Human capital and WASH

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Abstract

In labour economics, human capital is a worker's stock of knowledge and skills which contributes to their productivity and earnings. Human capital accumulation is a process of developing skills within and beyond cognitive domains, in which the first 1,000 days of a child's life are crucial. In this note, I present a conceptual model for the relationship between improvements in water, sanitation and hygiene services and increased human capital. Three pathways are proposed: early childhood development; all-age health capital; and school. The early childhood development pathway is likely to be most important, due to its far-reaching and long-lasting implications for human capital. I also review some recent evidence linking sanitation and early childhood cognitive development.

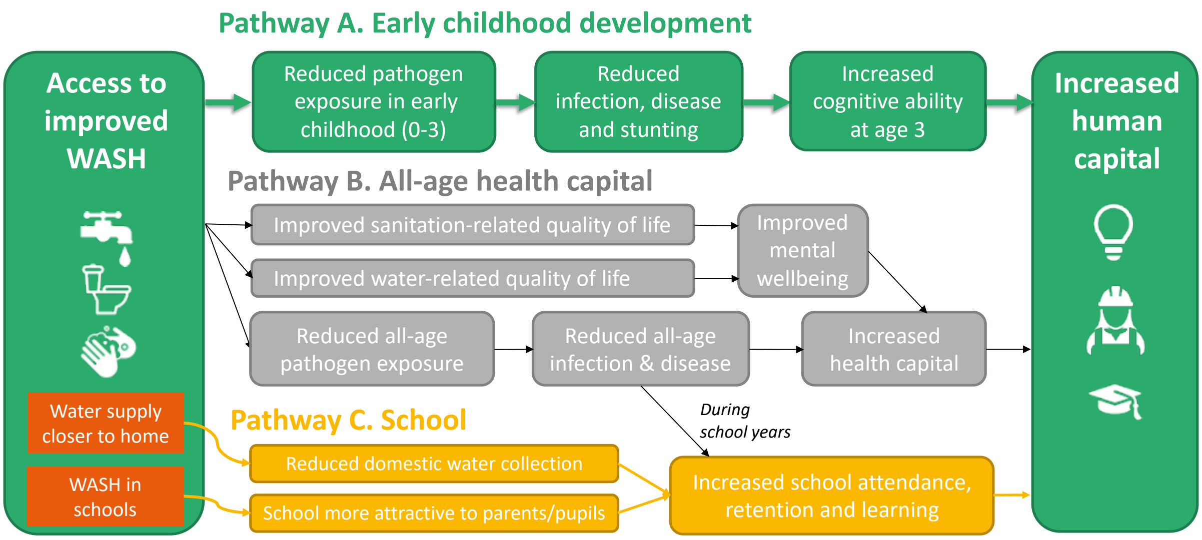
1. Introduction

In labour economics, human capital is a worker's stock of knowledge, skills or characteristics which contributes to their productivity (Becker, 1964). This affects earnings in the labour market, since the marginal product of labour is considered a determinant of wages (Stigler, 1980). Different aspects of an individual's human capital stock can be innate, or acquired through investment. Human capital accumulation is therefore the process by which people learn and grow as individuals, and develop skills within and beyond cognitive domains. It is ultimately about people achieving their potential. Framing human capital in terms of productivity and earnings may appear materialistic, but material wealth and income are ultimately hugely important for human and economic development. Health itself can, moreover, be seen as one form of human capital (Becker, 1964). Grossman's (1972) model sees health as a capital stock producing healthy years. He argues that "health capital" differs from other forms of human capital in that it affects productive *time* as well as the level of productivity.

There are numerous plausible factors affecting human capital accumulation, with attention understandably focusing on schooling and training as direct investments (Attanasio, 2015). However, an important period for the building blocks of human capital is the ages of 0-3, when children gain cognitive skills in processing information and language (Richter et al., 2017). Health status during the "first 1,000 days" affects this process (Cusick and Georgieff, 2016), and Impairments in cognitive development during this crucial window can have far-reaching and long-lasting implications for human capital (Grantham-McGregor et al., 2007). A longitudinal birth cohort study in eight LMICs found that higher rates of enteric pathogens and illness were associated with lower haemoglobin concentrations, and in turn with lower cognitive scores (Murray-Kolb et al., 2018). A historical study in the USA showed that areas with higher levels of hookworm prior to a 1910 mass treatment and education campaign experienced larger increases in literacy afterwards (Bleakley, 2007).

