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Unhealthy Weight among Children under Age 5 years in the Middle East and North African Region: Prevalence and Associated Factors

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Unhealthy Weight among Children under Age 5 years in the Middle East and North African Region: Prevalence and Associated Factors

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2012

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An abstract of
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Abstract

Unhealthy Weight among Children under Age 5 years in the Middle East and North African Region: Prevalence and Associated Factors
By Rebecca E Jones

BACKGROUND: The Middle East and North African(MENA) region is experiencing high rates of overweight and obesity among adults, however the prevalence of weight status among children in the region has not been examined in depth.
DATA: Demographic and Health Surveys(DHS) are nationally representative cross-sectional surveys which collect information on the health of women and children. We used DHS surveys to estimate the prevalence of weight status among children <5y (n=127,110) in each available MENA country(Armenia, Azerbaijan, Egypt, Jordan, Mauritania, Morocco, Tunisia, Turkey, and Yemen) over time(1987-2012). We used the most current wave of DHS data from six countries(Azerbaijan, Egypt, Jordan, Mauritania, Morocco, and Turkey) from 2001-2012 (n=30,404), to quantify the characteristics associated with children's weight status. We examined the determinants of mother-child household pairs (under-nutrition households, an underweight mother / thin child; over-nutrition households, an overweight or obese mother / overweight child; double burden households, an underweight mother / overweight child, and overweight or obese mother / thin child) using data from Azerbaijan, Egypt, Jordan, Mauritania, Morocco, and Turkey(n=30,209).
METHODS: Descriptive analyses were conducted for all variables; prevalence and mean values calculated. Survey-adjusted odds ratios with 95% confidence intervals were obtained for associated child and parent characteristics and characteristics of household pairs for child weight status.
FINDINGS: 36.3% of children experienced unhealthy weight with thinness being less common than overweight(13.6% vs. 15.6%). Over time(1988-2012), the proportion of unhealthy weight increased in the region, with overweight becoming more prevalent and thinness staying stable. In the region, children with obese mothers were more likely to be overweight(1.59) and less likely to be thin(0.74).Across the region, 7.8% of households were categorized as double burden.
INTERPRETATION: Our findings indicate thinness was a continual concern in the region, especially in Mauritania (34%). At the same time, overweight emerged as a potential health problem, especially in Egypt (22%). Children living in households with uneducated parents are at greatest risk for thinness while children living with an obese, highly educated mother are at greatest risk for overweight.

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Chapter 1. Introduction

De Onis *et al.* estimate major improvements have been made over the past 20 years in reducing the prevalence of underweight among children under five, with an average decrease of 2.1% per year, but also expect the prevalence of overweight at these ages to increase from 8.5% to 12.7% between 2010 and 2020(1-4). Yet, estimates still predict 16% of children under 5 are currently underweight(4), with under-nutrition hypothesized to be the largest contributor to the global burden of disease(2, 5). In developing countries, 52.5% of all deaths in young children (0-5y) was attributable to malnutrition(6, 7). The co-existence of under- and over-nutrition has important health consequences which present a unique challenge for public health researchers and policy makers(8, 9), particularly in certain areas of the world.

A recent analysis of adult obesity trends in 188 countries compiling nationally-representative surveys, longitudinal studies, and literature reviews identified the Middle East and North African (MENA) Region as an area particularly affected by overweight and obesity; with 3 countries in the region, Libya, Qatar, and Kuwait, having female (age 20 or older) obesity prevalence rates exceeding 50% (levels higher than the U.S. 33%)(4). The authors argue that the MENA region demonstrates ‘distinct regional patterns’ for weight status of adults as well as in child and adolescent obesity(4). Estimates of overweight and obesity among children are also high, though in many countries in the region thinness and underweight continue to affect many children(3, 10-14). The prevalence of overweight and obesity among children ages 6-18 years in the Khartoum state of Sudan has been estimated between 10-27% and 2-9% respectively(15); at the same time under-nutrition persists in countries such as Ethiopia and Morocco, with nationally representative surveys reporting between 25% to 38% of children ages 0 to 5 being underweight(16).

Countries in the Middle East and North Africa constitute a complex region linked by broad similarities of climate, religion, and culture(17). While the region is loosely united around these broad similarities, it is also true that subregional divisions derive from very different histories, cultural systems and political aspirations(17, 18).

For analysis we created two variables for over-nutrition and one for under-nutrition using standard procedures: at risk of overweight(excluding overweight), overweight, and thinness based on the WHO Child Growth Standards(19). Using these standards, 'at risk of overweight' is a BMI-z-score for sex and age between one and two standard deviations (SD) above the mean of the WHO international standards; 'overweight' is a BMI-z-score for sex and age more than two SD above the mean; 'thinness' is a BMI-z-score for sex and age less than one SD below the mean(19). These cut-points for children under five correspond to the WHO cut-points for children 5-18 of 'overweight' (more than one SD), 'obese' (more than two SD), and 'underweight' (less than one SD) (20). Unhealthy weight was defined as any child categorized as thin or overweight.

The prevalence of thinness, overweight, and unhealthy weight among young children (ages 0 to 5) in the region has not often been examined, but is important given the links between early life nutritional status and long-term health(21-25). Data for all analyses are from the Demographic and Health Surveys (DHS) for the nine MENA countries where the surveys have been implemented. DHS are nationally representative, cross-sectional surveys conducted using, multi-stage probability sampling. The surveys have been fielded in low and middle income countries since 1985 and collect information on the health of women and children, including direct anthropometric measurements. DHS data were available for nine of the twenty-eight MENA countries, with 25 surveys administered between 1987 and 2012.

In Chapter 3, we used directly-measured height and weight data from DHS to estimate and compare the prevalence of thinness, overweight, and unhealthy weight for children up to age five years (n=127,110) in each country over time and across countries (Armenia, Azerbaijan, Egypt, Jordan, Mauritania, Morocco, Tunisia, Turkey, and Yemen). Descriptive analyses were conducted for all variables (child's weight status, gender and age). Chi-square analysis, t-tests, and tests for trend were done for all countries and the region as a whole.

The Social Ecological Model postulates that changes in individual outcomes, such as weight status, are influenced by individual level factors such as age and gender and by interactions with the familial, social, cultural, economic, and environmental contexts in which individuals live(26, 27). Recent evaluation of the relative contributions of layers of the model found that parent characteristics were among the strongest contributions to overweight and obesity in children ages 6-12 years(28). Building on this model, Chapter 4 assesses the associations between children's nutritional status and child and family characteristics across the MENA region (n=30,404). This study used the most current survey wave for each MENA country: Azerbaijan(2006), Egypt(2008), Jordan(2012), Mauritania(2000-2001), Morocco(2004), and Turkey(2003). Armenia(2010), Tunisia(1990), and Yemen(1992) were excluded due to lack of anthropometric data for mothers. Child characteristic variables included birth weight, region (urban versus rural), and birth order. Family characteristic variables included mother's weight status, mother's age, mother's level of education, and father's level of education. In the analytic approach, multinomial logistic regression analyses (with all variables kept) was used to evaluate the associations between childhood weight status and child / parent characteristics. Odds ratios were presented along with 95% confidence intervals.

An emerging area of research is the evaluation of household pairs weight status, particularly mother / child pairs. Double burden households (households that have both underweight and overweight/obese persons) have been seen globally; however, the presence of such households is hypothesized to be particularly dominant in low and middle income countries demonstrating a shift from high prevalence of underweight adults to high prevalence of overweight adults with a concurrent steady prevalence of children categorized as underweight(29-31). This phenomenon seems counter-intuitive when considering the shared household environment; however, differences in nutritional status at the household level could reflect individual differences in age, exposure, physiology, and nutritional needs(32). Due to recent estimates of high proportions of obese adults in the MENA region(4, 33, 34), we hypothesize the region is an area of interest in terms of evaluating the potential presence of double burden households.

In Chapter 5, the study outcome was mother-child pairs (n=30, 209). We used the most current survey wave for each MENA country: Azerbaijan(2006), Egypt(2008), Jordan(2012), Mauritania(2000-2001), Morocco(2004), and Turkey(2003). Armenia(2010), Tunisia(1990), and Yemen(1992) were excluded due to lack of anthropometric data for mothers. We categorized mother-child pairs as under-nutrition household, double burden household, and over-nutrition household. Under-nutrition households were defined as an underweight mother with a thin child. Double burden households were defined as ‘discordant pairs’ of mother-child pairs such as an obese mother with a thin child(n=747), an overweight mother with a thin child(n=1554), and an underweight mother with an overweight child(n=42). Over-nutrition households were defined as an overweight mother with an overweight child. Demographic characteristics were analyzed for all household types regionally and by country on child gender, child’s age, birth order, birth

weight, mother's age, mother's level of education, and father's level of education. Further multinomial logistic regression analyses was used to evaluate the association between under-nutrition, over-nutrition, and double burden households (reference being normal weight households) and child/parent characteristics.

Chapter 2. Background

The recent Lancet Maternal and Child Nutrition Series noted the emergence of over-nutrition(obese [ages 5 and older] or overweight[<5y] children) in low and middle income countries while also documenting the unfinished agenda in under-nutrition(underweight [ages 5 and older] or thin[<5 y] children), resulting in an overall increase in unhealthy weight(3, 10-14). De Onis *et al.* estimate major improvements have been made over the past 20 years in reducing the prevalence of underweight among children under five, with an average decrease of 2.1% per year, but also expect the prevalence of overweight at these ages to increase from 8.5% to 12.7% between 2010 and 2020(1, 2, 35). The number of overweight children has increased worldwide since 1990, however, under-nutrition continues to be associated with one third to one half of deaths in children under age five years globally(3).

