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# Maternal education and child health outcomes: Moroccan evidence

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## Abstract

Using data from the Demographic Health Survey (DSH) from Morocco 2003-04, this paper examines maternal education's possible effect on children's health that are aged between 0-59 months. Maternal education is important since it can help mothers make better decisions for their children's health routines, such as immunization, nutrition, and breastfeeding. Therefore, more educated mothers are more likely to make better decisions for their children, and eventually limit the risk of certain conditions. Moreover, maternal education can be important for avoiding or limiting the risk of having underweight or stunted children. Using Logistic Regression models, while controlling for some characteristics, such as the mother's age and BMI, and other demographic variables, the models show a negative relationship between maternal education and the probability of stunting and being underweight in children among the observed age group. It is also shown that there is a positive relationship between maternal education and the children's immunization probability.

## 1. Introduction

Morocco's economy has been resistent despite all the challenges, with an expected growth of 3% in 2024. This growth, supported by the European Bank for Reconstruction and Development (EBRD), is caused by more exports and government spending. It's expected to increase to 3.6% in 2025.

In 2021, Morocco introduced a new plan called the New Development Model to boost its economy by reducing its dependence on agriculture. During the last ten years, agricultural activities in Morocco have decreased but still account for more than 10% of the economy in 2023. This new plan aims to improve the country's economy, which can provide more resources to increase healthcare spending or improve the quality of education, leading to a better and healthier society.

Additionally, unemployment in Morocco is influenced by several cultural factors, including issues related to gender inequalities, which causes higher unemployment rates among women at 18%.[1]

From 1990 to 2015, Morocco was able to reduce the deaths of mothers and young children. Maternal deaths decreased by 78.1%, and child deaths were 65% lower. By 2016, the rate of maternal deaths was 72.6 per 100,000 live births, and the death rate for children under five was 27.1 per 1,000 live births.

Morocco has been able to successfully eliminate several infectious diseases like polio and malaria thanks to strong vaccination and disease control programs. However, tuberculosis (TB) continues to be a problem in certain areas, and a program was started in 2013 to solve it. The HIV/AIDS rate remains low at about 0.1% as of 2017, but it is higher among certain high-risk groups. However, Morocco also has better access to HIV/AIDS treatments compared to other countries in the region. [2]

[1]source: https://www.moroccoworldnews.com/2024/05/362658/ebrd-forecasts-steady-3-growth-for-moroccos-economy-in-2024#google_vignette

[2]Source: https://iris.who.int/bitstream/handle/10665/136949/ccsbrief_mar_en.pdf?sequence=1

The problem of being underweight is a serious public health issue with many social consequences. It is not only a health problem; it also shows deeper issues with socio-economic and healthcare inequalities. Underweight children are more likely to get sick and even die. These health problems can weaken the immune system, making it easier for individuals to get infections and other diseases. The social costs of malnutrition, including being underweight, are high. These costs include higher spending on healthcare and less productivity because people might be unable to work due to their illnesses.

Nutrition can also affect how well children learn and perform in school. Underweight children could have trouble in school, which can keep them in poverty and limit their future opportunities. This research observes the association between being underweight and maternal education and other characteristics to help create targeted interventions and policies. This can improve public health and make society more fair.

This research is unique in its detailed analysis and more reliable methods. Precisely, this paper discusses the issues of being underweight and stunted in several groups: by gender, education level, and age. It is capable of finding complex relationships between variables by applying advanced statistical methods that answer questions that might be ignored in simpler studies.

This research is also unique because it combines ideas from public health, sociology, and economics. This paper offers a better overview since it looks at the child's health status from these different dimensions. This method is new compared to many studies that only look at these factors separately.

The research on the public health perspective looks into how maternal education is related to accessing health care services like immunization. From a sociological point of view, it considers how socioeconomic characteristics—family income and level of maternal education—are associated with the probability of being underweight and stunted. This work analyzes how social inequalities could contribute to health problems. By combining these three disciplines, the study

gives a full understanding of why children might be underweight and/or stunted. It shows how health, social factors, and financial conditions are associated. This detailed approach helps us understand the complicated reasons behind being underweight and/or stunted.

To measure the child's health outcome, much research uses anthropometric indicators, such as Height-for-Age (a measure of stunting) and Weight-for-Age (a measure of overweight and underweight).

According to Morocco's DHS survey in 2003-04, 23.53% of children aged 0 to 59 months suffer from stunting, and 10.49% are underweight. However, only 77.07% of these children are fully immunized.

In addition, among all the children surveyed in the DHS 2003-04, many children seem to be suffering from stunting followed by the problem of being underweight. More than 20% of the children appear to not be fully immunized.

Research shows that socioeconomic status (SES) impacts significantly child development and health. Studies have found that children from lower SES backgrounds are more likely to suffer from malnutrition, which affects their physical and mental development (Van de Poel et al., 2008). This problem is more common among the poorest children regardless of the overall malnutrition levels in their countries, showing persistent socioeconomic inequalities (Van de Poel et al., 2008).

Additionally, both age and SES together significantly impact health outcomes throughout a person's life. Children from lower SES are at risk of worse health outcomes, suggesting the need for early help for these groups to improve their long-term health (Prus, 2007).

The research question addressed in this study is "Does maternal education affect child health outcomes in Morocco?". To further explore the main research question and provide a detailed analysis, the following sub-questions will be considered:

“How does maternal education influence the nutritional status of children in Morocco?” The goal of this sub-question is to examine if higher levels of maternal education correlate with better nutritional outcomes such as lower stunting and underweight children.

“How does maternal education's effect on children's nutritional status differ between males and females in Morocco?” This sub-question aims to determine if there are any differences in the effect of maternal education on child nutritional status between males and females, highlighting any heterogeneous effects.

“Does maternal exposure to media, such as TV or radio enhance the health decisions of their children?” This sub-question aims to investigate whether educated mothers who regularly listen to radio or watch TV are more likely to have children with higher vaccination rates, compared to mothers who do not engage with such channels.

The paper analyses the effect of maternal education on child health outcomes, such as stunting and underweight. It will run regressions using proxies for maternal education level as the main explanatory variable but will control for demographic factors, including mothers' age and BMI, wealth index, and geographical factors like type of residence—urban or rural. Furthermore, it analyzes the probability of immunization as the dependent variable, using education as the main explanatory variable. The model also uses a number of control variables—the wealth status of the household, the age, and BMI of the mother—along with other factors like type of residence, parity and literacy, and even exposure to media. The literature will be reviewed in the first part of this paper to summarize what is already known. Presentations on data and methodology used will then be presented. A detailed discussion of the results will be given, followed by a comparison with the literature. The presentation will be followed by an examination of the limitations, and possible areas for improvement will be suggested. Finally, a summary of the findings and their implications for future research concludes the paper.

## 2. Literature review

Studying the impact of maternal education on child health outcomes is relevant for several theoretical and practical reasons.

Firstly, education is known to have an impact on socioeconomic outcomes, Grytten et al. (2005) and Chevalier & O'Sullivan (2007), used the reform of the minimum school leaving age in Norway and England respectively to study the causal effects, demonstrate that maternal education significantly affects child health outcomes such as low birth weight, mortality, and nutrition. These health outcomes, consequently, affect the productivity of economics and development, highlighting the important impact of maternal education on the well-being of society.

Boyle et al (2006) assess how important economic development level (measured by GDP adjusted for purchasing power parity: GDP-PPP), household wealth, and maternal education are to child health, as indicated by weight and height for age. Using multilevel regression models, it found that the three main variables—GDP adjusted for purchasing power (GDP-PPP), maternal education, and household wealth—all significantly impact child health. GDP-PPP had the biggest effect, followed by maternal education and household wealth.

Furthermore, Handa (1999) draws similar conclusions. The article suggests that in Jamaica, a mother's education significantly affects a child's height, regardless of the family's income or access to health services. This implies that education impacts child health through factors like household preferences, health knowledge, and food preparation techniques. It suggests also that women often share childcare and information, the education of any woman can improve child health, not just the education of the mother.

The paper Mensch et al. (2019) is a systematic review that evaluates whether maternal education directly improves health outcomes in low and middle-income countries or if observed benefits are inflated due to other influencing factors like genetics and motivation.

The study analyzed 4952 studies and only 16 met the inclusion criteria. The findings show that while models not adjusted for unobservable factors indicate strong positive effects of education on child health, these effects are smaller when these unobserved factors are considered.

The review shows that maternal education positively affects child and maternal health, but the impact is smaller when considering unobserved factors. This suggests that education's real effect on child health may not be as significant as previously thought.

Secondly, understanding the relationship between maternal education and child health can help in creating targeted interventions in public health and education.
As suggested by Luo et al. (2006) and Abuya et al. (2010), policies that promote female education can have many benefits, as educated mothers are more likely to adopt healthy behaviors and therefore reduce the child's mortality rate and improve health.
Luo et al. (2006) suggest that both lower maternal education and lower neighborhood income were linked to increased risks of negative birth outcomes like preterm births, and deaths shortly before and after birth.
Abuya et al (2010) conclude that a mother's education is crucial for a child's nutrition in poor urban areas. It suggests that improving education for girls could be essential to ending poverty and improving health in these areas, as better education is strongly associated with less child stunting.

