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Education and Hand Hygiene Practices in Senegal:

A Quantitative Study of Determinants of Hand Hygiene Compliance and the Impact of COVID-19

Anna J. Zalewska

Oliwia F. Cholewińska

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Supervisor: Gabriel Brea-Martinez
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Abstract

Although the relationship between education and hygiene has received much attention, few studies have examined it in the context of Senegal. Using data from the Demographic and Health Surveys Program, this paper investigates the relationship between educational attainment and handwashing frequency among 9,012 individuals aged 15 and above, while accounting for information access, wealth status, and type of place of residence. The study also inquires how COVID-19 influenced handwashing behaviours in Senegal. The results show that soap availability is a stronger predictor of frequent handwashing than education, and that other determinants do not meaningfully contribute to the outcome. Pandemics prove to be a powerful driver of behavioural change across all education groups, though soap availability largely shapes the effect, suggesting that public health awareness tends to increase during crisis periods.

Keywords: Senegal, hand hygiene, education, soap, media access, wealth status, urban, rural, COVID-19

Anna J. Zalewska and Oliwia F. Cholewińska

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1. Introduction

Many infectious diseases are transmitted through hand contact. Thus, good hand hygiene practices are one of the most important elements of hygiene (Arbogast et al., 2016; Costa et al., 2024). Hand hygiene refers to hand-cleaning action that removes oil and microorganisms from the hands (Hassen et al., 2025). Handwashing with soap remains one of the most reliable and cost-effective methods for preventing infectious diseases, reducing foodborne illness, and preventing hospital-acquired infections that can be detrimental or even fatal. Studies have found that proper hand hygiene reduces the risk of pneumonia and diarrhea, leading causes of death among young children, as well as respiratory infections (Endalew et al., 2022; Curtis et al., 2009). It has also been found that handwashing decreases the risk of mortality at home birth deliveries and severe outcomes (Curtis & Cairncross, 2003; Rhee et al., 2008). It has also played an essential role in preventing the spread of coronavirus (Smith et al., 2021).

Despite these well-documented benefits, compliance with proper handwashing remains suboptimal, with notable differences between high- and low-income countries. Globally, only between 19% and 30.3% of people reported practicing appropriate hand hygiene, and the prevalence of handwashing with soap after potential fecal contact is estimated at just 26%, rising to 51% in regions with greater access to handwashing facilities (Mbouthieu Teumta et al., 2019; Smith et al., 2020; Jatrana et al., 2021). Compliance is especially low in developing countries, where only 22% of people in areas with limited access to handwashing facilities wash their hands after potential fecal contact, and only 3–35% do so consistently at crucial moments (Smith et al., 2020; Tamene et al., 2023). In Sub-Saharan Africa, the situation is particularly concerning, with handwashing compliance estimated at just 21% and soap handwashing prevalence at only 14% of the population (Hassen et al., 2025; Mbouthieu Teumta et al., 2019).

Within Sub-Saharan Africa, Senegal represents a particularly concerning case, where the consequences of poor hand hygiene are clearly visible. Diarrhea is listed as the third leading cause of mortality in the country and the second leading cause driving caregivers of children under age 5 to seek medical consultation (Thiam et al., 2017). Nevertheless, proper handwashing promotion remains inadequate. It has been reported that approximately 34.7% of the population washes their hands

inappropriately (Jatrana et al., 2021). Further compounding the problem, only 20.8% of households in Senegal had soap available as of 2013, which was the lowest figure recorded globally at the time (Kumar et al., 2017).

Previous studies have found that handwashing compliance can be influenced by the educational level of the household head, media exposure, household income, and availability of handwashing facilities (Odo & Mekonnen, 2021; Hirai et al., 2016). While it might be assumed that access to handwashing facilities would be more important than education, some studies have found that education level itself affects access to such facilities, as communities with lower educational attainment tend to have more limited access, potentially due to lower awareness of the benefits of hand hygiene (Kisaakye et al., 2021; Endalew et al., 2022; Schmidt et al., 2022). Therefore, education may be a key factor in shaping handwashing practices, particularly in Senegal, where little research has examined the determinants of handwashing behavior. Senegal's educational profile further highlights this gap: between 55% and 60% of children completed primary school in 2022, between 42% and 52% complete secondary school, and only 17% complete tertiary education (UNESCO, 2024). This wide variation in educational attainment makes Senegal a compelling case to examine whether and how education influences handwashing compliance. Therefore, the study aims to answer the following research questions and test the following hypotheses:

Research Question: *How does educational attainment shape personal hygiene practices in Senegal among individuals above 15 years old?*

Sub questions:

- *How do other determinants, such as wealth status, information access, and place of residence, affect handwashing behaviors among education groups?*
- *Did the COVID-19 pandemic lead to improved hand hygiene practices in 2023 compared with the pre-pandemic period 2024-2019?*

Hypotheses:

- H0: *Educational attainment does not shape personal hygiene practices among individuals in Senegal, and is a weaker predictor than other determinants.*
- H1: *Educational attainment shapes personal hygiene practices, and is a stronger predictor than other determinants.*

- H2: *Pandemics led to improved hand hygiene practices among individuals in Senegal in 2023 compared with the pre-pandemic period.*

Thus, the study will investigate how educational attainment shapes personal hygiene practices among individuals aged 15 and above in Senegal, as well as the strength of this factor in relation to other determinants, such as access to information, wealth status, place of residence, and place of handwashing.

Additionally, since the data span 2014-2023, the study will examine whether the COVID-19 outbreak influenced hand hygiene practices by comparing handwashing practices in the pre-pandemic period (2014–2019) with those in the post-pandemic period (2023).

To investigate both the determinants of hand hygiene and the change in handwashing tendencies over time, the study uses a quantitative approach, drawing on data from the Senegal Continuous Demographic and Health Surveys covering the period 2014 to 2023, excluding data from the years affected by the COVID-19 outbreak between 2020 and 2022, provided upon request by the Demographic and Health Surveys (DHS) program. It applies the Health Belief Model and Social Learning Theory as theoretical frameworks and uses the linear probability model as the primary method of data analysis.

1. 1 Aim

The research aims to investigate how educational attainment shapes personal hygiene practices, and to examine its influence on handwashing behavior alongside other determinants. Such an examination will deepen understanding of the impact of education and the factors influencing handwashing frequency, which will in turn inform more effective policies, increase hygiene practices, and reduce mortality, disease incidence, and child deaths. Much of the existing literature on health literacy focuses on the health outcomes of hand hygiene and the presence of handwashing facilities, while studies examining determinants of hygiene practices, particularly education, remain scarce, especially in Senegal (Or et al., 2020). The study also investigates the potential overall impact of COVID-19 on handwashing frequency, examining whether disease outbreaks increase hand hygiene compliance. Therefore,

this study seeks to examine whether education shapes individuals' hygiene practices and how it influences handwashing frequency alongside other determinants, and to explore how epidemics affect those routines, thereby extending the concept of health literacy beyond disease awareness to encompass everyday preventive behaviors.

1.2 Scope and Relevance

The study examines how educational attainment shapes personal hygiene practices among individuals aged 15 and above in Senegal, with a secondary focus on whether the COVID-19 outbreak influenced hand hygiene practices. The study is geographically limited to Senegal and does not aim to generalize findings to other Sub-Saharan African countries. It draws on nationally representative survey data from the DHS Program covering the period 2014–2023, excluding 2020–2022. The data covers a large sample of individuals (approximately 110,000 women and 86,000 men) across all 14 regions of Senegal, spanning both urban and rural areas across 400 clusters. The study focuses on individuals rather than households, allowing for population-level analysis of how determinants influence people's hygiene practices. Also, using individual-level data is a better approach for the linear probability model (LPM) employed in this study. The paper focuses exclusively on handwashing frequency (after using the toilet, when handling food, and when caring for children) as a measure of personal hygiene. It does not extend to other hygiene behaviors.

The study remains relevant for several reasons. Diarrhea and other preventable illnesses continue to be the leading causes of death among children, making handwashing one of the most effective and low-cost preventive measures available, and therefore an important subject of investigation. The study also remains timely relevant given the current global health context. On 17 May 2026, the World Health Organization declared the Ebola outbreak in Congo and Uganda (ECDC, 2026). While Ebola transmission is primarily through contact with bodily fluids, hand hygiene remains a key component of infection prevention and control during such outbreaks, further underlining the public health importance of understanding and improving handwashing practices. Academically, the study addresses a gap in the literature on determinants of handwashing in Senegal, where research examining the factors influencing everyday hygiene behaviors remains scarce. However, as Odo & Mekonnen (2021, p. 2) noted, proper hand hygiene "has the potential to save millions of lives".

Furthermore, the study investigates the long-term behavioral effects of the COVID-19 pandemic, a topic that remains underexplored in the academic literature, particularly within the Sub-Saharan African context.

1.3 Definitions

This study primarily examines the influence of education on proper handwashing frequency and its interactions with other determinants, including access to information, wealth status, and type of residence, as well as the temporal dimension. The distances between the categories in the index variables were estimated using the Kernel Density Estimation.

Handwashing frequency is the outcome variable, generated as a composite index derived from several original dummy variables that measure how frequently participants wash their hands after using the toilet, before eating, before preparing food, before childcare, and before cleaning a child. Frequency is expressed in two categories: *rarely*, where participants wash their hands in at most 2 of the listed situations; and *frequently*, where participants wash their hands in at least 3 of the listed situations.

Educational attainment is the predictor variable. As the study concerns whether individuals attended a given level of education, regardless of whether they completed it, the "finished" and "unfinished" categories were combined. The variable is therefore divided into four categories: *no education* (including preschool education), *primary*, *secondary*, and *higher education*.

Information access is a composite index derived from original yes/no dummy variables measuring possession of a radio, television, mobile telephone, TV5 channel (Fr. TV5MONDE; the global French-language television network), Canal+, video player, computer, and internet at home. The variable is categorized as *low* (at most 4 items), *medium* (fewer than 6 items), or *high access* (at least 6 items).

Wealth status is a composite index derived from original yes/no dummy variables measuring possession of electricity, a refrigerator, a bicycle, a motorcycle or scooter, a washing machine, a stove, an improved kitchen, an air conditioner, and a personal car. The variable is categorized as *poor* (at most 5 items), *moderate* (fewer than 8 items), or *rich* (at least 8 items).

Residence indicates whether a participant lives in an urban or rural area.

The temporal dimension divides the years of interviews into three intervals: 2014–2016, 2017–2019, and 2023, to account for potential post-pandemic fluctuations in hygiene behaviors.