Middle East and North Africa Region

The Middle East and North Africa (MENA) region consists of mainly middle-income countries (Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Yemen, United Arab Emirates, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Syria, and Tunisia, with broader definitions also including Armenia, Azerbaijan, Cyprus, Djibouti, Georgia, Mauritania, Somalia, Sudan, Turkey, and Western Sahara)(18, 36). These countries together constitute a complex region linked by broad similarities of climate, religion, and culture(17). Countries in the Middle East and North Africa constitute a complex region linked by broad similarities of climate, religion and culture(17). While the region is loosely united around these broad similarities, it is also true that subregional divisions derive from very different histories, cultural

systems and political aspirations(17, 37). The most notable defining characteristics among MENA countries are the availability of oil resources and the size of their native populations(38). Based on these two factors, other researchers have suggested classifying the group into three main groups: resource-rich, labor-abundant countries; resource-rich, labor-importing countries; and resource-poor countries(38, 39). While the region is loosely united around these broad similarities, it is also true that subregional divisions derive from very different histories, cultural systems and political aspirations(17, 37). The region is diverse, with some countries such as Syria, Iraq, Libya, and Yemen suffering from heavy violence (spilling over into Jordan and Lebanon), while others are in the midst of political transitions (Tunisia and Egypt) with slow economic growth(17, 37).

Weight Status in the MENA Region

A recent analysis of adult obesity trends compiling nationally representative surveys, longitudinal studies and literature reviews from 188 countries identified the Middle East and North African (MENA) Region as an area particularly affected by overweight and obesity, with 3 countries in the region, Libya, Qatar, and Kuwait, having female (age 20 or older) obesity prevalence rates exceeding 50% (levels higher than the United States at 33%)(4). The authors argue that the MENA region demonstrates ‘distinct regional patterns’ for weight status of adults as well as in child and adolescent obesity(4). Estimates of overweight and obesity among children are also high, though in many countries in the region thinness and underweight continue to affect many children(3, 10-14). The prevalence of overweight and obesity among children ages 6-18 years in the Khartoum state of Sudan has been estimated between 10-27% and 2-

9%(15); at the same time under-nutrition persists in countries such as Ethiopia and Morocco, with merged nationally representative surveys reporting between 25% to 38% of children ages 0 to 5 being underweight(16).

Social Ecological Model

The Social Ecological Model postulates that changes in individual outcomes, such as weight status, are influence by individual level factors such as age and gender and by interactions with the familial, social, cultural, economic, and environmental contexts in which individuals live(26, 27). The model proposed places concentric layers of influence including individual, family, community, organization, government, industry, and societal domains and is frequently in childhood obesity research and prevention efforts(40, 41). In the case of a child, the ecological niche includes the family and the school, which are in turn embedded in larger social contexts including the community and society at large. In addition to these larger contexts, characteristics particular to the child interact with familial and societal characteristics to influence development. Other literature has hypothesized that the weight status of children under five is influenced by mother's BMI and age, parent's education, number of siblings, neighborhood income, and child's birth weight(28, 42-49).

Child Characteristics

Multiple individual level characteristics can impact child weight status including gender, age, familial susceptibility to weight gain, birth weight, and birth order(26, 28). In regards to gender literature in and near the MENA region, researchers report greater proportions of boys versus girls are categorized into the over-nutrition category with adolescents (ages 6-12) in Pakistan(50) and Kenya(51). Boys were more often thin compared to girls at ages 0 to 5 years across African DHS surveys(52), in adolescence in Turkey(53), and in rural areas of Ethiopia(54). While girls were more often underweight(50) in Pakistan or malnourished(51) in Kenya. In a nationwide study of Iranian adolescents (10-19 y) boys had a lower and higher BMI when compared to girls(55). Children with a higher birth weight are often overweight or obesity as children (6 months to 3 years old) (47). Birth weight is also well established as a heavy contributor to a newborn babies survival, health, growth and development(48, 56-58).

Familial Characteristics

Multiple interpersonal, or parent characteristics, can impact child weight status including mother's age, parental weight status, and parental education(26, 28, 43-46). In Bolivia, researchers demonstrated that each level of education decreased the likelihood of stunting by nearly 45%(26). Similarly, in Pakistan primary school children with parents holding a higher education degree were more likely to have a high BMI(28). A longitudinal study of European American children born between 1928 and 2008 aimed to fully characterize the relationship between maternal and paternal BMI and offspring growth(46). The authors concluded that parental obesity influences infant body size as well as at later ages (2-4 years) with maternal obesity a stronger contributor(46).

Concordance of Weight between Moms and Kids

An increasing trend of double burden households (households that have both underweight and overweight/obese persons) has been seen globally, but the presence of which is particularly prevalent in low- and middle-income countries(29-31). The presence of this type of household is hypothesized to be a manifestation of countries shifting at an adult population level from and underweight to an overweight with the continual presence of thinness and underweight in children and adolescents(31). This phenomenon seems counter-intuitive when considering the shared household environment resulting in common micro-level social, environmental, and economical factors; however, differences in nutritional status at the household level could reflect individual differences in age, exposure, physiology, and nutritional needs(32). Household pair research often targets mother-child pairs when assessing weight discordance, hypothesizing that these two in a household typically share more resources and are less likely to differ in weight status, particularly in younger ages for children(32). These households have been documented in Asia, Latin America, and Africa(29, 31, 59-62), with a prevalence that varies between 2% in Bangladesh to 25% in Guatemala(63). Within countries, these double burden households are more often seen in urban areas among the highest income levels and are often not easily distinguished from solely over-nutrition households(30, 31, 64).

Chapter 3. Assessment of Unhealthy Weight in Children under Age Five in the Middle East and North African Region

ABSTRACT

Background: Previous studies have hypothesized about the emergence in many developing countries of the co-existence of under- and over-nutrition. The Middle East and North African (MENA) Region is experiencing high rates of overweight and obesity among adults; the prevalence of thinness, overweight and unhealthy weight (defined as those either thin or overweight) among young children in the region has not been examined, but is important given the links between early life nutritional status and long-term health.

Methods: Using nationally representative, directly-measured height and weight data from Demographic and Health Surveys(DHS) (n=127,110), we estimated and compared the prevalence of thinness, overweight, and unhealthy weight for children up to age five years in each country over time and across countries (Armenia, Azerbaijan, Egypt, Jordan, Mauritania, Morocco, Tunisia, Turkey, and Yemen) between 1987 and 2012. Weight status of children was based on the WHO Child Growth Standards; 'overweight' is a BMI-z-score for sex and age more than two SD above the mean; and 'thinness' is a BMI-z-score for sex and age less than one SD below the mean.

Findings: Among children under age 5 in the MENA region, 36.3% experienced unhealthy weight, ranging from 32% in Jordan to 60% in Egypt. Overweight was more common than thinness(15.6% vs. 13.6%) in the region overall. Thinness ranged from 33.5% in Mauritania to 4.6% in Turkey and overweight ranged from 4.4% in Mauritania to 21.6% in Egypt. Between 1987 and 2012, the proportion of unhealthy weight has increased in the region (25% vs. 22%), with overweight becoming more prevalent and thinness staying static.

Interpretation: Our findings indicate that under-nutrition continues to be a major concern in the region, especially in Mauritania (34%). At the same time, over-nutrition is emerging as a potential health problem, even among young children, especially in Egypt (22%). Given the importance of early life weight status for long-term health and that the levels of unhealthy weight in children under five in the MENA region has increased, promoting healthy growth and improved nutrition is a priority in the area.

Chapter 3. Assessment of Unhealthy Weight in Children under Age Five in the Middle East and North African Region

BACKGROUND

The recent Lancet Maternal and Child Nutrition Series noted the emergence of over-nutrition in low and middle income countries while also documenting the unfinished agenda in under-nutrition, resulting in an overall increase in unhealthy weight(3, 10-14). Major improvements have been made over the past 20 years in reducing the prevalence of underweight among children under five, with an average decline of 2.1% each year (2, 35), but also researchers expect the prevalence of overweight at these ages to increase from 8.5% to 12.7% between 2010 and 2020(1). The number of overweight children has increased worldwide since 1990, however, under-nutrition continues to be associated with one third to one half of deaths in children under age five years globally(3). In developing countries, 52.5% of all deaths in young children (0-5y) was attributable to malnutrition(6, 7), including both over- and under-nutrition(65).

A recent analysis of adult obesity trends using a combination of nationally representative surveys, longitudinal studies and literature reviews from 188 countries identified the Middle East and North African (MENA) region as an area particularly affected by overweight and obesity, with 3 countries in the region, Libya, Qatar, and Kuwait, having female (age 20 or older) obesity prevalence rates exceeding 50% (levels higher than the United States at 33%)(4). The authors argue that the MENA region demonstrates ‘distinct regional patterns’ for weight status of adults as well as in child and adolescent obesity(4). Estimates of overweight and obesity among children are also high, though in many countries in the region underweight continues to affect many children. The prevalence of overweight and obesity among children ages 6-18 years in the

Khartoum state of Sudan has been estimated between 10-27% and 2-9% respectively(15); at the same time under-nutrition persists in countries such as Ethiopia and Morocco, with nationally representative surveys reporting between 25% to 38% of children ages 0 to 5 being underweight(16).

Countries in the Middle East and North Africa constitute a complex region linked by broad similarities of climate, religion and culture(17). While the region is loosely united around these broad similarities, it is also true that subregional divisions derive from very different histories, cultural systems and political aspirations(17, 37). The region has differing definitions in regards to countries with some including the following: Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Yemen, United Arab Emirates, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Syria and Tunisia(18); some definitions also include Armenia, Azerbaijan, Cyprus, Djibouti, Georgia, Mauritania, Somalia, Sudan, Turkey and Western Sahara(36).

Obesity and its co-morbidities are emerging in the MENA region more prominently than in any other non-Western region, but data on young children's weight status are scarce. This analysis focuses on weight among younger children in the MENA region, providing national and regional data on nutritional status, including thinness, normal weight, overweight, and overall unhealthy weight. Growth and development during the first years of life is critical for long-term health, specifically the development of chronic diseases(66-68). A global systematic review of rapid growth in infancy and associated adverse outcomes in later life concluded that high BMI during the first 5 years of life has been associated with adult obesity and early onset metabolic syndrome(69).

