AMERICAN UNIVERSITY OF BEIRUT

THE DOUBLE BURDEN OF MALNUTRITION IN UNDER-5 YEAR OLD CHILDREN IN ARAB COUNTRIES: AN ANALYSIS OF PREVALENCE AND PREDICTORS

by
MOUBADDA JOSEPH ASSI

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AN ABSTRACT OF THE THESIS OF

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Title: The Double Burden of Malnutrition in Under-5 Year Old Children in Arab Countries: An Analysis of Prevalence and Predictors

Globalization and increased urbanization catalyzed a series of socioeconomic changes in low- and middle-income countries that have resulted in a nutrition transition characterized by the westernization of diets paralleled with a decrease in physical activity. In a context still facing the burden of infectious diseases and chronic nutrient deficiencies, this has led to a coexistence of both extremities of malnutrition within populations, commonly referred to as the double burden of malnutrition (DBM). Although paradoxical in nature, this double burden is thought to be rooted in the same social determinants.

This study uses a pooled representative sample from the Middle East and North Africa (MENA) region for children between the ages of 6 to 59 months to estimate the prevalence of the individual single burdens "stunted child" and "overweight child", as well as the *double burden "*stunted -overweight child" among children less than 5 years of age. Furthermore, this study assesses the association of these outcomes with wealth, maternal education, urbanization and gender.

The results indicate that the highest proportions of child stunting (32.8%) were found in Sudan while the highest proportions of child overweight (19.6%) and child double burdens (11.8%) were found in Egypt. Males were at a greater risk of both child stunting and overweight. The urban-rural dichotomy did not significantly dissociate the burdens across most countries. Stunting was clustered within low socio-economic status whereas overweight was clustered in high socio-economic status, indicating that the nutrition transition was still at a relatively early stage in the region. The pooled analyses masked large heterogeneities across countries, particularly in the determinants of the double burden of malnutrition.

This study acknowledges that the pattern of associations between determinants and outcomes still reflect those common in LMICs at the early stages of the nutrition transition.

Furthermore, it appears that in a rather static background of chronic undernutrition, the increases in overweight, and therefore the determinants of overweight, pull the association between social determinants and the double burden.

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CHAPTER I

INTRODUCTION

The demographic and epidemiological transitions have paved the way for a series of changes in the world, some of which had a direct impact on behavioral and nutritional habits (Drewnowski & Popkin, 1997). These nutritional changes have materialized concurrently with the increases in life expectancies and reduced fertility rates, and the global disease shift from infectious and nutrient deficiency diseases towards non-communicable diseases (WHO, 2008). There is now evidence (Figures 1 and 2) that the epidemiological transition has led to the percent of deaths and diseases from non-communicable diseases (NCDs) overtaking deaths from communicable diseases between 1990 and 2010 (IHME, 2015).

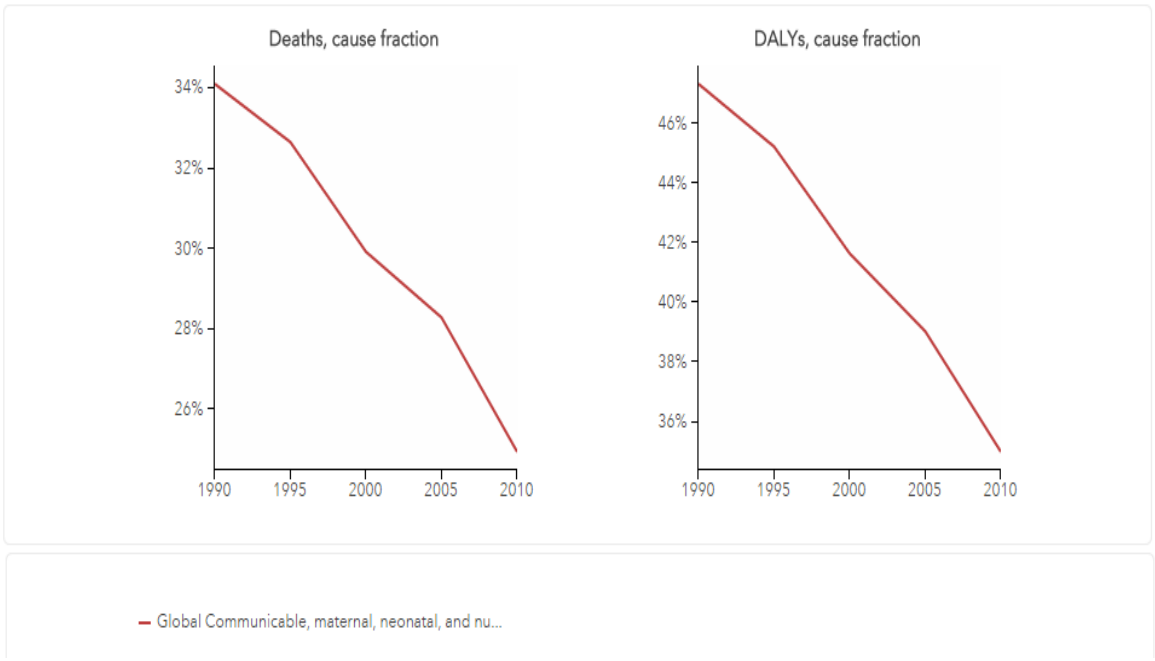


Figure 1: Decline in communicable disease proportions over a 20 year period (IHME, 2015)

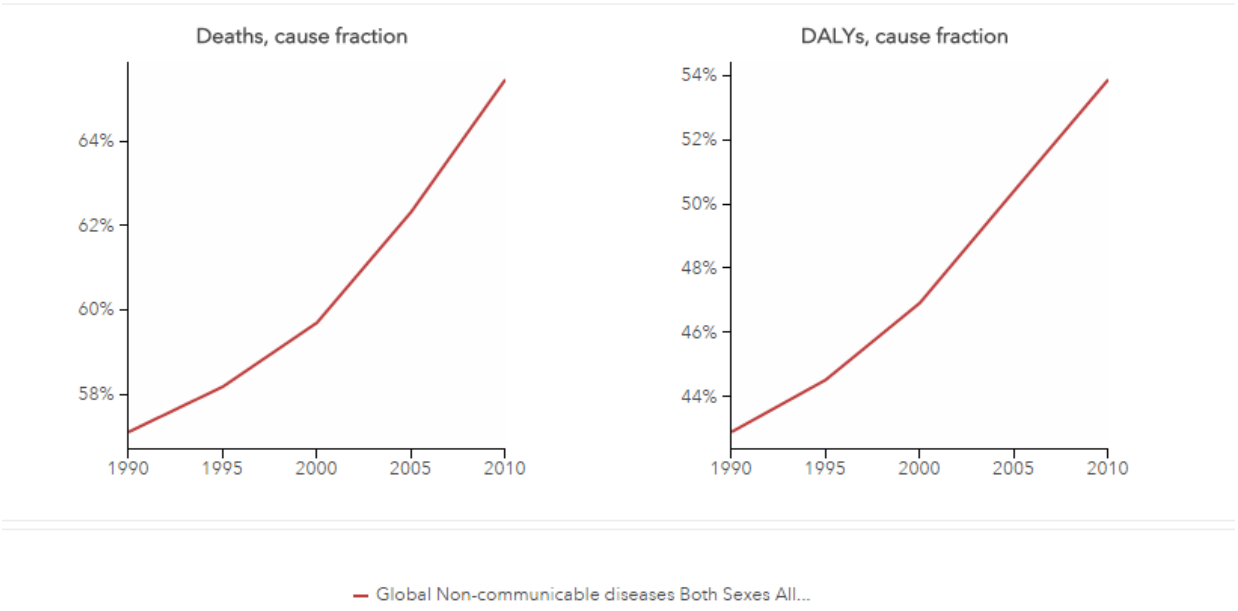


Figure 2: Rise in non-communicable disease proportions over a 20 year period (IHME, 2015)

As the weight of the burden shifts to NCDs, behavioral risk factors such as excessive dietary energy intake become increasingly important. While the burden of NCDs is viewed as a problem of the developed world, it is increasing at a very fast pace in regions of the world where hunger is still endemic (Figure 3). This increase is associated with changes in lifestyle, shifts in dietary habits to products with high fat and energy content, as well as reduced physical activity. Undernutrition in early infancy, as well as rapid weight gains at different points in infancy strongly increase the risk of later overweight and obesity (Prentice, 2006). Therefore, the burden of overweight and NCDs can develop at a faster pace and have an even greater impact on developing countries.

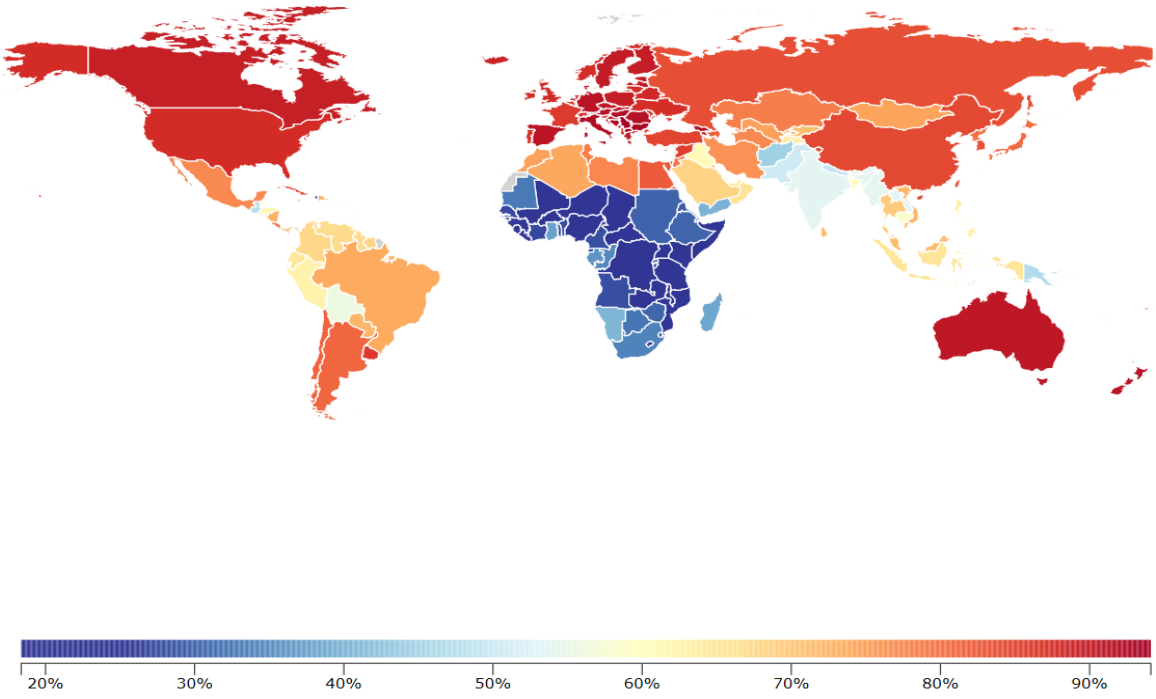


Figure 3: Geographic distribution of communicable and non-communicable diseases (IHME, 2015)

The demographic and epidemiological transitions have been conceptualized as paralleling the nutrition transition (B. M. Popkin & Gordon-Larsen, 2004), which is characterized by dietary and physical activity changes. In fact, the epidemiologic and nutrition transitions overlap in the disease profile that they result in (Figure 4).

