASH provision in schools and other learning institutions across the region (Jasper *et al.* 2012; Sommer *et al.* 2013; Gelaye *et al.* 2014; Nzengya 2015).

This paper aims to show potential linkages of adequate WASH and educational progress in Zambia. The term 'adequate' means there is sufficient quantity and quality of WASH facilities and services in a given situation (UNICEF/World Health Organization (WHO) 2015). The term 'educational progression' is used to imply an advancement of moving to a higher grade and eventually completing school. The term 'educational efficiency' is sometimes also used in this context. Although the educational benefits of improved WinS have been proven in different contexts, including in ESAR, there remains a significant gap in the understanding of the benefits of WASH facilities at different learning stages (i.e. disaggregated by grade or age). This paper aims to fill that gap by summarizing the findings of quantitative analyses of Education Management Information System (EMIS) data in Zambia. EMIS contains data from approximately 10,000 schools which are managed by the government, community, private sector or are grant-aided and are distributed across urban and rural areas. The paper tests the hypothesis that improved sanitation and water result in

higher female-to-male enrolment ratios, and reduced drop-out and repetition ratios, especially for girls.

METHODS

Data source

Datasets were obtained from EMIS, a national database designed to manage information about the education system for all Zambian schools. EMIS is the basis for collecting, processing and analysing data on schools, students, staff, infrastructure, social services and many more aspects. The Ministry of Education in Zambia provided access to the EMIS database containing educational data collected from over 10,000 schools in the year 2012. The EMIS data were collected through surveys designed in the form of questionnaires which were distributed to the schools, completed by the head teachers and then collected afterwards. The EMIS database contains multiple variables including school type (government, community, private, etc.), number of enrolled students, number of repeaters as well as drop-out numbers, all disaggregated by gender and grade. Information on the number and type of toilets available and type of water source in the school is also contained in the EMIS database.

Selected variables for analysis

By testing the hypothesis that improved WASH in schools would improve the educational progression of girls, the following educational indicators were selected for this analysis: female-to-male enrolment ratio, and repetition and drop-out ratios. Ideally, attendance data would have been analysed also but these were not available.

The three key educational progression indicators assessed are defined as follows:

- Female-to-male enrolment ratio: the number of girls who were enrolled in each grade divided by the number of boys in that grade.
- Repetition ratio: the number of girls or boys who repeated the same grade divided by the total number of students who have repeated in a school in that year.

- Drop-out ratio: the number of girls or boys who have left a specific grade divided by the total number of students from all the grades who have not completed in that year.

Prior to the analysis, the datasets were sorted and cleaned to remove irregularities. For example, three records were deleted because the sum of all students reported was smaller than the actual total number of boys and girls from a given grade. The analyses were disaggregated by gender and grade (1–12). The gender disaggregation was important to determine whether the lack of water or sanitation had a more significant impact on enrolment, repetition and drop-out ratios for girls than for boys. It was also used to correct for confounding socio-economic conditions since, in general, girls and boys will be affected equally by such conditions and therefore any differences will be related to gender-specific factors related to school attendance, such as MHM and teenage pregnancy, only the former of which has any relationship with WASH services. Disaggregation by grade was important to determine whether there were significant differences for specific age groups, which may have a link to MHM.

In terms of WASH infrastructure provision, the following variables were assessed: number of toilets in relation to the number of students and whether these were considered adequate or not, and the number and type of available water sources on the school premises.

The Zambian education policy requires at least one toilet for every 20 students enrolled in the school. Taking this into account, it was assumed that schools which reported at least one toilet per 20 students provide a better level of sanitation service than those where access to one toilet is by 100 or more students and/or where there are no toilets at all. Therefore, the schools were placed into three main categories as follows:

- Schools which reported having at least one toilet for every 20 students.
- Schools which reported having one toilet per 100 students or more.
- Schools which reported having no toilets for students.

For the analysis of the enrolment ratios, schools which reported toilets without specifying the toilet to student ratios were considered. However, for subsequent analysis

of repetition and drop-out ratios, this general category of schools was excluded because interest was on the specific number of toilets available for students in each school.