METHODS

Data are from the Demographic and Health Surveys (DHS) for the nine MENA countries where the surveys have been implemented. DHS are nationally representative cross-sectional surveys conducted using, multi-stage probability sampling. The surveys have been fielded in low and middle-income countries since 1985 and collect information on the health of women and children, including direct anthropometric measurements. DHS data were available for nine of the twenty-eight MENA countries, with 25 surveys administered between 1987 and 2012: Armenia (2000, 2005, 2010), Azerbaijan (2006), Egypt (1988, 1992, 1995, 2000, 2003, 2005, 2008), Jordan (1990, 1997, 2002, 2009, 2012), Mauritania (2000-2001), Morocco (1987, 1992, 2004), Tunisia (1990), Turkey (1993, 1998, 2003), and Yemen (1992). Jordan (2007) data were excluded from this analysis because anthropometric data on children were not accurately collected(70).

Participants and Settings

DHS recruit women ages 15 to 49 years and also collect information on their children aged five years and younger who live in the same household. The DHS's utilize a two-staged sampling design, the first stage involves selecting clusters typically drawn from census files(71), the second stage selecting households within the selected clusters, the third stage selecting women within households. The desired sample of households was selected using systematic sampling methods. This analysis includes all sampled children ages up to five years with anthropometric information (only children under age 4 years were sampled in Tunisian 1990 and Egypt 1988). The final analytic sample of the most current surveys for the nine countries was

35,805. The final analytic sample for children under five for all surveys in all nine countries across time was 127,110.

Measurements and Variables

Anthropometric measures were recorded by trained personnel in each country. Participants' weight was measured using solar-powered mother-baby scales with an accuracy of ±100 g. In all countries since 2007, electronic scale (SECA model 881-872) were used, bearing a maximum load of 150 kg. Previously, similar scales (SECA model 874) were employed, which had a maximum load of 200 kg. Height was measured using a wooden stadiometer- an adjustable board calibrated in millimeters- following international standards for DHS(72); adults and children older than two years height were measured in a standing position, whereas children younger than two years were measured lying down .

The WHO Child Growth standards were based on a longitudinal sample (birth to 24 months) and a cross-sectional sample (18-71 months of age) of healthy breastfed infants and young children from Brazil, Ghana, India, Norway, Oman, and the United States of America(20). These standards are based on the finding that well-nourished children of all population groups follow very similar growth patterns before puberty(73). For analysis, we created two variables for over-nutrition and one for under-nutrition using standard procedures: at risk of overweight (excluding overweight), overweight, and thinness based on the WHO Child Growth Standards. Using these standards, 'at risk of overweight' is a BMI-z-score for sex and age between one and two standard deviations (SD) above the mean of the WHO international standards; 'overweight' is a BMI-z-score for sex and age more than two SD above the mean of the WHO international standards; 'thinness' is a BMI-z-score for sex and age less than one SD below the

mean(74).These cut-points for children under five correspond to the WHO cut-points for children 5-18 of ‘overweight’ (more than one SD), ‘obese’ (more than two SD), and ‘underweight’ (less than one SD)(20). Unhealthy weight was defined as any child categorized as thin or overweight.

Analysis

Individual country files were used for the majority of analyses and were survey-adjusted using standard DHS survey adjustments and all analyses was done using *svy* commands. A regional file was created by pooling all country files.[1]

Descriptive analyses were conducted for all variables (child’s weight status, gender, and age); prevalence and mean values for the variables were calculated.[2] The overall regional datafile was thus survey-adjusted. The age-specific prevalence of thinness, at risk of overweight, overweight, and unhealthy weight were calculated as the proportion of individuals in each country (zero to five years), as well as each year, separately. Chi-square analysis, t-tests and trend analysis were done for all countries.

All analyses were conducted using STATA version 13.0 software (STATA Corp, College Station, TX, US).

RESULTS

[1]For the pooled regional file, the individual country children data files were de-normalized, and the provided sample weight was adjusted for overall population using the United States Census Bureau International Programs database(72). Once files were appended together, the cluster variable was modified so that each stratum could stand alone based upon the country.

[2] Surveys since 2003 have included in the children’s files the BMI-z score for sex and age produced by the WHO in 2006. For surveys done prior to 2003, DHS provided a separate datafile, “Height and Weight Scores,” which provides the WHO child growth standards. These separate “Height and Weight Scores” files were merged with the children’s original datafiles for each country survey year.

The survey-adjusted nutritional status of children under five years, stratified by age (0-1, 1-2, and 2-5 y) and by country using the most current DHS survey from each country is shown in Table 1. The proportion of children under five who were overweight from MENA countries with available data ranged between 4.4% in Mauritania 2000/1 and 21.6% in Egypt 2008. The proportion of children under five who were classified as thin ranged between 33.5% in Mauritania 2000-2001 and 4.6% in Turkey 2003. The majority of countries illustrate a decrease in thinness over the age ranges (with the exception of Egypt and Jordan), such as in Yemen with 47.5% of children between zero and one categorized as thin versus 23.0% of children between two and five.

(Place Table 1 here)

The patterns of overall unhealthy weight are illustrated in Figure 1. The proportion of unhealthy weight children in the region ranged from 41% in Yemen 1992 to 15% in Turkey 2008. Egypt's total proportion of unhealthy weight neared 60% (thinness: 15.2%, at risk of overweight: 22.4%, overweight: 21.6%), with similar levels seen in Morocco, Azerbaijan, and Armenia. The prevalence of unhealthy weight differed between countries with Yemen having 41.1% of children under five categorized as either thin or overweight versus 14.7% in Turkey.

(Place Figure 1 here)

The double burden of unhealthy weight, that is the proportion of children thin or overweight, is illustrated in Figure 2. Morocco and Egypt have fairly equal levels of thinness and overweight (thinness: 21-22%; overweight:15-16%). Other countries in the region had a high prevalence of just one type of unhealthy weight, for example, Mauritania with 33% of children under five being thin but only 4% overweight and Egypt and Armenia with high levels of overweight(22% and 18% respectively) and lower levels of thinness(15% and 12% respectively).

(Place Figure 2 here)

Nutritional status for boys and girls in each country is shown in Table 2. Across settings, boys had a higher prevalence of unhealthy weight compared to girls, with significant gender differences in Turkey (boys:16.7%, girls: 12.6%, p=0.002) and Azerbaijan (boys: 34.2%, girls: 29%, p=0.020). In all countries except Armenia and Jordan prevalence of thinness was higher among boys than among girls and in all countries except Egypt, Mauritania, and Yemen prevalence of overweight was higher among boys than girls.

(Place Table 2 here)

Over the range of years during which DHS data have been collected, the proportion of children in each weight status category in each country is illustrated in Table 3 (age-specific estimates are shown in the Supplemental Table). The majority of countries, with the exception of Armenia, experienced increases in the prevalence of overweight children over time, most marked in Egypt, Morocco, and Turkey. Armenia's prevalence of overweight over time stayed constant at 17.1% in 2000 to 17.5% in 2010. Three countries also had increases in the prevalence of thinness: Armenia, Egypt, and Morocc. Egypt demonstrated a considerable increase in both thinness and overweight overtime between 1988 and 2008 (9-15.2% and 9.4-21.6% respectively), resulting in an increase in overall unhealthy weight from 18.4% to 36.8%. On the other hand, Turkey is the only country which experienced a decrease in the prevalence of thinness over time with 11.8% of children being thin in 1993 and 4.6% in 2003.

(Place Table 3 here)

Figure 3 illustrates the prevalence of **A)** overweight and **B)** unhealthy weight in children under 5 in the region with overall regional trendline. The regional average prevalence of overweight (**Panel A)** has increased from 10% in 1988 to 12.4% in 2012(r^2=0.0146). The

average prevalence of total unhealthy weight (**Panel B)** has also increased from 22.8% in 1988 to slightly above 25%(r^2=0.0219).

(Place Figure 3 here)

DISCUSSION

Across the Middle East and North Africa, the prevalence of unhealthy weight among children under the age of five years was high, between 15% in Turkey and 41% in Yemen. Under-nutrition continues to be a major concern in the region(13.6%), and most critically so in Mauritania (34%). At the same time, over-nutrition is emerging as a potential health problem, even among young children(15.6%), and most critically so in Egypt (22%). Current regional estimates, based upon a compilation of nationally representative and sub-national surveys, report adult obesity percentages of 20%(males) to 34%(females), and, as well as in children under 20 years 8%(boys) to 10%(girls)(4). Analysis from DHS surveys in Egypt, Jordan, Morocco, and Turkey report far more overweight than underweight women in all four countries(33); for example, in urban areas of Egypt 69.9% of women were categorized as obese versus 0.7% as underweight. Observing high levels of unhealthy weight even by age 5 years is of concern given the life-long health implications of nutrition and growth patterns during the first years of life(75).

Across settings, boys in the region experienced total unhealthy weight more often than girls, a pattern that was statistically significant in Azerbaijan and Turkey. The overweight component of unhealthy weight was higher in boys than in girls in all countries except Egypt, Mauritania, and Yemen. Higher over-nutrition among boys has been observed among older children in other settings, including in Pakistan(50) and Kenya(51). In all countries, with the exception of Armenia and Jordan, a higher proportion of boys than girls were thinner, a pattern consistent with research on children in this age group across Africa(52)and older children in

Turkey(53), rural Ethiopia(54). As in our study, in a nationwide study of Iranian adolescents, boys were more likely to be low and high BMI compared to girls(55).

A limitation of this study was the lack of current available DHS data for seventeen of the twenty-eight MENA countries. Libya, Qatar, and Kuwait, identified as having particularly high prevalence of female obesity in sub-national studies, nearing 50%, lacked DHS data(4). Even among the countries with DHS data, Tunisia and Yemen had more than 20 years old, providing a potentially outdated picture of weight status. Other sources of data that can be used to estimate weight status in many MENA countries include using other multi-country surveillance programs and a comprehensive search of nationally representative and sub-national surveys(4).

The increasing overweight prevalence and small decreases in child thinness in the region suggested by de Onis et al.(35) point to the possibility that the prevalence of unhealthy weight in children under five will be a growing problem. Further studies should be conducted on the relation between socioeconomic and behavioral variables and the risk for unhealthy nutritional status in MENA countries, as well as research to further characterize the interplay of under- and over-nutrition in the region. These studies should focus on explaining the differences between countries in terms of level and type of unhealthy weight burden.