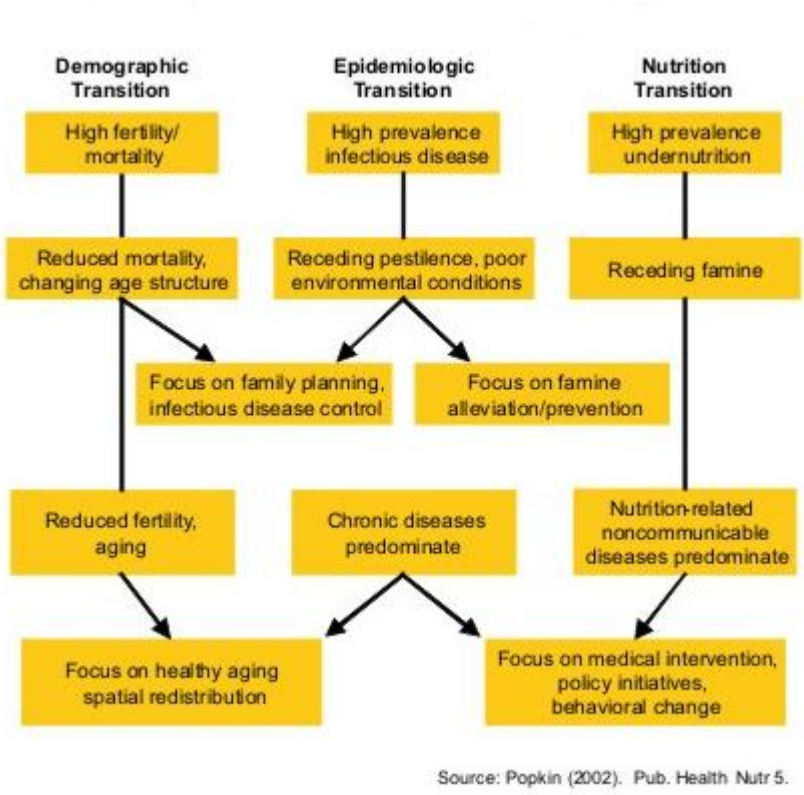


Figure 4: Demographic, Epidemiologic and Nutrition transitions (Popkin, 2002)

A- The "nutrition transition"

Although most parts of the developing world have managed to significantly target and reduce undernutrition, large disparities characterized by high prevalences of undernutrition persist across certain regions, especially in South Asia and sub-Saharan Africa(FAO, IFAD, & WFP, 2013). These disparities are paralleled by a global shift in behavioral trends of dietary intakes referred to as the "nutrition transition", and characterized by an increased intake of foods with high compositions of energy in the form of saturated fats and sugars, and a lower intake of nutrient- and fiber- rich foods (B. M.

Popkin, Adair, & Ng, 2012). The majority of the global population is primarily reliant on food staples such as wheat, rice and potatoes, which can easily be transformed into processed foods (Stuckler, McKee, Ebrahim, & Basu, 2012). Subsequently, these behavioral changes are catalyzed by shifts in global food markets characterized by the availability of cheap, refined oils and sugars. In parallel, the large global improvements in access to technology have reduced physical activity and work-related energy expenditures in terms of transportation and agricultural work (Bell, Ge, & Popkin, 2002; Monda, Adair, Zhai, & Popkin, 2008). This directly feeds into an increase in the rates of overweight and obesity in a global context still suffering from severe regional inequalities stemming from the persistent burden of undernutrition. This results in what is commonly referred to as the double burden of malnutrition.

B- The Double Burden: Concept and definitions

Malnutrition is a term used to describe all types of deviations from adequate and optimal nutritional status (Shetty, 2006). It therefore regroups deficiencies, excesses or imbalances in the intake of energy, protein and/or other nutrients. While under-nutrition is the result of food intake or absorption that is continuously insufficient to meet dietary energy requirements, over-nutrition refers to a chronic condition where food intake is overly reliant on energy(Chopra, Galbraith, & Darnton-Hill, 2002). The double burden of malnutrition (DBM) has been described as the coexistence of under-nutrition and over-nutrition in the same population (within the same nation) across the life course (Caballero, 2005; Mendez, Monteiro, & Popkin, 2005). In this case, under nutrition not only refers to underweight but to micronutrient deficiencies which often persist. It has also been related to

the coexistence of under and over-nutrition within the same family such as an overweight adult and an underweight child or a stunted child with an overweight/obese parent (Doak, Adair, Monteiro, & Popkin, 2000; J. L. Garrett & Ruel, 2005; Lee, Houser, Must, de Fulladolsa, & Bermudez, 2012).

According to the most recent Global Burden of Disease Study 2013, there has been an alarming increase in rates of overweight and obesity from 28.8% to 36.9% in men and from 29.8% to 38% in women for the past 33 years(Ng et al., 2014). Currently, 37% of the world's adult population is overweight or obese and 62% of the world's obese are living in developing countries (Ng et al., 2014). Popkin describes the trends of obesity across low- and middle-income countries (LMICs) noting that overweight seems to be increasing at a faster pace compared to the decrease in underweight (B. M. Popkin, 2001). In fact, while obesity has globally doubled in the last three decades, it has tripled in LMICs. The substantial global rise in the prevalence of obesity has occurred with marked variations across countries, highlighting distinct regional patterns (Ng et al., 2014). Since 2006, the increase in adult obesity has slowed down in developed countries, whereas the rates have been on a continuous rise in developing countries, most notably in countries of the Middle East and North Africa (MENA) region, especially for girls (Ng et al., 2014). The prevalence of obesity among children under 5 years of age is strikingly high in the Arab regions, as it ranges between 6.5% and 9.9% (Rahim et al., 2014), rates that are similar to those documented in developed countries such as the USA (10.4%) (Karnik & Kanekar, 2012).

In parallel, and on a global scale, undernutrition remains a problem with 17% of preschool children reportedly being underweight, 33% suffering from iodine deficiency, and 40% of women of reproductive age having anemia (Mason & Shrimpton, 2010). Furthermore, there is a bulk of evidence suggesting that rapid weight gains coupled with chronic undernutrition during childhood increase predispositions to later overweight and obesity (Adair et al., 2013; Cunningham, Kramer, & Narayan, 2014). This occurs through a process of changed hormonal response, which together with poor dietary intake (in terms of both food quantity or food quality), may increase the susceptibility of stunted children to the effects of high fat diets (El Taguri et al., 2009; Barry M Popkin, Richards, & Montiero, 1996). The origins of the concept of mismatch between environments of scarcity and plenty are traced back to the embryotic life of a child through the concept of the inter-generational transmission of disease (Robert E Black et al., 2008). In fact, the development of the embryo in a nutrient-limited environment leads to intra-uterine growth restriction characterized by a low birthweight and physiological adaptations to conditions of scarcity. In conditions where this is followed by post-natal availability of nutrients, this can increase susceptibility to overnutrition and chronic disease. The rapid shift in diet composition is a key characteristic of the nutrition transition which provides conditions for both stunting and overweight to occur. In the Arab world, the prevalence of indicators of undernutrition in the form of stunting (28%), underweight (11%), and wasting (9%) were very close to documented rates in other developing countries (Rahim et al., 2014).

C- Social determinants

Figure 5, developed by UNICEF, outlines the causal framework of malnutrition and highlights the role of structural (or basic) causes that can bring about poverty; the main underlying cause of malnutrition (UNICEF, 2010).

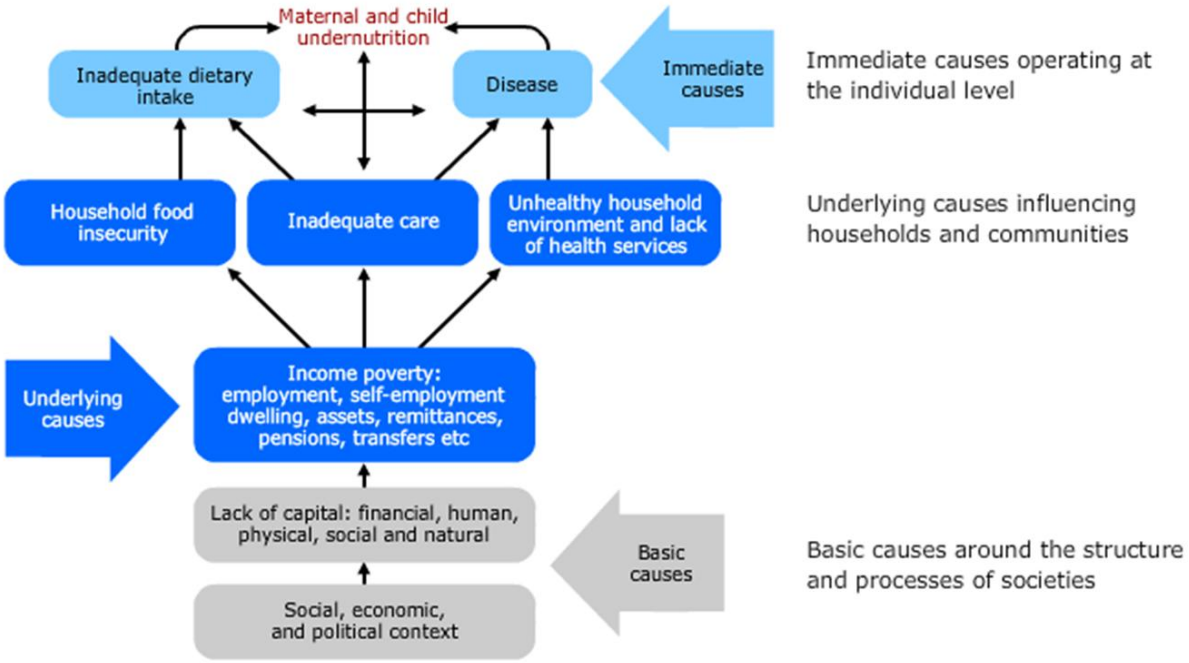


Figure 5: The UNICEF conceptual framework for the causes of under-nutrition (Black RE, 2008, UNICEF, 2010)

While poverty is often associated with scarcity, diseases of excess have also surfaced as a serious burden in many developing countries (B. M. Popkin, 2002). Subsequently, although apparently paradoxical, the co-existence of both extremes of malnutrition in a specific context remains in fact deeply rooted in poverty (Tanumihardjo et al., 2007).

Wealth and income are well documented as key determinants of nutritional burdens across the world (Godoy et al., 2005; Hong & Mishra, 2006; Keino, Plasqui, Ettyang, & van den Borne, 2014; Vollmer et al., 2014). Chronic undernutrition is strongly embedded in poverty (Hong, 2007; Janevic, Petrovic, Bjelic, & Kubera, 2010; Van de Poel, Hosseinpoor, Jehu-Appiah, Vega, & Speybroeck, 2007). In low- to middle-income countries, the proportions of obesity are predominant within high income groups whereas in high-income countries, obesity is common in low socioeconomic groups (Reynaldo Martorell, Khan, Hughes, & Grummer-Strawn, 2000; Subramanian, Perkins, Ozaltin, & Davey Smith, 2011).

Maternal education has widely been documented as a powerful determinant of child nutritional status through routes of improved nutritional knowledge and practices, as well as improved self-confidence and decision-making (Makoka, 2013; Semba et al., 2008). In the UNICEF framework, it is often placed on the arrow between poverty and inadequate care, however, the interaction between maternal education and household wealth and its resulting effect on child nutrition remains an interesting phenomenon to explore. In fact, the benefits of increased wealth on child nutrition are thought to be significantly more pronounced when combined with a high level of maternal education (Reed, Habicht, & Niameogo, 1996). While an increase in household wealth can have mixed effects on the prevalence of double burdens of malnutrition, maternal education is thought to buffer the negative consequences of increases in wealth on these proportions (Leroy, Habicht, Gonzalez de Cossio, & Ruel, 2014). Subsequently, maternal schooling in countries undergoing economic transitions plays a chief role in mitigating the isolated associations between

increased wealth and increased maternal body mass index (BMI) on the one hand, and increased wealth and decreased child linear growth on the other.