The study also includes other control variables, such as: **sex of the head of household**; **relationship to the head of household** categorised into head of household, spouse of head, child of head, other relatives of head, and unrelated individuals; **how hard it is to get to a water source** expressed as less time-consuming and more time-consuming; **availability of a handwashing** place indicating whether the interviewer observed a designated place for washing hands at a participant's household; finally, **items present at the place of washing hands**, such as soap or other detergent, measured as a yes/no dummy variable. The model using these variables is restricted to household members aged 15–96.

1.4 Thesis outline

The next section presents the study's context by examining the educational and hygiene situation in Senegal, establishing the background central to this research. Chapter 3 reviews previous studies on the determinants of handwashing in African countries and outlines the theoretical frameworks underpinning the study. Chapter 4 describes the methodology, methods, and data used, as well as the study's limitations and how they are addressed and mitigated. Chapter 5 presents the data analysis and findings. Chapter 6 offers a discussion in which the findings are compared and interpreted through the lens of existing literature. The final sections present the conclusion, references, and appendices A and B.

2. Background

2.1 Hand hygiene situation in Senegal

The situation regarding handwashing in Senegal is further complicated by the fact that open defecation remains practiced in some communities. In villages such as Diourbel and Saraya, residents continue to use sand pits, potties, or open bushes as toilets (Afolabi et al., 2022). As reported by Sy et al. (2022), in 2016, around 56% of households practiced open defecation in areas where the Rural Water Supply and Sanitation Initiative (RWSSI) program had not been implemented, compared to 21% in areas where the program had been active between 2006 and 2010. Moreover, in some communities, mothers clean their children's and potties' bottoms with their bare hands, which are then washed with water alone or, in some cases, with water and soap.

When it comes to handwashing compliance, data in Senegal are scarce, underscoring the need for further research on this topic. However, based on available data, it is estimated that around 34.7% of the population washes their hands inappropriately, meaning they do not wash their hands before eating or after using the toilet and do not use soap (Jatrana et al., 2021). A study by Wolf et al. (2019) found that only 14.3% of the population washed their hands after contact with feces. According to Daffe et al. (2022), only 21% of households in Senegal had soap or detergent available at the handwashing place, indicating that only a small minority used soap for hand hygiene. This figure has changed little since 2013, when Kumar et al. (2017) found that only 20.8% of households in Senegal had soap available. The challenges regarding hand hygiene in Senegal are therefore shaped by both infrastructural limitations and deeply rooted behavioral patterns.

What makes such low soap usage particularly striking is that Senegal is a predominantly Muslim country, where religious leaders and Koranic teachers emphasize strict personal hygiene, including washing different parts of the body five times a day before prayer (Afolabi et al., 2022). Despite this cultural emphasis on cleanliness, many Senegalese find it difficult to adhere to thorough handwashing practices because soap is often unavailable at handwashing facilities, and many reportedly wash their hands with water and sand instead. According to a joint WHO

and UNICEF report (2021), around 57% of the population had no handwashing facility at home as of 2020.

Several programs have sought to address these challenges by developing basic infrastructure and providing institutional support. The RWSSI, for instance, focused on improving water access and sanitation by establishing boreholes, installing drinking water supply systems, constructing household and public latrines, and promoting handwashing awareness (Sy et al., 2022). The program increased water access by over 60% and sanitation access by almost 40%. It also led to improvements in handwashing behavior, which became more regular and systematic before eating and after using the toilet, with approximately 88% of beneficiary households reporting improved environmental hygiene after 2006 (Sy et al., 2022). Despite these efforts, compliance remains low, suggesting that infrastructure alone is insufficient to drive lasting behavioral change.

2.2 Educational situation in Senegal

Literacy is a broad concept that encompasses not only learning to read and write but also developing critical thinking, thereby enabling people to understand and interpret texts. Being literate enables people to read and interpret factual information on health risks and how to navigate the health system. To build literacy, one needs a good educational system. However, the educational system in Senegal is characterized by a complex structure and significant barriers that minimize the positive impact of education. In Senegal, there are three types of schooling: formal schooling, Nonformal Education (NFE), and Koranic schools (Kuenzi, 2011, p. 3).

The formal educational system in Senegal consists of a 6-year primary school, followed by secondary schooling that concludes at the 13th grade, inherited from the French colonial system, which used schooling as a tool of cultural assimilation rather than genuine education (Kuenzi, 2011, p. 21). Critically, this system fails to meet the population's educational needs due to multiple structural and linguistic barriers. French remains the only official language of instruction from the first grade of primary school (Shiohata, 2010). However, a significant majority of the population does not speak French, and thus teaching in French creates a substantial barrier for children entering the school system, ultimately undermining the quality of learning, since students must acquire both basic knowledge and a second language simultaneously

(Kuenzi, 2011, pp. 11–20). Therefore, although people may be attending school, their literacy levels may remain low. Moreover, the issue is even greater in rural areas, as during colonial times, citizens, especially those from rural areas, would often express their resistance against colonialism by not attending formal schools, which were perceived as a colonial imposition. As a result, attendance at formal education remains low in rural areas, where many adults lack formal schooling. Even if they have attained school, most of them have completed only the first 5–6 years of schooling, resulting in continuously lower educational and literacy levels in rural than in urban regions (Kuenzi, 2011, p. 11). These language and attendance issues demonstrate that formal schooling in Senegal fails to deliver meaningful educational outcomes, underscoring a critical need for systemic reform to achieve genuine literacy and learning.

NFE is a nonformal educational system, often targeting adults and usually administered by international nongovernmental organizations (NGOs), that aims to address the limitations of formal education, meet citizens' educational needs, improve literacy, and empower communities. In African countries, it is considered a more culturally relevant form of education because it is often delivered in people's mother tongues, enabling participants to learn more efficiently (Kuenzi, 2011, p. 14). However, the skills gained through these programs are often shallow, and teachers often replicate formal schooling methods. Additionally, those who complete NFE programs frequently find themselves in nonliterate environments, meaning they rarely use their newly acquired skills, which cannot be reinforced over time (Kuenzi, 2011, p. 14). Although NFE is still not a perfect form of schooling, it remains a better option than formal education, as people gain knowledge in languages they understand, making actual learning more likely.

Aside from ordinary schools, a uniquely important feature of Senegal's educational landscape is the parallel Koranic school system. With 95% of the population Muslim, many parents prefer to send their children to Koranic schools alongside formal ones, particularly at an early age, as state schools do not provide religious education (Diame, 2024, p. 41). However, Koranic schools are not an effective educational system, as children attending them primarily memorize Quranic verses and are not genuinely taught to read or write (Kuenzi, 2011, p. 76). These schools often do not run long enough for students to develop critical thinking or to extract meaning from the verses they memorize, particularly given that the Quran is written in Arabic, a language most

Senegalese do not speak (Kuenzi, 2011, p. 76; Kuenzi, 2018). Nevertheless, Koranic schools do provide essential education on hygiene, as the Quran mandates handwashing before prayer (Ng, Shaban, & Mortel, 2019). As a result, many religious leaders strongly emphasize handwashing and encourage believers to cleanse themselves before praying (Widyasari et al. 2020; Afolabi et al., 2022). However, although Koranic schools place considerable pressure on hand hygiene, compliance is not sustained due to other determinants discussed in this study and, as mentioned in the previous section, because many believers consider washing their hands with sand sufficient.

There is limited information, particularly from recent years, on Senegal's educational system and its influence on hygiene practices, which complicates efforts to fully assess the relationship between education and health outcomes. Although the system's different strands are meant to complement each other, educational attainment remains low, which contributes to low health literacy. The lack of instruction in students' mother tongues further exacerbates the challenge, preventing many children from developing not only general literacy but also critical health literacy necessary for effective hygiene practices. While Koranic schools emphasize the importance of hygiene, their focus on rote memorization and instruction in languages unfamiliar to most students limits their broader impact on literacy and long-term behavioral change. These observations suggest that, beyond the religious encouragement of hygiene, enduring obstacles such as linguistic barriers, insufficient integration of practical health education, and underlying structural inequalities may play a more decisive role in inhibiting consistent hand hygiene compliance. Therefore, to meaningfully improve health outcomes, reforms must address the educational system's foundational limitations, ensuring that both literacy and health-promoting behaviors are accessible and sustainable for all segments of the population.

3. Literature review

3.1 Previous Research

3.1.1 Factors Influencing Handwashing

Previous studies have investigated the determinants of handwashing practices in African countries. It has been found that handwashing behavior is least common in low-income countries, especially in Sub-Saharan Africa, where most countries are low-income (Smith et al., 2020). Handwashing practices are either examined using surveys asking about the frequency of handwashing, thus directly looking into the behavior frequency (Kebede et al., 2022; Smith et al., 2020; Tamene et al., 2023; Kumar et al., 2017; Schmidt et al., 2009), or by estimating handwashing behaviors based on the presence of handwashing facilities (Odo & Mekonnen, 2021; Kisaakye et al., 2020; Endalew et al., 2022). This section will examine both types of studies: those that directly examine handwashing behaviors and those that inquire about the availability of handwashing facilities.

Several studies conducted across Sub-Saharan Africa have consistently identified education as a key determinant of handwashing behavior and facility availability. Previous studies (Kebede et al., 2022; Tamene et al., 2023; Kisaakye et al,. 2020) have found a positive relationship between household head education and handwashing practices using soap and water, whereby the use of essential facilities gradually increased with higher educational level. For example, Kebede, Tusa, and Weldesenbet (2022) showed that households whose head had attended secondary education were 66% more likely to wash their hands, and those whose head had higher education were twice as likely, compared to households whose head had no formal education. Similar findings were reported by Odo and Mekonnen (2021), who found a positive relationship between the availability of a basic handwashing facility and the household head's education level, with higher educational attainment associated with a greater likelihood of having a handwashing facility. The most notable differences were observed when comparing household heads with no formal education to those who had attended primary school (24% higher odds), secondary school (83% higher odds), or higher education (135% higher odds). The results are consistent even at a more general level, as Endalew et al. (2022) also found that communities with lower levels of

education were less likely to have handwashing facilities, while Schmidt et al. (2009) obtained similar results when investigating the determinants of handwashing practices in Kenya, where higher education was associated with washing hands with soap, in both cases indicating that education is a significant determinant of hand hygiene. The positive relationship between education and handwashing behavior or facility presence, as identified across these studies, may be explained by the fact that more educated individuals are more likely to recognize the importance of hand hygiene (Kebede et al., 2022). There are also exceptions to the pattern: Rwanda, for unexplained reasons, showed that household heads with no formal education were more likely to have a handwashing station than those with only primary education (Kisaakye et al., 2020). Still, across the studies reviewed, education emerges as one of the most consistently identified determinants of handwashing behavior and facility availability. However, exceptions such as Rwanda suggest that broader contextual factors may shape its influence. The reasons behind this pattern in Rwanda remain unexplained in the existing literature, suggesting a gap worth further investigation.

