Empowering Communities

Evaluating the Educational and Health Outcomes of ALEF's Adult Education Program in Rural Uganda

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ABSTRACT

Introduction: This study evaluates the impact of the Adult Literacy and Empowerment Foundation (ALEF) program on literacy, numeracy skills, and children's school attendance within economically disadvantaged households in rural Uganda. Education is pivotal for individual and community empowerment, particularly in resource-constrained settings. Uganda faces significant challenges with adult literacy and numeracy, especially in rural areas with limited access to education.

Method: A rigorous quantitative before-and-after intervention approach was employed, utilizing chi-square tests, linear regressions, and within-level comparisons to assess the effectiveness of ALEF's program. Data collection involved comprehensive evaluations of literacy, numeracy skills, health behaviours, and school attendance among program participants from April to November 2023.

Results: Participants who completed Level 3 of the ALEF program demonstrated significant improvements in literacy skills, such as the ability to write their name (coefficient = 0.282, $p < 0.001$, 95% CI [0.194, 0.371]), and numeracy skills, such as calculating market transactions (coefficient = 0.216, $p < 0.001$, 95% CI [0.131, 0.301]). Additionally, participants showed improvements in reading signs, labels, and report cards, as well as identifying and entering telephone numbers. However, the program's impact on health behaviours, including the use of bed nets and household illness, and children's school attendance, was not statistically significant (Pearson chi2 for health behaviours and school attendance > 0.05).

Discussion: The study highlights ALEF's success in improving literacy and numeracy skills among economically disadvantaged participants. Rigorous statistical analyses provided insights into program impacts, although limitations include the short duration of data collection, which limits the ability to assess long-term sustainability. The findings suggest that while the program effectively enhances educational outcomes, its impact on health behaviours and school attendance requires further investigation. Inconsistencies in some literacy outcomes underscore the need for accurate data collection processes and consideration of broader participant inclusion in future research.

Conclusion: ALEF's program effectively promotes literacy and numeracy skills among vulnerable households in Uganda, contributing to socio-economic empowerment. Future research should incorporate longer follow-up periods and broader participant inclusion to fully evaluate the program's long-term impact and effectiveness.

Global Health Implications: This study underscores the potential of targeted educational interventions in enhancing literacy and numeracy skills, thereby fostering socio-economic development. The findings can inform policy and strategy development to promote equitable access to education and improve health outcomes globally.

CONTENTS

ABBREVIATIONS

ALEF	**A**dult **L**earning and **E**mpowerment **F**acilitators
CACI	**C**hange **A**frican **C**hild **I**nternational
NCES	**N**ational **C**enter for **E**ducation **S**tatistics
NNLM	**N**etwork of the **N**ational **L**ibrary of **M**edicine
OECD	The **O**rganisation for **E**conomic **C**o-operation and **D**evelopment
RISE	**R**esearch on **I**mproving **S**ystem of **E**ducation
PISA	**P**rogram for **I**nternational **S**tudent **A**ssessment
SCB	**S**tatistiska **C**entral **B**yrån (**S**tatistical **C**entral **B**ureau)
SES	**S**socio**e**conomic **s**tatus
UECD	**U**gandan **E**mpowerment & **C**areer **D**evelopment
WHO	**W**orld **H**ealth **O**rganisation

1 INTRODUCTION

Education is widely recognized as a crucial factor for individual and societal development, particularly in low-income countries. Uganda, like many Sub-Saharan African countries, faces significant challenges in providing quality education to its population, especially in rural areas. Despite efforts to improve literacy and numeracy rates, many adults in Uganda remain illiterate or lack basic numeracy skills due to inadequate access to education and persistent socio-economic barriers.

This study evaluates the impact of ALEF's adult education program on improving literacy and numeracy skills among economically disadvantaged adults in rural Uganda. Additionally, it examines the program's broader effects on health behaviours and children's school attendance. By exploring these outcomes, the research aims to highlight the potential of adult education in enhancing various aspects of life for economically disadvantaged households, thereby informing strategies to promote equitable access to education and improve health outcomes globally.

The importance of this study lies in its focus on targeted interventions, specifically those aimed at people living in poverty who have not received any or limited education. By concentrating on this group, the study addresses a critical gap in educational provision and explores the potential of adult education programs to foster socio-economic development. Understanding the impacts of such programs can inform policy decisions and educational strategies, ultimately contributing to the reduction of poverty and the improvement of quality of life for marginalized communities.

2 BACKGROUND

2.1 ALEF

ALEF (Adult Literacy Education Foundation) is a non-profit organization established in 2010 and headquartered in Vällingby, Stockholm, Sweden (ALEF, n.d. *b*). ALEF operates internationally and collaborates with local authorities and educators to provide financial assistance and educational support, focusing on adult education (ALEF, n.d. *ac*). The program includes three levels, each lasting seven months, with classes held twice a week, requiring approximately 4-6 hours of study per week (ALEF, n.d. *a*). ALEF operates independently of any religious or political affiliations and is supported by various sponsors, including Equmeniakyrkan Mariestad, Dear Foundation, Bokhjälpen, Little Beat Music, and Dahlstönska stiftelsen (ALEF, n.d. *abcd*).

The first level of the program focuses on basic literacy, teaching participants to read and write in their local language. The second level introduces numeracy skills, covering the four basic arithmetic operations necessary for daily life. The third level incorporates more advanced literacy and numeracy skills, alongside practical knowledge such as human rights and small business management. Each level is designed to progressively build on the skills acquired in the previous one, ensuring comprehensive development (ALEF, n.d. *ad*).

ALEF's commitment to adult education is driven by the belief that literacy and numeracy are foundational skills that empower individuals to improve their socio-economic status. By providing educational opportunities to adults who missed out on formal schooling, ALEF aims to break the cycle of poverty and foster sustainable development (ALEF, n.d. *ab*).

2.2 Benefits of Literacy and Numeracy

Education, particularly in literacy and numeracy, provides numerous benefits across various aspects of life. Literacy enables individuals to access and understand health information, follow medical instructions, and engage with written communication. Numeracy skills are essential for managing finances, budgeting, and making informed decisions. These skills collectively contribute to improved health outcomes, economic stability, and social participation (Baum, 2015; Lövdén et al., 2020).

Research has shown that educated individuals are more likely to make healthier lifestyle choices, such as following medical advice and maintaining hygiene practices (Baum, 2015). Additionally, literacy and numeracy skills enhance cognitive functions, providing resilience against age-related conditions like dementia (Lövdén et al., 2020). Education also promotes civic engagement, allowing individuals to participate in community activities, vote, and advocate for their rights (Mungas et al., 2018).

The economic benefits of education are significant. Educated individuals have higher employability, earning potential, and job stability, contributing to overall economic growth. Education also reduces healthcare costs by promoting healthier lifestyles and enabling individuals to manage chronic conditions effectively. Thus, investing in education, particularly for marginalized communities, is a crucial strategy for socio-economic development (Castiglione et al., 2008).

2.3 The Current State in Uganda

Uganda, a country with a rapidly growing population, faces substantial challenges in its education system. While the overall literacy rate for individuals aged 15 and above has reached approximately 81% (World Bank, 2023e), significant disparities persist. Gender disparities are evident, with literacy rates at 77% for women and 85% for men (World Bank, 2023g; World Bank, 2023i). Rural areas are particularly affected by limited access to education, financial constraints, and inadequate infrastructure, exacerbating the literacy and numeracy challenges..

The school system in Uganda is rooted in its colonial history, which continues to influence its structure and accessibility. Despite legislative efforts to make primary education more accessible, financial barriers remain, particularly in rural areas where families struggle to afford uniforms, books, and other necessary materials (Uganda Investment Authority, n.d.).

Access to basic services such as safe water and electricity is also limited, further complicating the efforts to improve educational outcomes. Only 18% of the population had access to safe water, and approximately 45% had access to electricity by 2022 (World Bank, 2022). These conditions highlight the urgent need for targeted educational interventions like ALEF’s adult education program.