Urbanization refers to the change in size, density and heterogeneity of cities while urbanicity refers to the consequences of living in urban areas at a given time (Vlahov & Galea, 2002). It was previously used as a proxy measure for poverty, but its association with poverty is very context-specific (Barth, Wildfire, & Green, 2006). The gap between urban and rural settings is still persistent in sub-Saharan Africa, the least urbanized region of the world with more than 60% of the population still living in rural areas (Worldbank, 2013). On the other hand, reports have shown that only 40% of the MENA population is still living in rural areas (Worldbank, 2013). The dichotomous nature of this urban-rural classification scheme can be traced back to the 1940s and reflects on a period in time where the differences between urban and rural settings were much clearer than they are today (Dahly & Adair, 2007). Some studies have highlighted the importance of focusing on urban poor populations in order to fight malnutrition (Fotso, 2007; Ziraba, Fotso, & Ochako, 2009).

Food security is a state where all members of a household have, at all times, access to enough food for a healthy life. It can be measured through several scales composed of different indicators (Pinstrup-Andersen, 2009). In adults, the experience based-measures of food insecurity are reportedly associated with poverty, unemployment, poor access to education, chronic diseases and nutritional outcomes (Ali & Khan, 2013; Laraia, Siega-Riz, Gundersen, & Dole, 2006; Peterman, Wilde, Silka, Bermudez, & Rogers, 2013). In children, food insecurity is associated with unhealthy nutritional outcomes ranging from

acute malnutrition (wasting), to chronic malnutrition in the form of stunting to overweight and obesity. Food insecurity is shown to be associated with underweight and stunting (Ali & Khan, 2013) in children of low- and middle-income countries whereas it is associated with obesity in children of high-income countries (Kaur, Lamb, & Ogden, 2015). The importance of food security in this context is not only due its association with the outcome in the conceptual framework but also due to its known association with the exposure which makes it a potential confounder of the association between SES and unhealthy weight.

D- Gender differentials

Across populations of developing countries, the proportions of overweight women are generally higher than those of underweight women(Mendez et al., 2005) . The dynamics of modernization, through increases of national incomes, shift the burden of obesity towards lower socioeconomic groups of the population. These shifts are thought to occur at lower levels of income for women as compared to men (Monteiro, Moura, Conde, & Popkin, 2004) subsequently rendering chronically undernourished women susceptible to over-nutrition at lower thresholds than men. In sub-Saharan Africa, male children under the age of five are at greater risk of being stunted as compared to their female counterparts (Wamani, Astrom, Peterson, Tumwine, & Tylleskar, 2007). More specifically, African male children are at a greater risk of stunting in poor households but not in richer ones (Wamani, Tylleskar, Astrom, Tumwine, & Peterson, 2004). Several studies in low-income countries detected a similarly greater risk of stunting in males as compared to females (Espo et al., 2002; Ngare & Muttunga, 1999; Zere & McIntyre, 2003). In Asia, female

children are at a greater risk of stunting as compared to males (Khatun, Stenlund, & Hornell, 2004).

E- Conceptual conundrum

The parameters of the "nutrition transition" unfold at the national level, with symptoms of under- and over-nutrition logically expected to coexist at the population level. Indeed, wealthy households are expected to exhibit "diseases of affluence" commonly characterized by symptoms of over-nutrition, whereas poorer households are expected to spiral further down with symptoms of food insecurity and under-nutrition (James L Garrett & Ruel, 2003). Several studies describeed, however, the co-occurrence of these conditions and their ramifications at narrower levels of the population. In fact, the co-existence of maternal overweight and child undernutrition in the same household was observed and reported over three decades ago (Doak et al., 2000; Giugliano, 1978; Shrimpton & Guigliano, 1979). Furthermore, there is a vast amount of research that attempts to explain the manifestation of a subcategory of this intra-household burden, the stunted child-overweight mother pairs (SCOWT) (James L Garrett & Ruel, 2003; J. L. Garrett & Ruel, 2005; Jehn & Brewis, 2009). Subsequently, the mission for public health practitioners swiftly shifts from the challenging task of simultaneously responding to both extremities of malnutrition at a national level, to the even more complicated matter of responding to this DBM within households.

Moreover, the occurrence of the DBM within households represents a conceptual conundrum raising questions as to the underlying determinants responsible for this phenomenon. In fact, these intra-household differences in nutritional status indicate that the

"nutrition transition" is not simply a societal phenomenon, rather an individual one as well (James L Garrett & Ruel, 2003). Subsequently, it becomes more acceptable to theorize that under certain conditions, environmental factors such as wealth, education and urbanization become less important, while social and behavioral determinants such as intra-household resource allocation, food choices, and caring behaviors, surface. It is of paramount importance to feed policy-makers and interventionists with proper information related to the disease burden of a population and how that burden is distributed across different subpopulations(Robert E. Black et al., 2013), especially in light of its implications on health and human capital (Robert E Black et al., 2008). The possibility of under- and over-nutrition coexisting within a setting, however, is not usually accounted for in the design and implementation of nutrition interventions. Doak et al demonstrate that statistical models using indicators of urbanicity and wealth as independent variables were not able to predict significant differences between subpopulations of outcomes of malnutrition (Doak et al., 2000). In other words, nutrition interventions targeting households based on their income and location do not have the ability to differentiate between single and double burden households. Therefore, undernutrition interventions targeting low-income and rural households, and overnutrition interventions targeting high-income and urban households, are both likely to also capture households suffering from double burdens. In such a delicate context, there is no middle ground for nutrition interventions: they can either properly target the double burden of malnutrition and lessen its impact, or lessen a single burden of malnutrition at the expense of the other.

F- Significance

Malnutrition can take several forms, which are commonly characterized by the isolated occurrences of undernutrition and overnutrition, or their co-occurrence in a specific context. Although these outcomes represent opposite extremes of the nutritional scale, their recognized manifestation in the same countries, households or even individuals, blatantly bolsters the hypothesis that these outcomes are all related to a common set of underlying determinants. The bulk of evidence suggesting that chronic undernutrition during early life prominently increases the risk of obesity and chronic disease during adulthood, as well as the growing concerns that tackling one surface of malnutrition can have unwanted consequences on the other, highlight the multitude of connections between under- and over-nutrition. Subsequently, it becomes of fundamental importance to simultaneously tackle both facets of malnutrition.

Social determinants in the form of household wealth and maternal education have been primarily used to explain the variability in nutritional outcomes. These determinants are thought to be the underlying forces driving the occurrence of under and overnutrition and the DBM. Given the inter-connected web of associations, directions, and consequences of directly confronting specific forms of malnutrition in these delicate contexts, the prospect of operating at broader levels is encouraging in that it would, to a certain extent leapfrog the ambiguous multitude of pathways and help moderate altogether both aspects and extremities of malnutrition.

The phenomenon of stunted and overweight child is of particular importance because of the lifelong implications of this burden. In fact, children born to a stunted parent

were shown to have lower scores on cognitive scales (Walker, Chang, Wright, Osmond, & Grantham-McGregor, 2015). Furthermore, growth retardation is also associated with postnatal nutritional deficiencies such as reduced lipid oxidation, a risk factor of fat deposition (Said-Mohamed, Bernard, Ndzana, & Pasquet, 2012).

Research has wildly been directed towards understanding unhealthy weight at different societal echelons. In fact, while the literature documents very well the separate prevalences of adult obesity and child undernutrition, as well as their common occurrences within a household, few studies have attempted to explain the variability in the manifestation of the double burden within a single individual. To our knowledge, this study is the first of its kind in the Arab region.

CHAPTER II

THESIS OBJECTIVES

The causal framework of maternal and child malnutrition illustrates the pivotal determinants of negative nutritional outcomes at different levels. The immediate causes of malnutrition are either direct inadequate dietary intake or insufficient absorption of nutrients, factors that can be influenced and triggered through numerous pathways. At an intermediate stage of the causal framework reside broader social determinants that act as underlying causes of these nutritional outcomes. This study hypothesizes that the presence of favorable social determinants at this intermediate stage reduces negative nutritional outcomes, irrespective of the dynamics that exist at narrower levels of the causal framework.

The objectives of the study are as follows:

1. To estimate the prevalence of the individual single burdens "stunted child" and "overweight child", as well as the population *double burden "*stunted -overweight child" among children less than 5 years of age across the Middle East and North Africa (MENA) region, using a pooled representative sample of the latest editions of the Multiple Indicator Cluster Survey (MICS) and Demographic Health Survey (DHS) conducted in the relevant countries.
2. To study the association of these outcomes with four specific social determinants: wealth, maternal education, gender and urbanicity.

CHAPTER III

METHODOLOGY

A- Sources of Data

MICS is a household survey initiative developed by UNICEF that collects data on child-related indicators which are used to assess the socio-economic and health status of children and women. The standardized nature of this design enables the generation of nationally representative estimates and allows for cross-national comparisons of indicators. The study used the questionnaire for children under five, specifically, the Anthropometry module (AN). Furthermore, the study used the Education (ED) and Household Characteristics (HC) modules from the household questionnaire.

DHS is a USAID-funded household survey program that collects, analyzes, and disseminates accurate and nationally-representative data on population, health, HIV and nutrition in over 90 countries (Rutstein & Rojas, 2006). The ultimate purpose of the program is the use of the collected data in policy formation, program planning, monitoring and evaluation. In similar fashion to MICS, the DHS uses standardized measurement tools and techniques with identical core questionnaires to ensure comparability across countries or time points (Macro & Calverto, 2006). Both MICS and DHS surveys use a multistage stratified cluster sampling design where each elementary unit has a defined probability of selection (Macro, 1996).

B- Sample definition

In order to conduct the analysis, the study selected the most recent available datasets from the last 12 years, from countries of the Middle East and North Africa region. 5 MICS datasets (Syria 2006, Algeria 2006, Sudan 2010, Palestine 2010, Iraq 2011) and 3 DHS datasets (Morocco 2003, Egypt 2008, Jordan 2010) were available. Using the children datasets for every one of these countries, a specific set of anthropometric measurements and social determinants were isolated and their codes unified for harmonization and standardization purposes. The 8 datasets were subsequently pooled into a larger one. All children that were 0 to 6 months old were dropped from the analysis. Knowing that breastfeeding is a strong determinant of growth in children of this age group, this subpopulation was excluded, as the focus of this study was the underlying rather than the direct determinants of nutritional status outcomes. Table 1 displays sample sizes of the datasets across the different countries.

Table 1: Sample size of child datasets across different MENA countries

Jordan 2012 (DHS)	10,360
Iraq 2011 (MICS)	36,599
Palestine 2010 (MICS)	11,273
Sudan 2010 (MICS)	13,587
Egypt 2008 (DHS)	10,872
Algeria 2006 (MICS)	15,000
Syria 2006 (MICS)	11,104
Morocco 2003 (DHS)	6,180
Pooled data	114,975

C- Measures

1- Dependent variables

The nutritional status of children under five was assessed using indicators of nutritional imbalance in the form of undernutrition (stunting) and overnutrition (overweight). Using the zscore06 command on Stata, the study generated standardized z-scores based on the WHO Child Growth curves (WHO, 2015). Subsequently, stunting and overweight were defined as < -2 SD from the median of the height for age continuum and > +2 SD from the median of the weight for height continuum, respectively, based on WHO classification. Furthermore, outliers were defined as cases who have z-scores > + 6 SD or < - 6 SD. The third indicator of nutritional imbalance was a computed double burden of malnutrition defined as a child being both stunted and overweight, according to the above classification. If any of the measurements used to calculate the standardized z-scores was missing, the outcome score was not generated for that particular case.

2- Independent variables

The independent variables were social determinants hypothesized to be associated with malnutrition. Namely, of particular interest were the specific indicators of gender, wealth, urbanicity, and education. The wealth index was categorized into quintiles using a composite measure based on a household's ownership of selected assets such as televisions, housing material, and sanitation facilities. The wealth index places individual households on a continuous scale of relative wealth. Maternal education was standardized across all

datasets as a three-category variable (no education/primary education/secondary education or more). Age was categorized and treated as a discrete variable.