Given that education and wealth tend to be closely interrelated, as educated individuals are more likely to be employed or to hold higher-earning positions, and are thus better placed to afford handwashing facilities, it follows that wealth may also be associated with handwashing behavior (Kebede et al., 2022; Schmidt et al., 2009; Tamene et al., 2023). Accordingly, wealthier households are more likely to wash their hands (Endalew et al., 2022; Kebede et al., 2022). Kebede, Tusa, and Weldesenbet (2022) found that households in the highest wealth quintile had a 94% higher likelihood of washing their hands properly than those in lower wealth quintiles, while the wealthiest households were 145% more likely to use essential handwashing facilities than those in lower economic status. Odo & Mekonnen (2021) and Kisaakye et al. (2020) similarly found that wealthier households (those with a higher wealth index) were five times more likely to have a handwashing facility than those with a lower wealth index, indicating that wealthier households are more likely to wash their hands. The findings are also supported in a broader context: White et al. (2020) found that socioeconomic factors, such as education and wealth, appear to positively affect the likelihood of handwashing globally. The difference in handwashing behavior between economic statuses might be due to the cost of establishing a handwashing facility and obtaining water and soap (Tamene et al., 2023). Nevertheless, hygiene practices remain uneven, as Rwanda again proved an exception, with poorer households more likely to have a

handwashing facility than the wealthiest (Kisaakye et al., 2020). Taken together, the evidence strongly suggests that wealthier households are better positioned to access and maintain handwashing facilities, reinforcing the view that handwashing behavior is deeply embedded in household socioeconomic conditions.

Education and wealth are also closely linked to media exposure, as media ownership is generally regarded as a marker of wealth, and more educated individuals tend to have greater access to media (Schmidt et al., 2009). Accordingly, Schmidt et al. (2009), Endalew et al. (2022), and Odo & Mekonnen (2021) identified a positive correlation between the presence of handwashing facilities and media exposure. The latter found that households owning a radio had 32% higher odds of having a handwashing facility, and those owning a television had 49% higher odds of having one in Ethiopia. It has also been noted that media exposure tends to independently encourage handwashing, because those who engage with media are generally more open to adopting new behaviors (Schmidt et al., 2009). Additionally, the media play an essential role in handwashing frequency, as health campaigns broadcast through the media further promote hand hygiene, amplifying their reach and impact (Schmidt et al., 2009; Endalew et al., 2022; Odo & Mekonnen, 2021). Media also contributes to sustaining handwashing practices in the long term, as education alone is insufficient to ensure consistent hand hygiene, as social and organizational triggers are also required (Odo & Mekonnen, 2021). Schmidt et al. (2009) further found that social activities positively influenced handwashing frequency in Kenya. The relationship between media exposure and handwashing, therefore, appears to go beyond simple socioeconomic status, suggesting that access to information and openness to behavioral change are independent drivers of hand hygiene practices.

Beyond factors such as education, wealth, and media exposure, the type of residence also appears to shape handwashing behaviors. Many previous studies have found that urban areas are more likely to practice handwashing. For example, Odo & Mekonnen (2021) indicated that handwashing facilities are likely to be used 29% more frequently in urban than in rural settings. Similarly, Kisaakye et al. (2020), in their study examining the availability of handwashing facilities across four East African countries, found that the type of place of residence was a significant factor in Rwanda and Tanzania. The greater prevalence of handwashing stations in urban settings suggests that households in those regions wash their hands more often than those in rural areas.

The difference may partly be because the least educated household heads and the poorest households are more commonly located in rural areas (Kumar et al., 2017). Those households are also more likely to have a mobile handwashing station or none at all, and Endalew et al. (2022) and Kebede, Tusa, & Weldesenbet (2022) found that households with mobile handwashing stations are less likely to practice handwashing. The decline in hand hygiene practice when there is mobile handwashing facility might be due to the inconvenience of travelling to a water source solely to wash hands and a lack of motivation to use hard-won water for handwashing (Endalew et al., 2022), as Schmidt et al. (2009) found that households that had to travel over 30 minutes for water showed lower handwashing compliance than those with a water source much closer. As limited handwashing stations, including the absence of fixed facilities, are more common in rural areas, this may explain why the type of place of residence plays a role in handwashing behavior (Smith et al., 2020).

Furthermore, soap and clean water may be more expensive and less accessible in rural areas, and levels of education, including health education that raises awareness of the necessity of hand hygiene, tend to be lower (Smith et al., 2020). However, there are unexplained exceptions: Kisaakye et al. (2020) found no significant relationship between place of residence and the presence of handwashing facilities in Kenya and Uganda, where ownership rates were relatively equal across rural and urban areas. Overall, urban residence is associated with better access to handwashing facilities and, consequently, possibly more frequent handwashing. However, the evidence is not uniform across countries, underscoring the importance of country-specific and contextual factors.

Most of the studies presented have shown positive associations between handwashing behaviors and education, media exposure, wealth, and type of residence. Some studies have also identified additional factors, such as religious affiliation, as potentially influencing handwashing behavior; for instance, areas with a high proportion of Muslims showed higher handwashing rates (Schmidt et al., 2009). Beyond religion, the gender of the household head has also been shown to be an essential factor in whether adults wash their hands (Tamene et al., 2023). Following from that, the likelihood of having a handwashing facility and essential supplies, and thus the probability of washing hands properly, is more frequent in female-headed households and among older household heads in some countries (Kisaakye et al., 2021; Endalew

et al., 2022; Tamene et al., 2023). However, in some studies, the sex and age of the household head are not significant for hand hygiene or yield opposite results (Kebede et al., 2022; Odo & Mekonnen, 2021; Endalew et al., 2022). That said, education, media exposure, wealth, and type of place of residence have received the most consistent support across studies and appear to be the most essential determinants of handwashing behavior. Other factors were either less studied or showed no significant association with handwashing. Previous studies have also shown that experiences vary across countries and that hygiene is not universal but depends on country context, overall access to water, and hygiene promotion campaigns (Kisaakye et al., 2020).

Nevertheless, the literature presented in this study has its shortcomings. Many studies (Odo & Mekonnen, 2021; Kisaakye et al., 2020) focus on the availability of handwashing facilities rather than on handwashing practices themselves, and the presence of a handwashing facility does not necessarily mean people wash their hands (Wolf et al., 2019). Thus, studying handwashing behavior in facilities has its limitations. Still, these studies provide a useful overview of potential determinants. Additionally, some studies, such as those by Schmidt et al. (2009) and Kumar et al. (2017), are becoming dated, meaning their findings may no longer accurately reflect the current situation. Moreover, findings that are inconsistent with the rest, such as the fact that in Rwanda household heads with no education were more likely to have handwashing facilities, lack an explanation (Kisaakye et al., 2020).

Furthermore, although conducted in African countries, none of the studies investigate the determinants of handwashing practices specifically in Senegal or in the region, thereby reinforcing the need for the present research. Lastly, studies that examine handwashing practices directly, as in this research, may be subject to response bias, as self-reported handwashing frequency can be inflated by socially desirable responses (Kisaakye et al., 2020; Endalew et al., 2022). Nevertheless, this limitation is difficult to overcome without constant monitoring of participants, and as such, remains acceptable, leaving the studies relevant and valuable.

3.1.2 Impact of Disease Outbreaks on Hand Hygiene: COVID-19

Disease outbreaks have been shown to increase proper handwashing frequency, as was the case during the Ebola outbreak in 2014–2015 and the COVID-19 outbreak in 2020–2022 (Ilesanmi & Alele, 2015; Amuakwa-Mensah et al., 2021; Jatrana et al., 2021). Hand hygiene plays a crucial role in disease prevention. It is seen as an important measure against the spread of viruses. Much disease prevention work has focused on improving handwashing and emphasizing hand hygiene globally during disease outbreaks, including COVID-19 (Lamb et al., 2024; Midzi et al., 2024). Therefore, during the pandemic, more people adopted positive handwashing behaviors, though consistency was not sustained, as high levels of compliance declined soon after (Wang et al., 2025). Studies have shown that most people in some African countries believe that handwashing helps prevent COVID-19 (Seytre et al., 2021). However, some people still reported not seeing handwashing with soap as a way to prevent the spread of the virus (Lamb et al., 2024).

Despite this, previous studies have reported increases in handwashing frequency and soap use alongside growing concern about COVID-19 (Lamb et al., 2024; Amuakwa-Mensah et al., 2021). Fear of infection and health anxiety were identified as key factors driving increased hand hygiene during disease outbreaks. Results from Sub-Saharan Africa showed that people washed their hands more than 5 times a day due to concerns about COVID-19 transmission (Amuakwa-Mensah et al., 2021). Those results could indicate that fear and awareness of diseases and their consequences are a stronger motivator of handwashing compliance than the belief that handwashing is an effective preventive measure alone. Media played an important role in increasing handwashing compliance, as pandemic coverage heightened public concern and promoted preventive behaviors, thereby increasing disease-prevention behaviors (Wang et al., 2025). Social interactions, religious leaders, traditional leaders, and public transport have also consistently raised awareness about COVID-19, its consequences, and ways to avoid it (Midzi et al., 2024). In some cases, such as in Zimbabwe, access to handwashing was facilitated by providing sanitizers and handwashing stations at supermarkets, pharmacies, and churches, alongside recommendations to purchase inexpensive tippy taps (Midzi et al., 2024). The increased availability of handwashing facilities during the pandemic may therefore have been one of the factors contributing to higher handwashing frequency.

However, previous studies found that limited access to handwashing facilities, such as a handwashing place, soap, and water, was a major barrier to hand hygiene compliance even during the outbreak (Lamb et al., 2024). Lower availability of handwashing facilities, clean water, or soap made it impossible for many people to wash their hands more frequently. Individuals with a water source outside their homes were less likely to wash their hands properly (Amuakwa-Mensah et al., 2021). Those findings show that the availability of handwashing facilities is a crucial determinant of hand hygiene practice, and even a pandemic cannot fully overcome this barrier. Nevertheless, even if people are not accustomed to washing their hands, the availability of facilities does not necessarily lead to more frequent handwashing, as it requires a behavioral change that may not occur easily. As health workers noted, despite having sanitizers or handwashing stations at the entrances of gatherings, some people still entered without washing their hands (Midzi et al., 2024). A lack of knowledge about proper handwashing and its benefits also partially created barriers, yet handwashing frequency increased at the community level during the pandemic (Lamb et al., 2024).