Additionally, studies like Ruiz et al. (2016) highlight the role of maternal education in reducing health inequalities and improving access to health information and resources. It found that children with less educated mothers were 1.58 times more likely to be overweight and had a much higher risk of obesity, with a 2.61 relative index of inequality. The differences were consistent among boys but varied among girls. The results show how important maternal education is to children's health in early childhood and highlight the importance of addressing educational inequalities to improve health outcomes for children across Europe.
As also suggested by Prickett, Martin-Storey, and Crosnoe (2015) in the U.S. and Das Gupta (2007) in India, educated mothers seek out more preventive care and medical advice and this contributes positively to the child's health.

Other literature like Mensh et al. (2019) and Thomas, Strauss, & Henriques (1986) show that educated mothers exploit media, like TV and radio to learn more about healthcare, leading them to be better informed about how to take care of their children and make them healthier.

Vikram et al. (2012) discuss how maternal education in India boosts childhood immunization thanks to better knowledge, bigger social networks, and more effective communication with healthcare providers.

Boyle et al (2006) also show that higher maternal education levels are associated with better child health indicators such as weight and height, thanks to better economic and living conditions.

In addition, results from such research can support global health initiatives, by offering evidence to support strategies that lower child mortality rates and support maternal health.

Other studies like Balogun et al. (2017) found that literate mothers are more likely to complete all the vaccinations for their children. This protects children from many diseases and shows how a mother's behavior can change a child's health.

In Bangladesh, Huq and Tasnim (2008) concluded that the mother's education also plays a role in choosing a more qualified doctor for her children, leading to better control of illnesses and better health. Additionally, Anwar et al. (2014) found that educated mothers in Pakistan are more likely to search for health facilities and utilize them, leading to better preventive care for their children.

Maternal education plays a crucial role even before the birth of the child, as shown by Handa(1999) and Thomas,Strauss,&Henriques(1986), educated mothers are more likely to be healthier and better nourished. The underlying reason is that these mothers are more likely to follow a good diet and a healthy lifestyle which help the child to grow better and healthier.

The literature shows that maternal education has a strong positive impact on child health. Studies from around the world confirm that educated mothers have better access to health information, adopt healthier behaviors, and use healthcare services more. This highlights the need for policies

focused on improving education for women, as they can greatly improve child health and well-being.

## 3. Data and Methodology

### 3.1 Source of Data

The Data for this paper was obtained from DHS in 2003-2004. The National Population and Family Health Survey of Morocco conducted the survey. It was carried out by the Health Studies and Information Service (SEIS), Division of Planning and Studies of the Directorate of Planning and Financial Resources, Ministry of Health in collaboration with the MEASURE DHS+ Program of ORC Macro and the Pan-Arab Project for Family Health - The Pan Arab Project for Family Health (PAPFAM) (EPSF, 2005, p.xxiii). The survey covers households in rural and urban areas in all regions of Morocco. The survey covered topics such as fertility, maternal and child health, nutrition, family planning, mortality rates, and diseases like HIV/AIDS across the country. The interviews, carried out from October 2003 to February 2004, included a total sample of 11513 households, with 16798 female respondents aged between 15 and 49, representing respective response rates of 99% and 96%(EPSF, 2005, p.xxiii).

Table 1 shows the percentage of stunted, underweight, and immunized surveyed children in Morocco between the ages of 0-59 months. These figures are representative only of the children surveyed.

Table 1 Prevalence of stunting, underweighting, and immunization in children between the ages of 0-59 months.

| **Group** | **% Children** |
|---|---|
| Stunted | 23.53 |
| Underweight | 10.49 |
| Immunized | 77.07 |

*Note.*Total number of children 5490.

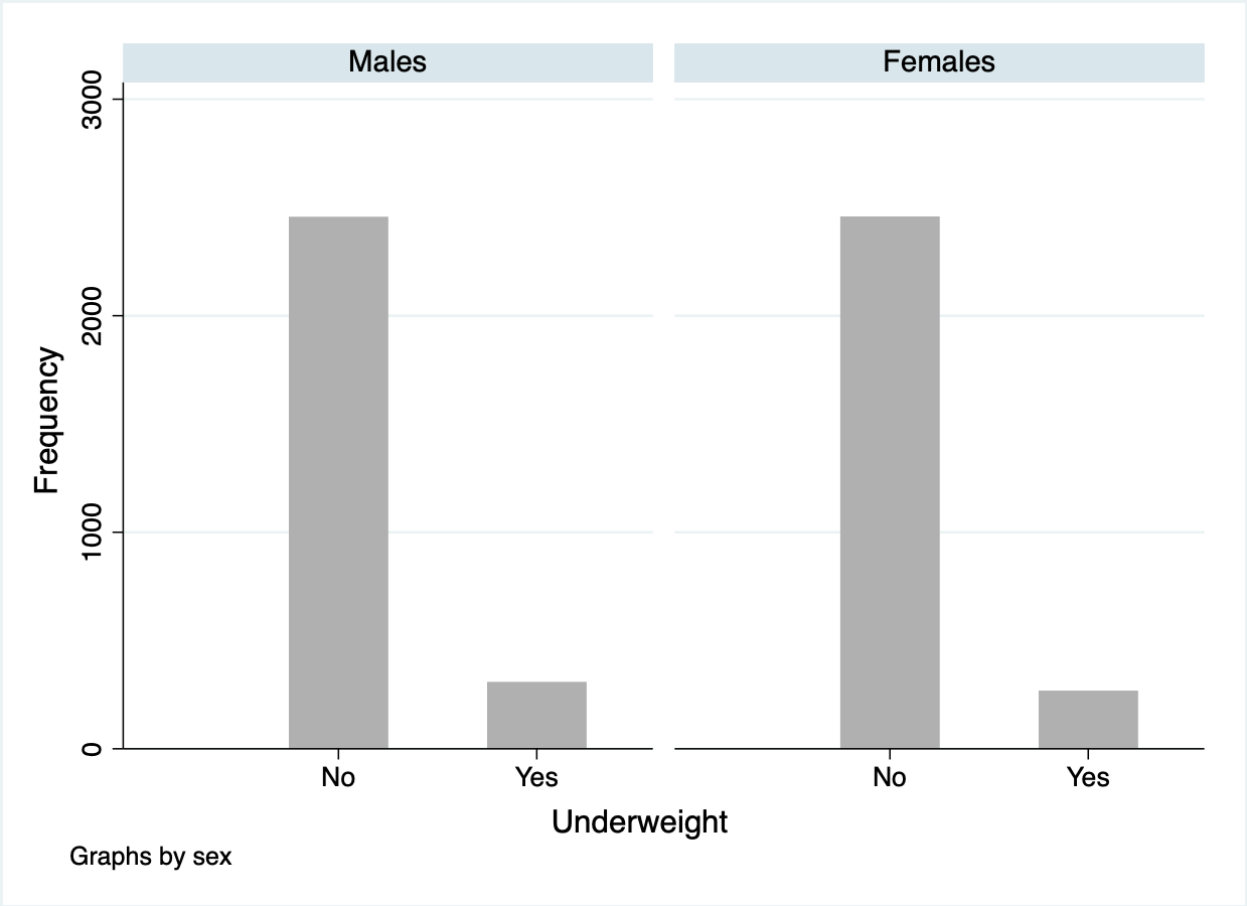


Figure 1 Number of male and female children suffering from stunting in Morocco (2003-2004)