Regarding the water situation, schools were also categorized as follows:

- Schools with a piped water system (e.g. water from the mains supply or piped from a mechanized borehole).
- Schools with an improved water source on site (e.g. protected well or pumped borehole).
- Schools with an unimproved source (e.g. unprotected well or untreated surface water).
- Schools with no source of water at all.

The analysis

In the first step, analyses of the sanitation and water source situations were undertaken by adding up the total number of schools under the different categories above, taking into account the school type (i.e. government, grant-aided, private and community-managed). This was useful in determining the proportion of schools with and without adequate sanitation facilities, as well as those with different types of water sources. From this, background knowledge was gained on the sanitation and water situation in different school types in Zambia.

In step two, the WASH situation was linked with the three educational indicators, i.e. enrolment, repetition and drop-out ratios. In relation to gender, average female-to-male enrolment ratios were calculated for each sanitation category, as outlined above, taking into account the concept of adequate WASH indicators. The output was displayed on a line graph which was used as a reference to interpret the gender differences in enrolment ratios within each grade and their linkages with the level of provision of sanitation facilities in schools.

Average drop-out and repetition ratios were calculated for each grade for girls and boys under each sanitation category. Since the variances were assumed to be unequal in all cases, a *t*-test was used to examine whether there were significant gender differences statistically at 95% confidence level ($P \leq 0.05$). Similarly, a line graph was used to display the output and to interpret whether inadequate toilets had a disproportional influence on drop-out and repetition for

girls and if so, in what grades. This analysis was repeated with reference to the water situation in order to determine if schools with adequate water sources, such as a piped water system, recorded reduced drop-out and repetition ratios, especially for girls.

In the final step, average drop-out and repetition ratios were calculated, for each grade for girls and boys under both water and sanitation categories (e.g. no toilets, no water) to ascertain if these were influenced by levels of WASH service provision in the schools. By doing this, a disaggregation was done to show the best and worst WASH scenarios and linkages with education indicators, as well as detect if any specific aspect of WASH (sanitation or water) alone played a relatively higher significant role in promoting learning in schools.

Study limitations

The principal challenge was the fact that EMIS is a general educational database with over one hundred variables but which lacks additional information on WASH such as quality, functionality and accessibility of toilets and water sources, as well as availability of handwashing facilities and supplies and extent of use. This is a shortcoming, particularly when considering issues of accessibility and disability, as well as long-term sustainability of WASH services in Zambian schools. The EMIS database is also populated by self-reported data from schools, which may lead to bias in under-reporting school infrastructure, such as toilets.

Another challenge is that EMIS was not designed to collect data on direct linkages between toilets or water and the educational indicators and it was assumed that poor WASH was amongst reasons for school drop-out and repetition. Hence the analyses are mainly descriptive and the *t*-test shows differences based on probability. It is important to note that this analysis aims to highlight the importance of building an evidence base for WinS advocacy and that due to the nature of EMIS, the analysis was restricted to gender differences and that it was not possible to do further analysis of other potential factors, such as socio-economic indicators, which may have influenced educational outcomes. This was due to data scarcity on these factors.

RESULTS AND DISCUSSION

An overview of the WASH situation in Zambian schools

Since 2011, the education system in Zambia has been comprised of the following levels: pre-school, basic primary (grades 1–7), junior secondary (grades 8–9), senior secondary (grades 10–12) and higher learning which includes university/college and others (UNICEF 2014). Data from all primary and secondary schools were analysed and approximately 6,000 of 10,000 schools were government managed; the rest were community and privately owned and grant aided.

Out of just over 10,000 schools, the proportion without toilets was 50% ($N = 5130$), the majority of which were in Southern, Eastern, Central and Northern provinces. The percentage of schools which reported having a toilet without indicating the number was 18% ($N = 1890$). A total of 15% of schools ($N = 1530$) reported 20 or less students per toilet while 13% ($N = 1348$) reported between 21 and 99 students per toilet and 4% of schools ($N = 450$) had 100 or more students per toilet. Most of the schools with better toilet provision were found in Lusaka and some parts of Central province. This finding is consistent with previous studies that have shown that the distribution of resources and access to and availability of public services is often asymmetrical, favouring urban areas such as Lusaka and Copper Belt and worse in remote rural areas (UNICEF 2014).