After the pandemic, handwashing practices declined, which is thought to be associated with reduced media coverage and, in turn, decreased concern about the threat (Wang et al., 2025). Lower media coverage of the pandemic is assumed to be associated with reduced face masking, physical distancing, and handwashing frequency because, when coverage decreases, people tend to assume the threat has diminished. When there is no coverage at all, people naturally assume the threat has passed and that they no longer need to be as cautious as before. Such findings suggest that the media play a crucial role in sustaining more frequent handwashing practices.

There is little research on the impact of COVID-19 on handwashing behaviors before and after the pandemic and studying handwashing behavior during such periods is also challenging, as self-reported responses can be easily inflated. Nevertheless, previous studies suggest that disease outbreaks increase handwashing behavior, mainly because of heightened concern about infection, even among people who do not believe hand hygiene effectively prevents illness. Those findings suggest that fear may have a greater impact than education alone, as even people with limited health literacy may comply with handwashing to avoid getting ill. Additionally, both this section and the previous one highlight the importance of media in increasing and sustaining long-term handwashing frequency, as it can foster concern about illness by increasing coverage

of disease outbreaks and promoting hand hygiene. However, the positive impact of disease outbreaks on handwashing can still be undermined by limited access to handwashing facilities.

3.2 Theoretical Framework

To fully comprehend the complexity of the relationship between education and handwashing, and to examine the impact of COVID-19 on hygiene practices, two theories must be explained: **Health Belief Model** (HBM) and **Social Learning Theory**.

Irwin M. Rosenstock and others pioneered the HBM to explain why people do or do not take preventive health actions, including hygiene practices (Rosenstock, 1974). The model shows that individuals are more prone to engaging in health-protective behaviors when certain psychological conditions are met. Rosenstock (1974) identified four key components shaped by personal beliefs: perceived susceptibility, perceived severity, perceived benefits, and perceived barriers.

Perceived susceptibility refers to a person's beliefs about their risk of contracting a disease or experiencing a health problem. This means that, for instance, patients who believe that they may develop tuberculosis are more likely to undertake a voluntary chest X-ray check-up. *Perceived severity* relates to how serious a person believes a disease and its consequences may be. For instance, patients who believed that the consequences of not attending preventive dental visits were serious were more likely to schedule those visits. *Perceived benefits* are associated with a person's beliefs about the effectiveness and safety of preventive actions, such as check-ups or vaccinations, in reducing the risk of disease. *Perceived barriers* are obstacles to taking preventive action, such as financial costs, travel distance, or fear of outcomes. This means that if treatment is low-cost or people have easy access to a health center, they are more likely to attend preventive check-ups.

The HBM aligns well with the study, as more educated individuals, who more effectively obtain and process health information, may be more likely to understand the likelihood of experiencing health issues, the seriousness of poor health habits, and the benefits of preventive health practices, regardless of obstacles. Moreover, taking into account information access defined as "cues to stimulate action" by Rosenstock

(1974, p. 364) increases the theory's applicability to the study, as access to mass media may improve hygiene behaviors among individuals.

The relationship between education and hygiene practices may also be explained through Social Learning Theory. It was developed by Albert Bandura, showing that human behavior is not solely driven by internal factors or environmental pressures, such as social norms or cultural practices, but also by continuous reciprocal interactions among behavior, personal factors, and the social environment (Bandura, 1971, p. 2). The theory is thus based on the concept of *observational learning*, whereby people acquire new behaviors by observing and modeling others without necessarily performing those behaviors themselves or experiencing direct reinforcement (Bandura, 1971, p. 3).

Bandura (1971, p. 2) argued that most human behaviors are learned through observational learning, which enables people to develop complex behavioral patterns by observing others while avoiding the costs and risks of "trial and error." This implies that individuals may feel more confident adopting certain practices when they observe others successfully performing them. For instance, if one family member models the behavior and reports positive outcomes, others may be more likely to follow.

Social Learning Theory is particularly relevant to the study, as less educated people tend to rely more heavily on friends' and relatives' behaviors to acquire health practices rather than obtain information from professionals or mass media (Or et al., 2020). In communities where hygiene norms are not consistently observed or where social reinforcement of hygiene behaviors is limited, individuals may be less likely to adopt and maintain preventive health practices, regardless of their awareness of health risks. This is touched upon by Or et al. (2020), who show that participants, although aware of proper handwashing techniques, do not consistently apply them in practice due to low health literacy.

4. Methodology

4.1 Methodology

This study adopts an objectivist ontological position, which states that social phenomena, such as education and hygiene practices, exist as external realities independent of personal perceptions or interpretations (Clark et al., 2021, p. 494). This position assumes that those phenomena can be measured and analyzed objectively, making it compatible with quantitative methods and statistical analysis.

Furthermore, the study adopts a positivist epistemological position, which implies that social phenomena should be studied using the natural science approach, including measurement and hypothesis testing (Clark et al., 2021, p. 120). It holds that "objective accounts of the world can be given, and that the function of science is to develop descriptions and explanations in the form of universal laws" (Punch, 2013, p. 15). Under this view, knowledge is derived from observable, measurable empirical evidence, with a value-free approach that seeks to minimize researchers' bias and subjectivity.

Based on those positions, the research employs a deductive approach, linking theory to the existing literature to generate hypotheses, which are subsequently tested through statistical analysis. This implies that the study adopts a quantitative research design that examines measurable numerical data, allowing inquiry into how educational attainment shapes handwashing practices, as well as the influence of COVID-19 on hygiene practices in Senegal.

To analyze the data, this paper employs a *pooled cross-sectional method*, which combines independent samples from multiple data collection points into a single dataset without tracking the same individuals over time (Wooldridge, 2010, pp. 128–129). This implies that the focus shifts from identifying relationships among two or more variables to examining fluctuations in population behavior over time. Since the DHS assigns a unique ID to each household and household member each year, thereby guaranteeing respondents' anonymity, and the study dataset comprises seven datasets merged into one, the pooled approach is the most efficient way to explore hygiene practices in Senegal. The analysis is conducted at the individual level, with selected household-level variables, such as age of household members, educational attainment,

and relationship to the head of household, reshaped from wide to long format using Stata 19 software to investigate population trends.

To describe the data, a multivariate analysis is applied to examine relationships among three or more variables simultaneously (Clark et al., 2021, p. 1,055). The primary analytical method is a *linear probability model* (LPM), as it is well suited to modeling a binary outcome with a single main predictor (Agresti, 2010, p. 140). Furthermore, the LPMs will report results as predicted probabilities, indicating the likelihood that an individual will wash their hands more frequently, given their characteristics. As this method has been used in previous studies, such as Olawole (2023), this paper will employ it similarly to analyze the education-hygiene relationship. Eight models were generated to predict the likelihood that an individual with a given educational level will frequently wash their hands, including during COVID-19. The results are adjusted for nine control variables, three of which are distinguished because they are expected to meaningfully influence the outcome. The entire model, including those eight combinations, is discussed in depth in the *Data Analysis* section.

4.2 Data

As a unit of analysis, this study uses the *Senegal Continuous Demographic and Health Surveys* from 2014 to 2023, excluding the COVID-19 outbreak in 2020–2022. The surveys use a stratified two-stage cluster sampling design and provide unique information on households and their members, with a high level of anonymity. A special request had to be submitted to the DHS Program team because the data is not publicly available. The authors were informed that sharing the data with third parties is forbidden and that it should be used solely for this paper.

The research employs seven datasets, modified by renaming variables and retaining only those relevant to the analysis, to ensure data homogeneity across all years. The datasets were then merged using the "append" command to obtain meaningful results when creating the linear probability model (LPM). The merged data consist of 2,470,498 observations after the "reshape long" command, changing the unit of observation from household to individual for certain variables relative to the year of interview. This, however, resulted in a substantial number of missing values, as Stata generated additional combinations for which no corresponding observations existed.

Therefore, the study will proceed with 197,169 observations, including 110,669 women and 86,500 men ages 15–96. It is worth noting, however, that the sample size may change drastically, as Stata will account only for observations that meet all model criteria.

A total of 87 variables is included in the merged dataset, of which 39 are administrative (i.e., identifier and survey design variables), 31 are substantive (i.e., demographic, geographic, and household characteristic variables), and 17 were created through altering the original variables. However, most administrative variables are not included in the analysis, as they serve solely for validity purposes. **Table 1** (see *Appendix A*) presents variables that were either used directly or served as a basis for generating new measures. They comprise a mix of variable types, mostly categorical, thereby reinforcing the choice of the LPM as the primary method.

Variables such as educational attainment and year of interview were generated by recoding selected substantive measures, while handwashing frequency, information access, and wealth status were created using composite indexes derived from principal component analysis (PCA). Derived variables, indices, and their indicators are grouped into three bordered sections in **Table 1**. How hard it is to get to a water source is an exception because it was derived from two dummy variables. The measures highlighted in bold will be used in the LPM, and their components are explained in the *Definitions* section. All variables were generated by converting "I don't know" or other confusing responses, such as "15" in relationship to the head of household, to missing values to facilitate analysis, while preserving the number of observations.

4.3 Study Limitations

The methodology used in this paper has some limitations. As Jia (2026) points out, a cross-sectional design cannot establish a causal relationship between variables. This means the LPM cannot determine whether higher levels of education *cause* people to wash their hands more frequently. Moreover, in the LPMs, predicted probabilities may not always be restricted to the feasible probability range of 0–1 (Wooldridge, 2010, p. 455). This implies that the values can fall below zero or exceed one for certain categories.

From a data perspective, the datasets had to be manipulated to ensure Stata ran smoothly when merging across all years simultaneously. This required dropping certain variables and renaming selected codes and labels. Although this simplified the process, the datasets' reliability slightly decreased, even though the dropped variables were not used further in the analysis, and standardized codes and labels improved the comparability of the measures across the years. In addition, the DHS for Senegal lacks information on the pandemic period, creating a gap between 2019 and 2023. However, this limitation can serve as a basis for analysis, in which handwashing behaviors will be examined across pre- and post-pandemic periods.

Finally, there is always a risk that survey participants may have reported more frequent handwashing than they actually engaged in to appear more favorable to the interviewers. This phenomenon is known as social desirability bias, which either leads to over- or underestimation of behaviors in society (Clark et al., 2021, p. 707).