Further examination in 2022 reveals a discernible gender disparity in literacy rates. Among women aged 15 to 24, the literacy rate stood at 93% compared to 76% in 2002, while among men in the same age group, it was 91%, an increase from 81% in 2002 (World Bank, 2023*fh*). For individuals aged 15 and above, the literacy rate was 77% for women, up from 59% in 2002, and 85% for men, a slight increase from 78% in 2002 (World Bank, 2023*gi*).

Assessing health literacy in Uganda poses a challenge due to limited documentation at the individual level. However, insights into the prevailing conditions can be gleaned from reports and statistics published by the World Health Organization (WHO). As of 2020, WHO data indicates a neonatal mortality rate of 19.01 per 1000 live births, an infant mortality rate of 31.17 per 1000, and an under-five mortality rate of 42.13 per 1000. Furthermore, Uganda exhibited commendable medical coverage rates in 2020, with 83% coverage for neonatal tetanus, 84% completion of Rotavirus vaccination among children at age 1, 84% coverage of antiretroviral therapy among individuals with HIV, and approximately 70% access to general medication (WHO, n.d.).

As for the school system in Uganda, it has its roots in the colonial era and today reflects a complex interplay between historical legacies, socioeconomic challenges, and changing government initiatives (Uganda Investment Authority, n.d.). Uganda's school system primarily comprises day schools where access to education, though legally mandated for seven years, often encounters practical barriers, especially in rural areas characterized by agricultural livelihoods. Despite legislative efforts to make primary education more accessible, financial constraints persist, with costs associated with uniforms, books, and other materials impeding regular attendance for many families (UECD, n.d.). Moreover, middle education, which encompasses the first phase of secondary academic education, typically lasts four years and concludes with students passing their O-Levels before proceeding further (Scholaro database, n.d.). However, the financial burden of secondary schooling poses a significant challenge, limiting opportunities for higher education (UNICEF, n.d. *b*). Furthermore, access remains inequitable, with disparities observed between different socioeconomic groups and regions, as evidenced by the significant variation in secondary level enrolment rates across different population segments and geographical areas (UNICEF, n.d. *b*).

As we've observed in Uganda, there are struggles with literacy and numeracy skills; there are, however, also notable differences compared to other countries. For instance, Sweden boasts a remarkable 99% literacy rate accompanied by proficient numeracy skills, facilitating daily tasks (OECD, n.d.; SCB, 2023; Dagens Medicin, 2022; Folkhälsomyndigheten, 2023; Runngren et al., 2022; World Bank, 2023). Conversely, South Africa grapples with fluctuating literacy rates and limited numeracy skills, while Ethiopia struggles with a 52% literacy rate compounded by a lack of health literacy data (World Bank, 2023; Burton, 2020; Global Data, 2022; Businesstech, 2022; Prince & Frith, 2020; Janse van Rensburg, 2020; Taylor, 2014; Mofokeng, 2022; Tiruneh et al., 2022). Meanwhile, Morocco has shown steady growth in literacy rates, reaching about 77% of individuals aged 15 and above in 2022, although it still faces challenges with low numeracy skills and limited health literacy data (World Bank, 2023; OECD, 2019; Mahdaoui & Kissani, 2023).

2.4 Rationale for Study

This study is essential to evaluate the impact of ALEF's adult education program on literacy, numeracy, health behaviors, and children's school attendance among economically disadvantaged adults in rural Uganda. By focusing on individuals who have received little or no formal education, the research addresses a critical gap in educational provision. The insights gained can inform policy and strategy development, contributing to poverty reduction and improved quality of life for marginalized communities.

3 AIM

The aim of this study is to assess the impact of participation in the ALEF adult literacy education program on socio-economic indicators and educational outcomes in economically disadvantaged households in Uganda. This study also aims to explore the relationship between the duration of participation in the ALEF program and school attendance among the children of the participants.

Research questions:

1. Is there an association between the number of levels completed in ALEF's program by participants and their numeracy and literacy skills?

2. Is there any association between the number of levels completed in ALEF's program by participants and their health behaviours?

3. Is there any association between the parents participating in ALEF's program and if children goes to school?

4 THEORETICAL FRAMEWORK

For the study, two theoretical frameworks are particularly relevant. The first is Human Capital Theory, as described by Bhattacharya et al. (2014), which posits that investments in individuals' education and skill development contribute to long-term personal and societal growth and development. According to this theory, education serves as an investment that enhances individuals' skill sets, thereby increasing their productivity and competitiveness in the labour market. Moreover, education is viewed as a means to improve people's health, as enhanced skill sets enable individuals to continue acquiring new knowledge and utilize their skills to enhance their economic well-being. This improvement in economic standing allows for better access to essential resources such as housing, food, water, and healthcare facilities, ultimately leading to improved health outcomes and quality of life. Human Capital Theory suggests that investments in education lead to long-term benefits, including increased tax revenue due to a more skilled and healthier workforce, which in turn spurs greater productivity and consumption. This cycle generates additional resources that can be reinvested in human capital development (Bhattacharya et al., 2014).
Human Capital Theory is essential for this study as it highlights the economic and social benefits of investing in education. ALEF’s program aims to increase participants' literacy and numeracy, which are critical skills for improving employability, health management, and overall socio-economic status.

The second theory, Social Capital Theory as outlined in The Handbook of Social Capital (Castiglione et al., 2008), underscores the significance of social networks and relationships in enhancing individual and collective well-being. According to Lin (2000), social capital comprises the resources embedded within social networks, including norms of mutual exchange, trust, and social cohesion. These social resources enable people to access information, support, and opportunities beyond what formal structures provide. Social capital can significantly influence health behaviours and educational outcomes for children as well. Educated individuals often share beneficial behaviours and norms within their networks, promoting healthier lifestyles and better educational achievements. Although access to social capital can be unequal across social groups due to their structural positions and associated networks, understanding these mechanisms is crucial for identifying strategies to mitigate inequality and foster more inclusive and cohesive communities (Castiglione et al., 2008; Lin, 2000). Social Capital Theory is relevant to this study as it underscores the role of social

networks and relationships in enhancing educational and socio-economic outcomes. ALEF's program incorporates group discussions and collaborative learning, which build trust and mutual support among participants, facilitating resource sharing and collective problem-solving, thereby amplifying the program's impact on literacy, numeracy, and overall well-being.

The study of ALEF's adult education program in rural Uganda is enriched by these two foundational theories: human capital and social capital. Human Capital Theory underscores the individual benefits of education, positing that participation in the program enhances skills and capabilities, leading to improved employability and well-being. In contrast, Social Capital Theory emphasizes the collective advantages of social networks, highlighting how participation fosters community cohesion and mutual support among participants.

While both theories converge on the transformative potential of education and social relationships, they differ in focus and emphasis. Human Capital Theory centres on the individual acquisition of skills and knowledge, promoting economic advancement and self-improvement. Conversely, Social Capital Theory prioritizes community-level outcomes, emphasizing the role of social connections in resource mobilization, information sharing, and collective action. Simplified, Human Capital Theory is about individuals gaining skills and knowledge to improve their own lives and economic situations, while Social Capital Theory focuses on how connections within a community can benefit everyone by sharing resources and working together towards common goals.

In examining the interplay of human and social capital within ALEF's program, this study aims to uncover the potential impact on individuals' lives in rural Uganda. By delving into the dynamics of educational empowerment and community development, the research seeks to shed light on whether ALEF contributes positively to participants' well-being. This endeavour contributes to the broader understanding of adult education's role in fostering positive change in disadvantaged communities.

5 METHODS

5.1 Study design:

The study employs a quantitative before and after method, which follows the ALEF program levels. This design facilitates the comparison of outcomes between participants before and after their engagement in ALEF's adult literacy education program. By concentrating on economically disadvantaged households in Uganda, the study aims to examine the impact of ALEF program participation on socio-economic indicators and educational outcomes. Additionally, it investigates the duration of program participation in correlation with school attendance among the participants' children.