The prevalence of unhealthy weight in children under five appears to be a continuing problem. Thinness persists and heavily contributes to the unhealthy weight burden in the region; while, overweight is increasing. The presence of both under- and over-nutrition in this population creates unique challenges; interventions designed to prevent one problem could exacerbate the other(76). Full assessment of the situation via continual surveillance and determination of primary factors tied to childhood weight would be useful to better understand and address short- and long-term health needs.

Chapter 3. Tables and Figures

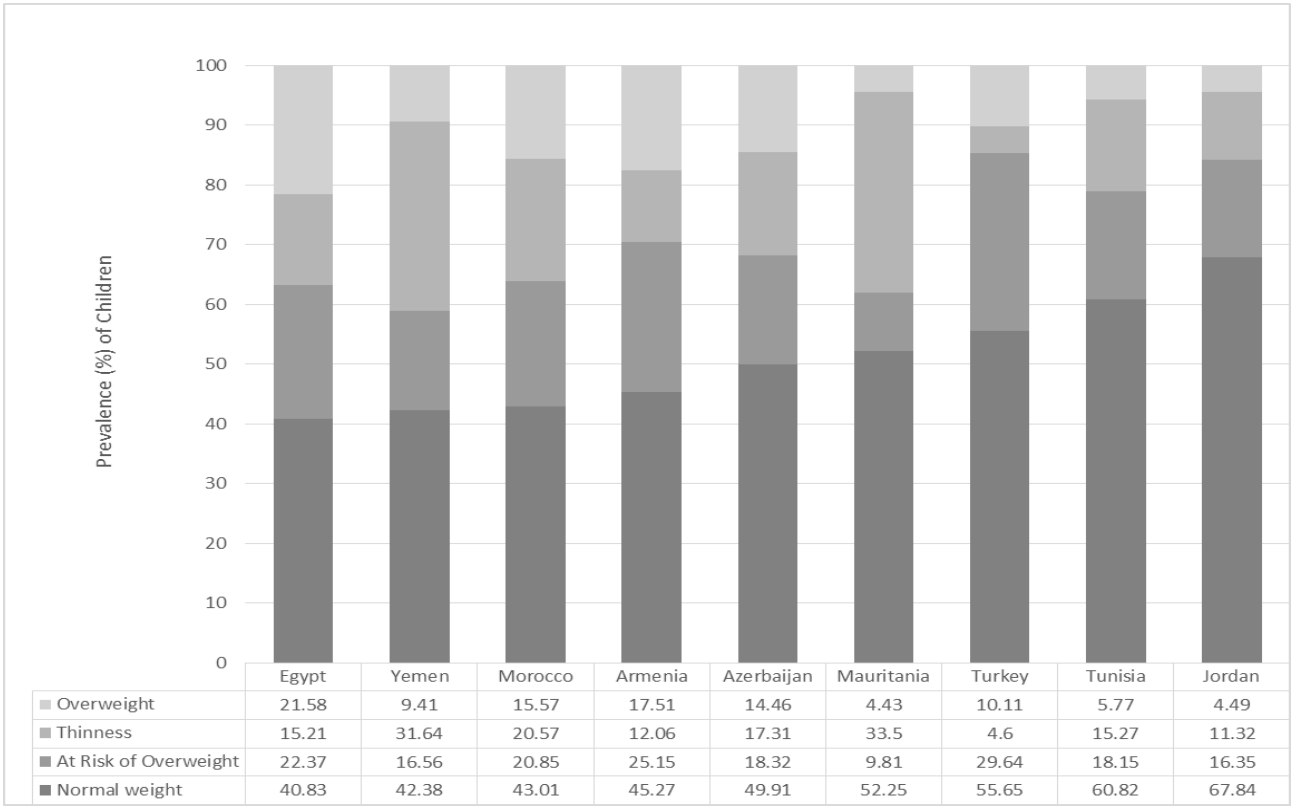
Table 1. Weight status among children under age 5 years in the Middle East and North Africa region at the most recent year of national data collection (%)

	Thinness	Normal weight	At risk of Overweight	Overweight
Armenia (2010)				
0-1 years	22.23	48.55	21.73	7.49
1-2 years	7.47	38.60	31.66	22.27
2-5 years	10.32	46.74	23.81	19.14
Total	12.06	45.27	25.15	17.51
Azerbaijan (2006)				
0-1 years	35.33	51.01	10.91	7.87
1-2 years	15.71	48.38	26.06	9.84
2-5 years	11.18	51.95	18.31	18.56
Total	17.31	49.91	18.32	14.46
Egypt (2008)				
0-1 years	19.58	42.18	20.78	17.45
1-2 years	13.61	35.96	24.54	25.89
2-5 years	14.12	42.11	22.18	21.59
Total	15.21	40.83	22.37	21.58
Jordan (2012)				
0-1 years	15.89	60.56	18.23	5.32
1-2 years	9.24	63.98	19.57	7.21
2-5 years	10.78	71.06	14.78	3.38
Total	11.32	67.84	16.35	4.49
Mauritania (2000-2001)				
0-1 years	45.97	42.02	6.85	5.16
1-2 years	30.50	50.45	13.19	5.86
2-5 years	29.07	57.57	9.81	3.55
Total	33.50	52.25	9.81	4.43
Morocco (2004)				
0-1 years	24.08	35.16	22.77	17.99
1-2 years	16.48	38.40	25.23	19.89
2-5 years	20.82	46.92	18.84	13.42
Total	20.57	43.01	20.85	15.57
Tunisia (1990)				
0-1 years	29.44	53.32	12.39	4.85
1-2 years	9.00	63.57	20.96	6.47
2-4 years	10.42	63.94	19.86	5.77

Total	15.27	60.82	18.15	5.77
Turkey (2003)				
0-1 years	10.69	58.05	20.01	11.26
1-2 years	2.97	47.85	35.12	14.06
2-5 years	3.26	57.32	30.86	8.55
Total	4.60	55.65	29.64	10.11
Yemen (1992)				
0-1 years	47.45	35.00	10.11	7.44
1-2 years	27.10	40.71	20.15	12.04
2-5 years	22.99	48.65	19.07	9.29
Total	31.64	42.38	16.56	9.41

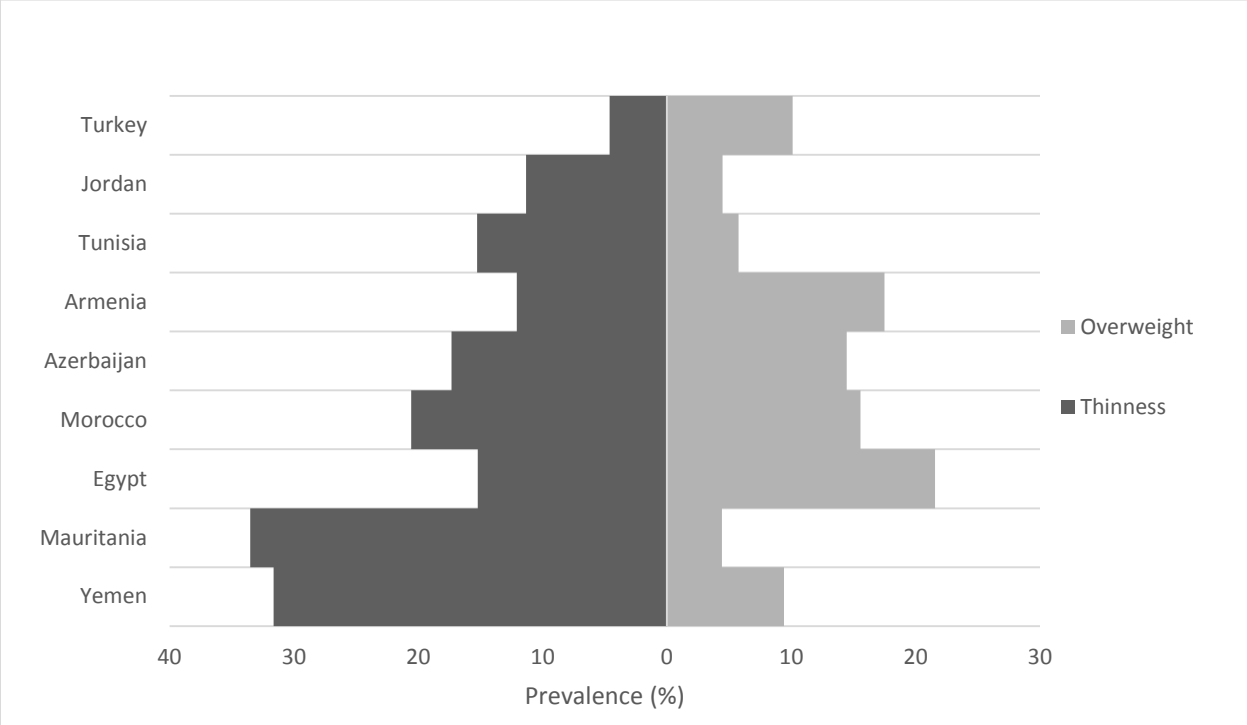
Note: Survey-adjusted estimates based on Demographic and Health Surveys (1990-2012) data for 0 to 5 y with the exception of Tunisia (0 to 4 y); samples sizes ranged from 1,329 to 9,478 based upon the country. Using the World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < -2; at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2; overweight defined as BMI-for-age-z-score defined as ≥ 2.

Figure 1. Weight status among children under 5 years in the Middle East and North Africa region at the most recent year of national data collection (%)



Note: Survey-adjusted estimates based on Demographic and Health Surveys (1990-2012) data for 0 to 5 y with the exception of Tunisia (0 to 4 y); samples sizes ranged from 1,329 to 9,478 based upon the country. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < -2; at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2; overweight defined as BMI-for-age-z-score defined as ≥ 2.