D- Statistical analysis

The analysis was conducted on Stata 13.0 and Microsoft Excel. The prevalence of single and double burdens was estimated across countries and a pooled estimate was generated. Bivariate analyses were used to describe the outcomes of interest across the selected social determinants and the χ^2 test was used to detect significant associations. Binary logistic regression models were used to calculate odds ratios (ORs) of the association between the various socio-demographic determinants and each of the three outcomes, adjusting for age. Moreover, the analysis adjusted for sampling weight and intra-country clusters. A p-value of 0.05 was used to indicate statistical significance. All data is publically available, therefore ethical review was not required.

CHAPTER IV

RESULTS

Out of the initial 114,975 children, 11,096 were excluded for lack of indispensable anthropometric information. A total sample of 103,879 children dispersed over the 8 datasets remained in the study.

A- Sample profile

Table 2 describes the samples across the different available datasets. Across all countries, the sample was roughly equitably divided between males and females. The primary area of residence varied across samples of different countries whereby 79.4% and 69.2% of residents in Palestine and Jordan, respectively, resided in urban settings. On the other hand, 71.4% and 63.5% of Sudan and Egypt residents, respectively, resided in rural settings. At 89.9%, the vast majority of Jordan respondents reported a maternal education of secondary or higher degree. In contrast, at 65.8%, the vast majority of Morocco respondents reported no maternal education. The highest proportion of the poorest quintile was found in Iraq at 34.2% whereas the highest proportion of the wealthiest quintile was found in Algeria at 17.4%.

Table 2: Sample profile across 8 Arab countries

	Algeria	Egypt	Iraq	Jordan	Morocco	Palestine	Sudan	Syria
Gender (%)								
male	50.9	50.9	51.1	51.8	50.5	50.9	50.7	52.6
female	49.1	49.1	48.9	48.2	49.5	49.1	49.3	47.4
Age in months (%)								
6-11	12.5	13.8	11.6	10.2	11.2	11.3	12.3	8.8
12-23	22.6	23.3	22.9	22.6	21.6	20.5	22.1	21.1
24-59	64.9	62.8	65.5	67.2	67.2	68.2	65.6	70.1
Area (%)								
urban	57.4	36.5	54.1	69.2	43.3	79.4	28.6	49.5
rural	42.6	63.5	45.8	30.8	56.7	20.6	71.4	50.5
Maternal education (%)								
none	31.7	28.0	24.8	3.0	65.8	6.8	57.4	17.9
primary	43.7	10.5	50.2	7.1	16.8	51.6	29.6	37.4
secondary+	24.6	61.5	25.0	89.9	17.3	41.6	13.0	44.7
Wealth index (%)								
poorest	25.2	23.1	34.2	27.0	27.3	23.3	21.7	21.3
poorer	19.5	20.6	23.9	26.6	25.0	22.8	25.8	23.2
middle	19.2	20.8	18.5	22.6	19.7	20.0	23.8	21.5
rich	18.7	18.4	13.6	16.4	14.0	19.1	17.2	17.5
richest	17.4	17.1	9.8	7.4	14.0	14.8	11.5	16.5

B- Prevalence of outcomes

The pooled prevalence estimates revealed rates of 21.1% stunting and 10.6% overweight among children. The prevalence of co-occurrence of these two burdens within an individual was 4.9%. The disaggregated country-level analysis illustrates the existing heterogeneity across countries. In fact, the rates of stunting stretched towards 30.4% in Egypt and 32.8% in Sudan, and were as low as 10.3% in Palestine and 7.2% in Jordan. The rates of overweight portrayed a similar variability across countries with proportions of 19.6% in Egypt and 3.9% in Jordan. Figure 6 portrays the estimated prevalence rates with countries listed from highest to lowest GDP per capita for the year of the survey, using World Bank GDP data (Worldbank, 2015). As the GDP per capita decreases, there is a clear upward trend in the rates of stunting across countries. The trend is in the opposite direction when assessing overnutrition whereby the rates of overweight children decrease with decreasing GDP per capita across countries. The highest rates of overweight children are found in Syria and Egypt where the rates of stunting are also high. The prevalence of the double burden of malnutrition is as high as 11.8% in Egypt and as low as 0.4% in Jordan

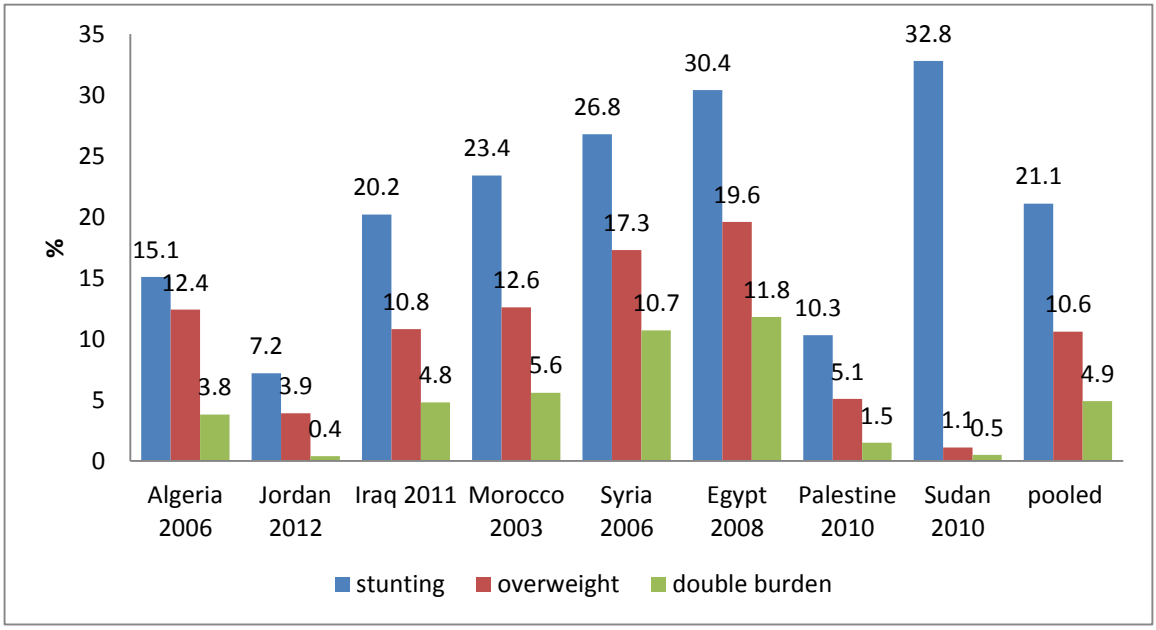


Figure 6: Prevalence of stunting, overweight and double burden by decreasing GDP per capita

C- Bivariate analysis between social determinants and outcomes

In bivariate analysis of the pooled data (Table 3), child age, maternal education, area of residence and wealth index were all significantly associated with stunting, overweight and double burden. Gender was associated with stunting and overweight but not double burden.

Table 3: Outcomes across social determinants

	stunting			overweight			double burden		
	n	**%**	**p-value**	**n**	**%**	**p-value**	**n**	**%**	**p-value**
Gender			0.0000			0.0000			0.2854
male	10,897	22.1		5,081	11.0		2,207	5.0	
female	9,522	20.1		4,555	10.2		2,085	4.8	
Age in months			0.0000			0.0000			0.0058
6-11	1,677	15.8		1,178	11.4		470	5.0	
12-23	5,114	23.6		2,624	13.0		1,085	5.4	
24-59	13,628	21.2		5,834	9.6		2,737	4.7	
Area			0.0000			0.0251			0.0002
urban	8,638	17.7		5,097	10.9		2,103	4.6	
rural	11,679	25.9		4,495	10.3		2,173	5.3	
Maternal education			0.0000			0.0000			0.0000
none	7,627	28.3		2,327	8.5		1,165	4.4	
primary	7,172	20.2		3,495	10.3		1,466	4.6	
secondary+	5,578	17.2		3,803	12.3		1,656	5.5	
wealth index			0.0000			0.0000			0.0000
poorest	6,580	25.8		2,275	8.4		1,082	4.3	
poorer	5,007	22.5		2,091	9.9		944	4.7	
middle	3,956	19.9		1,934	10.7		835	4.7	
rich	2,836	18.8		1,703	11.7		744	5.3	
richest	2,040	16.4		1,633	13.5		687	5.8	

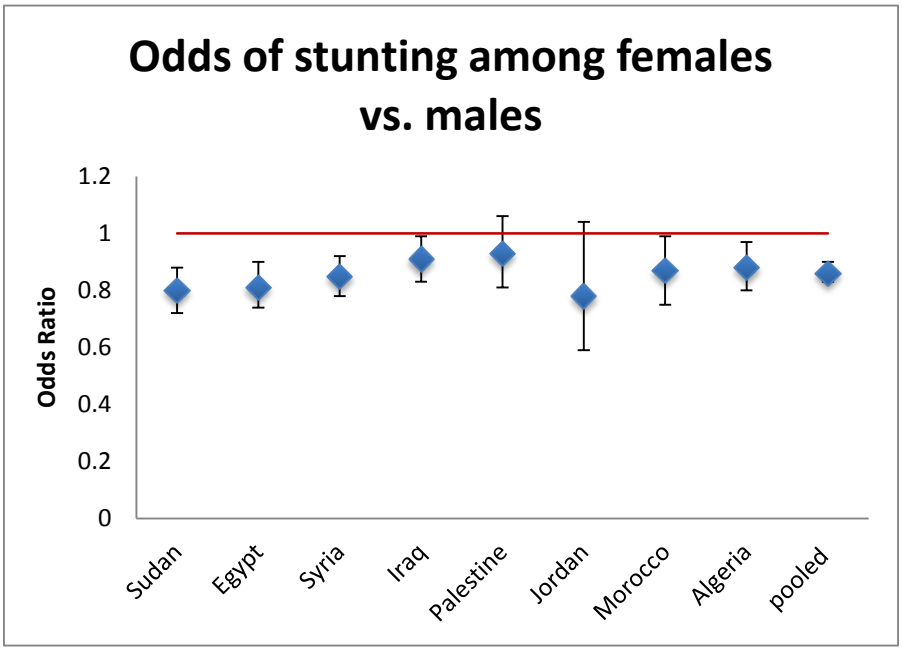
D- Multivariate analysis

The study initially hypothesized that specific social determinants at the household level would be associated with the nutritional outcomes of interest, and subsequently set out to introduce them all together in separate multivariate logistic models. These multivariate models, therefore, assessed the ability of a social determinant to explain the variability in every one of the outcomes, while adjusting for the remaining determinants, as well as the age of the children. At the level of the pooled data analysis, these models adjusted for the differential weights of the associations across countries. Furthermore, in both pooled and country-specific analyses, these models adjusted for clustering effects within countries that might create biased patterns.