4.4 Source Criticism

The DHS data have already been used in myriad studies over the years, such as Lloyd and Mensch (2008), Magadi (2013), and Ouedraogo and Bougma (2024); however, despite their prominence, they warrant some criticism. First, the datasets provided by the DHS Program do not have a homogeneous structure across the years. Variables, their codes, and labels are not standardized, hampering dataset merging. As previously mentioned, the data had to be manipulated by dropping non-essential variables or changing code and label names, which was time-consuming. Moreover, the problem of homogeneity concerns the language of the surveys. Some variables contain French categories and thus require recoding or label renaming, which may cause operations to pile up in the do-file.

Second, to reduce social desirability bias, the DHS Program should consider improving the survey structure to make its questions less susceptible to manipulation. This should resolve the issue of unresponsiveness, which may have influenced certain variables in the datasets. For instance, while as many as 1,027,895 individuals answered whether they washed their hands after using the toilet, only 360,824 reported their educational attainment. However, this may also be attributed to the selection of respondents rather than to the survey design itself.

4.5 Ethics Statement

Permission to access the DHS datasets was granted on March 27, 2026, and the data file received contained no individual names or household addresses. The dataset is highly anonymized, as individuals are assigned new IDs with each survey cycle, meaning a single individual may hold different IDs across survey waves, preventing tracing while safeguarding participant privacy. No additional data were collected directly for this study. The dataset was accessed via https://www.dhsprogram.com/, shared exclusively among the researchers involved, kept strictly private, and will be deleted upon thesis submission.

5. Data Analysis

Linear probability models were estimated using the "reg" command in Stata to test into how educational attainment shapes handwashing frequency in Senegal. The analysis will also examine the influence of COVID-19 on hygiene behaviors. Observations are clustered by household ID (*hhid*) and restricted to individuals aged 15–96. The results are presented in **Table 2** (see: *Appendix A*), followed by a series of graphs of 95% CI (see: *Appendix B*).

5.1 Explaining the Models' Components

All models aim to predict the outcome (handwashing frequency), with educational attainment as a predictor. There are nine controls, of which information access, wealth status, and place of residence were most frequently selected, as they are expected to strongly impact the outcome. Reference categories were chosen based on the intrinsic structure of the variables, reflecting the rationally expected hygiene behaviour of an individual in the presence or absence of a certain characteristic (e.g., "place of washing hands 'not observed' " or "no soap/detergent"), the neutral midpoint of symmetrically ordered variables (e.g., "moderate access to media" or "moderate wealth status"), or standard analytical practice (e.g., "head of household" or "base period 2014–2016"). The difficulty of getting to a water source is an exception. Its original variable consists of 69 categories, which, unequally divided, make "less time-consuming" a suitable baseline, with more observations but significantly fewer intrinsic categories than "more time-consuming".

M1 is unadjusted for information access, wealth status, and place of residence, providing only raw estimates of the effects of primary, secondary, and higher education on handwashing frequency relative to no education. M2–M8 represent different combinations of educational attainment with controls to obtain predicted probabilities ($\hat{y}$), while accounting for variables that are likely to impact the predictor effectively and thus the outcome. In each model, the sample (N) is restricted to 9,012 individuals selected from 197,169 observations.

Predicted probabilities in the LPMs exhibit positive and negative directions: the former indicates that, compared to the baseline, selected categories increase the predicted

probability of more frequent handwashing practices by *x* percentage points, while the latter indicates the opposite. Standard errors are not included in the table for a more comprehensive interpretation of the results.

The model presents a series of R2 values across all combinations. They are relatively stable, with M1 having the lowest R2 (0.2, not adj.) and M8 the highest (0.22, not adj.). Adjusted R2 values minimally differ from the standard R2, reflecting solely 0.001–0.002 of the variance between the estimates. The stability of R2 indicates that the models are equally valuable with respect to the outcome; however, the low parameter values suggest that the models explain only 20–22% of the variance in handwashing behaviors. On the other hand, this does not necessarily imply a weak association between handwashing frequency and educational attainment. As human behavior is inherently difficult to predict in real-world settings, R2 in behavioral models serves as a conceptual benchmark rather than a definitive measure of explanatory power; thus, a relatively low value does not undermine the models' goodness of fit.

5.2 Results

The most fundamental finding across all models is that educational attainment has a moderate positive relationship with frequent handwashing. This holds more firmly, however, for individuals with secondary and higher education. Beginning with M1, coefficients are greater than those in other combinations, where estimates are adjusted for the effect of additional control variables. Compared with individuals with no education, those with secondary education are 10 percentage points more likely to wash their hands frequently ($p < 0.01$). In comparison, those with higher education are 20 percentage points more likely to comply with hand hygiene ($p < 0.01$). For individuals with primary education, the predicted probability remains at 4 pp ($p < 0.05$), the highest value within that category across all combinations.

Upon introducing new variables, coefficients change throughout M2–M8. The full model, accounting for all control variables, yields the lowest estimates: individuals with secondary and higher education are more likely to engage in frequent handwashing practices by 6 pp and 13 pp ($p < 0.01$) respectively, relative to those with no education. Primary education becomes less central to the discussion in this context, as its predicted probability remains at 2 pp relative to the baseline and falls below the significance thresholds.

The model clearly reveals three patterns that emerge when additional variables are introduced. First, coefficients for the predictor decrease across categories in M2–M8, reflecting a strong conditioning effect of the controls on the outcome. Second, as noted above, primary education becomes less valuable because its coefficients diminish substantially once new variables are included. Finally, in each combination, the coefficients for the predictor show a twofold or greater increase relative to the preceding category, indicating a consistent and gradual increase in predicted probabilities across education levels. Importantly, however, this stepwise growth does not compensate for lower educational attainment, as in all models, individuals with primary and secondary education remain below those with higher education, so the gap between the groups does not close.

5.2.1 Information Access, Place of Residence, and Wealth Status

The results have shown that information access, place of residence, and wealth status do not meaningfully influence the relationship between education and frequent handwashing. In all models, the coefficients for educational attainment are insignificantly lower than in M1, meaning that the three variables capture only a small fraction of the effect from the predictor. In contrast, they do not close the gap between education groups.

Graph 1 confirms this for information access, showing relatively modest changes in the predicted probability of frequent handwashing across education groups. For individuals with primary and secondary education, relative to moderate access, predicted handwashing probabilities remain stable at low access and increase moderately at high access (by 7 pp and 9 pp, respectively). Similarly, those with no education follow an upward, though subtle, pattern at high access (3 pp). However, they decline more steeply at low access (6 pp). Finally, highly educated individuals experience a decrease across both low and high access, with almost unobservable differences in the values (approximately 8 pp in each category). The changes in probabilities are therefore relatively small, aggregately below 10 pp.

Those findings are consistent with the results for information access in **Table 2**, which show dramatically low probabilities across education groups. Across combinations, information access negatively influences handwashing frequency at low access and

positively at high access; however, this effect on the predictor is not significant due to their low values.

Place of residence appears to follow a pattern similar to that of information access. **Graph 2** depicts comparatively small changes in predicted probabilities across education groups living in either urban or rural areas. Rural residents with no, secondary, and higher education have lower predicted probabilities of washing hands frequently than their urban counterparts; however, the regression lines reveal relatively modest differences (8 pp, 6 pp, and 5 pp, respectively). Interestingly, for individuals with primary education, the probability is nearly equal between urban and rural areas, suggesting that handwashing frequency may be less sensitive to area-specific factors. Overall, changes in probabilities are not significant, suggesting that information access is not affected.

This pattern is reflected in **Table 2** for place of residence, where negative coefficients indicate that individuals living in rural areas are less likely to wash their hands frequently than those in urban areas; however, the magnitudes of the coefficients do not differ significantly. Therefore, the place of residence shares the situation of information access.

To a certain degree, wealth status contributes the least to the relationship between education and handwashing frequency. **Graph 3** shows unexpected results worth examining. Relative to a middle stratum, among those with no, secondary, and higher education, predicted handwashing probabilities decrease for both poor and rich individuals, with minor differences within categories. Interestingly, the regression line for primary education behaves slightly differently from the other results. It shows a modest 2 pp increase between the middle and high strata. This, however, may be attributed to a small number of outliers, thereby elevating the estimates.

These findings correspond with the coefficients for wealth status in **Table 2.** They reveal considerably low probabilities, with slightly lower values for people with low incomes, as shown in **Graph 3**, with steeper slopes between the low and middle strata across all education groups. Across combinations, wealth status negatively affects outcomes for both poor and rich individuals; however, as with other covariates, low coefficient values reduce their overall effect.

As the three variables were expected to contribute strongly to the results, an additional test was run, in which soap availability was removed, as it was assumed to dominate the effect on the outcome (**Table 3**; see *Appendix A*). The test reveals that coefficients rose or declined, depending on their association with the covariate. However, the variables examined did not yield meaningful results, indicating that removing soap availability did not alter their impact on the relationship between education and frequent handwashing. In fact, dropping soap directly affected the predictor, with its coefficients increasing by 5 pp on average. On the other hand, this did not bridge the gap between education groups, as the predicted probabilities showed a stepwise increase similar to those in the models with soap availability.

Interestingly, coefficients for the place of handwashing and the period show a substantial increase, indicating that they are closely related to soap availability. Perhaps more significant results for information access, place of residence, and wealth status could be obtained by removing those two covariates; however, this might affect each variable differently or make the analysis incomplete.

5.2.2 Pandemics

The most dramatic pattern emerges from the temporal analysis. In this case, the change in predicted handwashing probabilities is substantial compared with the previous variables. **Graph 4** shows a clear and in fact, anticipated outcome. Compared with 2014–2016, all educational groups exhibit a surge in the predicted probabilities of frequent handwashing by 2023, closing the gap between individuals. The effect is notably strong for individuals with no primary or secondary education, with differences of 37 pp, 34 pp, and 30 pp, respectively. For those with higher education, the increase is rather modest; nonetheless, it represents a 7 pp change. This indicates that the COVID-19 outbreak was likely to render a robust and positive influence on frequent handwashing behaviors among individuals, especially those with a lower academic background. **Table 2** supports this assumption and shows that, across all combinations, 2023 has the highest covariate coefficients, indicating that it contributes substantially to the outcome. On the other hand, this implies that 2023 surpasses educational attainment and, as a result, diminishes the effect of educational attainment on handwashing frequency.