Figure 2. Weight status (Overweight and Thinness) among children under age 5 years in the Middle East and North Africa region at the most recent year of national data collection (%)



Note: Survey-adjusted estimates based on Demographic and Health Surveys (1990-2012) data for 0 to 5 y with the exception of Tunisia (0 to 4 y); samples sizes ranged from 1,329 to 9,478 based upon the country. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < -2; overweight defined as BMI-for-age-z-score defined as ≥ 2.

Table 2. Weigth status among children under age 5 years in the Middle East and North Africa region stratified by gender at the most recent year of data collection (%)

	Thinness	Normal Weight	At Risk of Overweight	Overweight	Unhealthy Weight	p-value
Armenia (2010)						
Boys	10.65	45.12	24.84	19.39	30.04	
Girls	13.60	45.44	25.50	15.47	29.07	
Total	12.06	45.27	25.15	17.51	29.57	0.522
Azerbaijan (2006)						
Boys	18.63	45.44	20.36	15.57	34.20	
Girls	15.80	55.00	16.00	13.20	29.00	
Total	17.31	49.91	18.32	14.46	31.77	0.020
Egypt (2008)						
Boys	16.23	40.18	22.73	20.85	37.09	
Girls	14.20	41.47	22.01	22.31	36.52	
Total	15.21	40.83	22.37	21.58	36.80	0.430
Jordan (2012)						
Boys	11.26	65.97	17.38	5.39	16.65	
Girls	11.38	69.84	15.24	3.54	14.92	
Total	11.32	67.84	16.35	4.49	15.81	0.450
Mauritania (2000-2001)						
Boys	34.95	51.09	9.61	4.35	39.30	
Girls	32	53.46	10.02	4.53	36.52	
Total	33.5	52.25	9.81	4.43	37.94	0.180
Morocco (2004)						
Boys	20.66	41.28	20.80	17.26	37.92	
Girls	20.49	44.69	20.90	13.92	34.41	
Total	20.57	43.01	20.85	15.57	36.14	0.070
Tunisia (1990)						
Boys	16.47	59.28	18.46	5.79	22.26	
Girls	14.04	62.40	17.83	5.74	19.77	
Total	15.27	60.82	18.15	5.77	21.03	0.176
Turkey (2003)						
Boys	4.91	53.31	29.98	11.80	16.70	
Girls	4.28	58.14	29.26	8.32	12.60	
Total	4.60	55.65	29.64	10.11	14.71	0.002
Yemen (1992)						
Boys	35.35	44.09	13.80	6.75	38.43	
Girls	28.66	41.01	18.78	11.56	37.10	
Total	31.64	42.38	16.56	9.41	41.05	0.467

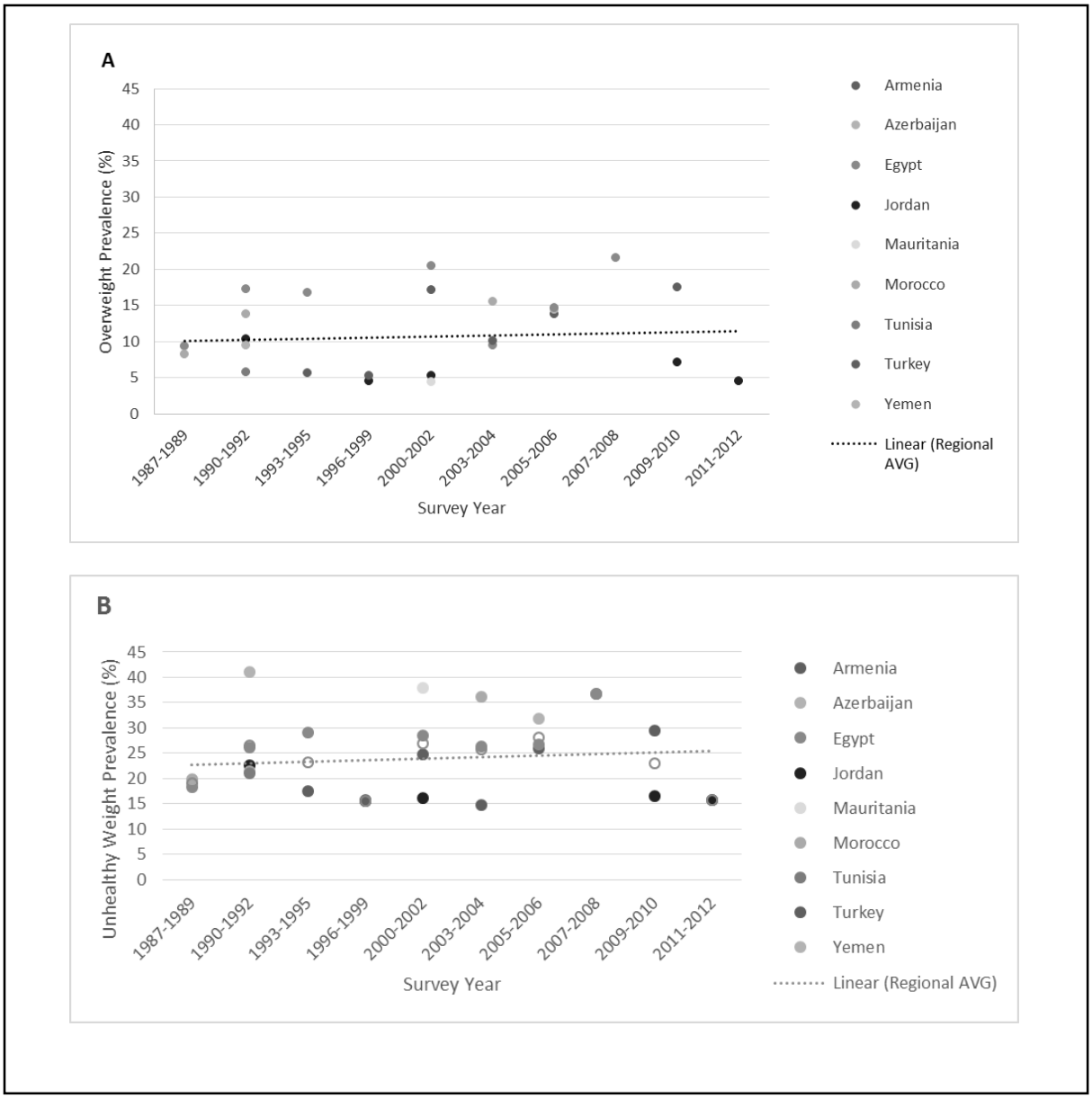
Note: Survey-adjusted estimates based on Demographic and Health Surveys (1990-2012) data for 0 to 5 y with the exception of Tunisia (0 to 4 y); Samples sizes ranged from 1,329 to 9,478 based upon the country. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < -2; at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2; overweight defined as BMI-for-age-z-score defined as ≥ 2; unhealthy weight defined as children who are thin or overweight, with p values representing if there is a difference between genders.

Table 3. Weight status among children under age 5 years in the Middle East and North Africa region over time of national data collection (%)

	Thinness	Normal Weight	At Risk of Overweight	Overweight	Unhealthy Weight
Armenia (2000)	7.78	43.91	31.25	17.07	24.85
Armenia (2005)	12.15	50.96	23.1	13.78	25.93
Armenia (2010)	12.06	45.27	25.15	17.51	29.56
Azerbaijan (2006)	17.31	45.91	18.32	14.46	31.77
Egypt (1988)	9.00	56.54	25.09	9.37	18.37
Egypt (1992)	8.83	47.77	26.10	17.30	26.13
Egypt (1995)	12.21	46.07	24.98	16.79	29.00
Egypt (2000)	8.09	45.57	25.91	20.43	28.52
Egypt (2003)	16.77	60.07	13.72	9.45	26.27
Egypt (2005)	12.20	52.24	20.95	14.61	26.81
Egypt (2008)	15.21	40.83	22.37	21.58	36.79
Jordan (1990)	12.27	53.78	23.63	10.32	22.59
Jordan (1997)	11.05	66.94	17.50	4.51	15.56
Jordan (2002)	10.87	66.06	17.83	5.24	16.11
Jordan (2009)	9.39	62.35	21.14	7.11	16.50
Jordan (2012)	11.32	67.84	16.35	4.49	15.81
Mauritania (2000-2001)	33.50	52.25	9.81	4.43	37.93
Morocco (1987)	11.52	59.61	20.61	8.26	19.78
Morocco (1992)	7.70	51.21	27.3	13.78	21.48
Morocco (2004)	20.57	43.01	20.85	15.57	36.14
Tunisia (1990)	15.27	60.82	18.15	5.77	21.04
Turkey (1993)	11.75	62.03	20.55	5.66	17.41
Turkey (1998)	10.39	64.02	20.3	5.28	15.67
Turkey (2003)	4.6	55.65	29.64	10.11	14.71
Yemen (1992)	31.64	42.38	16.56	9.41	41.05

Note: Survey-adjusted estimates based on Demographic and Health Surveys (1987-2012) data for 0 to 5 y with the exception of Tunisia (0 to 4 y) and Egypt 1988 (0 to 4 y); samples sizes ranged from 1,329 to 12,618 based upon the country. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < -2; at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2; overweight defined as BMI-for-age-z-score defined as ≥ 2; unhealthy weight defined as children who are thin or overweight.

Figure 3. Prevalence of **A)** overweight and **B)** unhealthy weight children under age five years in the Middle East and North Africa region over time of national data collection (%)



Note: Survey-adjusted estimates based on Demographic and Health Surveys (1987-2012) data for 0 to 5 y with the exception of Tunisia (0 to 4 y) and Egypt 1988 (0 to 4 y); samples sizes ranged from 1,329 to 12,618 based upon the country. Using World Health Organization child growth reference standards: overweight defined as BMI-for-age-z-score defined as ≥ 2; thinness defined as BMI-for-age-z-score < -2; unhealthy weight defined as children who are thin or overweight. Regional estimates based upon the average survey weighted prevalence for each range of years. $R^2 = 0.0146$ for Overweight trendline and $R^2 = 0.0219$ for Unhealthy weight trendline.