With respect to the water situation, 45% had point water sources on site (e.g. hand pump-equipped boreholes or protected wells); 22% had piped water systems and the majority were private; 21% had unprotected wells and only 12% of schools had no water source and these institutions were managed by the community.

Enrolment ratios

Analysis showed that the lack of toilets negatively influenced girls' enrolment in Zambian schools. Female-to-male ratios were lower in schools with no toilets compared to schools with 20 or less students per toilet (Figure 1). At grade 8 in particular, at the beginning of which most students are aged 13 years old, significantly more girls had

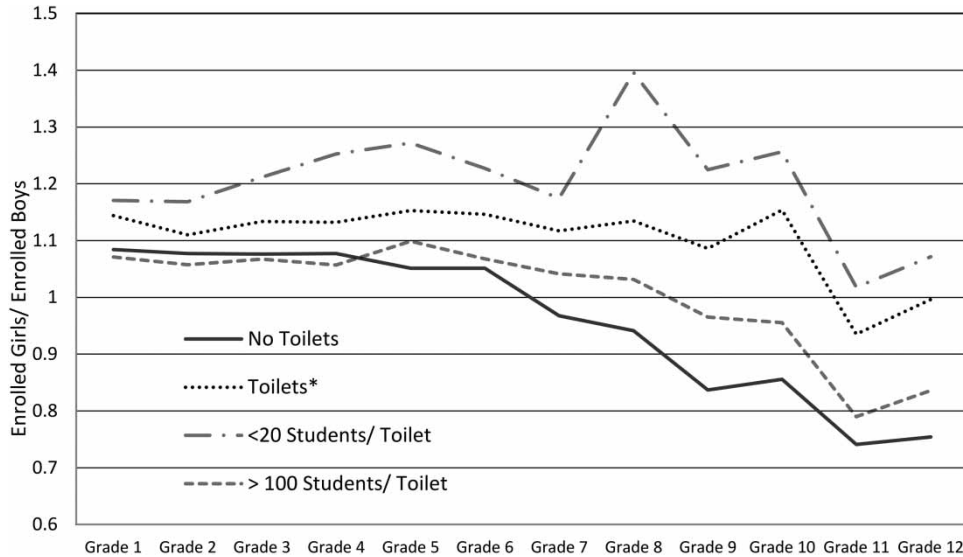


Figure 1 | Female-to-male enrolment ratios per grade and access to sanitation in schools in Zambia. *Toilets: Schools reported that there is at least one toilet without indicating the number.

enrolled in schools with good toilet provision, most likely due to the critical need for adequate toilet facilities during their menstrual cycle. Inadequate WinS is particularly problematic to girls who often face the stigma and marginalization associated with menstrual cycles (Sahin 2015). At this critical age for teenage girls (grade 7–8), there is potential to choose to enrol in schools with adequate toilets particularly with the influence of their parents and guardians.

Repetition ratios

A *t*-test revealed a significant difference in repetition ratios between schools with no toilet and those with 20 or less

students per toilet ($P = 0.0008$). Similarly, there were significant differences between schools with more than 100 students per toilet and those with 20 or less per toilet ($P = 0.0091$) particularly in grades 7 and 9. However, no significant differences were found between schools with no toilets and those with 100 or more students per toilet ($P = 0.165$), suggesting that there is little difference between a school with no toilets and one with too few toilets. Repetition ratios were relatively high for girls within schools with 100 or more students per toilet ($P = 0.036$), particularly in grades 7, 8 and 9, at typical ages of 13, 14 and 15 years respectively (Figure 2).

These findings show that WinS is a possible deciding factor in educational outcomes, as teenage girls are more

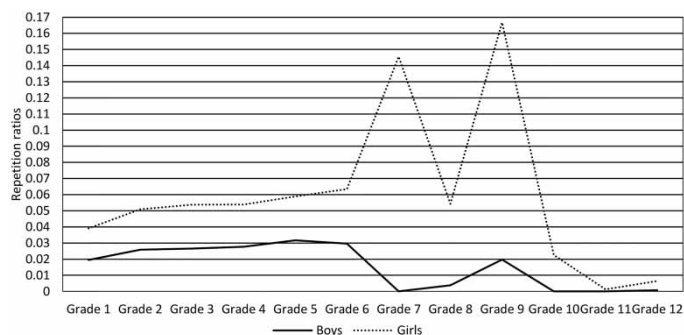


Figure 2 | Repetition ratios in schools with 100 or more students per toilet in Zambia.

likely to repeat a grade in schools without adequate sanitation. It is possible that this is the result of increased absenteeism during menstruation, as has been reported elsewhere (e.g. Sommer 2010; McMahon et al. 2011; Jewitt & Ryley 2014).