5.2 Study setting:

This quantitative study is conducted within the framework of ALEF's adult literacy education program. ALEF, a non-profit organization, operates in Uganda, focusing on economically disadvantaged households across diverse demographics and geographical locations. The raw data was originally gathered in Uganda's rural areas, the specific villages from where the data was gathered is not disclosed.

5.3 Data Source:

The dataset utilized in this study is sourced from ALEF's records, capturing participants engaged in ALEF's adult education program along with information about participants age, gender, source of income, access to amenities (such as electricity, phones and refrigerators), skills relating to literacy and numeracy, health related information and what level of ALEF's program they have completed-.

5.4 Study Population:

This study focuses on participants from the ALEF dataset, consisting of individuals who have undergone the adult literacy education program. For the first two research questions, which examine adults' literacy and numeracy skills and health behaviours, there are 378 observations. For the third research question, which explores school attendance among the participants' children, there are 724 observations.

The participants live in economically disadvantaged situations and live in rural areas of Uganda. The ALEF program includes three distinct levels, with each level comprising separate

groups of participants. Specifically, the individuals in Level 1 are not the same as those in Levels 2 and 3, and the participants in Levels 2 and 3 are also distinct from each other. These three separate groups were observed simultaneously, with each group being measured at two points in time to capture data before and after the intervention.

The participants were selected based on their enrolment in the ALEF adult education program. Only participants who received passing grades at each level were included in the study. This process took six months, from April to November 2023, to ensure that data was collected from participants who successfully completed each level. This approach ensured a thorough and representative sample of economically disadvantaged households in rural Uganda.

5.5 Inclusion and Exclusion Criteria:

Inclusion criteria encompass individuals who actively participated in the ALEF program, ensuring that the study sample accurately represents the population engaged in adult literacy education. Exclusion criteria are applied to individuals with incomplete data or those who do not meet specified demographic criteria. After a preliminary analysis, men have been excluded from this study as the variation in their numbers from the first and second data collection are rather large and could potentially skew the results.

Recognizing the impact of selection effects and participant retention on study outcomes is crucial. Dropout rates and variations in participant engagement can introduce biases, influencing the interpretation of results. Efforts were made to include individuals with complete data and adhere to predefined inclusion criteria. Sensitivity analyses may be conducted to assess the robustness of findings concerning dropout rates and participant retention, aiming to enhance the study's validity and reliability.

5.6 Data collection methods:

Data was collected between April and November 2023 by on-site personnel. The data collection process took place at the locations where participants attended their lectures due to their limited access to technology, ensuring comprehensive data capture.

Data collection involved gathering relevant information from the comprehensive ALEF dataset, which includes socio-economic indicators, educational outcomes, and participation duration. This process utilized questionnaires and written exams. ALEF has been collecting

data through exam results, surveys, and interviews since its establishment in 2012. On-site data collection was necessary, as not all participants have access to computers, phones, or the internet. ALEF and CACI personnel, primarily the teachers, were responsible for collecting and recording the data using the necessary technology.

5.7 Data management methods:

As for managing the quantitative data collected from the ALEF dataset, rigorous procedures are being employed to ensure accuracy and consistency. The dataset comprises information on socio-economic indicators, educational outcomes, and the duration of participation in the ALEF program, collected through surveys, interviews, and exam results since the organization's inception in 2012. Initially, data undergo thorough cleaning and validation processes to identify and rectify any errors or inconsistencies. Following this, variables of interest, including exposure (participation in the ALEF program), outcome (socio-economic indicators and educational outcomes), and control variables (demographic factors), are defined, and organized systematically. This organization facilitates subsequent analysis by ensuring clarity and accessibility of the data. Moreover, data management procedures adhere to established guidelines and best practices to maintain integrity and reliability throughout the research process. Finally, the dataset is being prepared for analysis using the statistical software Stata, which offers robust capabilities for quantitative data analysis and visualization.

5.8 Analytical approach:

The analytical approach consists of descriptive analysis, chi-square tests, and regression analysis. Descriptive statistics, such as percentages, summarize educational outcomes among participants. Chi-square tests assess the association between different categorical variables. Regression analysis examines the relationship between participation in the ALEF program and educational outcomes while controlling for relevant factors. P-values are reported directly, allowing for the interpretation of statistical significance. These analyses aim to provide insights into the influence of the ALEF program on educational outcomes in economically disadvantaged households in Uganda.

5.9 Variables included:

In investigating the impact of ALEF's program, specific variables will be utilized to assess potential correlations between the exposure variable, the ALEF program and adult literacy, numeracy, and health literacy skills. The outcome variables used will be written as a statements.

For the literacy skills, the following variables will be included:

- Ability to write one's name.
- Ability to read signs on roads/buildings.
- Ability to read one's children's report card from school.
- Ability to read labels on food/medicine.

For numeracy skill, the following variables will be included:

- Ability to calculate change when buying/selling at the market.
- Ability to identify/enter telephone numbers.

For health behaviours, the following variables will be included:

- Whether the individual slept under a mosquito net last night.
- Whether any of the individual's children slept under a mosquito net last night.
- Sickness in the household the last three months.[1]

For children's school attendance, it will be trickier to measure as there are mainly one important variables to consider:

- Attending school

[1] Sickness within the household might in itself not be a direct proxy for health behaviours, however it can serve to give an idea of different health practices such as hygiene.

6 ETHICAL CONSIDERATIONS

For this study there are some ethical considerations that is being taken into account.
For guidelines, literature on research methodology (Helgesson, 2015; Campbell et al. 2011; Kumar 2011; Oakes et al 2017) as well as the Swedish Research Council (2023) have been used to find ethical considerations relevant for this study.

Given that the data provided by ALEF, it's important to acknowledge that they have fulfilled some ethical approval before collecting the data. ALEF has assured that the data provided complies with ethical guidelines and respects participants' rights to privacy and confidentiality. The data used won't give any identifying information about the participants.

7 RESULTS

7.1 Literacy skills

The first few analysis will examine participants' abilities related to literacy skills, including writing their name and reading various materials such as signs, report cards, and labels on food and medicine.

Table 1 - Frequency of literacy skills

Level of intervention	Can you write your name? Tries, but fails N (%)	Can you write your name? No N (%)	Can you write your name? Yes N (%)	Read signs roads/ buildings No N (%)	Read signs roads/ buildings Yes N (%)	Read labels on food/medicine No N (%)	Read labels on food/medicine Yes N (%)	Read report card from school No N (%)	Read report card from school Yes N (%)
Level 1 (start)	6 (8.45)	13 (18.31)	52 (73.24)	51 (69.86)	22 (30.14)	55 (76.39)	17 (23.61)	46 (68.66)	21 (31.34)
Level 1 (end)	0 (0.00)	0 (0.00)	72 (100.00)	0 (0.00)	74 (100.00)	74 (100.00)	0 (0.00)	74 (100.00)	0 (0.00)
Level 2 (start)	0 (0.00)	1 (2.33)	42 (97.67)	27 (56.25)	21 (43.75)	38 (79.17)	10 (20.83)	36 (78.26)	10 (21.74)
Level 2 (end)	0 (0.00)	0 (0.00)	46 (100.00)	0 (0.00)	47 (100.00)	47 (100.00)	0 (0.00)	47 (100.00)	0 (0.00)
Level 3 (start)	0 (0.00)	0 (0.00)	66 (100.00)	9 (13.43)	58 (86.57)	12 (17.65)	56 (82.35)	8 (11.94)	59 (88.06)
Level 3 (end)	0 (0.00)	0 (0.00)	66 (100.00)	0 (0.00)	67 (100.00)	0 (0.00)	67 (100.00)	0 (0.00)	67 (100.00)

Table 1 presents the distribution of participants' literacy skills, including their ability to write their name, read signs/road buildings, read labels on food/medicine, and read report cards from school. Frequencies and percentages are shown for each skill across different levels of intervention at both the start and end of the study period.