Investments in public health which reduce infection and disease can improve human capital, with water, sanitation and hygiene (WASH) interventions comprising one such investment. In this note, I present a conceptual model for the relationship between improvements in WASH services and increased human capital. I also review some of the evidence linking sanitation and cognitive development, focusing on studies undertaken since the last systematic review of this topic (Sclar et al., 2017).

Figure 1: Possible mechanisms by which WASH increases human capital



2. The role of WASH in human capital accumulation

A conceptual model (Figure 1) illustrates some of the plausible mechanisms by which WASH interventions across settings could increase human capital. It is likely that the most important mechanism is via reduced domestic pathogen exposure and consequent infection, disease and stunting in early childhood, leading to improved cognitive development by age 3 (Sclar et al., 2017). This is illustrated as Pathway A in green (Figure 1). Many pathogens playing a role in this relationship can be influenced by WASH interventions, including those causing diarrhoeal disease (Wolf et al., 2018), acute respiratory infections

(McGuinness et al., 2018), helminth infections (Strunz et al., 2014), and environmental enteric dysfunction (EED) (Kosek et al., 2017). All of these have some relationship to stunting, itself a risk factor for impaired cognitive development (Walker et al., 2011). Helminth infections appear particularly important for cognitive development (Pabalan et al., 2018).

However, there are two other plausible pathways. Reduced pathogen exposure at any age can lead to reduced infection, disease and increase health capital (Pathway B – grey boxes). Acutely and/or chronically sick people are less productive, which has led someone to propose “productivity-adjusted life years” as a metric for use in economic evaluation (Ademi et al., 2021). Recalling that health has mental as well as physical aspects (WHO, 1948), improved WASH can contribute to health capital via quality of life and mental wellbeing. This is plausible both for sanitation (Caruso et al., 2018; Ross et al., 2021) and water security (Brewis et al., 2019; Cooper-Vince et al., 2018). Following Grossman (1972) then, WASH can contribute to human capital at any age, via influence on health capital.

The third way in which WASH might increase human capital is via school attendance, retention, and learning (Pathway C – yellow boxes). Chronic helminth infections can affect children’s ability to learn, in an extension of pathway B (Pabalan et al., 2018). There is some evidence that domestic water collection affects school attendance, particularly by girls (Hemson, 2007), but there are few intervention studies on this topic. While a girl under-15 is the *main* person collecting water in only 4% of households in developing regions (2% for boys), this masks the fact that many children under-16 participate to some degree in water collection in many countries (United Nations, 2015). In Ghana and Rwanda, for example, 30-90% of children under-16 contribute to water collection, depending on age group and gender (Ghana Statistical Service, 2012; National Institute of Statistics of Rwanda, 2012). At the very least, involvement in such labour may contribute to late arrival, early departure, or decreased ability to concentrate in class (Hemson, 2007).

Considering WASH *in schools,* the most plausible pathway is that such improvements make schools more attractive to pupils and parents, for example once separate, private facilities are available for adolescent girls (Boosey et al., 2014; Sommer, 2010). Evidence for impact of interventions is mixed, however, for sanitation at least (Sclar et al., 2017). The only two RCTs available at that time reported no effect on absence of latrine provision (Freeman et al., 2012) or enhanced latrine cleaning (Caruso et al., 2014). Subsequent studies of broader school WASH interventions find no effect (Chard et al., 2019; Garn et al., 2017), though some studies of administrative data find positive effects of sanitation improvements (Adukia, 2017).

Table 1: Studies of the effect of sanitation improvements on cognitive development undertaken since 2016