Even within schools with a piped water system, repetition ratios for girls were relatively high, especially from grade 6 where there were no toilets (Figure 3). The gender differences were statistically significant according to a *t*-test ($P = 0.0514$), which indicates that the lack of toilets in schools is a much more important risk factor in girls' educational progression than the water supply.

Where toilet facilities were inadequate (i.e. 100 or more students per toilet), significant differences were detected by the *t*-test ($P = 0.0232$), due to crowded toilet facilities which possibly led to absenteeism amongst girls who were experiencing their menstrual cycle. Even in schools with improved water sources but reporting 100 or more students per toilet, gender differences in repetition ratios were significant, as the *t*-test suggests ($P = 0.0232$). No significant differences were established in schools with adequate sanitation (i.e. less than 20 students per toilet) and water supply (e.g. piped water system). In schools with adequate WASH facilities, gender differences may not necessarily be significant due to their positive influence on attendance for both boys and girls.

Drop-out ratios

A *t*-test confirmed significant gender differences in drop-out ratios, particularly between schools with no toilets and those

with 20 or less students per toilet ($P = 0.006$, 95% confidence limit). Certainly, without any form of sanitation facilities, girls are more likely to drop out during their menstrual cycle if they repeatedly experience difficulties in managing their hygiene every month. Significant gender differences in drop-out ratios ($P = 0.024$) were also found within schools where there were 100 or more students per toilet and such disparities were most obvious in grades 6, 7, 8 and 9, (i.e. from age 12 years old). Practically, it would be difficult for girls experiencing their menstrual cycle to attend classes or school and queue up for crowded toilets and easier to remain at home to manage personal hygiene.

Within schools with records of 20 or less students per toilet, the *t*-test suggested no significant gender differences ($P = 0.47$). This is an indication that where there are adequate sanitation facilities in schools there are negligible gender differences in drop-out ratios compared to situations where there are no toilets at all. Results also revealed that availability of water sources influenced drop-out for both girls and boys but no major significant gender differences were detected, for example in schools with improved water sources ($P = 0.2373$).

Further analysis showed that the worst-case scenario (i.e. schools with neither toilet facilities nor water sources) had a more significant effect on girls compared to boys, particularly in grades 6 and 7, where students are typically aged 12 to 14 years old. This supports previous studies which have shown that without toilet facilities and water, girls' mobility is restricted during their menstrual cycle, mostly likely due to the stigma which often surrounds menstruation

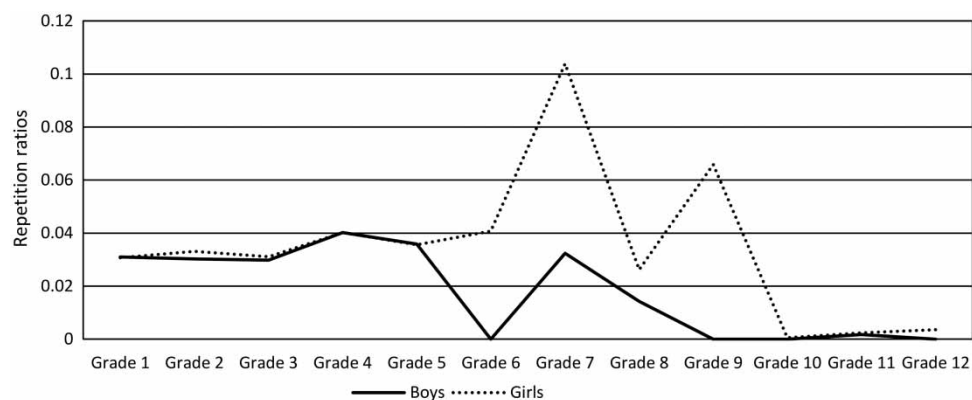


Figure 3 | Repetition ratios in schools with piped water but with no toilets in Zambia.

such as impurity, indignity and embarrassment (Crofts & Fisher 2012; Sommer *et al.* 2013; Alexander *et al.* 2014; Cronin *et al.* 2015; Hirve *et al.* 2015).