Supplemental Table. Weight status among children under age 5 years in the Middle East and North Africa region over time of national data collection (%)

	Thinness	Normal Weight	At risk of Overweight	Overweight
Armenia (2000)				
0-1 years	19.63	46.05	23.22	11.09
1-2 years	5.87	37.46	32.79	23.87
2-5 years	4.94	45.23	33.09	16.74
Total	7.78	43.91	31.25	17.07
Armenia (2005)				
0-1 years	17.78	51.49	19.08	11.65
1-2 years	13.76	47.75	23.32	15.18
2-5 years				
Total	12.15	50.96	23.1	13.78
Armenia (2010)				
0-1 years	22.23	48.55	21.73	7.49
1-2 years	7.47	38.60	31.66	22.27
2-5 years	10.32	46.74	23.81	19.14
Total	12.06	45.27	25.15	17.51
Azerbaijan (2006)				
0-1 years	35.33	51.01	10.91	7.87
1-2 years	15.71	48.38	26.06	9.84
2-5 years	11.18	51.95	18.31	18.56
Total	17.31	49.91	18.32	14.46
Egypt (1988)				
0-1 years	19.03	59.51	16.23	5.22
1-2 years	6.26	57.79	26.35	9.61
2-4 years	3.75	52.85	30.93	12.46
Total	9	56.54	25.09	9.37
Egypt (1992)				
0-1 years	16.35	50.83	19.70	13.12
1-2 years	9.15	47.71	26.66	16.48
2-5 years	6.51	46.88	27.80	18.80
Total	8.83	47.77	26.1	17.3
Egypt (1995)				
0-1 years	24.47	46.04	18.20	11.29
1-2 years	11.49	46.24	26.39	15.87
2-5 years	8.22	46.02	26.86	18.90
Total	12.21	46.07	24.98	16.79
Egypt (2000)				
0-1 years	17.83	45.03	19.38	17.75

1-2 years	6.49	41.12	27.74	24.65
2-5 years	5.18	45.99	27.85	20.97
Total	8.06	44.81	26.08	21.05
Egypt (2003)				
0-1 years	27.35	53.54	10.95	8.16
1-2 years	10.26	59.04	17.59	13.11
2-5 years	15.27	62.62	13.41	8.70
Total	16.77	60.06	13.72	9.45
Egypt (2005)				
0-1 years	22.94	44.44	18.74	13.88
1-2 years	11.21	47.12	22.82	18.84
2-5 years	9.15	56.40	21.02	13.43
Total	12.2	52.24	20.95	14.61
Egypt (2008)				
0-1 years	19.58	42.18	20.78	17.45
1-2 years	13.61	35.96	24.54	25.89
2-5 years	14.12	42.11	22.18	21.59
Total	15.21	40.83	22.37	21.58
Jordan (1990)				
0-1 years	18.96	52.57	18.00	10.47
1-2 years	9.46	47.28	29.53	13.74
2-5 years	11.02	56.55	23.39	3.34
Total	12.27	53.78	23.63	10.32
Jordan (1997)				
0-1 years	17.51	59.76	16.53	6.20
1-2 years	9.35	61.68	22.53	6.44
2-5 years	9.63	70.94	16.09	4.74
Total	11.05	66.94	17.5	4.51
Jordan (2002)				
0-1 years	15.86	62.00	15.06	7.09
1-2 years	8.08	59.73	25.89	6.30
2-5 years	8.57	66.11	20.18	5.14
Total	10.87	66.06	17.83	5.24
Jordan (2009)				
0-1 years	15.84	57.45	19.79	6.92
1-2 years	8.19	56.47	27.10	8.23
2-5 years	8.87	59.96	23.24	7.92
Total	9.39	62.35	21.14	7.11
Jordan (2012)				
0-1 years	15.89	60.56	18.23	5.32
1-2 years	9.24	63.98	19.57	7.21
2-5 years	10.78	71.06	14.78	3.38
Total	11.32	67.84	16.35	4.49

Mauritania (2000-2001)				
0-1 years	45.97	42.02	6.85	5.16
1-2 years	30.50	50.45	13.19	5.86
2-5 years	29.07	57.57	9.81	3.55
Total	33.5	52.25	9.81	4.43
Morocco (1987)				
0-1 years	22.13	59.10	13.51	5.27
1-2 years	12.39	51.86	24.45	11.29
2-5 years	6.49	62.44	22.49	8.58
Total	11.52	59.61	20.61	8.26
Morocco (1992)				
0-1 years	15.43	48.00	22.29	14.29
1-2 years	7.99	42.49	32.27	17.25
2-5 years	5.11	55.26	27.21	12.43
Total	7.7	51.21	27.30	13.78
Morocco (2004)				
0-1 years	24.08	35.16	22.77	17.99
1-2 years	16.48	38.40	25.23	19.89
2-5 years	20.82	46.92	18.84	13.42
Total	20.57	43.01	20.85	15.57
Tunisia (1990)				
0-1 years	29.44	53.32	12.39	4.85
1-2 years	9.00	63.57	20.96	6.47
2-4 years	10.42	63.94	19.86	5.77
Total	15.27	60.82	18.15	5.77
Turkey (1993)				
0-1 years	23.24	54.83	17.13	4.80
1-2 years	11.97	59.47	22.55	6.01
2-5 years	7.40	65.61	21.12	5.87
Total	11.75	62.03	20.55	5.66
Turkey (1998)				
0-1 years	23.03	59.42	13.82	3.73
1-2 years	9.65	59.65	23.39	7.32
2-5 years	5.86	67.31	21.68	5.15
Total	10.39	64.02	20.30	5.28
Turkey (2003)				
0-1 years	10.69	58.05	20.01	11.26
1-2 years	2.97	47.85	35.12	14.06
2-5 years	3.26	57.32	30.86	8.55
Total	4.60	55.65	29.64	10.11
Yemen (1992)				
0-1 years	47.45	35.00	10.11	7.44
1-2 years	27.10	40.71	20.15	12.04

2-5 years	22.99	48.65	19.07	9.29
Total	31.64	42.38	16.56	9.41

Note: Survey-adjusted estimates based on Demographic and Health Surveys (1987-2012) data for 0 to 5 y with the exception of Tunisia (0 to 4 y) and Egypt 1988 (0 to 4 y); samples sizes ranged from 1,329 to 12,618 based upon the country. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < -2; at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2; overweight defined as BMI-for-age-z-score defined as ≥ 2.

Chapter 4. Factors Associated with Unhealthy Weight in Children under Age Five in the Middle East and North African Region

ABSTRACT

Background: Child under-nutrition is estimated to be the largest contributor to the global burden of disease, but child over-nutrition is of increasing concern. This study aims to evaluate child and parent characteristics associated with thinness, overweight, and overall unhealthy weight among 0-5 year old children in the Middle East and North African Region (MENA).

Methods: Using nationally representative data from the six countries' in the MENA Region with Demographic and Health Surveys since 2001, Azerbaijan, Egypt, Jordan, Mauritania, Morocco, and Turkey(n=30,404), we used logistic regression to quantify the independent predictors of unhealthy weight, including both thinness and overweight. Weight status was calculated using the WHO Child Growth Standards, with 'thinness' categorized as a BMI-z score for sex and age less than one SD below the mean of the WHO international standards and 'overweight' as a BMI-z score for sex and age more than two SD above the mean. Survey-adjusted odds ratios with 95% confidence intervals were calculated.

Findings: In the region, children of obese mothers were more likely to be at risk of overweight(OR [95%CI]: 1.35 [1.15,1.58]) or overweight(1.59 [1.31, 1.93]). Conversely, children of obese mothers were less likely to be thin(0.74 [0.59,0.91]). Children with uneducated mothers and fathers were at the greatest risk for thinness while children living with an overweight or obese higher educated mother were at greatest risk of being overweight.

Interpretation: Individual and family-level factors were significantly associated with weight status among children under 5 in the MENA Region and within individual countries. Obese, higher educated mothers were independent predictors of overweight, while low birth weight, uneducated fathers and mothers were independent predictors of thinness. These findings support the need to design evidence-based child health policy and strategies, considering the impact of these individual and family-based factors.

Chapter 4. Factors Associated with Unhealthy Weight in Children under Age Five in the Middle East and North African Region

BACKGROUND

In global estimates from 2011, 16% of children under five years of age were underweight, defined as stunted or thin, (a 35% decrease from 1990), and 7% of children under five years of age were categorized as overweight (a 54% increase within the same time frame)(2). The number of overweight children has increased worldwide since 1990, however, under-nutrition continues to be associated with one third to one half of deaths in children under age five years globally(33).

The Middle East and North Africa (MENA) region consists of mainly middle-income countries (Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Yemen, United Arab Emirates, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Syria, and Tunisia, with broader definitions also including Armenia, Azerbaijan, Cyprus, Djibouti, Georgia, Mauritania, Somalia, Sudan, Turkey, and Western Sahara)(18, 36). These countries together constitute a complex region linked by broad similarities of climate, religion, and culture(17). Countries in the Middle East and North Africa constitute a complex region linked by broad similarities of climate, religion and culture(17). While the region is loosely united around these broad similarities, it is also true that subregional divisions derive from very different histories, cultural systems and political aspirations(17, 37). The most notable defining characteristics among MENA countries are the availability of oil resources and the size of their native populations(38). Based on these two factors, other researchers have suggested classifying the group into three main groups: resource-rich, labor-abundant countries; resource-rich, labor-importing countries; and resource-poor countries(38, 39). While the region is loosely united around these broad similarities, it is also true that subregional divisions derive from very different histories, cultural

systems and political aspirations(17, 37). The region is diverse, with some countries such as Syria, Iraq, Libya, and Yemen suffering from heavy violence (spilling over into Jordan and Lebanon), while others are in the midst of political transitions (Tunisia and Egypt) with slow economic growth(17, 37).