At the start of Level 1, 6 participants (8.45%) attempted but could not write their name intelligibly, 13 participants (18.31%) indicated they could not write their name, and 52 participants (73.24%) confirmed they could write their name. By the end of Level 1, all participants (100%) reported they could write their name.

At the start of Level 2, 1 participant (2.33%) indicated they could not write their name, and 42 participants (97.67%) confirmed they could write their name. By the end of Level 2, all participants (100%) reported they could write their name.

At the start of Level 3, all 66 participants (100%) reported they could write their name, and this remained the same by the end of Level 3.

For reading signs, at the start of Level 1, 51 participants (69.86%) could not read signs, while 22 participants (30.14%) could. By the end of Level 1, all 74 participants (100%) reported they could read signs.

At the start of Level 2, 27 participants (56.25%) could not read signs, while 21 participants (43.75%) could. By the end of Level 2, all participants (100%) reported they could read signs.

At the start of Level 3, 9 participants (13.43%) could not read signs, while 58 participants (86.57%) could. By the end of Level 3, all participants (100%) reported they could read signs.

For reading labels, at the start of Level 1, 55 participants (76.39%) could not read labels, while 17 participants (23.61%) could. By the end of Level 1, all participants (100%) reported they could read labels.

At the start of Level 2, 38 participants (79.17%) could not read labels, while 10 participants (20.83%) could. By the end of Level 2, all participants (100%) reported they could read labels.

At the start of Level 3, 12 participants (17.65%) could not read labels, while 56 participants (82.35%) could. By the end of Level 3, all participants (100%) reported they could read labels.

For reading report cards, at the start of Level 1, 46 participants (68.66%) could not read report cards, while 21 participants (31.34%) could. By the end of Level 1, all participants (100%) reported they could read report cards.

At the start of Level 2, 36 participants (78.26%) could not read report cards, while 10 participants (21.74%) could.

By the end of Level 2, all participants (100%) reported they could read report cards.

At the start of Level 3, 8 participants (11.94%) could not read report cards, while 59 participants (88.06%) could.

By the end of Level 3, all participants (100%) reported they could read report cards.

The Pearson chi-squared test indicates significant associations between program level and participants' abilities for all literacy skills: writing their name (Pearson chi2(10) = 77.4945, Pr = 0.000), reading signs (Pearson chi2(5) = 179.3488, Pr = 0.000), reading labels (Pearson chi2(5) = 179.3488, Pr = 0.000), and reading report cards (Pearson chi2(5) = 248.2668, Pr = 0.000). These results suggest that the program levels significantly influenced participants' literacy abilities across all measured aspects.

Table 2 – Literacy skills

Level of intervention	Can write name Coeff.	(95% CI)	Read signs Coeff.	(95% CI)	Read labels Coeff.	(95% CI)	Read report cards Coeff.	(95% CI)
Level 1 (end)	.270*	(.184 to .357)	.703*	(.602 to .803)	-.230*	(-.323 to -.136)	-.284*	(-.377 to -.191)
Level 2 (start)	.172*	(.075 to .270)	.140**	(.027 to .153)	-.021****	(-.126 to .084)	-.075****	(-.180 to .294)
Level 2 (end)	.276*	(.178 to .374)	.703*	(.589 to .658)	-.230*	(-.335 to -.124)	-.284*	(-.389 to -.178)
Level 3 (start)	.268*	(.180 to .356)	.556*	(.453 to .658)	.594*	(.499 to .689)	.584*	(.489 to .679)
Level 3 (end)	.282*	(.194 to .371)	.703*	(.600 to .806)	.770*	(.675 to .866)	.716*	(.621 to .812)
Constant	.703*	(.642 to .764)	.297*	(.233 to .368)	.230*	(.164 to .866)	.284*	(.218 to .350)
R-Squared	.142		.474		.659		.665	

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1 **** p-value > 0.1

Table 2 presents the regression results for literacy skills, including coefficients and 95% confidence intervals for the ability to write a name, read signs, read labels, and read report cards. The table displays results for different levels of intervention, with R-squared values provided to indicate the explanatory power of each model. Significance levels are indicated by asterisks.

For writing ability, The end of Level 1 exhibit a strong significant impact with a coefficient of 0.270 (95% CI [0.184 to 0.357], $p < 0.001$). This coefficient means that for every unit increase in the intervention level, the ability to write a name increases by 0.270 units on the measured scale.

The start of Level 2 shows a strong significant impact with a coefficient of 0.172 (95% CI [0.075 to 0.270], $p = 0.001$), meaning it is a 0.172 unit increase.

The end of Level 2 shows a strong significant impact with a coefficient of 0.276 (95% CI [0.178 to 0.374], $p < 0.001$), meaning it is a 0.276 unit increase.

The start of Level 3 results in a significant impact with a coefficient of 0.268 (95% CI [0.180 to 0.356], $p < 0.001$), meaning it is a 0.268 unit increase.

The end of Level 3 shows a strong significant impact with a coefficient of 0.283 (95% CI [0.194 to 0.371], $p < 0.001$), meaning it is a 0.268 unit increase.

For reading signs, the end of Level 1 shows a strong significant impact with a coefficient of 0.703 (95% CI [0.602 to 0.803], $p < 0.001$), meaning it is a 0.703 unit increase.

The start of Level 2 shows a moderately significant impact with a coefficient of 0.140 (95% CI [0.027 to 0.253], $p = 0.015$) meaning it is a 0.140 unit increase.

The end of Level 2 shows a strong significant impact with a coefficient of 0.703 (95% CI [0.590 to 0.816], $p < 0.001$), meaning it is a 0.703 unit increase.

The start of Level 3 shows a strong significant impact with a coefficient of 0.556 (95% CI [0.453 to 0.658], $p < 0.001$), meaning it is a 0.556 unit increase.

The end of Level 3 shows a strong significant impact with a coefficient of 0.703 (95% CI [0.600 to 0.805], $p < 0.001$), meaning it is a 0.703 unit increase.

For reading labels, the end of Level 1 shows a strong significant impact in difficulty with a coefficient of -0.230 (95% CI [-0.323, -0.137], $p < 0.001$), meaning it is a 0.230 unit decrease.

The start of Level 2 does not have a significant impact with a coefficient of -0.021 (95% CI [-0.126, 0.084], $p = 0.689$), the coefficient alone indicate a 0.230 unit decrease in the ability to read labels, however the 95% CI include the value 0 and the p-value is above 0.5.

The end of Level 2 shows a strong significant impact with a coefficient of -0.230 (95% CI [-0.335, -0.125], $p < 0.001$), meaning it is a 0.230 unit decrease in the ability to read labels.

The start of Level 3 results shows a strong significant impact with a coefficient of 0.594 (95% CI [0.498, 0.689], $p < 0.001$), meaning it is a 0.594 unit increase in the ability to read labels.

The end of Level 3 shows a strong significant impact with a coefficient of 0.770 (95% CI [0.675, 0.866], $p < 0.001$), meaning it is a 0.770 unit increase in the ability to read labels.

For reading report cards, the end of Level 1 shows a strong significant impact with a coefficient of -0.284 (95% CI [-0.377, -0.191], $p < 0.001$). This coefficient indicates that the ability to read report cards decreases by 0.284 units on the measured scale.

The start of Level 2 has no significant impact with a coefficient of -0.076 (95% CI [-0.180, 0.029], $p = 0.158$), meaning that there is a 0.076 unit decrease in the ability to read report cards from school, there 95% CI however includes the value 0 which makes it statistically insignificant.

The end of Level 2 shows a strong significant impact with a coefficient of -0.284 (95% CI [-0.389, -0.178], $p < 0.001$), meaning it is a 0.284 unit decrease in the ability to read report cards from school.

The start of Level 3 shows a strong significant impact with a coefficient of 0.584 (95% CI [0.489, 0.679], $p < 0.001$), meaning it is a 0.584 unit increase in the ability to read report cards from school.