However, **Graph 4** presents another issue worth examining. Relative to 2014–2016, predicted probabilities of washing hands frequently are fairly stable for individuals with no and primary education, while declining for those with secondary and higher education, with a substantial 20 pp decrease among the latter. As **Table 2** does not provide a meaningful explanation for this issue, **Table 3** is employed instead. It reveals that removing soap availability notably increases coefficients for 2017–2019, while decreasing them for 2023. The corresponding change in probabilities is reflected in **Graph 5**. Compared with 2014–2016, predicted handwashing probabilities rise for those with no, primary, and secondary education by 2017–2019, then remain relatively stable by 2023. For highly educated individuals, the probability declines by 10 pp between 2014 and 2023.

This implies that soap availability has strong explanatory power in temporal analyses, especially among less educated people. Therefore, the rapid surge in probabilities in **Graph 4** may be attributed, for instance, to heightened awareness of soap use during pandemics. In contrast, the decline between 2014 and 2019 may reflect diminished awareness resulting from the adaptation period following the 2014–2015 Ebola outbreak.

6. Discussion

6.1 Education alone (M1)

The study examined the predictability of frequency of proper handwashing by educational level alone, and when accounting for determinants such as media exposure, type of place of residence, and wealth. Alongside this, it investigated the impact of the COVID-19 pandemic on hand hygiene compliance. The results showed that the frequency of handwashing and doing it properly can be predicted by educational level in Senegal. However, it was expected that proper hand hygiene compliance would increase significantly for every unit of education. The results instead showed that individuals who attended primary school do not wash their hands properly much more often than those without any education. Secondary and higher education had the most positive impact on proper handwashing frequency, creating a substantial difference between those with no or primary education and those with secondary and higher education.

These outcomes are once again compatible with previous studies (Kebede et al., 2022; Odo & Mekonnen, 2021; Schmidt et al., 2009; Endalew et al., 2022), where participants with secondary and higher education showed much more frequent handwashing and had handwashing facilities more often than those with no education, while those with primary education were not substantially better off than those without any. People with primary education or below may still lack health literacy, possibly due to the poor structure of primary schooling, in which children may not fully understand lectures delivered in an unfamiliar language, limiting their educational potential and literacy gains. Similarly, Koranic schools, where learning is largely restricted to memorizing verses in a foreign language without translation or explanation, likely yield literacy levels comparable to those with no formal education at all, and thus a similar inability to understand the benefits of hand hygiene compared to those with higher education levels. The meaningful educational gain, therefore, appears to begin at the secondary level. Since the data included both non-graduates and secondary school graduates, the results suggest that simple attendance, even without completing the degree, is sufficient to increase proper hand hygiene compliance. This could be explained by the fact that secondary school students, after years of language exposure,

may become more able to follow lectures conducted in French, gradually developing the health literacy needed to understand and act on hygiene-related information. Thus, the findings with prior research indicate that education positively affects the frequency and quality of hand hygiene practices in African countries. However, they also show that for meaningful improvements to materialize at the population level, more people must access secondary schooling.

6.2 Information Access, Place of Residence and Wealth Status (M2-M8)

The study also expected education to be a strong predictor of frequent handwashing. It was assumed that adding the determinants to education would produce a significant change in handwashing behaviours, and that the gap between less and highly educated individuals would be bridged. The findings confirm this: after accounting for information access, wealth status, and place of residence, the relationship between education and handwashing frequency does not change substantially, with the most notable changes appearing only at high levels of information access. While adding these determinants slightly decreased predicted handwashing probabilities, the changes were too small to close the gap between individuals with no or primary education and those with secondary or higher education.

This implies that providing less educated uneducated individuals with the same media exposure, wealth, or place of residence as someone with secondary education would lead to modest increases in handwashing frequency, but would not eliminate the gap between the groups. Therefore, these findings diverge from the general pattern reported in previous research and instead appear compatible with the exceptions identified by Kisaakye et al. (2020) in Kenya and Uganda, where place of residence did not significantly predict the possession of handwashing facilities. A possible explanation is that urban and rural areas in Senegal have broadly similar rates of handwashing behaviour, suggesting that place of residence alone does not determine whether individuals wash their hands more frequently or properly. Similar reasoning may apply to media exposure and wealth, in that participants may have comparably similar levels of both across groups. This pattern persisted after removing the soap variable from the model, further confirming that media exposure, wealth status, and place of residence do not meaningfully predict handwashing behaviour when

education is accounted for. As with Kisaakye et al. (2020), this may reflect the specific context of Senegal, or alternatively, a degree of sample bias.

Nevertheless, some directional patterns consistent with the broader literature remain visible, even if statistically insignificant. Regardless of education level, individuals in rural areas are generally less likely to wash their hands frequently than their urban counterparts, which may be attributable to the greater prevalence of mobile or outdoor handwashing stations in rural settings (Endalew et al., 2022; Kebede et al., 2022; Schmidt et al., 2009). However, the difference between urban and rural areas is modest, and relocating from a rural to an urban area alone would not produce a meaningful change in handwashing habits.

The results are also broadly consistent with previous findings showing that individuals with higher wealth status wash their hands more frequently than those with lower incomes (Endalew et al., 2022; Kebede et al., 2022; Odo & Mekonnen, 2021; Kisaakye et al., 2020), possibly because lower-income individuals are less able to afford handwashing facilities (Tamene et al., 2023). Though, it contradicts with them regarding significance, as in this research wealth status is insignificant. However, increasing income alone would not substantially improve handwashing behaviour without a corresponding increase in education, which represents a new contribution relative to studies that have previously reported either a positive relationship between wealth and handwashing or the opposite pattern observed in Rwanda.

Also, the results show that higher media access benefit handwashing frequency among less educated individuals, consistent with previous research, but is insufficient to close the educational gap. The insignificance of media access may imply that people gain handwashing awareness from different sources. These sources could include Islam, which emphasises hygiene and cleanliness (Widyasari et al., 2020; Afolabi et al., 2022), or social interactions within communities (Schmidt et al., 2009). The impact of social activities can be connected to Social Learning Theory, which explains that people learn certain behaviours by observing others (Bandura, 1971, p. 3). Thus, in everyday social occasions, such as within the family home or during community interactions, people may learn handwashing practices from observing others rather than from media exposure. Notably, low media access negatively affects handwashing even among more educated individuals, suggesting that sustained media exposure may contribute to

maintaining handwashing habits over time (Odo & Mekonnen, 2021), rather than increasing them in the first place.

Overall, the results do reflect the general directional patterns established in previous studies, confirming that urban residents and wealthier individuals tend to wash their hands more frequently, and that media exposure may help sustain positive handwashing habits. However, in contrast to previous research, this study does not find that changes in wealth, place of residence, or information access alone meaningfully increase handwashing frequency. For that to occur, educational attainment would need to increase as well.

6.3 Soap Influence

During our analysis, soap availability appeared to dominate the outcome alongside education. Educational attainment increases predicted handwashing probabilities increases, However, after removing soap availability, its impact rises only slightly. This suggests that handwashing behaviours are more strongly affected by soap availability, meaning that regardless of educational background, individuals may broadly share awareness of proper handwashing practices. This could be due to sample bias or because the majority of Senegalese are Muslim, a faith in which hygiene is strongly emphasised, though differences between education levels still remain (Diame, 2024, p. 41; Widyasari et al., 2020; Afolabi et al., 2022). Nevertheless, individuals with higher educational attainment are more likely to have soap available and wash their hands properly, which has also been found in previous studies (Odo & Mekonnen, 2021; Kisaakye et al., 2020; Endalew et al., 2022). However, it remains unclear whether this relationship is driven directly by education or through related factors such as soap availability. This also implies that in the absence of soap, individuals across all educational backgrounds may prefer not to wash their hands at all, wash them with sand, or use water only. The absence of soap may therefore represent a perceived barrier in the sense of the Health Belief Model (Rosenstock, 1974), preventing individuals from acting on their existing handwashing awareness regardless of their educational background. This helps explain why information access, place of residence, and wealth status do not meaningfully influence handwashing frequency alongside educational attainment, as people may already be broadly aware of handwashing regardless of where they live or how much wealth they possess. Thus, the results show

that handwashing frequency is more strongly predicted by the availability of handwashing facilities, consistent with previous studies indicating that facility availability drives handwashing behaviours (Endalew et al., 2022; Schmidt et al., 2009).

6.4 Pandemics

Our data accounts for the years 2014–2023, which gives us the opportunity to look into the impact of COVID-19 on handwashing habits. Since illness outbreaks usually lead to increases in handwashing behaviours, as was the case during the Ebola outbreak between 2014–2015 (Ilesanmi & Alele, 2015) and COVID-19 (Amuakwa-Mensah et al., 2021), it was expected that the results would show an increase in handwashing frequency across educational levels, especially among those with no, primary, and secondary education, and less so among the highly educated, thereby decreasing the gap between lower and higher educated individuals regarding proper hand hygiene compliance. The results confirmed these assumptions, as the gap between the highly educated and the rest narrowed significantly between 2017–2019 and 2023, and was almost fully bridged by the latter period. Individuals across all educational levels began to wash their hands more frequently, with the most significant increases among those with no, primary, and secondary education, largely making up for what they previously lacked compared to highly educated individuals. Notably, when soap was removed from the model, the magnitude of this increase declined, suggesting that the pandemic's influence on handwashing frequency was largely amplified by soap availability, meaning that people were more likely to wash their hands properly when soap was present. This suggests that the pandemic specifically increased proper handwashing frequency, as people appeared to wash their hands primarily in situations where soap was available. This is consistent with the finding of Lamb et al. (2024), where although people did not believe that washing hands with soap would prevent COVID-19 infection, indicating low health literacy, the proportion of people who washed their hands still increased. This suggests that there is a factor other than education that pressures people to wash their hands more often, and that factor is likely concern over getting sick (Lamb et al., 2024; Amuakwa-Mensah et al., 2021).

However, the results also revealed that people can be generally already aware of handwashing before the pandemic, but not everyone had soap available. When soap

was removed as a control variable, the trend between 2014–2019 increased, except for those with high education, whereas when soap was controlled for, it was declining over the same period, most significantly for highly educated people. This suggests that people were washing their hands more often during that time, possibly due to an increased number of handwashing places, as the place of handwashing variable had a strong impact after removing soap, but were less likely to have soap available, thus possibly less likely to wash hands properly. This indicates a general awareness of handwashing across all educational levels, but a limited understanding of the importance of using soap. Then, following the pandemic, overall handwashing frequency remained high while soap availability increased notably, once again suggesting that people broadly share awareness of handwashing across educational levels, but they may differ in perceiving soap as a necessary possession, reflecting differences in perceived benefits of proper hand hygiene.