Current regional estimates, based upon a compilation of nationally representative and sub-national surveys, report adult obesity percentages of 20%(males) to 34%(females), and, as well as in children under 20 years 8%(boys) to 10%(girls)(4). Analysis from DHS surveys in Egypt, Jordan, Morocco, and Turkey report far more overweight than underweight women in all four countries(33); for example, in urban areas of Egypt 69.9% of women were categorized as obese versus 0.7% as underweight. Our findings for children under the age of five years (see Chapter 3) show stable prevalence of thinness with concurrent increases in overweight, resulting in an overall increase unhealthy weight(77).

The Social Ecological Model postulates that individual outcomes are shaped by individual characteristics, and by interactions with the social, cultural, economic, and environmental contexts in which individuals live(26, 27). Theses form concentric layers of influence, including intra-personal, family, community, organization, government, industry, and societal domains and is frequently used as a model in childhood obesity research and prevention efforts(40, 41). Other literature has hypothesized that the weight status of children under five is influenced by mother's BMI and age, parent's education, number of siblings, neighborhood income, and child's birth weight(28, 42-49). We assess the association of children's nutritional status and child and family characteristics across the MENA region, where under-nutrition and over-nutrition may both present a threat to the short and long-term health of children.

METHODS

Data are from the Demographic and Health Survey (DHS) for 6 MENA countries where the surveys have been implemented and information collected on the health of women and children, including direct anthropometric measurements. DHS are nationally representative cross-sectional surveys conducted using, multi-staged, and probabilistic sampling. The surveys have been fielded in low and middle-income countries since 1985 and collect information on the health of women and children, including direct anthropometric measurements. DHS data were available for nine of the twenty-eight MENA countries. This study used the most current survey wave for each MENA country: Azerbaijan (2006), Egypt (2008), Jordan (2012), Mauritania (2000-2001), Morocco (2004), and Turkey (2003). Armenia (2010), Tunisia (1990), and Yemen (1992) were excluded from this analysis due to lack of anthropometric data on mothers.

Participants and Settings

DHS survey recruitment and measurements are discussed previously in Chapter 3(77). The final analytic sample for the children under five in the six MENA countries was 30,404.

Measurement and Variables

Anthropometric variables were recorded by trained personnel in all countries. Participants' weights were measured using solar-powered mother-baby scales with an accuracy of ± 100g. Specifications of the scale used and measurements were also delineated in Chapter 3(77).

The study outcome was child weight status; we created two over-nutrition and one under-nutrition variables in children under five years: at risk of overweight (excluding overweight), overweight, and thinness based on the WHO Child Growth Standards(74). Using these standards, 'risk of overweight' is a BMI-z score for sex and age more than one SD and less than two SD above the mean of the WHO international standards; 'overweight' is a BMI-z score for sex and

age more than two SD above the mean of the WHO international standards; 'thinness' is a BMI-z score for sex and age less than one SD below the mean. These cut-points for children under five correspond to the WHO cut-points for children 5-18 of 'overweight' (more than one SD), 'obese' (more than two SD), and 'underweight' (less than one SD)(20). Unhealthy weight was defined as any child categorized as thin or overweight.

Child characteristic variables included birth weight, region (urban versus rural), and birth order (i.e., 1, 2, 3-4, 5+). For birth weight, we categorized children using CDC birth weight categories: low birth weight was defined as < 2.5 kg, normal birth weight was defined as 2.5-4.5 kg, and high birth weight was defined as > 4.5 kg(78). Parent characteristic variables included mother's weight status, mother's age (i.e., 15-24, 25-29, 30-34, 35+), mother's level of education, and father's level of education. For mother's weight status: underweight was defined as < 18.5 kg/m^2, normal was defined as 18.5-24.9 kg/m^2, overweight was defined as 25.0-29.9 kg/m^2, an obese was defined as ≥ 30 kg/m^2. Mother's and father's education were left in the categories used by DHS: no education, primary, secondary, and higher.

Analysis

Data were merged and analyzed using STATA software (Version 13.0; STATA Corp, College Station, TX, US). Individual country files were used for the majority of analysis and were survey-adjusted using standard DHS survey adjustments.[3] The overall regional datafile was survey-adjusted and all analyses done using *svy* commands. In the analytic approach, multinomial logistic regression analyses (with all variables kept) was used to evaluate the

[3]For the pooled regional file, the six individual country children data files were de-normalized, and the provided sample weight was adjusted for overall population using the United States Census Bureau International Programs database(85). Once files were appended together, the cluster variable was modified so that each stratum could stand alone based upon the country.

associations between childhood weight status and child/parent characteristics. Odds ratios were presented along with 95% confidence intervals.

RESULTS

The demographic characteristics of children under five for the MENA region and by country according to the most recent DHS are shown in Table 1. Children were on average 1.98 years old. Regionally, 32% of children were first born children; 44% of children in Azerbaijan were first born versus 19% of children in Mauritania. The proportion of normal birth weight children was 85% with little variation between countries with the exception of Mauritania (67%). Among mothers regionally, 37% were overweight, 23% were obese and 2% were underweight. The smallest proportion of normal weight mothers were in Egypt (30.1%) and the highest in Azerbaijan (54.5%). Mother's age was evenly distributed between the four age groups with ages 35+ being the smallest for every country with the exception of Turkey and Jordan.

Socio-economic characteristics were also diverse across the region. Equal proportions of children lived in either urban or rural settings at a regional level. The smallest proportion of children living in rural areas were in Jordan (18.5%) and the highest in Egypt (63.9%). Regionally, over 40% of mothers had a secondary degree or higher and 56% of fathers had a secondary education or higher. However, country level estimates differed with over 60% of mothers and over 35% of fathers in Mauritania and Morocco had no education, while in Azerbaijan, Egypt, and Jordan over 60% of mothers and 68-99% of fathers had a secondary education or higher.

(Place Table 1 here)

Figure 1 shows relationships between overweight in young children and child and family characteristics: **A.** mother's weight status, **B.** mother's education, **C.** father's education, and **D.** child's birth weight.

As shown in Panel **A**, across the entire region, the proportion of overweight among children under 5 was lowest among children of underweight mothers, (10%), and increased greatly with over 20% of children having overweight among the children of normal weight mothers. Slightly lower than 30% of children having overweight among the children of overweight and obese mothers. This pattern was consistent across most of the countries in the region.

Panel **B** shows the prevalence of overweight among young children according to mother's education. Across the region, overweight was least prevalent among children of women with primary school education (just under 20%) and 30% among women with a secondary education or higher. In Egypt and Mauritania, prevalence of overweight was highest among children of women with higher education (Mauritania: just under 20%, Egypt: just over 40%).

Panel **C** shows the proportion of children under 5 with overweight according to the father's education. For the entire region, between 20 and 30% of children were of overweight with no major differences according to father's education level. This pattern persisted in the majority of countries with the exception of Morocco and Egypt, with the prevalence of overweight being highest among children of fathers with secondary or higher education.

Panel **D** shows the proportion of children under 5 with overweight according to the child's weight at birth. For the entire region, between 20 and 30% of children were of overweight with overweight most prevalent among high birthweight children . This pattern was consistent and more pronounced across most of the countries in the region, with the exception of Jordan.

(Place Figure 1 here)

Figure 2 shows relationships between unhealthy weight in young children and child and family characteristics: **A.** mother's weight status, **B.** mother's education, and **C.** child's birth weight.

As shown in Panel **A**, across the entire region, the proportion of unhealthy weight among children under 5 was lowest among children of underweight mothers, (almost 30%), and increased slightly with increase in mother's BMI category, reaching a high of 40% of children having unhealthy weight among the children of overweight and obese mothers. This pattern was consistent across most of the countries in the region.

Panel **B** shows the prevalence of unhealthy weight among young children according to mother's education. Across the region, unhealthy weight was least prevalent among children of women with primary school education (just under 30%) and 40% or higher among women with all other levels of education. In most countries, prevalence of unhealthy weight was highest among children of women with no education and lowest among mothers with higher education.

Panel **C** shows the proportion of children under 5 with unhealthy weight according to the child's weight at birth. For the entire region, between 30 and 40% of children were of unhealthy weight with no major differences according to their size at birth. This pattern masks country-specific differences, with more unhealthy weight among high birthweight children in Morocco and Azerbaijan but more unhealthy weight among low birthweight children in Mauritania, Turkey, and Egypt.

(Place Figure 2 here)

Table 2 shows the odds of a child (ages 0 to 5) being in one of the 3 unhealthy weight types- thinness, overweight, or unhealthy weight, relative to being in a normal-weight type.

Children living in an urban area were less likely to be thin (0.78 [0.64, 0.96]). Children born small at birth were more likely to be thin (1.41 [95%CI: 1.08, 1.84]. A child with an older sibling was more likely to be thin (1.29 [1.02, 1.62]) and a child with multiple older siblings was less likely to be overweight (5+: 0.53 [0.37, 0.76]).

Children with an obese mother were less likely to be thin (0.74 [0.59, 0.91]), but more likely to be at risk of overweight (1.35 [1.15, 1.58]) or overweight (1.59 [1.31,1.93]). Children with an overweight mother were more likely to be overweight (1.25 [1.05, 1.48]). Children with underweight mothers were less likely to be at risk of overweight (0.52 [0.31, 0.86]). Children with uneducated mothers were more likely to be thin (1.80 [1.31,2.49]). Children with mothers having a secondary education were more likely to be at risk of overweight (1.56 [1.20, 2.01]), or overweight (1.39 [1.07, 1.80]) compared to mothers with a primary education. Children with mothers having higher education were likely to be overweight (1.43 [1.02, 3.00]). Children with uneducated fathers were more likely to be thin (1.58 [1.18, 2.10]) when compared to fathers with a primary education. Multinomial logistic regression results stratified by country can be found in the Supplemental Table.

(Place Table 2 here)

DISCUSSION

This study shows the individual and parental characteristics associated with unhealthy weight among children under the age of 5 years across the MENA region. 13.6% of children in the region are thin and 15.6% are overweight. The strongest predictors of thinness were a child born smaller and uneducated parents and the strongest predictors of overweight were obese mothers and higher educated mothers.