1- Gender differentials

The association between gender and each of the three outcomes was studied across countries while adjusting for the remaining covariates. The different magnitudes and directions of this adjusted association were plotted for every country. These countries were ranked based on the Gender Inequality Index from the country with most gender inequality to the one with least gender inequality. Figure 7 portrays the odds of stunting among females as compared to males across the ranked countries. The odds of stunting is consistently lower in females across all countries. Furthermore, the magnitude of the association is more pronounced and severe in countries with a greater gap of gender inequality. In fact, the odds of stunting among females as compared to males is at its significantly lowest value in Sudan. While the association is always in the same protective

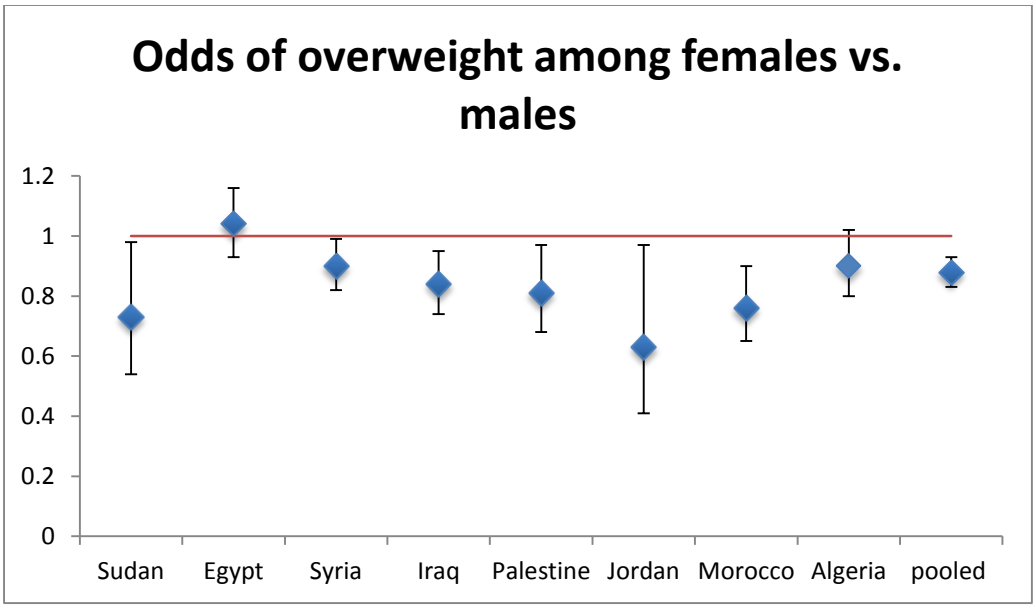
direction with respect to females, the magnitude of this association decreases as with move towards countries with less gender inequalities



***The reference category is males**

Figure 7: Association between sex and child stunting

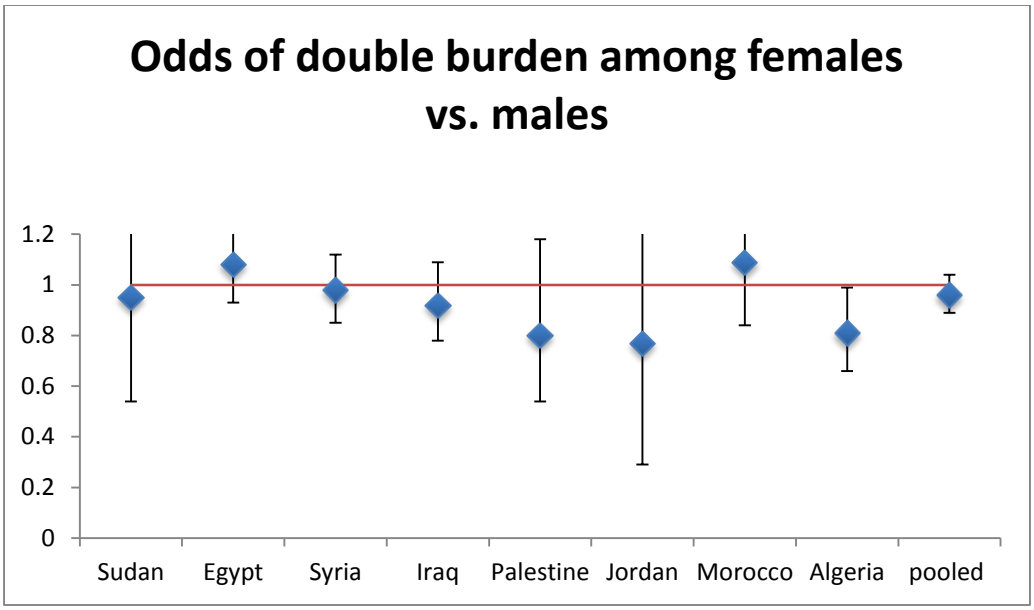
Figure 8 illustrates the odds of overweight among females as compared to males using the same ranking of countries. The odds of being overweight is consistently lower among females across all countries. Furthermore, females are mostly protected in Jordan with the odds of overweight being as low as 0.63 times that of males. There does not appear to be a clear pattern with increasing gender inequality.



***The reference category is males**

Figure 8: Association between sex and child overweight

Figure 9 illustrates the odds of double burden among females as compared to males using the same ranking of countries. The association between gender and the double burden of malnutrition is not significant across all countries except Algeria, where females are 0.81 times less likely to suffer from the double burden as compared to males.

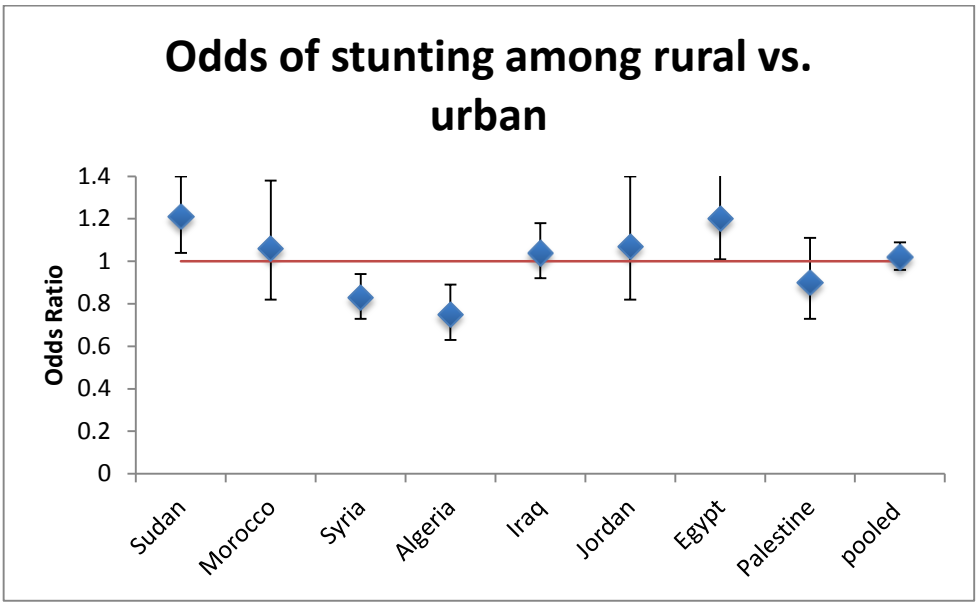


***The reference category is males**

Figure 9: Association between sex and child double burden

2- Urbanicity differentials

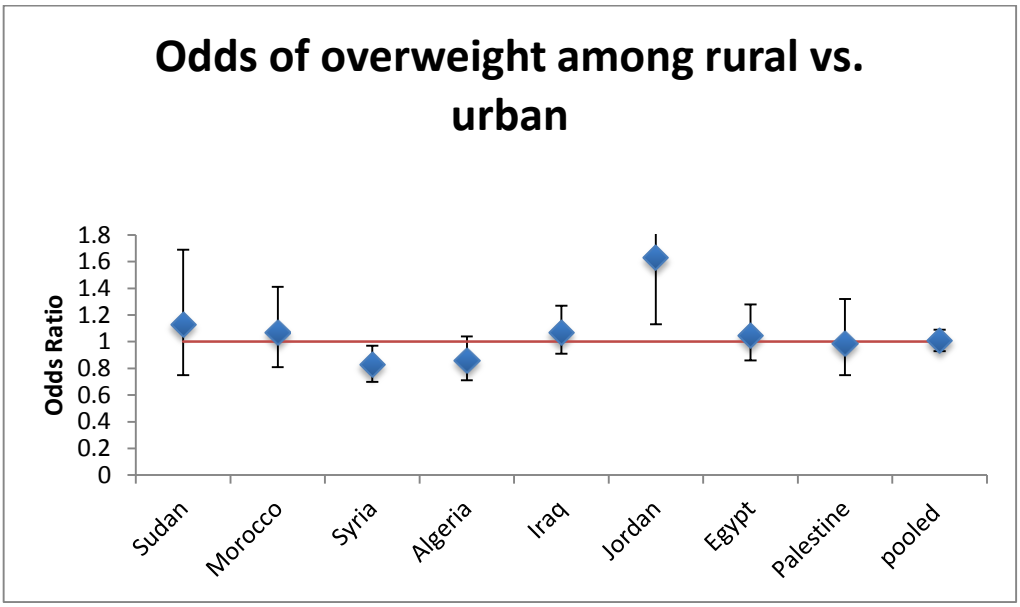
The study assessed the relationship between urbanicity and the three outcomes of interest across countries. For the purpose of flushing out fathomable trends, the countries were ranked in descending fashion based on a World Bank indicator measuring the absolute value of arable land in hectares per person. Figure 10 represents the odds of stunting among rural residents as compared to urban residents across countries. The odds of stunting is significantly higher among rural residents in Sudan and Egypt with rural residents being respectively 1.21 times and 1.20 times more likely to be stunted. In Syria and Algeria, rural residents were less likely to suffer from stunting with odds ratios of 0.83 and 0.75, respectively. There was no consistent pattern by per-capita arable land.



***The reference category is urban residents**

Figure 10: Association between urbanicity and child stunting

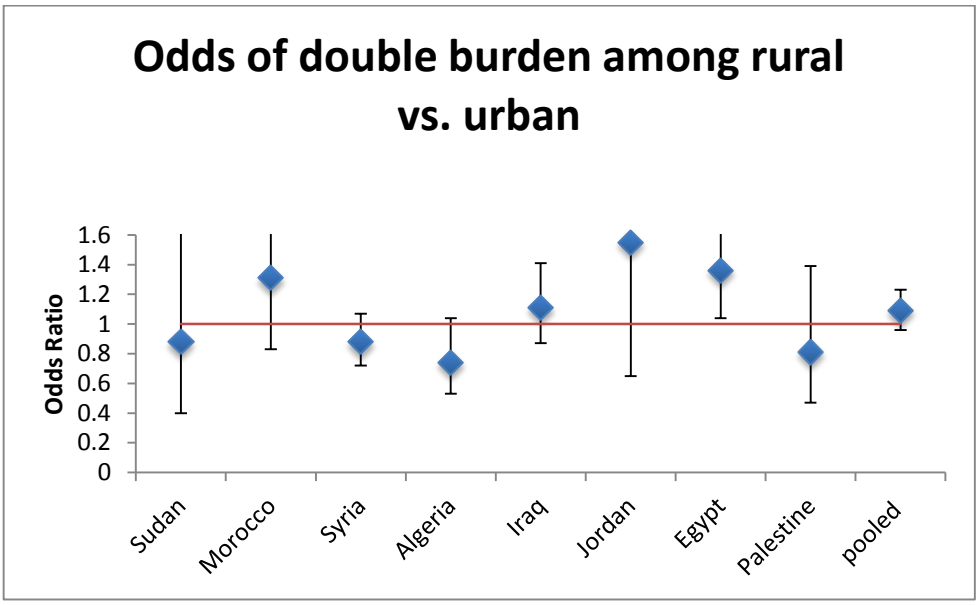
Figure 11 portrays the association between urbanicity and overweight children. This association is non-significant across all countries except Jordan and Syria. The odds of being an overweight child in a rural setting is 1.63 times that of being an overweight child in an urban setting in Jordan.



***The reference category is urban residents**

Figure 11: Association between urbanicity and child overweight

The association between urbanicity and the double burden of malnutrition was non-significant across all countries except Egypt (Figure 12). Rural residents were found to be 1.36 times more likely to suffer from the double burden of malnutrition in Egypt as compared to urban residents.