However, highly educated individuals remain an exception to the trends observed among other educational levels. Regardless of whether soap was controlled for or not, their predicted handwashing probabilities declined between 2014–2019, with the most pronounced decline occurring when soap availability was accounted for. This may suggest that highly educated individuals were washing their hands more frequently during 2014–2016 due to heightened concern about the Ebola outbreak, during which soap availability was also higher, and subsequently returned to lower baseline compliance once the threat had subsided, with soap availability declining alongside handwashing frequency (Ilesanmi & Alele, 2015). This would be consistent with evidence that handwashing compliance tends to decrease as disease threat perception fades (Wang et al., 2025). However, the outcome might also be due to the sample bias.

The findings in general align with HBM theory, showing that people are more prone to engage in health-protective actions, such as proper handwashing, when they believe they are at risk of infection and perceive the consequences as serious (Rosenstock, 1974). The results also show that pandemics can be an important trigger regarding handwashing frequency, but the effects are largely shaped by soap availability, since without soap handwashing frequency decreases and after controlling for soap the results sharply increase (Lamb et al., 2024; Amuakwa-Mensah et al., 2021). Thus, the findings show that illness outbreaks impact hygiene behaviours positively, though this impact may not be sustained once the perceived threat diminishes, as appears to be the

case among highly educated individuals who showed declining compliance in the post-Ebola period (Wang et al., 2025).

7. Conclusion

Most public health research assumes that higher levels of education lead to better hygiene practices, especially at higher levels of schooling. Moreover, information access, place of residence, and wealth status are widely regarded as important determinants of handwashing behavior. The findings of this paper, however, reveal that this is not entirely the case for Senegal: education does help improve handwashing practices, but not in a meaningful way, and the three determinants matter far less than anticipated.

The analysis shows unexpected results: soap availability dominates the outcome rather than education. However, its influence varies across variables. With soap in the model, education slightly increases the likelihood of frequent handwashing, whereas without it, this barely changes. On the other hand, information access, place of residence, and wealth status are only slightly affected in both cases. This suggests that, regardless of educational background, most individuals may already know that handwashing is important. Therefore, the real barrier appears to be whether soap is available, not whether people are aware of the need to use it. This awareness, however, does not develop equally across education groups. Among individuals with primary education, a teaching method in Senegal is likely to yield levels of health literacy similar to those of individuals with no education. It is only at secondary and higher levels that people may develop sufficient literacy to understand and act on hygiene-related information. Nevertheless, the findings suggest that education or awareness alone is not enough. Without soap being physically present, even those with higher education may be less likely to wash their hands frequently.

Pandemics add another layer to this. During the Ebola outbreak, handwashing likely increased across all groups, with only those with higher education returning to pre-pandemic habits (Ilesanmi & Alele, 2015; Wang et al., 2025). On the other hand, during COVID-19, the probability of engaging in risky behaviors increased across all educational groups, suggesting that major health crises can drive behavioral change

regardless of educational background (Amuakwa-Mensah et al., 2021). While removing soap availability, however, the situation changes completely. This may be attributed to other variables, such as the location of handwashing, which may reflect long-term investment in handwashing stations after Ebola, though this is pure speculation.

However, these results should be interpreted carefully, as the sample may be skewed towards people who are already well-educated, wealthy, and well-informed, which may explain why information access, place of residence, and wealth status do not meaningfully contribute to the relationship between education and handwashing frequency. Future research should therefore use broader, more representative data to more deeply explore the topic. In terms of policy, although improving access to higher levels of education remains the most important issue in Senegal, making soap and handwashing facilities more widely available is likely to produce more meaningful results and thus help accelerate the country's approach to hygiene.

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9. Appendix

9.1 Appendix A

Table 1. Variables used in the analysis (excluding the administrative)		
Code	**Name**	**Type**
hhid*		
member*		
hv007	year_interview	nominal**
recode hv007	**new_year_interview**	**ordinal**
hv025	**type_of_place_of_residence**	**dummy**
hv109_	educational_attainment	ordinal
recode of hv109_	**new_edu_attainment**	**ordinal**
hv105_	age_of_household_members	continuous***
recode of hv105_	**new_age_household**	**dummy**
sh137aa	hands_after_toilet	dummy
sh137ab	hands_before_eating	dummy
sh137ac	hands_before_prep_food	dummy
sh137ad	hands_before_childcare	dummy
sh137ae	hands_before_clean_child	dummy
composite index	hand_washing	continuous***
derived from the index	**wash_frequency**	**dummy**
hv101_	relationship_to_head	nominal
recode of hv101_	**new_rel_to_head**	**nominal**
hv219	**sex_of_head_of_household**	**dummy**
hv207	radio	dummy
hv208	television	dummy
hv243a	mobile_telephone	dummy
sh110d	tv5_chanel	dummy
sh110e	canal	dummy
sh110l	video_player	dummy
sh110n	computer	dummy
sh110o	internet_at_home	dummy
composite index	information	continuous***
derived from the index	**info_access**	**ordinal**
hv230a	plc_household_members_wsh_hnds	nominal
recode of hv230a	**new_plc_wsh_hnds**	**dummy**
hv206	electricity	dummy
hv209	refrigerator	dummy
hv210	bicycle	dummy
hv211	motorcycle_scooter	dummy
sh110h	washing_machine	dummy

Table 1. continuation

sh110j	stove	dummy
sh110k	improved_kitchen	dummy
sh110m	air_conditioner	dummy
sh118c	personal_car	dummy
composite index	ses****	continuous***
derived from the index	**wealth_level**	**ordinal**
hv232	**items_present_soap_detergent**	**dummy**
hv235	location_of_source_for_water	nominal
recode of hv235	new_loc_water	dummy
hv204	time_to_get_to_water_source_mnts	continuous***
recode of hv204	new_time_water	dummy
generated from new_loc _water & new_time_ water	**get_to_water**	**dummy**

*Identifiers of households and individuals respectively

**Year of interview is treated as nominal because the dataset consists of seven years merged

***Those variables are not included in the LPM and serve only as a basis for other variables

****Socioeconomic status

Table 2. Linear probability models for handwashing behaviors, where handwashing frequency is the outcome variable (rarely/frequently)

variables	categories	M1. only educational attainment	M2. educational attainment with information access	M3. educational attainment with wealth status	M4. educational attainment with place of residence	M5. educational attainment with information access and wealth status	M6. educational attainment with information access and place of residence	M7. educational attainment with wealth status and place of residence	M8. full model
predictor									
educational attainment	**no education**	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
	primary	0.042**	0.025	0.031*	0.028*	0.022	0.018	0.022	0.016
	secondary	0.100***	0.075***	0.082***	0.079***	0.070***	0.064***	0.070***	0.061***
	higher	0.202***	0.147***	0.165***	0.170***	0.142***	0.132***	0.150***	0.131***
important controls									
information access	**low**		-0.070**			-0.054	-0.050		-0.039
	moderate		Ref.			Ref.	Ref.		Ref.
	high		0.059			0.051	0.058		0.054

Table 2. continuation

other controls

relationship to the head of household					sex of the head of household		period			place of residence		wealth level		
not related	other relatives	child	spouse	head	female	male	2023	2017-2019	2014-2016	rural	urban	rich	moderate	poor
-0.062	-0.017	-0.042***	0.009	Ref.	Ref.	-0.042	0.386***	-0.004	Ref.					
-0.078*	-0.029**	-0.038**	0.007	Ref.	Ref.	-0.032	0.357***	-0.024	Ref.					
-0.072	-0.026*	-0.039**	0.007	Ref.	Ref.	-0.034	0.358***	-0.024	Ref.			-0.003	Ref.	-0.098***
-0.061	-0.016	-0.036**	0.009	Ref.	Ref.	-0.025	0.382***	-0.009	Ref.	-0.096***	Ref.			
-0.078*	-0.030**	-0.036**	0.006	Ref.	Ref.	-0.032	0.349***	-0.030	Ref.			-0.029	Ref.	-0.067*
-0.074	-0.026*	-0.033**	0.007	Ref.	Ref.	-0.022	0.358***	-0.023	Ref.	-0.069**	Ref.			
-0.068	-0.023	-0.034**	0.008	Ref.	Ref.	-0.023	0.361***	-0.023	Ref.	-0.074**	Ref.	-0.011	Ref.	-0.082**
-0.074	-0.027*	-0.033**	0.007	Ref.	Ref.	-0.023	0.352***	-0.028	Ref.	-0.063**	Ref.	-0.034	Ref.	-0.058

Table 2. continuation

place of washing hands	**observed**	0.071**	0.060*	0.057	0.064*	0.056	0.057	0.054	0.055
	not observed	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
get to a water source	**less time-consuming**	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
	more time-consuming	-0.108***	-0.087***	-0.096***	-0.091***	-0.085***	-0.078***	-0.086***	-0.078***
soap/detergent availability	**not present**	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
	present	0.286***	0.276***	0.283***	0.282***	0.277***	0.275***	0.280***	0.275***
_cons		0.326***	0.369***	0.412***	0.386***	0.419***	0.399***	0.446***	0.441***
N		9012	9012	9012	9012	9012	9012	9012	9012
R2		0.200	0.211	0.208	0.207	0.213	0.215	0.212	0.216
Adj. R2		0.199	0.210	0.207	0.206	0.212	0.213	0.210	0.214

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 3. Linear probability models for handwashing behaviors, without soap availability

variables	categories	**M9. only educational attainment**	**M10. educational attainment with information access**	**M11. educational attainment with wealth status**	**M12. educational attainment with place of residence**	**M13. educational attainment with information access and wealth status**	**M14. educational attainment with information access and place of residence**	**M15. educational attainment with wealth status and place of residence**	**M16. full model**
predictor									
educational attainment	**no education**	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
	primary	0.053***	0.036**	0.046***	0.041**	0.035**	0.030*	0.037**	0.029*
	secondary	0.119***	0.094***	0.108***	0.102***	0.093***	0.086***	0.096***	0.085***
	higher	0.246***	0.187***	0.222***	0.220***	0.189***	0.176***	0.207***	0.179***