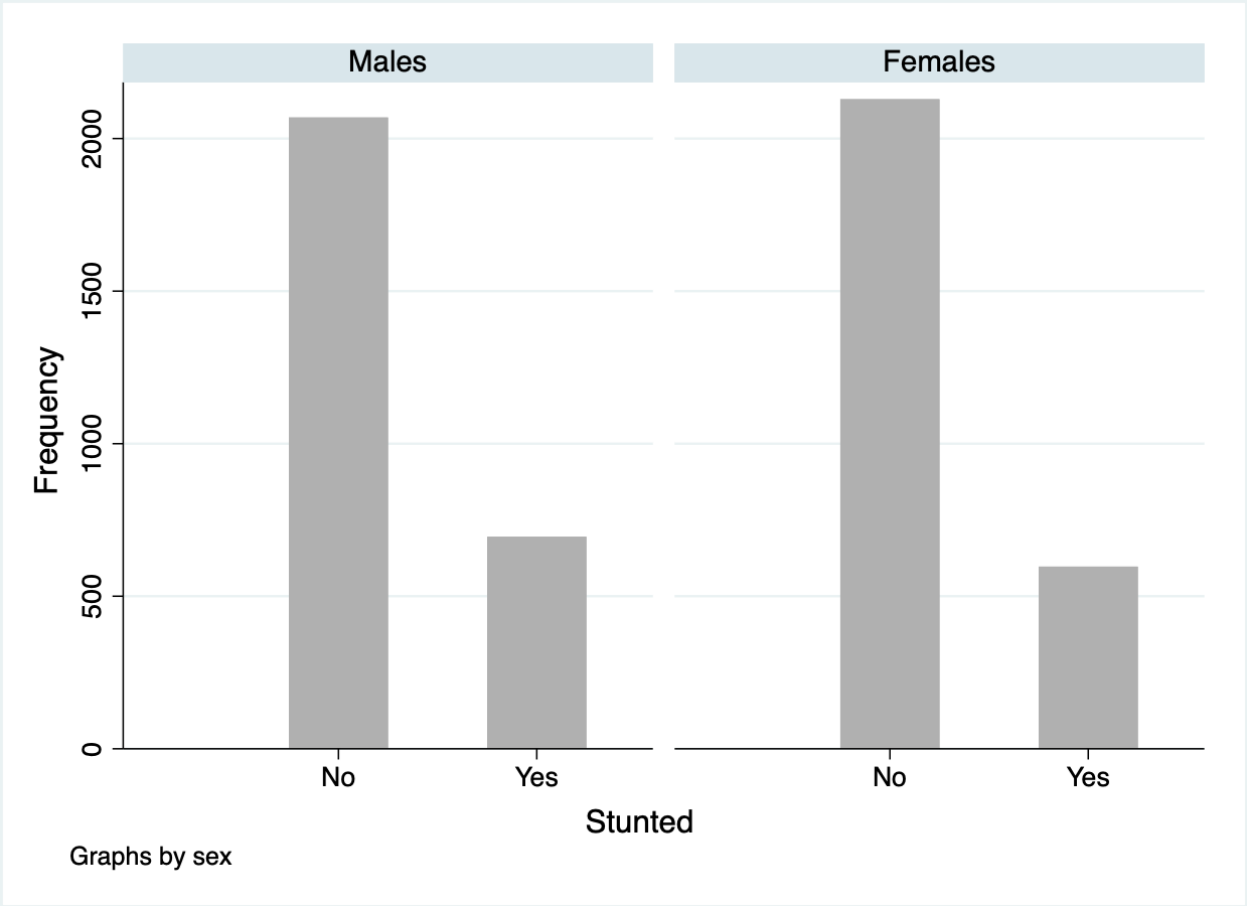


Figure 2 Number of male and female children suffering from stunting in Morocco (2003-2004)

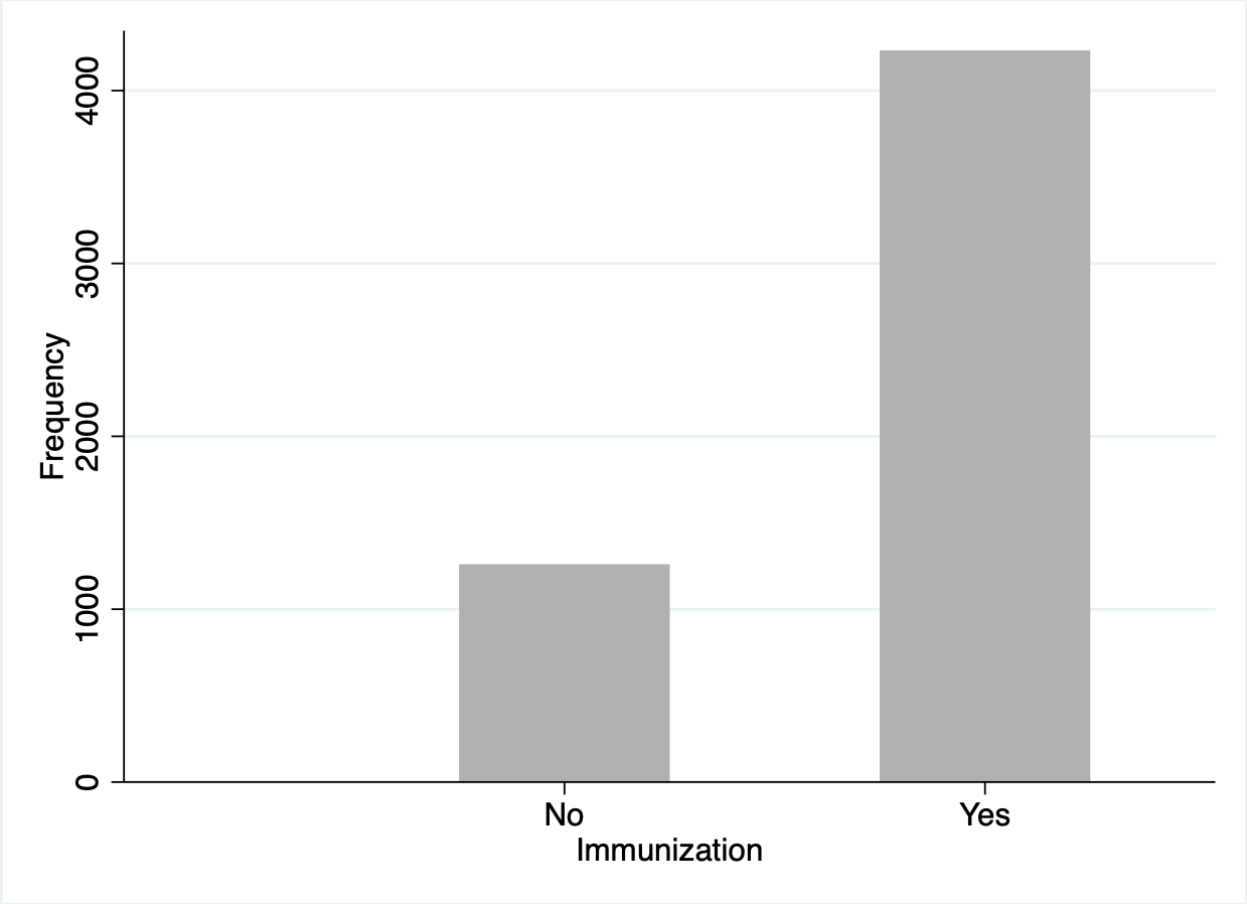


Figure 3 Number of children immunized from stunting in Morocco (2003-2004)

Figures 1-3 are visual representations of the data points in Table 1 among all the children surveyed in the DHS 2003-04, most children appear to be suffering from stunting followed by the problem of being underweight. More than 20% of the children seem to not be fully immunized.

### 3.2 Dependent variables: measures of child health outcomes

This paper analyses the impact of maternal education on child health outcomes while controlling for demographic and geographic variables. The analysis of this paper uses the following health indicators as dependent variables: Health-for-Age (HFA), Weight-of-Age(WFH), and Immunization. For example, other papers use these indicators, adapted to WHO child growth standards in specific contexts, such as the context of Indian children (Phukan, D., & Kumar, K. (2023)) or adopted children in China (Chen, Y., & Li, H. (2009)).

Both example papers use Z-scores to study child growth and health effectively. Phukan & Kumar show that Indian children need local growth standards because they differ significantly from international norms. Meanwhile, using Z-scores, Chen & Li's research demonstrates how a mother's education can affect a child's health. These scores help identify both undernutrition and overnutrition in different situations, helping public health initiatives.

Z-scores show how much a child's body measurements differ from the average in a reference group and are shown as standard deviations.

The Z-score is calculated using the formula:

$$\text{Z-score} = \frac{\text{Observed value} - \text{Median value of reference population}}{\text{Standard deviation of reference population}}$$

This measure is important because it adjusts for age and sex, allowing for a uniform assessment of a child's health status compared to global standards. It's important to use these international standards flexibly, seeing them as general guides rather than strict values that apply to everyone from different ethnic, economic, and health backgrounds.

The first dependent variable used in this paper is the HAZ score (Height-for-Age), according to the paper of Chen & Li, is defined as:

$$\text{HAZ}_i = \frac{h_{ij} - \bar{h}_j}{\sigma_j},$$

where hij is the actual height of child i in group j, where a group is divided by the child's sex and birth month. h¯j and σj represent the average height and the standard deviation of heights within group j, with children in America as the reference group.

The paper, as well as the WHO, defines a child stunted as presenting an HAZ score less than -2.

The second dependent variable used in this paper is the WAZ score (Weight-for-Age), according to the paper of Phukan & Kumar it's defined as:

$$Z = \frac{\left(\frac{Measurement}{M(t)}\right)^{L(t)} - 1}{L(t)S(t)}$$

where L(t) represents the skewness, which is adjusted by a Box-Cox transformation, M(t) denotes the median of the distribution, S(t) refers to the coefficient of variation (which measures the spread of the data relative to the median), and Zα is the normal equivalent deviation, which corresponds to a specific percentile in the distribution. The reason for using this formula is that WHO growth standards for underweight do not provide SD values. The analysis of underweight scores was conducted following the method used by Phukan & Kumar. Children are considered underweight if the WAZ score is lower than -2.

The third dependent variable used in this paper is the immunization rate, as it shows how a mother's education is associated with health decisions regarding her child. According to Balogun et al and Huq et al papers, a child is considered immunized if he/she received a dose of measles, tuberculosis (BCG), three doses of DPT (diphtheria, pertussis, tetanus), and three doses of oral polio vaccine (OPV). In this paper, only children aged 12 months, or more were considered, as the vaccinations are given separately throughout the first year of birth (Huq, M. N. et al (2008)).

All three dependent variables are binary with values 0 or 1 and they are obtained by merging the World Health Organization standard tables with the survey data. The variables stunted and underweight assume a value of 0 if the child is not stunted/underweight and 1 if he/she is. The variable immunization has a value of 0 if the child has incomplete or no vaccination at all, while 1 if he/she is completely immunized.