***The reference category is urban residents**

Figure 12: Association between urbanicity and child double burden

3- Wealth quintiles differentials

The three nutritional outcomes were individually studied across wealth index quintiles. The pooled analysis reveals a significantly decreased risk of stunting across wealth quintiles. In fact, the richest subgroup was 0.71 times less likely to suffer from stunting as compared to the poorest subgroup. The strongest protective effect of increased wealth was detected in Sudan, the country with the lowest GDP per capita. The richest subgroup in Sudan was 0.3 times less likely to suffer from stunting when compared to the poorest subgroup. As portrayed by Figure 13, the downward trend of stunting with increased wealth is significantly detectable across all countries except Egypt.

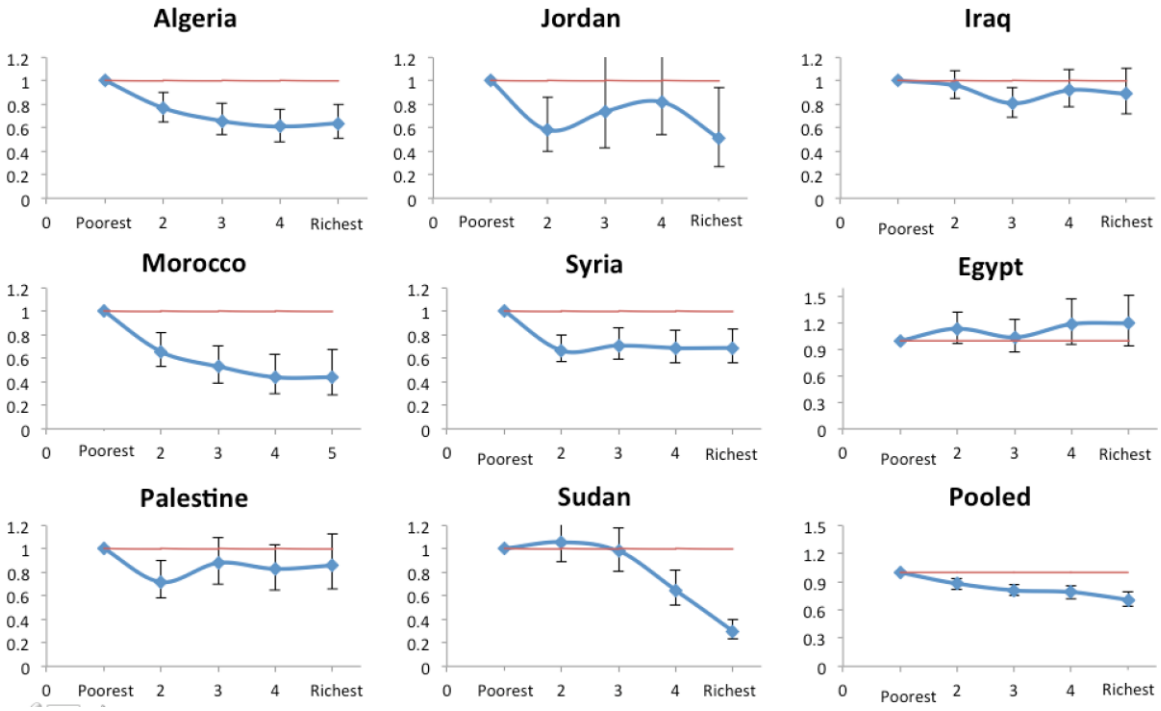


Figure 13: Association between wealth index quintiles and child stunting

The pooled analysis illustrates a significant increase in the risk of overweight with increased wealth. The richest subgroup is at the significantly highest risk (OR= 1.51) of having an overweight child as compared to the poorest subgroup. This increased risk of overweight children across wealth quintiles was most pronounced in Palestine where the richest subgroup was 2.34 times more likely to be overweight as compared to the poorest subgroup. Figure 14 depicts the trends across all countries and illustrates significant increases in risk of overweight children with advanced wealth in all countries except Jordan, Syria and Sudan.

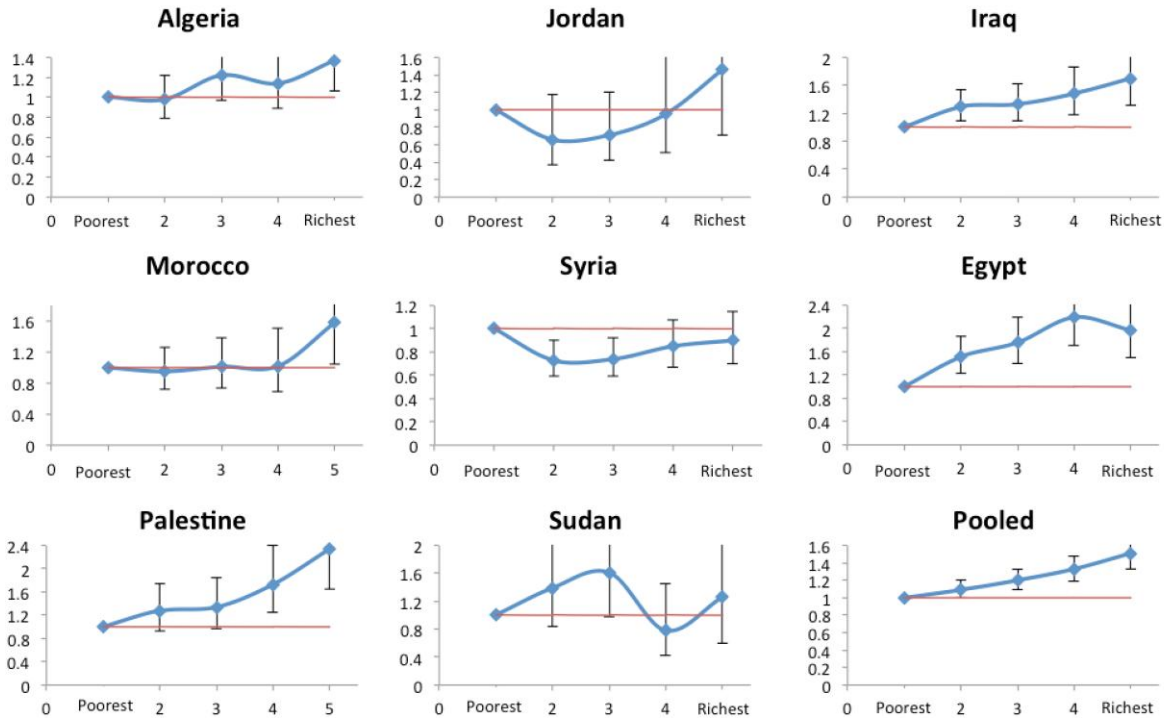


Figure 14: Association between wealth index quintiles and child overweight

The pooled analysis shows that the risk of the double burden of malnutrition in the region significantly increases with increased wealth (Figure 15).

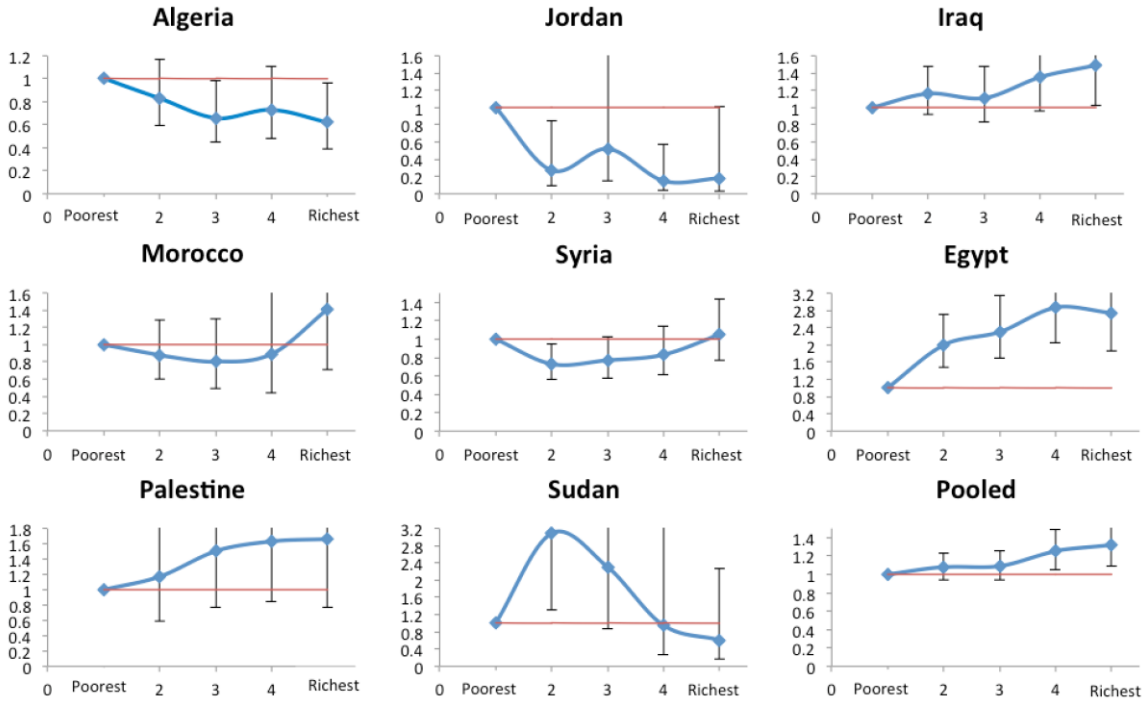


Figure 15: Association between wealth index quintiles and child double burden

4- Maternal education differentials

The association between maternal education and each of the three outcomes was similarly evaluated in the pooled data as well as the individual countries. The pooled analysis illustrates a significant decreased risk of child stunting with increased maternal education. This significant trend is similarly visible across all countries with the exception of Egypt. This decreased risk of child stunting is most pronounced in Jordan where the odds of stunting sharply decreases by 65% with a shift from no maternal education to primary maternal education. Figure 16 portrays this association for all datasets.

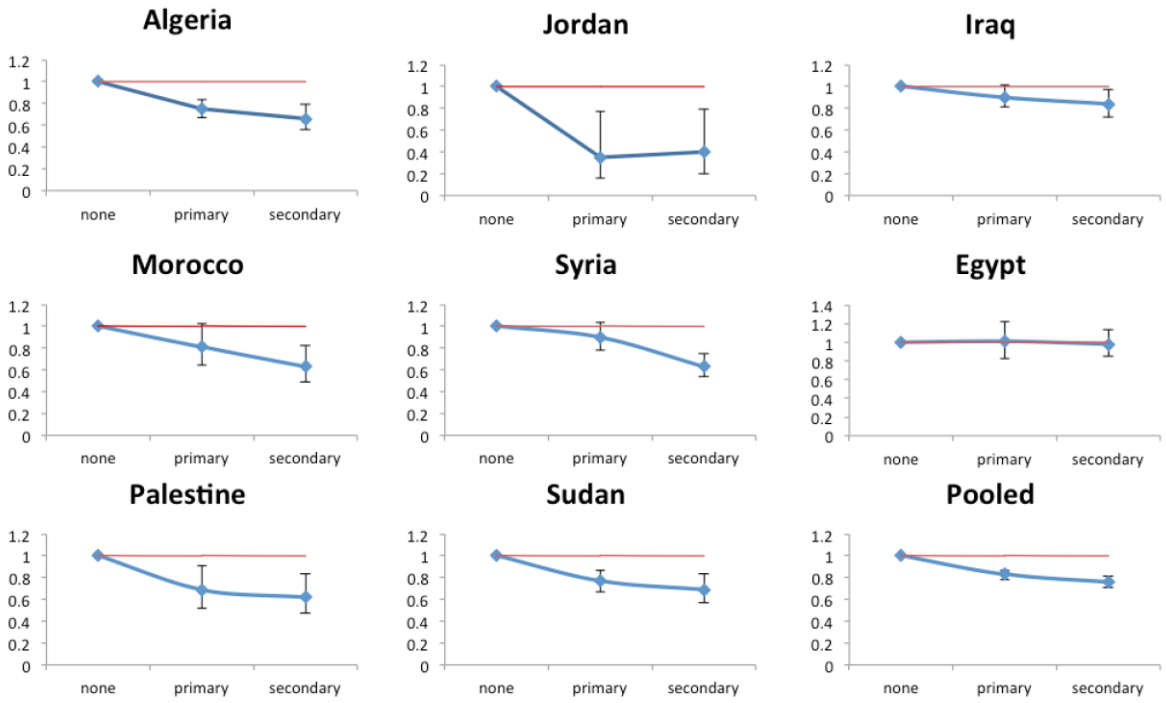


Figure 16: Association between maternal education and child stunting

The association between maternal education and overweight was assessed while adjusting for all other covariates. The pooled analysis shows with borderline significance a slight increase in the odds of overweight with increased education. This upward trend was also detected in Iraq, where the odds of overweight significantly increased by 29% with a shift from no maternal education to secondary or higher maternal education. Although the results were not significant, this increasing trend of child overweight with increasing maternal education was also observed in Algeria, Jordan, Egypt, as well as Sudan. Figure 17 displays these results.