The end of Level 3 indicates a strong significant impact with a coefficient of 0.716 (95% CI [0.621, 0.812], $p < 0.001$), meaning it is a 0.716 unit increase in the ability to read report cards from school.

The within-cohort tests confirm the significant improvements in literacy skills across the intervention levels. Here's a summary of the findings for each skill:

For the ability to write their names, significant improvements were observed between the start and end of Level 1 ($F = 37.85$, $p < 0.001$). This indicates a strong improvement in the

ability to write a name. The improvement between the start and end of Level 2 was moderate ($F = 3.58$, $p = 0.0593$), suggesting some progress. However, there was no significant change between the start and end of Level 3 ($F = 0.10$, $p = 0.7530$), indicating stable writing ability at this stage.

For reading signs, there were significant improvements at all levels. From the start to the end of Level 1, there was a strong improvement ($F = 189.84$, $p < 0.001$). This trend continued from the start to the end of Level 2 ($F = 78.07$, $p < 0.001$) and from the start to the end of Level 3 ($F = 7.58$, $p = 0.0062$), though the improvement was less pronounced in Level 3.

For reading labels, significant improvements were noted throughout. From the start to the end of Level 1, there was a strong improvement ($F = 23.51$, $p < 0.001$). This pattern continued from the start to the end of Level 2 ($F = 12.41$, $p = 0.0005$) and from the start to the end of Level 3 ($F = 12.66$, $p = 0.0004$), indicating consistent gains.

For reading report cards, significant improvements were seen at all stages. From the start to the end of Level 1, there was a strong improvement ($F = 36.03$, $p < 0.001$). The improvement continued from the start to the end of Level 2 ($F = 12.46$, $p = 0.0005$) and from the start to the end of Level 3 ($F = 7.15$, $p = 0.0078$).

Overall, these within-cohort tests validate the improvements in literacy skills, highlighting the effectiveness of the intervention at each stage.

7.2 Numeracy skills

Table 3 – Frequency of numeracy skills

	Calculate change at the market		Identify numbers	
Level of intervention	No N (%)	Yes N (%)	No N (%)	Yes N (%)
Level 1 (start)	15 (20.55)	58 (79.45)	13 (17.81)	60 (82.19)
Level 1 (end)	69 (93.24)	5 (6.76)	0 (0.00)	74 (100.00)
Level 2 (start)	6 (12.50)	42 (87.50)	12 (25.00)	36 (75.00)
Level 2 (end)	0 (0.00)	47 (100.00)	0 (0.00)	47 (100.00)
Level 3 (start)	2 (2.94)	66 (97.06)	3 (4.48)	64 (95.52)
Level 3 (end)	0 (0.00)	67 (100.00)	0 (0.00)	67 (100.00)

Table 3 shows the distribution of participants' numeracy skills, including their ability to calculate change at the market and identify numbers. Frequencies and percentages are displayed for each skill across different levels of intervention at both the start and end of the study period.

At the start of Level 1, 15 participants (20.55%) could not calculate change at the market, while 58 participants (79.45%) could. By the end of Level 1, the number of participants who could calculate change significantly decreased to 5 (6.76%), with 69 participants (93.24%) unable to calculate change.

At the start of Level 2, 6 participants (12.50%) could not calculate change, while 42 participants (87.50%) could. By the end of Level 2, all participants (100%) could calculate change.

At the start of Level 3, 2 participants (2.94%) could not calculate change, while 66 participants (97.06%) could. By the end of Level 3, all participants (100%) could calculate change.

For identifying numbers, 13 participants (17.81%) could not identify numbers at the start of Level 1, while 60 participants (82.19%) could. By the end of Level 1, all participants (100%) could identify numbers.

At the start of Level 2, 12 participants (25.00%) could not identify numbers while 36 participants (75.00%) could. By the end of Level 2, all participants (100%) could identify numbers.

At the start of Level 3, 3 participants (4.48%) could not identify numbers while 64 participants (95.52%) could. By the end of Level 3, all participants (100%) could identify numbers.

The Pearson chi-squared test indicates significant associations between program level and participants' numeracy skills: calculating change at the market (Pearson chi2(5) = 306.43, Pr = 0.000) and identifying numbers (Pearson chi2(5) = 178.64, Pr = 0.000). These results suggest that the program levels significantly influenced participants' numeracy skills.

Table 4 - Numeracy skills

	Calculate change		Identify number	
Level of intervention	Coeff.	(95% CI)	Coeff.	(95% CI)
Level 1 (end)	-0.716*	(-.799 to -.633)	-0.189*	(.107 to .271)
Level 2 (start)	0.091***	(-.002 to .185)	-0.061****	(-.154 to .032)
Level 2 (end)	0.216*	(.122 to .310)	0.189*	(.122 to .310)
Level 3 (start)	0.187*	(.102 to .271)	0.130**	(.102 to .271)
Level 3 (end)	0.216*	(.131 to .301)	.189*	(.131 to .301)
Constant	0.784*	(.725 to .842)	0.811*	(.725 to .842)
R-Squared	0.652		0.127	

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1 **** p-value > 0.1

Table 4 presents the regression results for numeracy skills, including coefficients and 95% confidence intervals for the ability to calculate change and identify numbers. The table displays results for different levels of intervention, with R-squared values provided to indicate the explanatory power of each model. Significance levels are indicated by asterisks.

For calculating change, the end of Level 1 exhibit an impact with a coefficient of -0.716 (95% CI [-0.799 to -0.633], $p < 0.001$). This coefficient indicates that the ability to calculate change at the market decreases by 0.716 units on the measured scale, but the 95% CI includes the value 0 which suggest no significant association.

The start of Level 2 shows an impact with a coefficient of 0.091 (95% CI [-0.002 to 0.185], $p = 0.053$). This coefficient indicates that the ability to calculate change at the market increased by 0.091 units on the measured scale, but the 95% CI includes the value 0 which suggest no significant association.

The end of Level 2 shows a strong significant impact with a coefficient of 0.216 (95% CI [0.122 to 0.310], $p < 0.001$), meaning it is a 0.216 unit increase.

The start of Level 3 results in a strong significant impact with a coefficient of 0.187 (95% CI [0.102 to 0.271], $p < 0.001$), meaning it is a 0.187 unit increase.

The end of Level 3 shows a strong significant impact with a coefficient of 0.216 (95% CI [0.131 to 0.301], $p < 0.001$), meaning it is a 0.216 unit increase.

For identifying numbers, the end of Level 1 shows a strong significant impact with a coefficient of -0.189 (95% CI [-0.271, -0.107], $p < 0.001$). This coefficient indicates that the ability to identify numbers decreases by 0.189 units on the measured scale.

The start of Level 2 has a weakly significant impact with a coefficient of -0.061 (95% CI [-0.154, 0.032], $p = 0.180$). This coefficient indicates that the ability to identify numbers decreases by 0.061 units on the measured scale, but the 95% CI includes the value 0 which suggest no significant association.

The end of Level 2 shows a strong significant impact with a coefficient of 0.189 (95% CI [0.122, 0.310], $p < 0.001$), meaning it is a 0.189 unit increase.

The start of Level 3 shows a strong significant impact with a coefficient of 0.130 (95% CI [0.102, 0.271], $p < 0.001$), meaning it is a 0.130 unit increase.

The end of Level 3 indicates a strong significant impact with a coefficient of 0.189 (95% CI [0.131, 0.301], $p < 0.001$), meaning it is a 0.189 unit increase.

The within-cohort tests further support these findings by showing significant improvements within each level.

For calculating change, significant improvements were observed from Level 1 start to Level 1 end ($F = 289.44$, $p < 0.001$). Level 2 start to Level 2 end ($F = 5.66$, $p = 0.0179$), and Level 3 start to Level 3 end ($F = 0.45$, $p = 0.5050$), showing significant gains in earlier levels with no significant change at Level 3.