Table 2 Descriptive statistics of the dependent variables (child health outcomes).

| Group | Observations | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|---|
| Height-for-Age* | 5207 | -0.860 | 1.818 | -5.990 | 5.870 |
| Weight-for-Age* | 5309 | -0.332 | 1.382 | -5.964 | 5.938 |
| Immunized | 5490 | 0.771 | 0. 420 | 0 | 1 |

*The variables are represented using Z-scores.

Table 2 shows that on average, children in the sample are in good health conditions. However, as the minimum and maximum values indicate, the HAZ and WAZ scores can be even lower than -5SD, suggesting severe conditions for certain categories of children.

This research will explore the factors that contribute to children's probability of being underweight and/or stunted. Moreover, it will examine the impact of maternal education on immunization decisions for children and analyze how exposure to media and radio influences these decisions.

### 3.3 Independent variables

The main explanatory variable used in this paper is the highest level of education and it's a categorical variable that assumes values between 0 and 4 (No Education, Primary, Secondary, and Higher Education). In fact, education greatly affects health outcomes. Mothers with higher education levels usually have healthier children because they know more about nutrition and health, have better job opportunities, and use healthcare services more often (Lawal, S. A. et al (2023)).

Other variables that are used to control for in the analysis of underweight and stunted children are the BMI and the age of the mother. The nutritional health of a mother significantly affects her pregnancy and her child's health. Both insufficient and excessive nutrition in mothers is associated with negative effects like stunting, wasting, and obesity in children (Lawal, S. A. et al (2023)). The mother's age can influence parenting and nutritional choices made for the child, in fact, education can reflect the mother's socioeconomic status and knowledge about raising her

child (Lawal, S. A. et al (2023)). Both variables are categorical, the BMI is divided into three categories: Underweight, Normal, and Overweight. The age of mother is divided into 5-years groups ranging from 15 to 49 years old. The paper also takes into consideration if the respondent is married (=1) or not (=0), because being married can provide more stability and support for taking care of children's health and access to healthcare (Lawal, S. A. et al (2023)). Other variables included in the analysis are the type of residence (Urban = 0 and Rural = 1), as urban areas typically provide better healthcare and educational opportunities, which can lead to better child health outcomes and the wealth index (Poorest = 0, Poorer =1, Middle = 2, Richer = 3, Richest = 4). In fact, wealthier families generally have better access to healthy food and medical care (Lawal, S. A. et al (2023)).

This paper also analyses the immunization of the child and as the main explanatory variable uses the highest level of education. The control variables used are the age and literacy (illiterate = 0 and literate = 1) of the mother, the type of residence and the wealth index. In fact, mothers being able to read and write improves their ability to understand health-related information, which influences healthcare choices and behaviours (Tsawe et al. (2015)). The analysis also controls for parity (0 = 1-2 children, 1 = 3-5 children, and 2 = 6 or more children), as this reflects a woman's childbirth experience. Women with more children may perceive less need for certain healthcare services, believing that their previous experiences reduce the need for additional support or interventions (Tsawe et al. (2015)). Other control variables used are the frequency of reading newspapers, watching tv, and listening to the radio (0 = Not at all, 1 = Less than once a week, 2 = At least once a week, and 3 = Almost everyday), because exposure to newspapers, radio, and television can increase awareness about the importance of healthcare services, potentially improving utilization rates (Tsawe et al. (2015)).

The sample details are presented in Table 3, which displays the frequency and percentage of each independent variable. The analysis includes a sample of 5,490 children, after excluding any missing observations and ensuring a consistent dataset across all models.

Table 3 Descriptive statistics of explanatory variables.

| Group | Frequency | Percentage |
|---|---|---|
| Education mother | | |
| No education | 3622 | 23.70 |
| Primary | 842 | 3.97 |
| Secondary | 839 | 8.67 |
| Higher | 187 | 63.66 |
| BMI mother | | |
| Underweight | 253 | 4.61 |
| Normal | 2967 | 54.04 |
| Overweight | 2270 | 41.35 |
| Age | | |
| 15-19 | 132 | 2.40 |
| 20-24 | 1022 | 18.62 |
| 25-29 | 1419 | 25.85 |
| 30-34 | 1327 | 24.17 |
| 35-39 | 981 | 17.87 |
| 40-44 | 476 | 8.67 |
| 45-49 | 133 | 2.42 |
| Marriage status | | |
| No | 108 | 1.97 |
| Yes | 5382 | 98.03 |
| Employment status | | |
| No | 4700 | 85.61 |
| Yes | 790 | 14.39 |
| Wealth index | | |
| Poorest | 1478 | 26.92 |
| Poorer | 1364 | 24.85 |
| Middle | 1064 | 19.38 |
| Richer | 789 | 14.37 |
| Richest | 795 | 14.48 |
| Type of residence | | |
| Urban | 2411 | 43.92 |
| Rural | 3079 | 56.08 |
| Parity | | |
| 1-2 children | 2405 | 43.81 |
| 3-5 children | 2222 | 40.47 |
| 6 or more | 863 | 15.72 |
| Literacy | | |
| Illiterate | 3715 | 67.67 |
| Literate | 1775 | 32.33 |
| Newspaper frequency | | |
| Not at all | 4429 | 80.67 |
| Less than once a week | 604 | 11.00 |
| At least once a week | 320 | 5.83 |
| Almost everyday | 137 | 2.50 |
| Radio frequency | | |
| Not at all | 2219 | 40.42 |
| Less than once a week | 937 | 17.07 |

| | | |
|---|---|---|
| At least once a week | 1039 | 18.93 |
| Almost everyday | 1295 | 23.59 |
| Television frequency | | |
| Not at all | 1301 | 23.70 |
| Less than once a week | 218 | 3.97 |
| At least once a week | 475 | 8.67 |
| Almost everyday | 3495 | 63.66 |
| Observations | 5490 | |

*Note.* Author's own calculations.

In this paper, we analyze the likelihood of children aged 0-59 months being underweight, with this being our dependent variable. Furthermore, separate models estimate the probabilities of stunting and immunization coverage among these children. To account for gender differences, the first two models, focusing on underweight and stunted conditions, are calculated separately for females and males, providing specific results for each gender.

In this study, we employ logistic regression to analyze the three binary dependent variables: being underweight, stunted, and immunization status. Initially, each model includes only the primary explanatory variable, education. Subsequently, other control variables are included to give more insights. The findings are presented as odds ratios, with standard errors provided in parentheses.

# 4. Empirical Results

## 4.1 Methodology

This paper uses logistic regressions with odds ratios and adjusted odds ratios because the dependent variables are binary. The dependent variables assume values 0-1. Additionally, there are several key advantages of using the odds in such studies, especially in the context of logistic regression…

Odds ratios work well with both cohort and case-control studies. This makes them extremely flexible; investigators can use the same strategy in various situations to often analyse how different variables relate to outcomes. Besides, logistic regression provides an odds ratio and allows for multiple confounders adjustment. This is important in studies where many variables might interact to influence the outcome, and adjustments are necessary to isolate the effect of the main variable of interest.

Contrary to some other statistical models, logistic regression does not assume that its independent variables are normally distributed. This contributes to making it a strong choice for dealing with real-world data, which may not always fit into some expected models. The technique will also provide results accurately in different situations without many assumptions about the data or the relationship of variables between them (Hailpern, S. M., & Visintainer, P. F. (2003)).

The adjusted odds ratio is, hence, a measure of the strength of association between a particular factor and the outcome, accounting for other variables. Simple OR, on the other hand, does not consider other factors that might be important to the outcome. Adjusted odds ratio controls for extra variables called confounders which might affect results. The adjusted odds ratio takes into consideration these additional variables through which the differences may make a difference in the results—the confounders.

In other words, from all of the above-mentioned reasons and existing literature, logistic regression with calculations of odds ratio and adjusted odds ratios seems to be the most suitable method for this paper.

The multivariable logistic regression model used in this paper is written as:

$$\log\left(\frac{p}{1-p}\right) = \alpha + b_1 X_1 + b_2 X_2 + \cdots + b_n X_n$$

Where p is the probability of the outcome, such as stunting/underweight, $\log(\frac{p}{1-p})$ is the logit, or log of odds, $\alpha$ is the constant, b1,b2,…,bn are the regression coefficients, and X1,X2,…,Xn are the explanatory variable and control variables (Lawal, S. A. et al (2023)).

### 4.2. Relationship between maternal education and underweight children

Table 4 Logistic regression (Odds Ratio = OR) of maternal education influencing the probability of the child being underweight in Morocco.

| | (1)<br>Male<br>Underweight | (2)<br>Female<br>Underweight | (3)<br><br>Underweight |
|---|---|---|---|
| No education | ref | ref | ref |
| Primary | 0.613* | 0.643* | 0.623*** |
| | (0.118) | (0.123) | (0.0843) |
| Secondary | 0.320*** | 0.529** | 0.414*** |
| | (0.0765) | (0.112) | (0.0655) |
| Higher | 0.315* | 0.154** | 0.231*** |
| | (0.0163) | (0.111) | (0.0967) |
| Constant | 0.155*** | 0.131*** | 0.143*** |
| | (0.010) | (0.010) | (0.007) |
| Observations | 2764 | 2726 | 5490 |

*Note.* Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Using the results from Table 4, male children whose mothers have primary education are much less likely to be underweight in comparison to boy children whose mothers have no education. In this case, the OR of 0.613 indicates that the odds of a male child being underweight reduced

by 38.7% as compared to the reference group—in this case, no education. The p-value (< 0.05) shows that the result is statistically significant at a 95% confidence interval.