Table 3. continuation

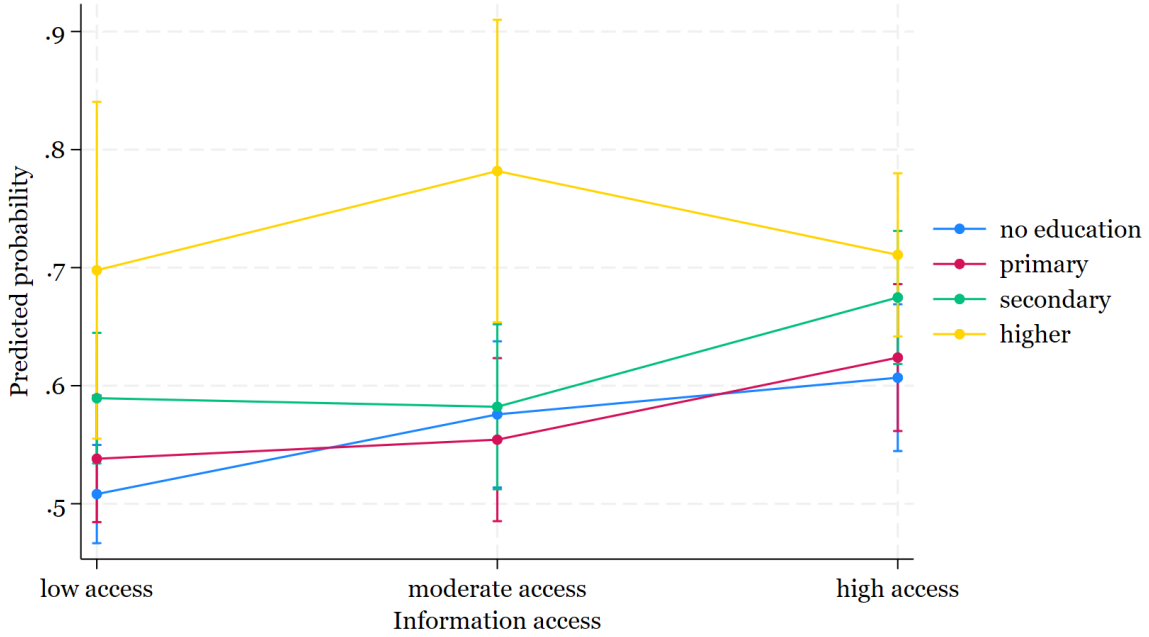
chosen controls									
information access	**low**		-0.053			-0.053	-0.039		-0.041
	moderate		Ref.			Ref.	Ref.		Ref.
	high		0.086**			0.090**	0.084**		0.090**
wealth level	**poor**			-0.058		-0.020		-0.044	-0.013
	moderate			Ref.		Ref.		Ref.	Ref.
	rich			0.010		-0.030		0.001	-0.035
place of residence	**urban**				Ref.		Ref.	Ref.	Ref.
	rural				-0.084***		-0.055*	-0.072**	-0.057*
place of washing hands	**observed**	0.320***	0.305***	0.310***	0.313***	0.306***	0.302***	0.307***	0.304***
	not observed	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
period	**2014-2016**	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
	2017-2019	0.174***	0.153***	0.161***	0.169***	0.152***	0.153***	0.161***	0.154***
	2023	0.190***	0.160***	0.170***	0.186***	0.160***	0.160***	0.172***	0.162***

* p < 0.10, ** p < 0.05, *** p < 0.01

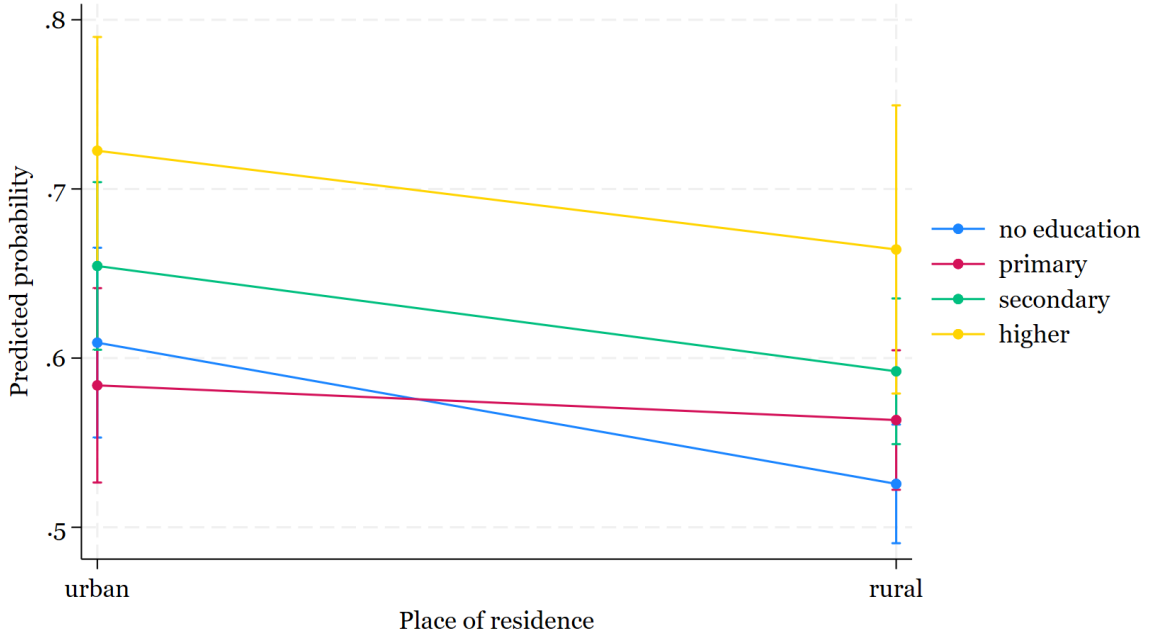
For more comprehensive interpretation, other controls were removed from the table; however, their effect is still present in the results

9.2 Appendix B

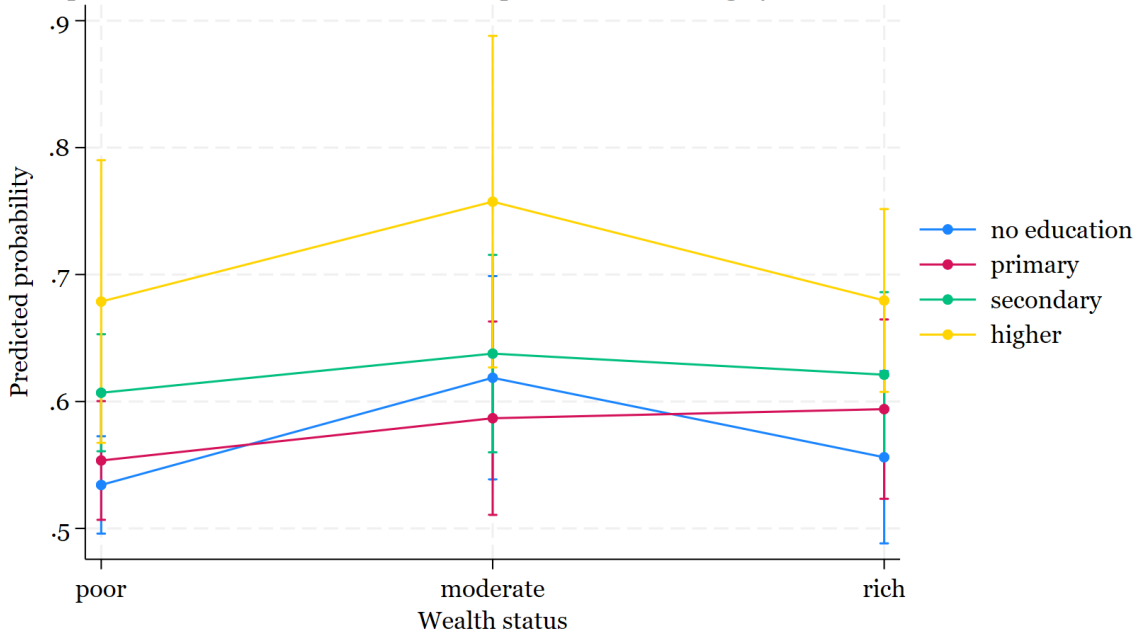
Graph 1. Predicted Probabilities of Frequent Handwashing by Education and Information Access



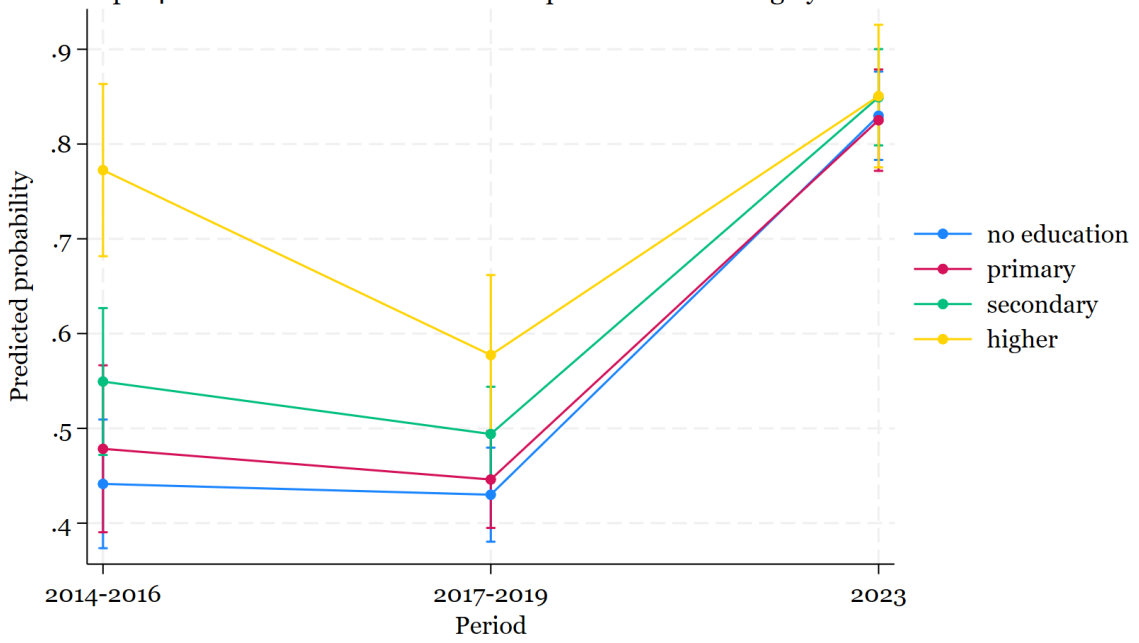
Graph 2. Predicted Probabilities of Frequent Handwashing by Education and Place of Residence



Graph 3. Predicted Probabilities of Frequent Handwashing by Education and Wealth Status



Graph 4. Predicted Probabilities of Frequent Handwashing by Education and Period



Graph 5. Predicted Probabilities of Frequent Handwashing by Education and Period (No Soap)