Even with piped water systems but inadequate toilets, drop-out ratios for girls were relatively higher in grades 6, 7, 8 and 9. A *t*-test showed significant gender differences in schools with 100 or more students per toilet ($P = 0.025$, Figure 4) whereby ratios were higher for girls than boys.

Similar trends were observed even in schools with improved water but with poor sanitation. It is clear from these revelations, that sanitation is important in schools and is significantly correlated with school attendance and progression, especially for girls who require adequate toilets.

CONCLUSION

This study re-emphasizes the need for adequate toilet facilities in schools as an important aspect of promoting better health and quality education (Freeman *et al.* 2012; Dreibelbis *et al.* 2013; Gelaye *et al.* 2014; Deroo *et al.* 2015). The research indicates the potential educational benefits of adequate WinS, namely, increased female-to-male student enrolment ratios and reduced repetition and drop-out ratios. The study also suggests that poor WinS is a potential source of gender disparity in many schools and can hinder educational progression for girls. It highlights the relative importance of sanitation compared to water supply, particularly for girls who are more likely to miss school during their menstrual cycle due to poor sanitation facilities.

The exploratory analysis presented in this study has deepened our understanding of WinS and especially the importance of sanitation for teenage girls. In the absence of toilets, the key critical educational progression indicators are affected even in schools with adequate piped water systems. Ideally, adequate provision of both toilets and water facilities is necessary in schools, however, this is not always possible in poorly resourced settings. Therefore, priority should be given to provision of separate toilets for girls, as this will protect their privacy, as well as reduce the stigma which is often associated with menstruation.

The nationwide analyses of WASH and educational progression disaggregated by grade is currently missing in empirical work on WASH. This paper adds to the evidence base for linkages between WinS and educational progression or educational efficiency which is much needed to develop appropriate strategies to advocate with Ministries of Education and Finance to invest in WinS infrastructure, not only in Zambia and the ESAR region but also elsewhere. We recognize the challenges of this study, particularly regarding limited analysis due to the ways in which the EMIS datasets were collected. We recommend that related studies be undertaken in similar settings by use of alternative approaches and methodologies, such as study-specific data collection and multivariate analysis, to generate a wider evidence base which is useful for strengthening WinS advocacy worldwide.

The EMIS is a useful tool for monitoring progress in the education sector. Unfortunately, water supply, sanitation and hygiene management do not feature strongly in the EMIS of many countries in the ESAR region. Very few

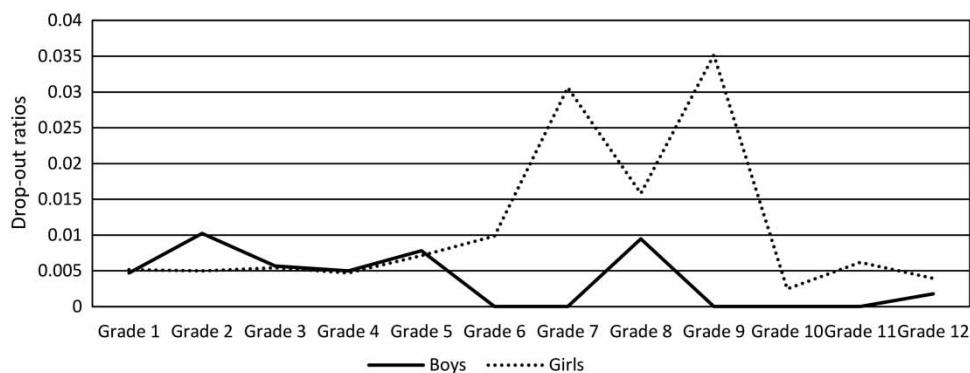


Figure 4 | Drop-out ratios in schools with piped water systems and with 100 or more students per toilet in schools in Zambia.

countries include specific data on the functionality and quality of WASH facilities provided in schools, while others have no WASH indicators at all. To build a good evidence base for WASH interventions in schools, it is recommended that countries include WASH indicators with detailed information on the quality of the facilities. Additional information such as proximity of the facilities to the learning institutions (accessibility), whether they are seasonal/permanent (e.g. water sources) are also useful, especially when evaluating accessibility and level of use.