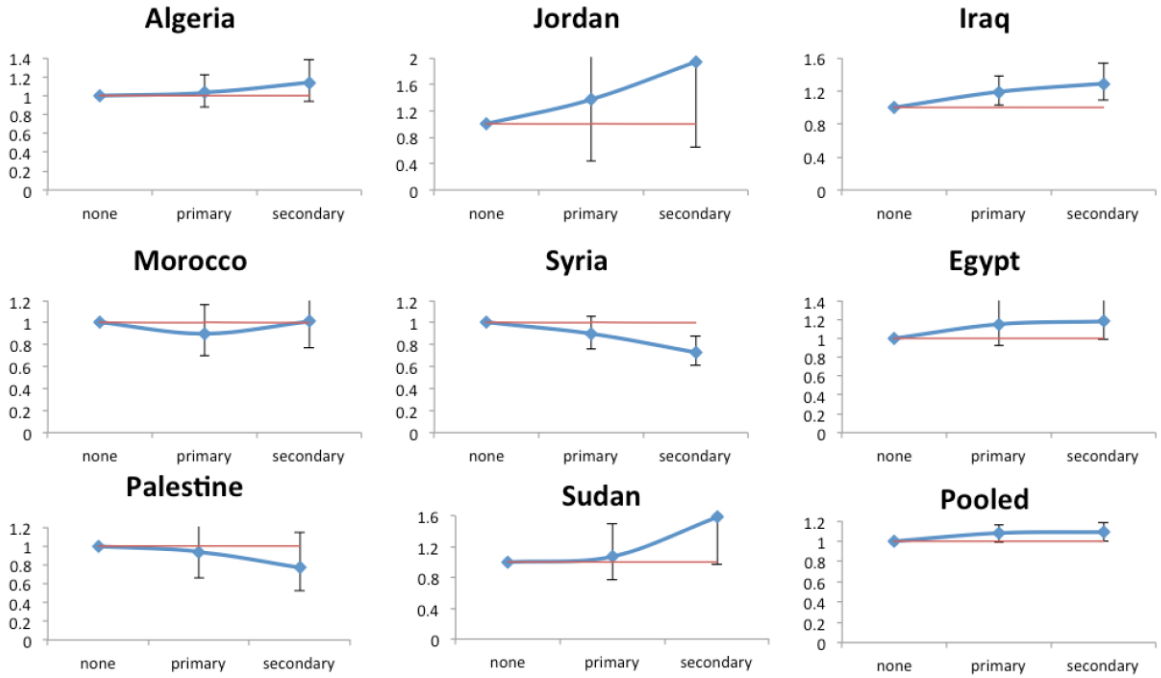


Figure 17: Association between maternal education and child overweight

The double burden of malnutrition was found to be associated with maternal education with borderline significance in Iraq and Morocco (Figure 18). Furthermore, it was significantly associated with education in Syria, Egypt and Palestine. The direction of these associations and the subsequent effect of maternal education on the double burden of malnutrition vary by country. The results indicate however, that the direction of this association is primarily influenced by the direction of the association of maternal education with the risk of child overweight, irrespective of the direction of its association with child stunting. In Iraq for instance, with increased education, the risk of stunting decreases, while that of overweight and the double burden both increase.

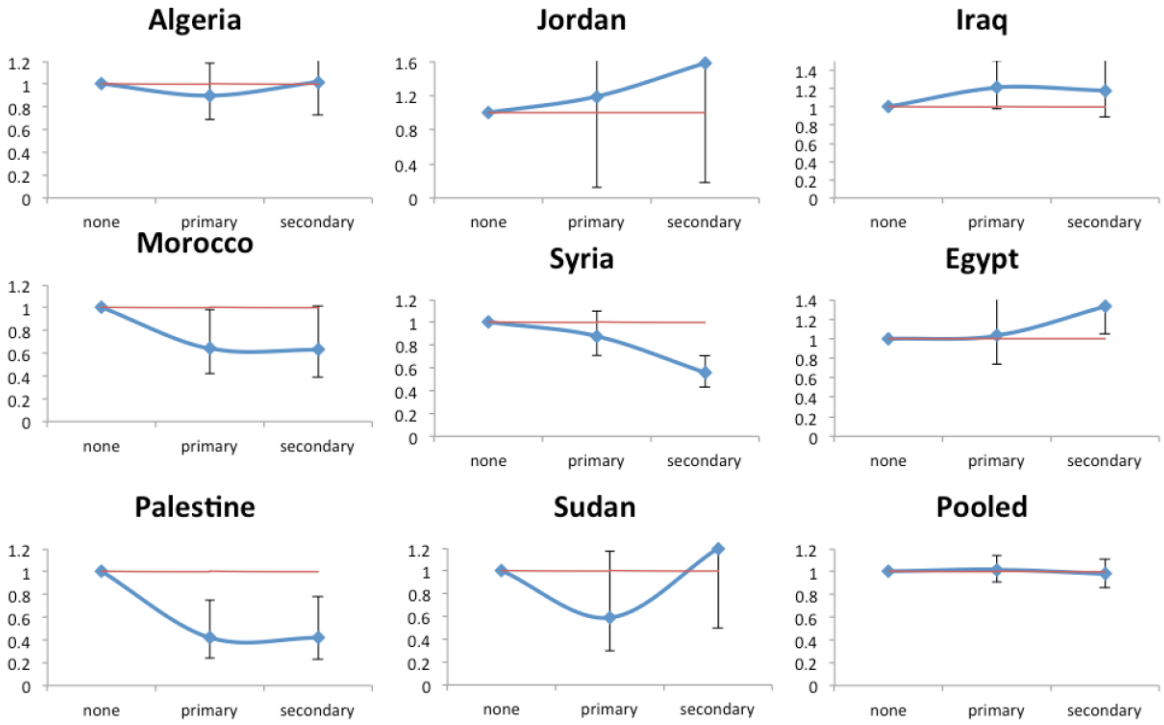


Figure 18: Association between maternal education and child double burden

CHAPTER V

DISCUSSION

The results of the analyses conducted in this study highlight the association between poverty, through the use of proxy indicators, and the double burden of child stunting and overweight. Furthermore, the results shed light on the progress of the MENA region with regard to the nutrition transition. Knowing that, with the exception of Sudan, all pooled countries are MICs (GBD, 2013), this sample of countries does not represent a full spectrum of GDP variability, nor does it capture the different countries at the same point in time. Conclusions based on prevalence trends with respect to GDP, however, can still be drawn in relative terms. Naturally, the nutrition transition is characterized by an initial rise in the absolute proportions of overnutrition, and later evolves through a transfer of these clusters of overnutrition from the richest to the poorest proportions of society (B. M. Popkin et al., 2012). The possible occurrence of this societal shift can be studied through a microeconomic level analysis within countries by stratifying subpopulations by household wealth quintiles. As an indicator of macroeconomic growth, the GDP reflects national proportions of unhealthy weights where we expect to witness a narrowing of the gap between rates of child stunting and child overweight as the nutrition transition proceeds in respective countries.

A- Socio-economic determinants

The burdens of malnutrition were assessed across socio-economic determinants of behavioral and dynamic nature. The investigation of these results highlights interesting commonalities and differences across both determinants and countries.

1- Poverty and chronic undernutrition

As expected, child stunting was found to be more prevalent in the poorest countries and the results exemplified a consistent decrease in the proportions of stunting with increasing GDP. Within countries, the results showed that the risk of stunting significantly decreased with increased wealth and maternal education across all countries, with the exception of Egypt where the results were not significant. These effects powerfully underpin how embedded undernutrition is in poverty. The lack of detectable significant association in Egypt could potentially be attributed to the long-standing food subsidy on sugar, bread and oil but not on fruits and vegetables (Asfaw, 2007). As a result, households might have at their disposal financial surplus to diversify their diets.

2- Overweight and its social distribution

Overweight, on the other hand, is prevalent across different countries, with the exception of Sudan. This finding is at odds with a recent study that reports high rates of overweight in Sudanese children between 10 and 18 years of age (Nagwa, Elhussein, Azza, & Abdulhadi, 2011). The substantial gap between proportions of child stunting (32.8%) and child overweight (1.1%) in Sudan, which is the poorest country from a macroeconomic

perspective, indicates that the country is still at the very early stages of the nutrition transition. In a comprehensive MENA region analysis of CVD risk factors, Sibai and colleagues explore the regional food availability and consumption data and conclude that Sudan experienced one of the lowest increases in dietary energy supply in the MENA region over a 35 year period (Mehio Sibai et al., 2010). This lack of increase in food energy availability likely explains the negligible proportions of overweight detected by this study. While the association of overweight with wealth quintiles was not found to be significant in Sudan, the study detected with borderline significance a greater risk of this burden with increased maternal education, further highlighting the early stage of the nutrition transition in this country.

The dynamics of the nutrition transition through which opposite extremes of malnutrition ultimately overlap is most palpable and measurable across middle-income countries. The results of this study portray, across middle-income countries ranging from Iraq to Egypt, a trend of increasing proportions of overweight children with decreasing GDP per capita, with highest prevalence of overweight observed in Syria and Egypt, where consequently, the double burden is also at its highest. This upward trend within MICs through which the rates of overweight children catch up with those of stunted children, seems to indicate that the nutrition transition is well under way in these countries. While that may very well be true, the microeconomic analysis indicates that the risk of overweight is primarily and significantly clustered within the richest and more educated subgroups for all countries, with the exception of Syria. This indicates that while the nutrition transition has clearly started in these countries, as evident by the relatively high prevalence of

overweight, the process is still at a relatively early stage. In Syria, the agglomeration of the risk of overweight within the poorest and least educated portions is intriguing especially since a recent study exploring adolescent obesity in Syria found that obesity consistently increased with increased parental education (Nasreddine, Mehio-Sibai, Mrayati, Adra, & Hwalla, 2010). The clustering of the risk of overweight in wealthy subpopulations might highlight cultural behaviors, tendencies and preferences through which the potential increases in income are associated with energy-dense food-related expenditures. This behavioral pattern has been widely reported across developing countries whereby the rates of overweight are associated with increasing economic resources (Hruschka & Brewis, 2013; R. Martorell, Khan, Hughes, & Grummer-Strawn, 1998).