In the case of male children whose mothers had secondary education, similar to the case with higher education, they were much less likely to be underweight compared to those whose mothers had no education. For example, the OR of 0.320 shows that the chances decrease by about 68% with statistical significance having a p-value less than 0.001.

These findings indicate that a mother's level of education significantly impacts the likelihood of her male child being underweight in Morocco, with higher levels of education associated with lower risks.

Column 2 of Table 4 shows that female children of mothers with primary education are less likely to be underweight compared to those whose mothers have no education. The odds ratio (OR) of 0.643 implies these children's odds of being underweight are 35.7% lower than the reference group (no education).

The odds of being underweight for female children of mothers with secondary education are even lower (OR = 0.529), suggesting a 47.1% reduction compared to the reference group.

The most significant effect is seen in female children of mothers with higher education. An OR of 0.154 indicates that the likelihood of these children being underweight is 84.6% lower than those whose mothers have no education. This finding is highly statistically significant, as reflected by the p-value less than 0.01.

The findings suggest that while education significantly impacts both genders, female children benefit more significantly, particularly when their mothers attain higher levels of education. This difference might be because of cultural reasons that affect how education benefits are passed down in families or because of different social expectations for taking care of boys versus girls.

Table 5 Multivariate logistic regression (Adjusted Odds Ratio = AOR) of maternal education and other factors influencing the probability of the child being underweight in Morocco.

| | | (1) Male Underweight | (2) Female Underweight | (3) Underweight |
|---|---|---|---|---|
| Education mother | No education | ref | ref | ref |
| | Primary | 0.790 | 1.012 | 0.863 |
| | | (0.161) | (0.211) | (0.125) |
| | Secondary | 0.450** | 1.184 | 0.723 |
| | | (0.123) | (0.303) | (0.134) |
| | Higher | 0.426 | 0.457 | 0.454 |
| | | (0.238) | (0.343) | (0.201) |
| Bmi mother | Underweight | ref | ref | ref |
| | Normal | 0.498** | 0.581* | 0.541*** |
| | | (0.119) | (0.138) | (0.0906) |
| | Overweight | 0.315*** | 0.449** | 0.380*** |
| | | (0.0795) | (0.114) | (0.0677) |
| Age mother | 15-19 | ref | ref | ref |
| | 20-24 | 0.896 | 1.307 | 1.023 |
| | | (0.350) | (0.645) | (0.311) |
| | 25-29 | 1.072 | 1.379 | 1.153 |
| | | (0.409) | (0.672) | (0.344) |
| | 30-34 | 0.950 | 1.190 | 1.004 |
| | | (0.367) | (0.586) | (0.303) |
| | 35-39 | 1.285 | 1.843 | 1.443 |
| | | (0.501) | (0.911) | (0.438) |
| | 40-44 | 0.861 | 1.248 | 0.978 |
| | | (0.369) | (0.667) | (0.325) |
| | 45-49 | 0.580 | 1.883 | 1.018 |
| | | (0.344) | (1.151) | (0.420) |
| Married | No | ref | ref | ref |
| | Yes | 6.677 | 0.863 | 1.747 |
| | | (6.792) | (0.420) | (0.749) |
| Wealth index | Poorest | ref | ref | ref |
| | Poorer | 0.690* | 0.736 | 0.712** |
| | | (0.110) | (0.122) | (0.0815) |
| | Middle | 0.610* | 0.608* | 0.617** |
| | | (0.137) | (0.141) | (0.0987) |
| | Richer | 0.809 | 0.614 | 0.725 |
| | | (0.232) | (0.188) | (0.151) |
| | Richest | 0.594 | 0.272** | 0.420** |
| | | (0.215) | (0.111) | (0.113) |
| Employed | No | ref | ref | ref |
| | Yes | 1.217 | 0.895 | 1.066 |
| | | (0.213) | (0.181) | (0.140) |
| Residence type | Urban | ref | ref | ref |
| | Rural | 1.203 | 1.418 | 1.307 |
| | | (0.257) | (0.307) | (0.198) |
| Constant | | 0.055** | 0.191** | 0.148*** |
| | | (0.061) | (0.141) | (0.082) |
| Observations | | 2764 | 2726 | 5490 |

*Note.* Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.00$

Table 5 shows findings from a multivariate logistic regression analysis investigating how maternal education and other sociodemographic characteristics could affect the probability of male children being underweight in Morocco. Each factor's effect is given as an Adjusted Odds Ratio (AOR), which measures how likely a child is to be underweight under certain conditions compared to a reference group.

Table 5 shows a non-significant effect of being male children of mothers with primary education and higher education on the likelihood of being underweight, compared to the reference category (no education).

However, being male children of mothers with secondary education is significantly associated with the likelihood of being underweight by 55% compared to the reference group (no education).

The findings also suggest that normal-weight mothers are associated with a 50.2% reduction in the likelihood of their children being underweight, which is statistically significant, and overweight mothers show an even stronger association with reduced likelihood of underweight children, at a 68.5% reduction.

The findings also show a generally decreasing trend in the odds of being underweight, with the middle wealth category showing a statistically significant reduction (AOR = 0.610, $p < 0.05$). This suggests socioeconomic status plays an important role in the likelihood of children being underweight. As shown in Table 5, other control variables, such as the mother's age and employment status, are not associated significantly with the likelihood of being underweight. Overall, the results demonstrate strong associations between maternal education, BMI, and socioeconomic status with the likelihood of male children being underweight in Morocco, highlighting some key areas for intervention to improve child health outcomes.

As shown in Column 2 of Table 5 maternal education seems to not be significantly associated with the likelihood of a daughter being underweight. However, normal BMI of the mother (AOR = 0.581, $p < 0.05$) is significantly associated with a decrease in the likelihood of daughters being underweight, and a high BMI (AOR = 0.449, $p < 0.01$) has an even stronger association with the reduction in the likelihood of daughters being underweight.

Table 6 also shows a trend of decreasing likelihood of being underweight with increasing wealth, with "Richest" showing a significant decrease (AOR = 0.272, $p < 0.01$).

Both boys and girls show similar trends in how their mother's education, BMI, and family wealth are associated with their health outcomes. However, the impact can differ slightly between the genders. There's also an unusual result regarding marital status for boys that may need a more detailed examination to understand any errors in the data.

### 4.2 Relationship between maternal education and stunted children

Table 6 Logistic regression (Odds Ratio = OR) of maternal education influencing the probability of the child being stunted in Morocco.

| | (1) Male Stunted | (2) Female Stunted | (3) Stunted |
|---|---|---|---|
| No education | ref | ref | ref |
| Primary | 0.722* | 0.706** | 0.708*** |
| | (0.095) | (0.093) | (0.0659) |
| Secondary | 0.412*** | 0.543*** | 0.471*** |
| | (0.061) | (0.080) | (0.0492) |
| Higher | 0.485* | 0.189*** | 0.326*** |
| | (0.144) | (0.080) | (0.0780) |
| Constant | 0.401*** | 0.335*** | 0.368*** |
| | (0.020) | (0.018) | (0.014) |
| Observations | 2764 | 2726 | 5490 |

Note. Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6 indicates that the odd of being stunted for a boy whose mother has primary education decreases by 27.8 percent as compared to one whose mother has no education, with an OR = 0.722 and $p < 0.05$. This effect is statistically significant and hence proves even primary education can influence child growth.

The association is much stronger for mothers with secondary education. That is, their male children have an 58.8% lesser probability of being stunted compared to the reference category, no education, with an OR = 0.412 and a p-value less than 0.001. Equally, boys whose mothers have higher education are 51.5%, less likely to be stunted compared to those whose mothers

have no education. This result is also statistically significant, although the effect here is weaker than that with secondary education.

As Column 2 of Table 6 shows female children of mothers with primary education have a 29.4% lower likelihood of being stunted compared to those whose mothers have no education. The association increases for mothers with secondary education. Their daughters are 45.7% less likely to be stunted compared to the reference category (no education). The strongest association with the likelihood of being stunted is shown among female children of mothers with higher education, who are 81.1% less likely to be stunted than those in the reference group. These findings are also statistically significant at the confidence level of 95%.

The results show that, with increased education, both sexes are much less likely to be stunted, especially where mothers have achieved higher levels of education. On the other hand, girls appear to obtain larger benefits from increased education by their mothers than boys. Meaning that this difference may be due to the different manners of raising boys from girls or that they have different health needs.