REFERENCES

- Alexander, K., Oduor, C. & Nyothach, E. 2014 [Water, sanitation and hygiene conditions in Kenyan rural schools: are schools meeting the needs of menstruating girls?](#) *Water* **6** (5), 1453–1466.
- Case, A., Paxson, C. & Ableidinger, J. 2004 [Orphans in Africa: parental death, poverty, and school enrollment.](#) *Demography* **41** (3), 483–508 (orphans).
- Chatterley, C., Linden, K. G. & Javernick-Will, A. 2013 [Identifying pathways to continued maintenance of school sanitation in Belize.](#) *Journal of Water Sanitation and Hygiene for Development* **3** (3), 411–422.
- Cigno, A. 2012 [How to deal with covert child labor and give children an effective education, in a poor developing country.](#) *The World Bank Economic Review* **26** (1), 61–77 (child labour).
- Cotton, A., Adams, J. & Shaw, D. 2013 [Improving water supply and sanitation programme effectiveness: lessons from WaterAid's outcome evaluation studies.](#) *Water and Environment Journal* **27** (1), 1–9.
- Crofts, T. & Fisher, J. 2012 [Menstrual hygiene in Ugandan schools: an investigation of low-cost sanitary pads.](#) *Journal of Water Sanitation and Hygiene for Development* **2** (1), 50–58.
- Cronin, A. A., Badloe, C., Torlesse, H. & Nandy, R. K. 2015 [Water, sanitation and hygiene: moving the policy agenda forward in the post-2015 Asia.](#) *Asia & the Pacific Policy Studies* **2** (2), 227–233.
- Davis-Kean, P. E. 2005 [The influence of parent education and family income on child achievement: the indirect role of parental expectations and the home environment.](#) *Journal of Family Psychology* **19** (2), 294–304.
- Deroo, L., Walter, E. & Graham, J. 2015 [Monitoring and evaluation of WASH in schools programs: lessons from implementing organizations.](#) *Journal of Water Sanitation and Hygiene for Development* **5** (3), 512–520.
- Dreibelbis, R., Greene, L. E., Freeman, M. C., Saboori, S., Chase, R. P. & Rheingans, R. D. 2013 [Water, sanitation, and primary school attendance: a multi-level assessment of determinants of household-reported absence in Kenya.](#) *International Journal of Educational Development* **33** (5), 457–465.
- Freeman, M. C., Greene, L. E., Dreibelbis, R., Saboori, S., Muga, R., Brumback, B. & Rheingans, R. D. 2012 [Assessing the impact of a school-based water treatment, hygiene and sanitation programme on pupil absence in Nyanza Province, Kenya: a cluster-randomized trial.](#) *Tropical Medicine & International Health* **17** (3), 380–391.
- Fuller, J. A., Westphal, J. A., Kenney, B. & Eisenberg, J. N. S. 2015 [The joint effects of water and sanitation on diarrhoeal disease: a multicountry analysis of the demographic and health surveys.](#) *Tropical Medicine & International Health* **20** (3), 284–292.
- Garn, J. V., Greene, L. E., Dreibelbis, R., Saboori, S., Rheingans, R. D. & Freeman, M. C. 2013 [A cluster-randomized trial assessing the impact of school water, sanitation and hygiene improvements on pupil enrolment and gender parity in enrolment.](#) *Journal of Water Sanitation and Hygiene for Development* **3** (4), 592–601.
- Garn, J. V., Caruso, B. C., Drews-Botsch, C. D., Kramer, M. R., Brumback, B. A., Rheingans, R. D. & Freeman, M. C. 2014 [Factors associated with pupil toilet use in Kenyan primary schools.](#) *International Journal of Environmental Research and Public Health* **11**, 9694–9711. doi:10.3390/ijerph110909694.
- Gelaye, B., Kumie, A., Aboset, N., Berhane, Y. & Williams, M. A. 2014 [School-based intervention: evaluating the role of water, latrines and hygiene education on trachoma and intestinal parasitic infections in Ethiopia.](#) *Journal of Water Sanitation and Hygiene for Development* **4** (1), 120–130.
- Hirve, S., Lele, P., Sundaram, N., Chavan, U., Weiss, M., Steinmann, P. & Juvekar, S. 2015 [Psychosocial stress associated with sanitation practices: experiences of women in a rural community in India.](#) *Journal of Water Sanitation and Hygiene for Development* **5** (1), 115–126.
- Jasper, C., Le, T. & Bartram, J. 2012 [Water and sanitation in schools: a systematic review of the health and educational outcomes.](#) *International Journal of Environmental Research and Public Health* **9**, 2772–2787.
- Jewitt, S. & Ryley, H. 2014 [It's a girl thing: menstruation, school attendance, spatial mobility and wider gender inequalities in Kenya.](#) *Geoforum* **56** (Supplement C), 137–147.
- Klasen, S., Lechtenfeld, T., Meier, K. & Rieckmann, J. 2012 [Benefits trickling away: the health impact of extending access to piped water and sanitation in urban Yemen.](#) *Journal of Development Effectiveness* **4** (4), 537–565.
- Lansford, J. E., Dodge, K. A., Pettit, G. S. & Bates, J. E. 2016 [A public health perspective on school dropout and adult outcomes: a prospective study of risk and protective factors from age 5 to 27 years.](#) *Journal of Adolescent Health* **58** (6), 652–658.
- Mbatha, T. 2011 [Addressing girls' challenges of water and sanitation in a rural schooling context in Swaziland.](#) *Agenda* **25** (2), 35–42.
- McMahon, S., Winch, P., Caruso, B., Obure, A., Ogotu, E., Ochari, I. & Rheingans, R. 2011 [The girl with her period is the one to](#)