3- Interactions between wealth, education and urbanicity

Interestingly, the results of this study depict a peak in the risk of detecting overweight children at the fourth quartile in Egypt with the risk decreasing across the fifth quintile. This suggests that the nutrition transition is advancing further in Egypt whereas the clustering of the risk of overweight is beginning to shift towards lower wealth quintiles. Furthermore, the potential presence of an effect modification caused by maternal education on the association between child overweight and increased wealth might be masking an even lower risk of the burden with increased wealth, and a subsequently more advanced stage of the nutrition transition in Egypt or other MICs. In a 2012 study, Aitsi-Selmi et al highlight the protective role played by education against the obesogenic effect of wealth in women of MICs, in particular Egypt (Aitsi-Selmi et al., 2012). The results of that study

underline the association between increased wealth and the risk of obesity which starts diverging at the third wealth quintile when stratifying by education of women. This divergence results in a lower risk of obesity in highly educated women from the third quintile onwards, as compared to a continued increased risk of obesity among women of lower education across all quintiles.

Leroy and colleagues similarly describe the effect of maternal education on the association between increased wealth and the double burden of malnutrition in Mexico (Leroy et al., 2014). Although this study examines a different demographic subpopulation (the SCOWT pair), it is still a manifestation of the same phenomenon; the nutrition transition. While increased income is found to be associated with an increase in the rates of double burden, Leroy et al show that among highly educated women, an increase in income leads to a decrease in the proportions of the double burden of malnutrition. As evident by a 2009 study of seven African countries using two DHS surveys with at least 10 years between them, it is not uncharacteristic to expect a transition of this burden of excess from the rich to the poor. In fact, Ziraba et al describe increases in rates of overweight women during that time period that were higher among the poorest as compared to the richest, and among the non-educated as compared to the educated (Ziraba et al., 2009). It is possible that specific trends and associations are embedded at an even narrower level within these settings; the African study demonstrates that while overweight was clustered in urban regions, it increased at a much faster pace among the urban poor as compared to the urban rich over a 10 year period (Ziraba et al., 2009).

The narrowest gap in proportions between the prevalence of child stunting and overweight is found in Algeria, the country with the highest GDP, which reflects on a potentially more advanced stage of the nutrition transition in this country, especially since Algeria has experienced one of the sharpest increases in dietary energy supply over the past 35 years (Mehio Sibai et al., 2010). Although the odds of overweight are still clustered within the richest subgroups of this population, it could be postulated that a similar effect modification caused by maternal education as the one detected in Egypt might be at the core of this association. Essentially, this study acknowledges that the distribution of overweight can be masked within narrower social subgroups and recognizes the importance of examining these interactions in future analyses for a better understanding of the burden distribution and the local nutrition transition.

4- Pooled and country-specific estimates

The importance of disaggregating the pooled analysis by countries is strongly tangible by the inverse pattern of association of overweight with wealth index quintiles in Syria. In fact, conclusions cannot be drawn with regard to the region based on a total pooled estimate due to potential underlying heterogeneity across countries emerging from cultural and societal differences.

5- Overweight as a driving force

One of the limitations of this study is that it did not create mutually exclusive categories for stunting, overweight and dual burden, and as such the single and double burdens were not independent of one another. It is therefore understandable to witness, through this study, concurrently high rates of the double burden in countries with the

highest rates of single burdens as is the case in Syria and Egypt. That being said, there is evidence suggesting that the double burden of malnutrition is pulled by the proportions and associations of overweight. The pooled regression model shows that with increased wealth, the risk of stunting decreases, but the risks of overweight and the double burden increase. Evidently, the risks of the single burdens are in opposite directions but the direction of the risk of the double burden is firmly driven by that of overweight. Stunting being an indicator of chronic malnutrition, the pace of its onset and decrease is much slower than that of overweight. Subsequently, the more dynamic nature of our indicator of overnutrition understandably causes the associations of the double burden to be primarily shaped by those of overweight, and that is most palpable whenever the directions of the associations between single burdens and a single social determinant are opposing.

6- Independent entity or statistical artifact ?

Certain studies have argued that the double burden of malnutrition is not an entity of its own and is simply a by-product of the differences in pace at which chronic malnutrition is disappearing and overnutrition is appearing. Dieffenbach and Stein (Dieffenbach & Stein, 2012) argue based on an analysis of 121 DHS datasets that stunted child, overweight mother (SCOWT) pairs are a statistical artifact, not a distinct entity. In their analysis, they show that the computed expected prevalence of SCOWT pairs exceeds in almost all countries the actually observed prevalence. Additionally, they demonstrate that the prevalence of SCOWT pairs is strongly and positively associated with the prevalence of maternal overweight, while being weakly and negatively associated with child stunting.

Child stunting becomes a positive predictor of SCOWT pairs only when maternal education is held constant in the model. These findings might instigate etiological debates but they do not change the fact that regions of the developing world are facing paradoxical nutritional burdens that still need to be tackled independently.

7- Proper use of measurement proxies

The use of indicators of macroeconomic growth and the study of their association with nutritional burdens, particularly burdens of undernutrition has been widely criticized across the literature (Alderman, Haddad, Headey, & Smith, 2014; Heltberg, 2009; Vollmer et al., 2014). Fundamentally, increases in economic growth are thought to lead to increases in average incomes particularly among the poor and subsequent improvements in their access and consumption of services that enhance their nutritional status. This trickle down of wealth is thought to feed the different underlying pockets of poverty. In their study, Vollmer and colleagues accentuate the notion that economic growth does not necessarily benefit poor households (Vollmer et al., 2014). At any rate, the trickle down of wealth to poor communities or its absence is rendered irrelevant due to the complexity of the causal framework leading to child malnutrition. While it could be argued that an increase in household income can ensure a direct access to sufficient food and micronutrients, it is highly unlikely to guarantee access to clean water and sanitation, access to treatment and prevention of infections. Through the use of an indicator of microeconomic growth at the household level, this study leapfrogs the concern that the measured wealth would not be representing the different existing clusters within countries. Furthermore, this study employs several proxies of poverty, most notably maternal education, with the purpose of

detecting the greatest possible variability in poverty from a social determinants perspective. It will be essential, however, to move on to study the potential associations with more proximate indicators such as infant feeding, sanitation and acute illnesses.

8- Urbanicity as a regional proxy of poverty

The segregation of urban and rural settings has normally been used as a proxy estimate of poverty line, and as such expected to be strongly associated with nutritional outcomes. This is especially true in Africa. The study findings not only fail to detect a pattern for nutritional outcomes across levels of urbanization, but also fail to detect significant associations with single and double burdens across most countries. In other words, the urban-rural dichotomy defined by MICS and DHS surveys does not have the ability to significantly explain the variability in nutritional outcomes in this region.

With the pace of globalization and modernization, the gap between urban and rural surroundings seems to be narrowing in such a way that the urban-rural dichotomy is no longer a good proxy for poverty and subsequently correlated poorly with nutritional outcomes (Dahly & Adair, 2007). While that might be very plausible, it could also be postulated that the definition of urbanicity across DHS and MICS datasets does not satisfy the heterogeneity required to flush out significant differences with relation to nutritional outcomes. The specific urban/rural classification procedures vary across countries and take into account population density, administrative function and physical infrastructure (Razak & Berkman, 2014; Vlahov & Galea, 2002). These differences pose a challenge when interpreting results attempting to make urban/rural distinctions using multiple countries. In fact, there exists a lot of between-country variability as to what constitutes an urban

environment and that makes the simple application of these segregations to pattern health outcomes across contexts an overly simplistic approach (Razak & Berkman, 2014). Interestingly, the multivariate analysis detects a significant protective effect of rural settings as compared to urban ones in Syria and Algeria. With these two countries ranked high on the scale of absolute value of arable lands, it could be hypothesized that their agricultural sector is strong enough to provide a sustainable amount of nutrients to fend off chronic undernutrition. The lower risk of overnutrition in these rural settings could be due to higher rates of physical activity associated with intensive farming labor, and the access to nutritious as opposed to energy-dense foods.

B- Gender differentials

The study findings indicate that males are at higher risk of stunting, overweight and double burden across the region. This is in line with a meta-analysis of 10 Sub-Saharan African countries based on 16 DHS datasets, showing that male children are more susceptible to stunting (40%) than their female counterparts (36%). These differences suggest that boys are more vulnerable to health inequalities in the same age groups, and these differences were more pronounced in the lowest SES groups (Wamani et al., 2007). Despite studies showing parental preference for male children including dietary discrimination (Crognier, Baali, Hilali, Villena, & Vargas, 2006), our results do not indicate that male children are more nutritionally advantaged than female children, and it could be that the greater quantities of food given to boys are not micronutrient-dense, which is why male children also appear to be more overweight than female children in our study. These

results may also derive from misconceptions regarding adequate infant feeding practices where some cultures might favor formula feeding over breastfeeding. The results could therefore highlight the value of food quality, which ultimately has the potential to cause both overnutrition and undernutrition.

C- Time component

Ultimately, this study recognizes that the nutrition transition is primarily shaped and characterized by the current clustering of the proportions of overweight in different contexts. This transition does not happen overnight, and it parallels in magnitude events such as the demographic and epidemiologic transitions. This makes the cross-sectional nature of our analyses a major limitation that prevents proper monitoring of the dynamic shift of the distribution of overweight over time. Although through cross-sectional surveys, the analyses conducted by Ziraba on African datasets and Aitsi-Selmi in Egypt and their subsequent conclusions are primarily based on the comparative examination of two different cross-sectional time points (Aitsi-Selmi et al., 2012; Ziraba et al., 2009). Their findings go a long way into untangling essential associations and patterns deeply hidden within clusters, microscopic trends that are only detectable over time.

D- Limitations

This study acknowledges the main limitation stemming from the cross-sectional nature of the datasets. This limitation is important in our context because the nutrition transition is a phenomenon that occurs over time and it is very important to detect its

patterns and trends of changes in order to better understand how it is occurring. The study also acknowledges the need to study the association of unhealthy weights with proximate indicators on the conceptual framework of malnutrition, such as infant feeding, acute illnesses, sanitation and hygiene. Finally, the double burden of malnutrition will need to be explored using mutually exclusive categories in order to better understand its etiology.

E- An eye on the future

While acknowledging the existence of variations across countries, these findings systematically seem to indicate that the countries included in this analysis is still at rather early stages of the nutrition transition. As the nutrition transition unfolds and free markets infiltrate deprived communities, the prevalence of overweight agglomerates within poor proportions of the community. In a region currently plagued with alarmingly high rates of overnutrition (Obermeyer, Bott, & Sassine, 2015), the suggestion that the prevalence and risks of overnutrition are still concentrated within richer proportions of society and the subsequent conclusion that the region is still in the early phase of the nutrition transition, has severe implications on the projected rates of overweight and obesity which do not seem to have yet peaked.

CHAPTER VI

CONCLUSIONS

As populations live longer and the disease burden shifts from infectious to NCDs, behavioral factors such as diets, lifestyle choices and physical activity grow in importance. These shifts have paved the way for a nutrition transition characterized by free markets and low physical activity, and catalyzed by the pace of globalization and modernization. This study, therefore, recognizes that while undernutrition is statically embedded in poverty, the social distribution of overnutrition is the cause of much debate. Inadequate dietary intake is at the essence of child malnutrition. In periods characterized by poverty, deprivation and scarcity, this factor could have been primarily shaped by a blunt unavailability of food. Nowadays, as behavioral determinants carry more weight, the load of the burden is shared by both inadequate food quantity and quality.

The results of this study showed that both the prevalence and the risk of stunting are associated with low socio-economic status whereas the risk of overweight is associated with high socio-economic status. Gender was the only non-modifiable predictor we studied and the analysis interestingly revealed a consistently higher risk of both burdens among males. These differences potentially reflect inequalities in intra-household food distribution, limited knowledge about adequate nutrition, as well as cultural preferences around infant

and young child feeding. The heterogeneity of results across countries emphasizes the importance of not drawing conclusions based on pooled regional estimates. In order to explain this heterogeneity, further analyses will need to study more proximate indicators such as food security, caring behaviors, food choices, household size, as well as sanitation and hygiene items. Finally, further stratification of clusters and interaction studies could flush out hidden patterns of associations.

CHAPTER VII

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