Table 7 Multivariate logistic regression (Adjusted Odds Ratio = AOR) of maternal education and other factors influencing the probability of the child being stunted in Morocco.

| | | (1) Male Stunted | (2) Female Stunted | (3) Stunted |
|---|---|---|---|---|
| | No education | ref | ref | ref |
| Education mother | Primary | 0.945 | 0.896 | 0.917 |
| | | (0.133) | (0.130) | (0.0922) |
| | Secondary | 0.600** | 0.814 | 0.704** |
| | | (0.106) | (0.145) | (0.0878) |
| | Higher | 0.687 | 0.308** | 0.497** |
| | | (0.228) | (0.138) | (0.130) |
| Bmi mother | Underweight | ref | ref | ref |
| | Normal | 1.042 | 0.828 | 0.907 |
| | | (0.226) | (0.165) | (0.132) |
| | Overweight | 0.692 | 0.580** | 0.617** |
| | | (0.154) | (0.121) | (0.0933) |
| Age mother | 15-19 | ref | ref | ref |
| | 20-24 | 1.007 | 1.674 | 1.298 |
| | | (0.300) | (0.571) | (0.289) |
| | 25-29 | 1.182 | 1.266 | 1.221 |
| | | (0.346) | (0.429) | (0.269) |
| | 30-34 | 1.107 | 1.059 | 1.083 |
| | | (0.327) | (0.362) | (0.240) |
| | 35-39 | 1.246 | 1.417 | 1.319 |
| | | (0.375) | (0.490) | (0.297) |
| | 40-44 | 0.073 | 1.213 | 1.140 |
| | | (0.345) | (0.448) | (0.275) |
| | 45-49 | 1.002 | 1.476 | 1.197 |
| | | (0.400) | (0.659) | (0.354) |
| Married | No | ref | ref | ref |
| | Yes | 0.748 | 1.815 | 1.068 |
| | | (0.236) | (0.757) | (0.261) |
| Wealth index | Poorest | ref | ref | ref |
| | Poorer | 0.681** | 0.721* | 0.696*** |
| | | (0.080) | (0.092) | (0.0599) |
| | Middle | 0.479*** | 0.721* | 0.588*** |
| | | (0.080) | (0.120) | (0.0681) |
| | Richer | 0.385*** | 0.582* | 0.473*** |
| | | (0.084) | (0.126) | (0.0723) |
| | Richest | 0.578* | 0.429*** | 0.493*** |
| | | (0.139) | (0.110) | (0.0856) |
| Employed | No | ref | ref | ref |
| | Yes | 1.006 | 1.215 | 1.119 |
| | | (0.132) | (0.168) | (0.106) |
| Residence type | Urban | ref | ref | ref |
| | Rural | 1.038 | 0.961 | 1.001 |
| | | (0.156) | (0.144) | (0.106) |
| Constant | | 0.716 | 0.242** | 0.469** |
| | | (0.346) | (0.140) | (0.170) |
| Observations | | 2764 | 2726 | 5490 |

*Note*. Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As shown in Table 7 male children of mothers with secondary education have a 40% lower likelihood of being stunted compared to those whose mothers have no education. This significant reduction highlights the importance of at least secondary education in reducing stunting.

The findings also show a clear association between family wealth and the chance of male children being stunted. Children from families indicated as 'Poorer' (AOR = 0.681, $p < 0.01$) have a reasonably reduced risk of stunting compared to the poorest group, indicating some economic advantages. As family wealth increases, the decrease in stunting risk becomes more significant: the 'Middle' wealth group has a 52.1% lower chance of stunting (AOR = 0.479, $p < 0.001$), and the 'Richer' group has the biggest reduction (AOR = 0.385, $p < 0.001$). However, the 'Richest' group, while still showing a significant reduction in stunting risk (AOR = 0.578, $p < 0.05$), does not show as strong association as the 'Richer' group, showing that the relationship between the highest wealth levels and health outcomes is complex.

These important results show that higher maternal education (especially secondary) and better family wealth status are key in greatly lowering the risk of stunting in male children in Morocco.

Column 2 of Table 7 presents the association of education and other variables with the probability that female children are stunted. On the table, higher education of mothers is significantly associated with a decreased risk of stunting (AOR = 0.308, $p < 0.01$). In other words, daughters whose mothers have higher education are much less likely to be stunted. The results also suggest that having an overweight BMI significantly puts one at a lower risk of the child being stunted compared to underweight mothers. This was an indicator of the health benefit of better nutrition on the part of the mothers.

In both categories, 'richer' and 'richest', the likelihood of stunting decreases considerably with a rise in family wealth. The strongest association is found in the richest category, underpinning the role of socioeconomic factors in child health.

Both male and female children benefit from higher maternal education and better family wealth, but the magnitude and significance of these benefits seem to be different. Female children seem to benefit more from higher maternal education and maternal overweight status in terms of stunting likelihood reduction.

## 4.3 Relationship between maternal education and child immunization

Table 8 Logistic regression (Odds Ratio = OR) of maternal education influencing the child's probability of being immunized in Morocco.

| | (1)<br>Stunted |
|---|---|
| No education | ref |
| Primary | 1.236* |
| | (0.115) |
| Secondary | 1.366** |
| | (0.131) |
| Higher | 1.360 |
| | (0.258) |
| Constant | 3.083*** |
| | (0.119) |
| Observations | 5490 |

*Note.* Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8 presents the findings of logistic regression analysing how maternal education is associated with the probability of a child being immunized in Morocco. The findings are expressed as Odds Ratios (OR), showing the likelihood of children being immunized based on different levels of maternal education compared to the reference group (no education).

Children of mothers with primary education are 23.6% more likely to be immunized compared to those whose mothers have no education. Whereas children of mothers with secondary education are 36.6% more likely to be immunized compared to the reference category.

The findings indicate that higher levels of maternal education are associated with an increased likelihood of children being immunized in Morocco. Although higher education shows a positive effect, it is not statistically significant, possibly due to data variability. Overall, the results show that maternal education is important for improving children's health outcomes.

Table 9 Multivariate logistic regression (Adjusted Odds Ratio = AOR) of maternal education and other factors influencing the child's probability of being immunized in Morocco.

| | | (1)<br>Immunized |
|---|---|---|
| Education mother | No education | ref |
| | Primary | 1.054 |
| | | (0.113) |
| | Secondary | 0.952 |
| | | (0.129) |
| | Higher | 0.713 |
| | | (0.167) |
| Age mother | 15-19 | Ref |
| | 20-24 | 1.912*** |
| | | (0.364) |
| | 25-29 | 2.805*** |
| | | (0.539) |
| | 30-34 | 3.743*** |
| | | (0.747) |
| | 35-39 | 4.924*** |
| | | (1.040) |
| | 40-44 | 6.584*** |
| | | (1.564) |
| | 45-49 | 9.232*** |
| | | (3.095) |
| Parity | 1-2 | Ref |
| | 3-5 | 0.749*** |
| | | (0.063) |
| | 6 or more | 0.551*** |
| | | (0.071) |
| Newspaper frequency | Not at all | Ref |
| | Less than once a week | 1.104 |
| | | (0.153) |
| | At least once a week | 1.353 |
| | | (0.247) |
| | Almost everyday | 1.053 |
| | | (0.257) |
| Radio frequency | Not at all | ref |
| | Less than once a week | 1.257* |
| | | (0.124) |
| | At least once a week | 0.967 |
| | | (0.088) |
| | Almost everyday | 1.154 |
| | | (0.103) |
| Television frequency | Not at all | ref |
| | Less than once a week | 1.245 |
| | | (0.218) |
| | At least once a week | 1.111 |
| | | (0.144) |
| | Almost everyday | 1.315** |
| | | (0.128) |
| Wealth index | Poorest | ref |
| | Poorer | 1.070 |
| | | (0.103) |

| | | |
|---|---|---|
| | Middle | 1.264 |
| | | (0.169) |
| | Richer | 1.253 |
| | | (0.209) |
| | Richest | 1.062 |
| | | (0.196) |
| Residence type | Urban | ref |
| | Rural | 0.978 |
| | | (0.105) |
| Constant | Constant | 0.905 |
| | | (0.196) |
| Observations | Observations | 5490 |

*Note.* Standard errors in parentheses; $^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$

As shown in Table 9 children of older mothers are significantly more likely to be immunized. Specifically, the odds of immunization increase with maternal age. Children of mothers aged 20-24 are nearly twice as likely to be immunized compared to those whose mothers are aged 15-19 (AOR = 1.911, p < 0.001) and children of mothers aged 35-39 are nearly five times more likely to be immunized (AOR = 4.924, p < 0.001). As also evident children of mothers aged 45-49 are over nine times more likely to be immunized (AOR = 9.232, p < 0.001). This strong trend indicates that older maternal age is significantly associated with higher child immunization rates.

Family size also plays a significant role in child immunization. Having 3-5 children is associated with a 25.1% lower likelihood of immunization compared to having 1-2 children (AOR = 0.749, p < 0.001), and having six or more children reduces the likelihood of immunization by 44.9% (AOR = 0.551, p < 0.001).

This suggests that larger family sizes are associated negatively with the probability of child immunization, likely due to limited resources and attention.

As included in the appendix the correlation coefficient between the variable of literacy and the maternal education is higher than 0.8. As learned during these years in econometrics courses, the rule of thumb indicates that if the correlation coefficient is higher than 0.8, there is a severe correlation. As a result, the variable literacy was excluded due to the perfect collinearity with the variable education and in fact, the results do not change significantly (See Appendix).