- hang her head'. Reflections on menstrual management among schoolgirls in rural Kenya. *Biomedical Central* **11**, 1–10.
- Nzengya, D. M. 2015 The impact of a school-based hygiene education intervention on student knowledge in Kenya. *Journal of Water Sanitation and Hygiene for Development* **5** (2), 271–278.
- Pal, D., Kanungo, S., Bal, B., Bhowmik, K. & Mahapatra, T. 2016 Malnutrition scenario among school children in Eastern-India – an epidemiological study. *Epidemiology (Sunnyvale)* **6**, 228. doi:10.4172/2161-1165.1000228.
- Sabates, R., Hossain, A. & Lewin, K. M. 2013 School drop out in Bangladesh: insights using panel data. *International Journal of Educational Development* **33** (3), 225–232.
- Sahin, M. 2015 Guest editorial: tackling the stigma and gender marginalization related to menstruation via WASH in schools programmes. *Waterlines* **31** (1), 3–6.
- Sommer, M. 2010 Where the education system and women's bodies collide: the social and health impact of girls' experiences of menstruation and schooling in Tanzania. *Journal of Adolescence* **33** (4), 521–529.
- Sommer, M., Kjellén, M. & Pensulo, C. 2013 Girls' and women's unmet needs for menstrual hygiene management (MHM): the interactions between MHM and sanitation systems in low-income countries. *Journal of Water Sanitation and Hygiene for Development* **3** (3), 283–297.
- United Nations Children's Fund 2014 *Global Initiative on out-of-School Children*. UNICEF, Zambia.
- United Nations Children's Fund 2017 *Tracking Progress in Water, Sanitation and Hygiene in Schools in the Eastern and Southern Africa Region (2012-2015)*. UNICEF, ESARO.
- Vishnupriya, S., Prasad, S., Kasav, J. B., Trout, K., Murthy, S., Surapaneni, K. M. & Joshi, A. 2015 Water and sanitation hygiene knowledge, attitudes and practices among school settings in rural Chennai. *Journal of Water Sanitation and Hygiene for Development* **5** (2), 192–200.
- Walker, C. L. F. & Black, R. E. 2010 Diarrhoea morbidity and mortality in older children, adolescents, and adults. *Epidemiology & Infection* **138** (09), 1215–1226.
- WHO & UNICEF 2015 *Progress on Sanitation and Drinking Water: 2015 Update and MDG Assessment*. WHO, Geneva.

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