Reference	Country	Intervention	Methods	Outcomes	Result
Gladstone et al. (2019)	Zimba-bwe	VIP latrine, handwashing stations & soap, water chlorination, play yard	**RCT (SHINE trial)** – following up 2yo *in utero* at time of intervention	• MDAT (motor, language, social) • CDI (vocabulary, grammar) • A-not-B (object permanence) • Self-control task	No effect
Spears & Lamba (2016)	India	Total Sanitation Campaign (TSC) – building latrines & promoting use	**Observational (difference-in-difference)** – district-level matching of 6yo test scores with TSC intensity in early life	• ASER (ability to recognise letters and numbers)	Small (0.3pp) increase in children recognising letters (sample mean 74.8%) and same increase for single-digit numbers (74.7%)
Stewart et al. (2018)	Kenya	Plastic latrine pans, handwashing stations & soap, water chlorination	**RCT (WASH Benefits trial)** – following up 2yo *in utero* at time of intervention	• EASQ (communication, gross motor, personal, social)	No effect
Tofail et al. (2018)	Bangla-desh	Pour-flush toilet, handwashing stations & soap, water chlorination	**RCT (WASH Benefits trial)** – following up 2yo *in utero* at time of intervention	• EASQ (communication, gross motor, personal, social)	Beneficial effects on combined EASQ in all intervention groups, smallest in the water group (0.15 mean difference vs control), larger in sanitation (0.31) and handwashing (0.29).
Orgill-Meyer & Pattanayak (2020)	India	CLTS and sanitation marts	**Observational (instrumental variable)** – 10-year follow up of RCT intervention and control groups	• RCPM (pattern association)	'Treatment on the treated': a child in a village with 100% latrine coverage scored 30% higher than in a village with 0% coverage. 'Intent-to-treat': smaller effect (5%) of living in a treated village.

Notes. 2yo = 2 year old child, RCT = randomised controlled trial, MDAT = Malawi Developmental Assessment Tool, CDI = MacArthur–Bates Communicative Development Inventories, ASER = Pratham's annual status of education report, EASQ = Extended Ages and Stages Questionnaire, RCPM = Raven's Colored Progressive Matrices, pp = percentage point, CLTS = community-led total sanitation, OLS = ordinary least squares

3. Sanitation and cognitive development

Amongst the three pathways, the early childhood development pathway is likely to be most important, due to its far-reaching and long-lasting implications for human capital. Within the various aspects of WASH, most attention regarding effects on cognitive development has focused on domestic sanitation. This is due to its more direct links to helminth infections and stunting, which are already known to have a strong relationship with cognitive development. A systematic review of the effects of sanitation improvements on cognitive development identified five studies, and concluded there was some support for positive effects (Sclar et al., 2017). I have identified a further five studies published since 2016, tabulated below (Table 1). Some of these also assess water treatment and hand hygiene interventions.

Sclar et al. summarise the state of the literature in 2016 as follows:

> *"Our review provides some support for the positive effects of sanitation on measures of cognitive development. All but one of the of the five studies reviewed, reported sanitation to be associated with improvements in cognitive [scores, but] four out of the five studies followed cross-sectional designs placing them at high risk of confounding. … more rigorous research is necessary … (e.g. randomized trials)."*

As Table 1 shows, the SHINE and WASH Benefits RCTs have now explored this question, with no effect in Zimbabwe and Kenya, but a beneficial effect in all WASH arms in Bangladesh. Focusing on sanitation, the incremental changes in sanitation service level evaluated by the two WASH-B trials were small, as I have set out elsewhere (Ross, 2019). We might therefore anticipate bigger effects in a setting with high baseline open defecation prevalence, though SHINE (which saw bigger incremental changes) did not find this. Nonetheless, in WASH-B Bangladesh, ~95% of households had a latrine with a concrete slab at baseline. The incremental change in moving to a pour-flush toilet was small, but effects on cognitive development were nonetheless seen.

The large effect Orgill-Meyer & Pattanayak (2020) identified in their 10 year follow-up study is eye-catching (Table 1). However, note that this is for the 'treatment on the treated' analysis, while the 'intent-to-treat' analysis effect size was much smaller. The effect size identified by Spears & Lamba (2016) in their cross-sectional study is also small. All in all, while the quality of the evidence has improved since the Sclar et al. (2017) review, the conclusion to be drawn remains more or less similar. There is some support for positive effects of sanitation on measures of cognitive development. On the other hand, two out of three RCTs found no effect.

4. Conclusion

Human capital is a worker's stock of knowledge and skills which contributes to their productivity and earnings. I have presented a conceptual model for the relationship between improvements in WASH services and increased human capital comprising three pathways: early childhood development; all-age health capital; and school. The early childhood development pathway is the one likely to be most important, due to its far-reaching and long-lasting implications for human capital. There is some support for a positive impact of sanitation, in particular, on measures of cognitive development. However, the evidence is mixed, with some randomised trials identifying an effect and others not.

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