Media exposure is significantly associated with immunization rates. Listening to the radio less than once a week is associated with a 25.7% higher likelihood of child immunization compared to not listening to the radio at all (AOR = 1.257, $p < 0.05$).

Watching television almost every day increases the likelihood of child immunization by 31.5% compared to not watching TV at all (AOR = 1.315, $p < 0.01$).

Limited radio exposure and frequent television watching are both positively associated with the likelihood of child immunization, highlighting the importance of media in health promotion.

The analysis reveals that older maternal age, smaller family sizes, and media exposure are significant factors that are positively associated with the likelihood of child immunization in Morocco. Older mothers are much more likely to immunize their children, and smaller families facilitate higher immunization rates. Additionally, even limited exposure to media, particularly radio and television, can play a role in promoting child immunization. While the impact of maternal education on immunization rates was not statistically significant in this analysis, the observed trends suggest that education still could play a role in influencing health behaviours and decisions.

### 4.4 Robustness checks

Firstly, we computed the correlation coefficients to examine the presence of multicollinearity in each of the independent variables. As we learned from courses in Econometric, if two coefficients were above 0.8, that is highly correlated, and therefore an example of multicollinearity. For instance, in this paper, we considered that in case any variables had correlation coefficients above this threshold, they were suffering from multicollinearity and hence either modified or removed from the model to maintain accuracy in the analysis.

Table 12 in the Appendix shows the correlation of the explanatory variables of the underweight and stunted model. The table indicates that the analysis on the stunted children and underweight children passes the test for multicollinearity.

Table 13 shows a strong correlation between literacy and maternal education variables. As a solution, the literacy variable was removed from the analysis and as shown in Table 14 the results do not change significantly (see Appendix).

Secondly, the likelihood ratio test was conducted to compare the logistic regression models. The test will indicate whether adding more variables to the model significantly improves the fitting of the data. The LRT statistic was computed, and it follows a chi-square distribution. The degrees of freedom were given by the difference in the number of parameters in the two models. A p-value less than 0.05 was considered significant, and hence the more complex model provided a better fit to the data. Table 11 shows that the inclusion of explanatory variables provides a better fit to the data (see Appendix).

## 5. Discussion

The analysis of the relationship between maternal education and child health outcomes of this paper aligns with the existing literature on the topic and answers the main research question of this research.

The first hypothesis stated that higher levels of maternal education correlate with better nutritional outcomes for children, such as lower rates of stunting and underweight.

The results from Table 4 support this hypothesis, showing that male children of mothers with primary and secondary education have a lower probability of being underweight compared to those whose mothers have no education. This finding aligns with the conclusions of Grytten et al. (2005) and Chevalier & O'Sullivan (2007), who demonstrated that maternal education significantly affects child health outcomes, such as low birth weight and nutrition, leading to improved child health. The odds ratio (OR) of 0.320 for secondary education highlights a significant reduction in the probability of being underweight, aligning with the idea that educated mothers have better access to health information and resources (Boyle et al., 2006).

Similarly, the female child can strongly benefit from maternal education; the odds of being underweight are reduced to a greater extent as compared to a male child with higher levels of maternal education. This result is consistent with the finding by Abuya et al. (2010) based on the

2003 Kenya Demographic and Health Survey. On average, the data shows that children who are females whose mothers had higher education have an 84.6 percent lower likelihood of being underweight, stressing the important impact that maternal education can make in reducing undernutrition among children.

The analysis also signifies that mothers with normal overweight BMI values are less likely to give birth to underweight children. This confirms the view of Luo et al. (2006) that maternal health is a determinant factor for child health outcomes. In addition, children from rich families are less likely to be underweight or stunted. This finding is also supported by Boyle et al. (2006), who established that economic factors severely impact child health.
Table 7 indicates the older the child, the less likely he/she is to be stunted. The same case applies to wealthier children. Handa, 1999, testifies to this as he stated that economic factors were very significant in child health. A higher socio-economic status increases the chances of accessing health services and at the same time accessing nutrition hence less prone to stunting and being underweight.

The second hypothesis stated that the effect of maternal education on children's nutritional status differs between males and females in Morocco. The results show that both male and female children benefit from higher maternal education, but the magnitude and significance of these benefits can vary. For example, female children of mothers with higher education are 81.1% less likely to be stunted, compared to a 51.5% reduction for male children (Table 7). This suggests that while education impacts both genders positively, female children experience a higher benefit. This may be due to the cultural factors and childcare practices for male/female children. According to Prickett et al. (2015), educated mothers are more likely to seek care and medical services, which may benefit female children more than others.

The third hypothesis suggested that maternal exposure to media, such as TV or radio, enhances the health decisions of their children, leading to higher vaccination rates.

Table 8 shows the impact of maternal education on child immunization rates. While the positive effect of maternal education on immunization is not statistically significant, the trend is clear. This is in line with Mensch et al. (2019), who found that the impact of education on health outcomes might be smaller when taking into account hidden factors. However, studies by Vikram et al. (2012) showed that maternal education improves childhood immunization thanks to better knowledge and communication with healthcare providers.

Table 9 outlines that older mothers are more likely to immunize their children. This fact is supported by Ruiz et al. (2016), who commented that older mothers may have more experience and resources for the vaccination of their children. Besides, descriptive analysis shows that large families are less likely to fully immunize their children, probably due to the family's limited resources and attention, as discussed by Abuya et al. (2010).

The positive correlation between media exposure and child immunization rates is an indication that health promotion through media is very important. According to Mensh et al. (2019) and Thomas, Strauss, & Henriques, 1986, it has been found that educated mothers utilize media to gain knowledge regarding healthcare for better health outcomes for their children.

This paper confirms that maternal education, socioeconomic status, and maternal health are significantly associated with child health outcomes in Morocco. These findings align with existing studies and highlight the need for policies focused on improving women's education and addressing economic inequalities to improve child health. The analysis also shows the importance of considering gender differences, maternal age, family size, and media exposure in health interventions. Addressing these factors can lead to better plans for improving child health in Morocco and similar countries.

Policymakers should focus on increasing maternal education and addressing economic inequalities, as these are important to improve child health outcomes. Implementing educational programs for women and improving access to healthcare and nutritional resources in poor areas can significantly reduce undernutrition and improve overall child well-being.

## 6. Limitations

This paper observes the relationship between child health outcomes and maternal education. However, the method implemented, and the data used for this research present some limitations. Firstly, these analysis studies use cross-sectional data, which only provides a snapshot at one point in time and cannot prove cause and effect. This limitation makes it hard to determine whether factors like maternal education directly led to better health or higher immunization rates. Secondly, as the data used are collected through a survey, there could be potential errors in recording key data such as maternal education levels, child health outcomes, or immunization records leading to biased results. This includes how these variables are defined and collected, which may affect the accuracy of the findings. There may be also additional factors influencing both the independent variables (e.g., maternal education) and dependent outcomes (stunting, underweight, immunization) that the studies do not account for. These could include elements like household income, prenatal care, or healthcare access.

Another significant limitation is heterogeneity. Variations in cultural, economic, and healthcare contexts across different subgroups can cause differences in the relationships between predictors and outcomes. For example, the impact of maternal education on child health might differ notably across various regions within Morocco. If this heterogeneity is not adequately addressed in the analysis, it can lead to inaccurate conclusions.

The findings, while relevant to Morocco, might not apply to other regions with different cultural, economic, or healthcare contexts, limiting their external validity.

After cleaning the data and filtering the missing observations, the sample included 5490 individuals. As a result, the resulting sample is not representative of the entire population of Morocco, so the findings may not accurately reflect true relationships or effects within the general population.

Nutritional problems like stunting and being underweight could be affected by diet, health behaviors, and genetics, which are not fully considered in the study. Also, these issues develop over time and need longitudinal data to track the changes.

Additionally, immunization rates may be affected by access to healthcare services, which may vary within Morocco. The studies might not completely consider these differences in healthcare

access or quality. Also, parents' understanding of the benefits and schedules of immunization could affect the results, making it hard to see how education truly affects immunization rates.
To give more explanation to the path between maternal education and child health outcomes, a specific intervention is required.

## 7. Recommendations for Future Research

To improve the quality and impact of future research on how maternal education and other factors influence child health outcomes in Morocco, future studies should utilize longitudinal designs to track changes over time, providing clearer insights into the causal relationships between maternal education, healthcare access, and child health outcomes. Including more confounders could also help to understand the relationship between maternal education and child health outcomes. Additionally, conducting studies focused on specific areas in Morocco will help understand the different healthcare situations across the country. This targeted approach can uncover unique challenges and solutions for each area, making health interventions more effective. Future research could also add qualitative research components like interviews or focus groups to provide a deeper understanding of the quantitative data, showing how cultural and socio-economic factors influence health behaviors and decisions.
Stronger relations between researchers, local communities, healthcare providers, and policymakers can help in the design of an experiment and the running of an RCT. This would provide more reliable findings, with measures that could help policymakers in decisions regarding interventions and investments. In summary, these recommendations can help future research to be more detailed and relevant, leading to better health strategies and interventions that are specifically designed to meet the needs of Moroccan children and their families.