For identifying numbers, significant improvements were observed from Level 1 start to Level 1 end ($F = 20.43$, $p < 0.001$), Level 2 start to Level 2 end ($F = 22.89$, $p < 0.001$), and Level 3 start to Level 3 end ($F = 1.80$, $p = 0.1804$), showing significant gains in earlier levels with no significant change at Level 3.

7.3 Health behaviours

Table 5 – Frequency of health behaviours

	Slept under bed net		Children slept under bed net			Illness in household last 3 months	
Level of intervention	No	Yes	No, none	Yes, all	Yes, some	No	Yes
Level 1 (start)	9 (12.33)	64 (87.67)	15 (22.39)	30 (44.78)	22 (32.84)	44 (63.77)	25 (36.23)
Level 1 (end)	11 (15.07)	62 (84.93)	11 (16.67)	31 (46.97)	24 (36.36)	50 (69.44)	22 (30.56)
Level 2 (start)	9 (18.75)	39 (81.25)	8 (19.05)	27 (64.29)	7 (16.67)	35 (77.78)	10 (22.22)
Level 2 (end)	9 (19.15)	38 (80.85)	8 (19.51)	27 (65.85)	6 14.63	37 (80.43)	9 (19.57)
Level 3 (start)	7 (10.61)	59 (89.39)	6 (9.38)	53 (82.81)	5 (7.81)	50 (74.63)	17 (25.37)
Level 3 (end)	7 (11.11)	56 (88.89)	6 (10.17)	44 (74.58)	9 (15.25)	53 (80.30)	13 (19.70)

Table 5 shows the distribution of participants' health behaviours, including sleeping under a bed net, children sleeping under a bed net, and the occurrence of illness in the household over the last three months. Frequencies and percentages are displayed for each behaviour across different levels of intervention at both the start and end of the study period.

At the start of Level 1, 9 participants (12.33%) did not sleep under a bed net, while 64 participants (87.67%) did. By the end of Level 1, the number of participants not sleeping under a bed net slightly increased to 11 (15.07%), with 62 participants (84.93%) still using a bed net.

At the start of Level 2, 9 participants (18.75%) did not sleep under a bed net, while 39 participants (81.25%) did. By the end of Level 2, these numbers remained relatively stable with 9 participants (19.15%) not using a bed net and 38 participants (80.85%) using one.

At the start of Level 3, 7 participants (10.61%) did not sleep under a bed net, while 59 participants (89.39%) did. By the end of Level 3, 7 participants (11.11%) still did not sleep under a bed net, while 56 participants (88.89%) continued to use one.

For children sleeping under a bed net, at the start of Level 1, 15 households (22.39%) had no children sleeping under a bed net, 30 households (44.78%) had all children sleeping under a bed net, and 22 households (32.84%) had some children sleeping under a bed net. By the end of Level 1, 11 households (16.67%) reported no children sleeping under a bed net, 31 households (46.97%) had all children sleeping under a bed net, and 24 households (36.36%) had some children sleeping under a bed net.

At the start of Level 2, 8 households (19.05%) had no children sleeping under a bed net, 27 households (64.29%) had all children sleeping under a bed net, and 7 households (16.67%) had some children sleeping under a bed net. By the end of Level 2, the numbers were similar with 8 households (19.51%) reporting no children sleeping under a bed net, 27 households (65.85%) having all children sleeping under a bed net, and 6 households (14.63%) having some children sleeping under a bed net.

At the start of Level 3, 6 households (9.38%) had no children sleeping under a bed net, 53 households (82.81%) had all children sleeping under a bed net, and 5 households (7.81%) had some children sleeping under a bed net. By the end of Level 3, 6 households (10.17%) reported no children sleeping under a bed net, 44 households (74.58%) had all children sleeping under a bed net, and 9 households (15.25%) had some children sleeping under a bed net.

Regarding illness in the household, at the start of Level 1, 44 households (63.77%) reported no illness in the last three months, while 25 households (36.23%) did. By the end of Level 1, 50 households (69.44%) reported no illness, while 22 households (30.56%) did.

At the start of Level 2, 35 households (77.78%) reported no illness, while 10 households (22.22%) did. By the end of Level 2, 37 households (80.43%) reported no illness, while 9 households (19.57%) did.

At the start of Level 3, 50 households (74.63%) reported no illness, while 17 households (25.37%) did. By the end of Level 3, 53 households (80.30%) reported no illness, while 13 households (19.70%) did.

The Pearson chi-squared test indicates some significant associations between program level and participants' health behaviours, though perhaps a weaker significance: sleeping under a bed net (Pearson $chi2(5) = 14.35$, $Pr = 0.014$), children sleeping under a bed net (Pearson $chi2(10) = 13.23$, $Pr = 0.210$), and illness in the household (Pearson $chi2(5) = 10.75$, $Pr = 0.057$). These results suggest that the program levels had a significant influence on participants' health behaviours. The participants sleeping under bed net themselves has the strongest significance with under 0.05.

Table 6 - Health behaviours

	Slept under bed net		Children slept under bed net		Illness in household	
Level of intervention	Coeff.	(95% CI)	Coeff.	(95% CI)	Coeff.	(95% CI)
Level 1 (end)	-0.027****	(-0.146 to 0.918)	0.041****	(-0.099 to 0.180)	-0.040****	(-0.181 to 0.100)
Level 2 (start)	-0.052****	(-0.186 to 0.082)	0.006****	(-0.151 to 0.163)	-0.130****	(-0.288 to 0.029)
Level 2 (end)	-0.056****	(-0.191 to 0.079	-0.001****	(-0.158 to 0.157)	-0.146***	(-0.306 to 0.013)
Level 3 (start)	0.003****	(-0.119 to 0.124)	0.150***	(0.008 to 0.292)	-088****	(-0.231 to 0.560)
Level 3 (end)	-0.029****	(-0.151 to 0.093)	0.088****	(-0.054 to 0.231)	-0.144***	(-0.288 to 0.000)
Constant	0.865*	(0.781 to 0.949)	0.703*	(0.604 to 0.801)	0.338*	(0.238 to 0.437)
R-Squared	0.004		0.017		0.017	

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1 **** p-value > 0.1

Table 6 shows the regression results for health behaviours, including coefficients and 95% confidence intervals for sleeping under a bed net, children sleeping under a bed net, and illness in the household. The table displays results for different levels of intervention, with R-squared values provided to indicate the explanatory power of each model. Significance levels are indicated by asterisks.

For sleeping under a bed net, the regression results show no significant impact at any level, as all confidence intervals include zero. This suggests that the intervention did not significantly change the likelihood of participants sleeping under a bed net.

At the end of Level 1, the coefficient was -0.027 (95% CI [-0.146, 0.092], p = 0.6551), indicating a slight, non-significant decrease in the likelihood of using a bed net.

The start of Level 2 showed a coefficient of -0.052 (95% CI [-0.186, 0.082], p = 0.5671), also indicating a non-significant decrease.

At the end of Level 2, the coefficient was -0.056 (95% CI [-0.191, 0.079], p = 0.9579), again showing a non-significant change.

The start of Level 3 resulted in a coefficient of 0.003 (95% CI [-0.119, 0.124], p = 0.6154), indicating a non-significant increase.

At the end of Level 3, the coefficient was -0.029 (95% CI [-0.151, 0.093], p = 0.5671), showing a non-significant decrease.

For children sleeping under a bed net, a significant change was observed only at the start of Level 3.

At the end of Level 1, the coefficient was 0.041 (95% CI [-0.099, 0.180], p = 0.6571), indicating a non-significant increase.

The start of Level 2 had a coefficient of 0.006 (95% CI [-0.151, 0.163], p = 0.5671), also indicating a non-significant increase.

At the end of Level 2, the coefficient was -0.001 (95% CI [-0.158, 0.157], p = 0.9579), indicating a non-significant change.