## 8. Conclusion

The paper explores well the relationship between maternal education and child health outcomes in Morocco. It offers a clearer understanding of how these factors together influence the health of children, specifically regarding their immunization status and health status as measured by stunting and being underweight. In addition, children whose mothers have higher education levels are less likely to be underweight or stunted and more likely to be fully vaccinated. This shows that educated mothers have the knowledge and resources needed to provide for their children's health needs effectively.

The findings indicated that older mothers usually had children with better health outcomes. This can be related to more life experience, more emotional maturity, and, most probably, greater economic stability—factors that can provide better health care and good nutrition to children. The result shows a positive effect of exposure to media on immunization rates. Regular engagement with media resources helps to keep mothers informed about important health treatments and schedules, therefore improving child health outcomes. The strong link between higher family wealth and better child health outcomes highlights the critical role of economic factors. Wealthier families likely have better access to healthcare services and can afford higher nutritional standards and this could directly benefit their children's health. Considering all the limitations mentioned, future research can offer better insights and help create specific programs that effectively improve child health in Morocco and possibly in other similar countries.

## 9. Appendix

Table 10 Multivariate logistic regression (Adjusted Odds Ratio = AOR) of maternal education and other factors influencing the child's probability of being immunized in Morocco.

| | | (1)<br>Immunized |
|---|---|---|
| Education mother | No education | ref |
| | Primary | 0.990 |
| | | (0.158) |
| | Secondary | 0.883 |
| | | (0.175) |
| | Higher | 0.672 |
| | | (0.182) |
| Age mother | 15-19 | ref |
| | 20-24 | 1.899*** |
| | | (0.362) |
| | 25-29 | 2.779*** |
| | | (0.533) |
| | 30-34 | 3.731*** |
| | | (0.744) |
| | 35-39 | 4.886*** |
| | | (1.032) |
| | 40-44 | 6.456*** |
| | | (1.533) |
| | 45-49 | 9.126*** |
| | | (3.060) |
| Parity | 1-2 | ref |
| | 3-5 | 0.750*** |
| | | (0.0626) |
| | 6 or more | 0.554*** |
| | | (0.0711) |
| Newspaper frequency | Not at all | ref |
| | Less than once a week | 1.122 |
| | | (0.162) |
| | At least once a week | 1.315 |
| | | (0.247) |
| | Almost everyday | 1.039 |
| | | (0.257) |
| Media frequency | Not at all | ref |
| | Less than once a week | 1.453** |
| | | (0.177) |
| | At least once a week | 1.335** |
| | | (0.140) |
| | Almost everyday | 1.499*** |
| | | (0.171) |
| Wealth index | Poorest | ref |
| | Poorer | 1.106 |
| | | (0.103) |
| | Middle | 1.334* |
| | | (0.170) |
| | Richer | 1.348 |
| | | (0.217) |

| | | |
|---|---|---|
| | Richest | 1.148 |
| | | (0.206) |
| Literacy | No | ref |
| | Yes | 1.081 |
| | | (0.194) |
| Residence type | Urban | ref |
| | Rural | 0.985 |
| | | (0.105) |
| Constant | Constant | 0.836 |
| | | (0.184) |
| Observations | Observations | 5490 |

*Note.* Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The table includes literacy as an explanatory variable.

Table 10 merges television frequency and radio frequency under a unique variable called media exposure. As noticed, the results do not change significantly. For instance, following the analyzed literature we kept radio frequency and television frequency separate. In this way, we applied consistent methods with the existing literature.

Table 11 Likelihood-ratio test of the models.

| Models compared | LRT | P-value | $Df^2$ |
|---|---|---|---|
| Full model underweight male vs reduced model underweight male | 59.01 | 0.000 | 15 |
| Full model underweight female vs reduced model underweight female | 54.01 | 0.000 | 15 |
| Full model stunted male vs reduced model stunted male | 82.72 | 0.000 | 15 |
| Full model stunted female vs reduced model stunted female | 60.37 | 0.000 | 15 |
| Full model immunization vs reduced model immunization | 177.93 | 0.000 | 23 |

*Note.* *LRT = chi-square test statistic for the likelihood-ratio test: - 2(Log reduced model - Log full model).
**$Df^2$ = degrees of freedom for the y-test statistic defined as the difference

The likelihood ratio test compares the full model to the reduced model. The models are treated separately for male and female children. Table 11 indicates that the full model explains better than the reduced model.

Table 12. Correlation table of confounding variables for underweight and stunted.

| | Education | Bmi | Age | Marriage status | Wealth index | Employment | Residence type |
|---|---|---|---|---|---|---|---|
| Education | 1.000 | | | | | | |
| Bmi | 0.120 | 1.000 | | | | | |
| Age | -0.034 | 0.161 | 1.0000 | | | | |
| Marriage status | -0.040 | 0.002 | -0.025 | 1.000 | | | |
| Wealth index | 0.591 | 0.220 | 0.075 | -0.028 | 1.000 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Employment status | 0.150 | -0.018 | 0.116 | -0.099 | 0.037 | 1.000 | |
| Residence type | -0.454 | -0.193 | -0.078 | 0.068 | -0.760 | -0.028 | 1.000 |

*Note.* Author's own calculations.

Table 12 calculates the correlation coefficients between the explanatory variables for stunting and underweight analysis. This table aims to test for multicollinearity and obtain more accurate results. During econometric courses, we learned that if the correlation coefficient is above 0.8 it can be considered a severe correlation, therefore collinearity. The table shows that the analysis of stunted children and underweight children was successfully tested for multicollinearity.

Table 13. Correlation table of confounding variables for immunization.

| | Education | Age | Parity | Newspaper frequency | Radio frequency | Television frequency | Wealth index | Literacy | Residence type |
|---|---|---|---|---|---|---|---|---|---|
| Education | 1.000 | | | | | | | | |
| Age | -0.0345 | 1.000 | | | | | | | |
| Parity | -0.313 | 0.563 | 1.0000 | | | | | | |
| Newspaper frequency | 0.638 | 0.019 | -0.197 | 1.000 | | | | | |
| Radio frequency | 0.179 | -0.026 | -0.109 | 0.196 | 1.000 | | | | |
| Television frequency | 0.321 | 0.009 | -0.149 | 0.240 | 0.207 | 1.000 | | | |
| Wealth index | 0.591 | 0.075 | -0.242 | 0.458 | 0.153 | 0.565 | 1.000 | | |
| Literacy | **0.857** | -0.061 | -0.291 | 0.631 | 0.190 | 0.339 | 0.577 | 1.000 | |
| Residence type | -0.454 | -0.078 | 0.200 | -0.351 | -0.088 | -0.411 | -0.760 | -0.444 | 1.000 |

*Note.* Author's own calculations.

Table 13 calculates the correlation coefficients between the explanatory variables of immunization analysis. As explained earlier if the correlation coefficient is above 0.8 it can be considered a severe correlation, therefore collinearity. The table shows that the analysis of immunization shows a collinearity between the variable literacy and maternal education. We conducted the analysis excluding the variable literacy and keeping maternal education. The

results are shown in Table 13 and they seem to not differ significantly from the one including literacy. Therefore, in the analysis the variable literacy is excluded.

Table 13 Multivariate logistic regression (Adjusted Odds Ratio = AOR) of maternal education and other factors influencing the child's probability of being immunized in Morocco.

| | | (1)<br>Immunized |
|---|---|---|
| | No education | ref |
| Education mother | Primary | 1.000 |
| | | (0.160) |
| | Secondary | 0.893 |
| | | (0.177) |
| | Higher | 0.672 |
| | | (0.182) |
| Age mother | 15-19 | ref |
| | 20-24 | 1.911*** |
| | | (0.364) |
| | 25-29 | 2.806*** |
| | | (0.539) |
| | 30-34 | 3.742*** |
| | | (0.746) |
| | 35-39 | 4.927 *** |
| | | (1.041) |
| | 40-44 | 6.588*** |
| | | (1.565) |
| | 45-49 | 9.246*** |
| | | (3.100) |
| Parity | 1-2 | ref |
| | 3-5 | 0.749*** |
| | | (0.063) |
| | 6 or more | 0.551*** |
| | | (0.071) |
| Newspaper frequency | Not at all | ref |
| | Less than once a week | 1.085 |
| | | (0.157) |
| | At least once a week | 1.329 |
| | | (0.249) |
| | Almost everyday | 1.036 |
| | | (0.257) |
| Radio frequency | Not at all | ref |
| | Less than once a week | 1.257* |
| | | (0.124) |
| | At least once a week | 0.966 |
| | | (0.088) |
| | Almost everyday | 1.153 |
| | | (0.103) |
| Television frequency | Not at all | ref |
| | Less than once a week | 1.244 |
| | | (0.217) |
| | At least once a week | 1.113 |

| | | |
|---|---|---|
| | | (0.145) |
| | Almost everyday | 1.315** |
| | | (0.128) |
| Wealth index | Poorest | ref |
| | Poorer | 1.069 |
| | | (0.103) |
| | Middle | 1.258 |
| | | (0.168) |
| | Richer | 1.246 |
| | | (0.208) |
| | Richest | 1.082 |
| | | (0.195) |
| Residence type | Urban | ref |
| | Rural | 0.977 |
| | | (0.105) |
| Constant | Constant | 0.907 |
| | | (0.200) |
| Observations | Observations | 5490 |

*Note.* Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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