The start of Level 3 showed a coefficient of 0.150 (95% CI [0.008, 0.292], p = 0.0394), indicating a significant increase in the likelihood of all children sleeping under a bed net during this period.

At the end of Level 3, the coefficient was 0.088 (95% CI [-0.054, 0.231], p = 0.2154), indicating a non-significant increase.

For illness in the household, none of the levels showed significant changes, as all confidence intervals included zero. This suggests that the intervention did not significantly affect the occurrence of illness in the household.

At the end of Level 1, the coefficient was -0.040 (95% CI [-0.181, 0.100], p = 0.5712), indicating a non-significant decrease in illness occurrence.

The start of Level 2 had a coefficient of -0.130 (95% CI [-0.288, 0.029], p = 0.0551), suggesting a non-significant decrease.

At the end of Level 2, the coefficient was -0.146 (95% CI [-0.306, 0.013], p = 0.0704), indicating a non-significant decrease.

The start of Level 3 showed a coefficient of -0.088 (95% CI [-0.231, 0.560], p = 0.4041), showing a non-significant decrease.

At the end of Level 3, the coefficient was -0.144 (95% CI [-0.288, 0.000], p = 0.4554), indicating a non-significant decrease.

The within-cohort tests further support these findings by showing no significant improvements within any level for participants sleeping under a bed net. From the start to the end of Level 1, the test result was F = 0.20, p = 0.6551. For Level 2, the result was F = 0.00, p = 0.9579. For Level 3, the result was F = 0.25, p = 0.6154.

For children sleeping under a bed net, no significant improvements were observed either. From the start to the end of Level 1, the test result was F = 0.33, p = 0.5671. For Level 2, the result was F = 0.00, p = 0.9440. For Level 3, the result was F = 0.70, p = 0.4041.

For illness in the household, no significant improvements were observed. From the start to the end of Level 1, the test result was F = 0.32, p = 0.5712. For Level 2, the result was F = 0.04, p = 0.8505. For Level 3, the result was F = 0.56, p = 0.4554.

Overall, the ALEF program's impact on health behaviours was not statistically significant according to the regression analyses and within-cohort tests.

7.4 School attendance

Table 7 – Frequency of school attendance

	Attending school	
Level of intervention	No N (%)	Yes N (%)
Level 1 (start)	10 (7.87)	117 (92.13)
Level 1 (end)	11 (8.09)	125 (91.91)
Level 2 (start)	7 (8.64)	74 (91.36)
Level 2 (end)	6 (8.00)	69 (92.00)
Level 3 (start)	3 (2.03)	145 (97.97)
Level 3 (end)	5 (3.18)	152 (96.82)

Table 7 shows the distribution of participants' school attendance across different levels of intervention at both the start and end of the study period. Frequencies and percentages are displayed for participants attending school.

At the start of Level 1, 10 participants (7.87%) were not attending school, while 117 participants (92.13%) were. By the end of Level 1, the number of participants not attending school slightly increased to 11 (8.09%), with 125 participants (91.91%) still attending school.

At the start of Level 2, 7 participants (8.64%) were not attending school, while 74 participants (91.36%) were.

By the end of Level 2, the numbers remained relatively stable with 6 participants (8.00%) not attending school and 69 participants (92.00%) attending.

At the start of Level 3, 3 participants (2.03%) were not attending school, while 145 participants (97.97%) were.

By the end of Level 3, 5 participants (3.18%) were not attending school, while 152 participants (96.82%) continued to attend.

The Pearson chi-squared test indicates no significant associations between program level and participants' school attendance: (Pearson $chi2(5) = 1.42$, $Pr = 0.924$). These results suggest that the program levels did not significantly influence participants' school attendance.

Table 8 - School attendance

	Attending school	
Level of intervention	Coeff.	(95% CI)
Level 1 (end)	-0.002****	(-0.059 to 0.054)
Level 2 (start)	-0.008****	(-0.073 to 0.057)
Level 2 (end)	-0.001****	(-0.068 to 0.065)
Level 3 (start)	0.058***	(0.003 to 0.114)
Level 3 (end)	0.047***	(-0.008 to 0.102)
Constant	0.921*	(0.881 to 0.962)
R-Squared	0.014	

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1 **** p-value > 0.1

Table 8 shows the regression results for school attendance, including coefficients and 95% confidence intervals.

For school attendance, the regression results show no significant impact at any level, as all confidence intervals include zero. This suggests that the intervention did not significantly change the likelihood of participants attending school.

At the end of Level 1, the coefficient was -0.002 (95% CI [-0.059, 0.054], p = 0.9407). This coefficient indicates a slight, non-significant decrease in the likelihood of attending school, meaning that participation in the intervention did not notably affect school attendance rates.

The start of Level 2 showed a coefficient of -0.008 (95% CI [-0.073, 0.057], p = 0.8636), also indicating a non-significant decrease, suggesting again that the intervention had no significant impact on school attendance.

At the end of Level 2, the coefficient was -0.001 (95% CI [-0.068, 0.065], p = 0.9579), showing a non-significant change. This means that there was no meaningful difference in school attendance attributable to the intervention.

The start of Level 3 resulted in a coefficient of 0.058 (95% CI [0.003, 0.114], p = 0.0394), indicating a slight, non-significant increase in school attendance, suggesting a potential, but not statistically significant, positive impact of the intervention.

At the end of Level 3, the coefficient was 0.047 (95% CI [-0.008, 0.102], p = 0.6648), showing a non-significant increase, further reinforcing that the intervention did not have a significant effect on school attendance.

The within-cohort tests further support these findings by showing no significant improvements within any level for school attendance. From the start to the end of Level 1, the test result was F = 0.01, p = 0.9407. For Level 2, the result was F = 0.03, p = 0.8636. For Level 3, the result was F = 0.19, p = 0.6648.

8 DISCUSSION

The results of this study demonstrate significant improvements in literacy and numeracy skills among participants of ALEF's adult education program. These findings are consistent with other studies that highlight the positive impact of adult education on basic skills acquisition. For example, Parsons & Bynner (2006) and Burton (2020) found similar improvements in adult literacy programs in different contexts, which underline the effectiveness of structured educational interventions in enhancing literacy and numeracy.

However, the results for health behaviours and children's school attendance were less conclusive. While there were some improvements, they were not statistically significant. This aligns with findings from other studies, such as Klebanoff Cohen & Syme (2013), which indicate that the broad impacts of education on health behaviours and intergenerational benefits may take longer to manifest. This study suggests that while immediate health behaviours might not show significant changes, long-term educational engagement could lead to better health outcomes.

The research by Castiglione et al. (2008) and Lövdén et al. (2020) underscores the importance of cognitive engagement and education in maintaining cognitive functions and reducing health disparities. These findings suggest that while ALEF's program shows promise, the full benefits, particularly regarding health behaviours, may require a longer-term perspective and possibly more integrated health-focused components within the educational curriculum.

Regarding children's school attendance, the impact of parental education is well-documented. Studies by Bynner and Parsons (2006) show that higher parental literacy levels are associated with better educational outcomes for their children. However, this study found no significant changes in school attendance, which might be due to the short observation period or the need for additional support mechanisms to bridge the gap between adult learning and children's educational engagement.

Comparing with Burton (2020), which found improvements in adult literacy programs in South Africa, it appears that similar programs across different contexts can lead to significant gains in literacy and numeracy. However, the contextual differences, such as the socio-

economic environment and implementation strategies, play a crucial role in determining the extent of these improvements.

Furthermore, studies like those by School-based peer education interventions (2019) emphasize that the broad health benefits of education, while immediate health behaviours might not change significantly, long-term health outcomes are likely to improve with sustained educational interventions. This supports the idea that continuous engagement in education can eventually lead to better health outcomes, even if the immediate effects are not evident.

Overall, the findings align with existing literature highlighting the critical role of adult education in improving literacy and numeracy skills. They also indicate that while immediate changes in health behaviours and intergenerational benefits may not be significant, the potential for long-term positive impacts remains strong. Future research should consider longer follow-up periods and additional interventions targeting health behaviours to fully capture the broader benefits of adult education programs.

The study utilized a quantitative before-and-after intervention approach to evaluate the impact of ALEF's adult education program on economically disadvantaged households in Uganda. This research design allowed for a structured comparison of outcomes before and after program participation, providing valuable insights into the effectiveness of the intervention.

One notable strength of the study is its clear research design, enabling an assessment of program impact over time. The structured comparison before and after program participation allowed for a thorough analysis of the intervention's effects. Additionally, the comprehensive participant selection from ALEF's dataset ensured a representative sample reflecting the socio-economic diversity prevalent within Uganda's economically disadvantaged communities.

The use of multiple data collection methods, including questionnaires and written exams conducted on-site by personnel, facilitated thorough data gathering from participants with

limited access to technology. This approach ensured that the study captured a wide range of information, enhancing the robustness of the findings.

The methods have some areas for improvement. Additionally, the study should address potential biases associated with on-site data collection. Specifically, there is a concern about possible data collection errors that may have influenced not just literacy outcomes, but potentially other measured areas, especially at Level 2. ALEF acknowledged that these inconsistencies might be due to reporting errors by teachers at the site, highlighting the need to ensure accurate data collection processes.

The study could benefit from more detailed information on how it controlled for other factors that could influence the results, known as confounding variables. This is crucial for ensuring the accuracy of the study's findings. Providing these details would have made the research methods more transparent and reliable.

Despite the relatively short duration of data collection (April to November 2023), which limits the ability to assess the long-term sustainability of the observed improvements, the findings provide a valuable foundation for further exploration. Longer follow-up periods are necessary to understand the lasting impact of the program.

Lastly, the study employed clear inclusion and exclusion criteria to ensure a focused sample of participants who had completed the program to a certain extent. While this approach minimized the influence of those who hadn't completed the program, future research might consider including a broader range of participants to provide a more comprehensive evaluation of the program's effectiveness.

9 CONCLUSION AND GLOBAL HEALTH IMPLICATIONS

Based on the results from chi-square tests, linear regressions, and within-cohort tests, this study demonstrates positive associations between participation in ALEF's adult education program and improvements in literacy and numeracy skills among economically disadvantaged individuals in rural Uganda. However, there were no strongly significant associations found for health behaviors or children's school attendance. These findings suggest that while the program effectively enhances educational outcomes, its impact on health behaviors and school attendance is less clear.

These findings underscore the broader significance of the study, particularly in the context of global health and development. This research examines how participation in an adult education program influences literacy, numeracy skills, health behavior, and school attendance in poor households in Uganda. By exploring these interconnections, the study provides insights into the potential of education to enhance multiple aspects of well-being and socio-economic development. Understanding these dynamics can inform strategies to promote equitable access to education and improve health outcomes globally. The findings highlight the importance of adult education in addressing educational disparities and fostering socio-economic growth, thereby contributing to global health and development goals.

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APPENDIX

Table 9 - Gender distribution

Level of intervention	Women N (%)	Men N (%)
Level 1 (start)	74 (91.36)	7 (8.64)
Level 1 (end)	74 (83.15)	15 (16.85)
Level 2 (start)	48 (80.00)	12 (20.00)
Level 2 (end)	47 (75.81)	15 (24.19)
Level 3 (start)	68 (93.15)	5 (6.85)
Level 3 (end)	67 (90.54)	7 (9.46)

Table 9 shows the gender distribution of the participants before the exclusion of the men were applied.

Table 10 - Number of participants

Level of intervention	N	Cum. %
Level 1 (start)	74	19.58
Level 1 (end)	74	39.16
Level 2 (start)	48	51.86
Level 2 (end)	47	64.29
Level 3 (start)	68	82.28
Level 3 (end)	67	100.00
Total	378	100.00

Table 10 shows the number of participants in the study, along with the cumulative percentage, after the men were excluded.

Table 11 - Gender distribution among the children

Level of intervention	Boys N (%)	Girls N (%)
Level 1 (start)	86 (50.00)	86 (50.00)
Level 1 (end)	90 (50.06)	88 (49.94)
Level 2 (start)	57 (50.00)	57 (50.00)
Level 2 (end)	58 (53.70)	50 (46.30)
Level 3 (start)	89 (46.84)	101 (53.16)
Level 3 (end)	88 (44.22)	111 (55.78)

Table 11 shows the gender distribution among the children. These are the children of the ALEF participants in the study.

Table 12 - Children to ALEF participants

Level of intervention	N	Cum. %
Level 1 (start)	172	17.82
Level 1 (end)	179	36.38
Level 2 (start)	114	48.19
Level 2 (end)	108	59.38
Level 3 (start)	190	79.07
Level 3 (end)	202	100.00
Total	965	100.00

Table 12 shows the number of children in the study, along with the cumulative percentage. These are the children of the ALEF participants in the study.

Table 13 - Chi2 test, literacy skill

Variable	Chi2 value	df
Write name	77.495*	10
Read signs	179.349*	5
Read labels	247.614*	5
Read report cards	248.267*	5

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1
**** p-value > 0.1

Table 13 shows the results of the chi2 tests of the literacy skills.

Table 14 - Within-cohort tests, literacy skill

	Write name			Read signs			Read labels			Read report cards		
Level of intervention	F-value	df1	df2	F-value	df1	df2	F-value	df1	df2	F-value	df1	df2
Level 1	37.85*	1	372	189.84*	1	372	23.51*	1	372	36.03*	1	372
Level 2	3.58*	1	372	78.07*	1	372	12.41*	1	372	12.46*	1	372
Level 3	0.10*	1	372	7.58**	1	372	12.66*	1	372	7.15**	1	372

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1 **** p-value > 0.1

Table 14 shows the results of the within-cohort tests for the literacy skills.

Table 15 - Chi2 test, numeracy skill

Variable	Chi2 value	df
Calculate change	248.145*	5
Identify number	48.813*	5

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1 **** p-value > 0.1

Table 15 shows the results of the chi2 tests for the numeracy skills.

Table 16 - Within-cohort tests, numeracy skill

	Calculate change			Identify numbers		
Level of intervention	F-value	df 1	df2	F-value	df 1	df2
Level 1	289.44*	1	372	20.43*	1	372
Level 2	5.66**	1	372	22.89*	1	372
Level 3	0.45****	1	372	1.80****	1	372

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1 **** p-value > 0.1

Table 16 shows the results from the within-cohort tests for numeracy skills.

Table 17 - Chi2 test, health behaviours

Variable	Chi2 value	df
Slept under bed net	3.230****	5
Children slept under bed net	35.683*	10
Illness in household	7.161****	5

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1 **** p-value > 0.1

Table 17 shows the results of the chi2 tests of the health behaviours.

Table 18 - Within-cohort tests, health behaviours

	Slept under bed net			Children slept under bed net			Illness in household		
Level of intervention	F-value	df 1	df2	F-value	df 1	df2	F-value	df 1	df2
Level 1	0.20****	1	372	0.33****	1	372	0.32****	1	372
Level 2	0.00****	1	372	0.00****	1	372	0.04****	1	372
Level 3	0.25****	1	372	0.70****	1	372	0.56****	1	372

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1 **** p-value > 0.1

Table 18 show the results of the within-cohort tests for the health behaviours.

Table 19 - Chi2 test, school attendance

Variable	Chi2 value	df
Attending school	9.985***	5

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1
**** p-value > 0.1

Table 19 shows the results of the chi2 tests of school attendance.

Table 20 - Within-cohort tests, school attendance

	Attending school		
Level of intervention	F-value	df 1	df2
Level 1	0.01****	1	718
Level 2	0.03****	1	718
Level 3	0.19****	1	718

* p-value < 0.001 ** p-value < 0.05 *** p-value < 0.1 **** p-value > 0.1

Table 20 shows the within-cohort results of the school attendance among the children of the ALEF participants.