Maternal weight status was significantly associated with all levels of childhood weight status (thinness, at risk of overweight, and overweight), such that offspring of obese mothers were at a greater risk of being overweight and at risk of overweight as well as less likely of being thin. Mother's weight status can reflect on the diet and health of her child(49, 79, 80). As supported by other research, child and parent characteristics parent play a pivotal role in childhood weight status(26-28).

Children with uneducated parents were at the greatest risk of being thin; conversely children with mothers holding a secondary degree or higher were at greatest risk of being overweight. Our findings are consistent with current literature on parental education's impact on child weight status. Higher parental education was associated with over-nutrition in primary-school children(ages 6-12) in Pakistan and Turkey(44, 81), along with similar estimates in Germany(82) and with younger children (0-5 y) in Brazil(49). In addition, other authors have demonstrated that a mother's education impacts the weight status of her child(83, 84). Researchers have hypothesized that a mother with higher levels of schooling provides better care to her children due to increased knowledge, and information and access to health care services are influenced by the level of schooling(49, 85), which can effect either spectrums of unhealthy weight.

A limitation of this study was the lack of current available DHS data for seventeen of the twenty-eight MENA countries. Libya, Qatar, and Kuwait, identified as having particularly high prevalence of female obesity in sub-national studies, nearing 50%, lacked DHS data(4). Even among the countries with DHS data, Tunisia and Yemen had more than 20 years old, providing a potentially outdated picture of weight status. Other sources of data that can be used to estimate

weight status in many MENA countries include using other multi-country surveillance programs and a comprehensive search of nationally representative and sub-national surveys(4).

In summary, the impact of child and parent characteristics on all levels of child (0-5 y) weight status is significant in the MENA region. These findings support the need to design evidence-based child health policy and strategies, considering the impact of these individual and family-based factors. How the MENA region's unhealthy weight burden might impact future mortality and morbidity in the region is unclear, yet changes in the economic, social, and demographic determinants of health and the adoption of unhealthy lifestyles are hypothesized to contribute to the observed prevalence in disease(86). The presence of both under- and over-nutrition in this population and its associated factors creates unique challenges(76). Deficit and excess are intertwined at different levels; thus the consequences of what we do or fail to do in either under- nutrition or over-nutrition will affect the region in multiple ways. Then answer, when allocating resources, is not choosing between these two but rather addressing them jointly with an integrated approach(76). Full assessment of the situation via continual surveillance and implementation of interventions considering primary associated factors impacting childhood weight status within the region as well as within each individual country are necessary to prevent the continued increase of this phenomenon in the Middle East and North African Region. This information with help identify ways to eliminate under-nutrition and its associated morbidity and mortality without contributing to over-nutrition(32).

Chapter 4. Tables and Figures

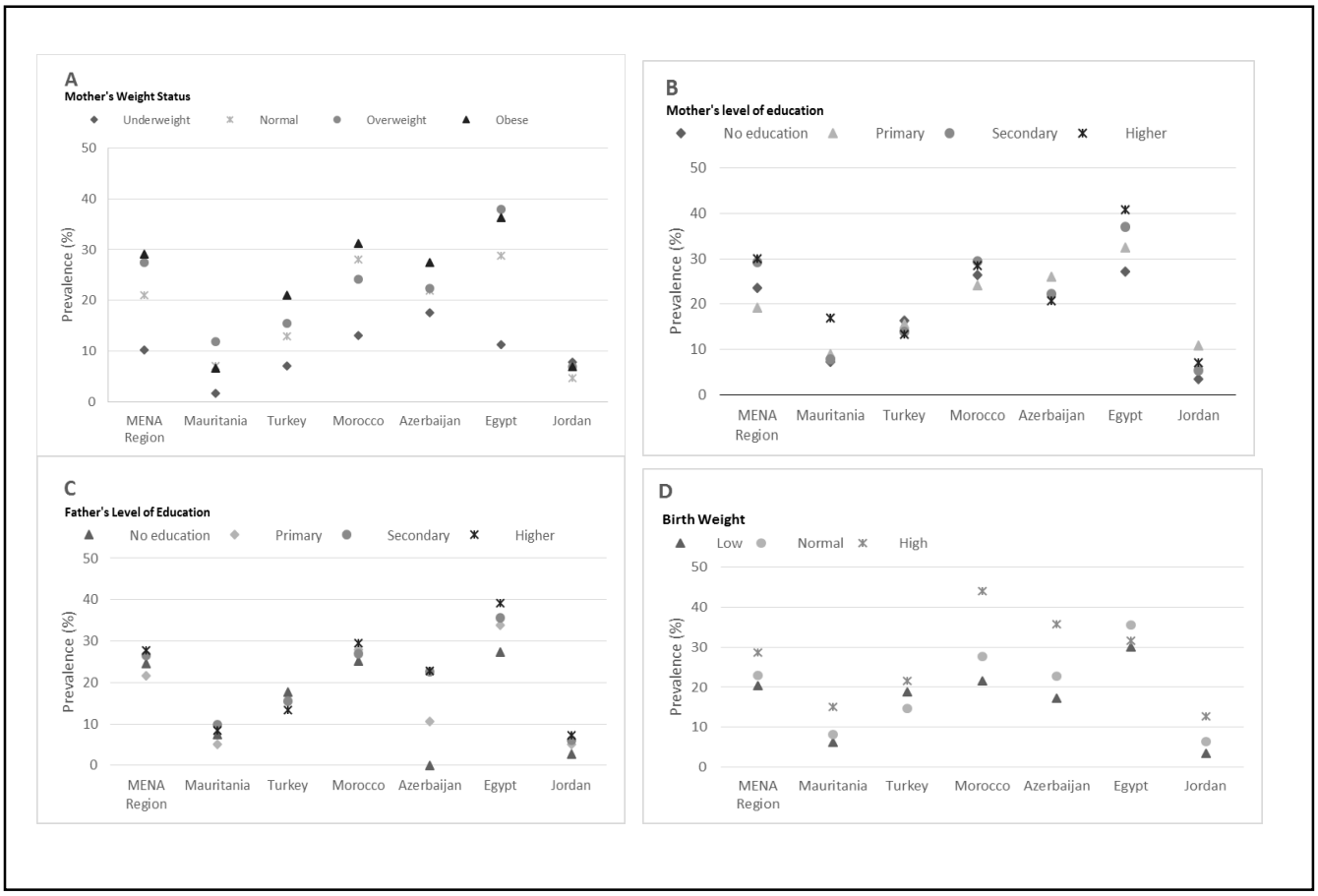
Table 1. Children under 5 years characteristics by most recent DHS country survey and overall MENA region (2001-2012).

	MENA region (total)	Mauritania 2001-02	Turkey 2003	Morocco 2004	Azerbaijan 2006	Egypt 2008	Jordan 2012
Child Characteristics							
Sex, % male	50.6	51.5	51.6	50.3	46.8	50.0	51.6
Age, y	1.98 ± 1.4	1.96± 1.45	2.06 ± 1.4	2.03±1.41	1.96± 1.41	1.92 ± 1.42	2.07± 1.39
Birthweight, %							
Low (<2.5 kg)	11.1	31.2	11.0	11.0	9.0	10.5	13.7
Normal (2.5-4.5 kg)	85.0	67.1	84.7	83.6	87.7	86.6	83.7
High (> 4.5 kg)	3.8	1.7	4.4	5.4	3.3	2.8	2.7
Area, %							
Urban	49.9	43.0	65.9	50.5	48.9	36.1	81.6
Rural	50.1	57.0	34.1	49.5	51.1	63.9	18.5
BMI-for-age, %							
Thinness	13.0	33.5	4.6	20.6	17.3	15.2	11.3
Normal Weight	47.4	52.3	55.7	43.0	49.9	40.8	67.8
At Risk of Overweight	23.8	9.8	29.6	20.9	18.3	22.4	16.4
Overweight	15.8	4.4	10.1	15.6	14.5	21.6	4.5
Birth Order, %							
1	31.6	19.4	33.3	26.6	44.4	32.6	22.2
2	26.7	16.7	27.8	24.0	33.9	27.3	21.6
3-4	27.7	27.7	24.5	29.0	19.7	29.6	33.0
5+	14.0	36.2	14.4	20.0	2.0	10.5	23.5
Parent's Characteristics							
Mother's BMI, %							
Underweight (<18.5 kg/m^2)	1.8	7.8	1.5	4.5	3.9	0.7	2.2
Normal (18.5-24.9 kg/m^2)	38.7	52.4	41.5	53.7	54.5	30.1	32.9
Overweight (25.0-29.9 kg/m^2)	37.0	22.3	35.7	29.6	31.2	41.9	35.3
Obese (≥30.0 kg/m^2)	22.5	17.5	21.3	12.2	10.4	27.3	29.6
Mother's Age, %							
15-24	27.0	24.6	29.0	21.4	35.8	28.2	16.2
25-29	33.1	24.5	33.6	25.8	34	35.8	27.8
30-34	22.1	23.9	22.7	23.9	18.8	20.4	27.4
35 +	17.8	27.1	14.7	28.8	11.4	15.7	28.6
Mother's level of education, %							
No education	29.0	66.5	21.5	62.6	0.8	26.2	1.7
Primary	25.3	23.6	54.0	18.0	2.2	10.3	6.5
Secondary	36.6	9.1	19.7	15.8	83.8	50.9	61.4
Higher	9.2	0.9	4.7	3.6	13.2	12.7	30.5
Father's level of education, %							
No education	16.2	35.6	5.9	44.4	0.5	15.9	0.9
Primary	27.6	9.6	48.9	29.2	0.3	16.1	10.4
Secondary	43.0	12.3	36.1	19.4	80.7	52.3	64.8
Higher	13.3	42.6	9.1	7.0	18.5	15.7	23.8
n	30404	3315	4025	5550	1942	9478	6267

Note: Data Source: Demographic and Health Surveys (2001-2012) from the Middle East and North Africa countries.
a. All estimates are survey-adjusted.

b. Data are from the most recent DHS in each country.
c. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < - 2; normal defined as BMI-for-age-z-score ≥ -2 and < 1; at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2; overweight defined as BMI-for-age-z-score defined as ≥ 2.

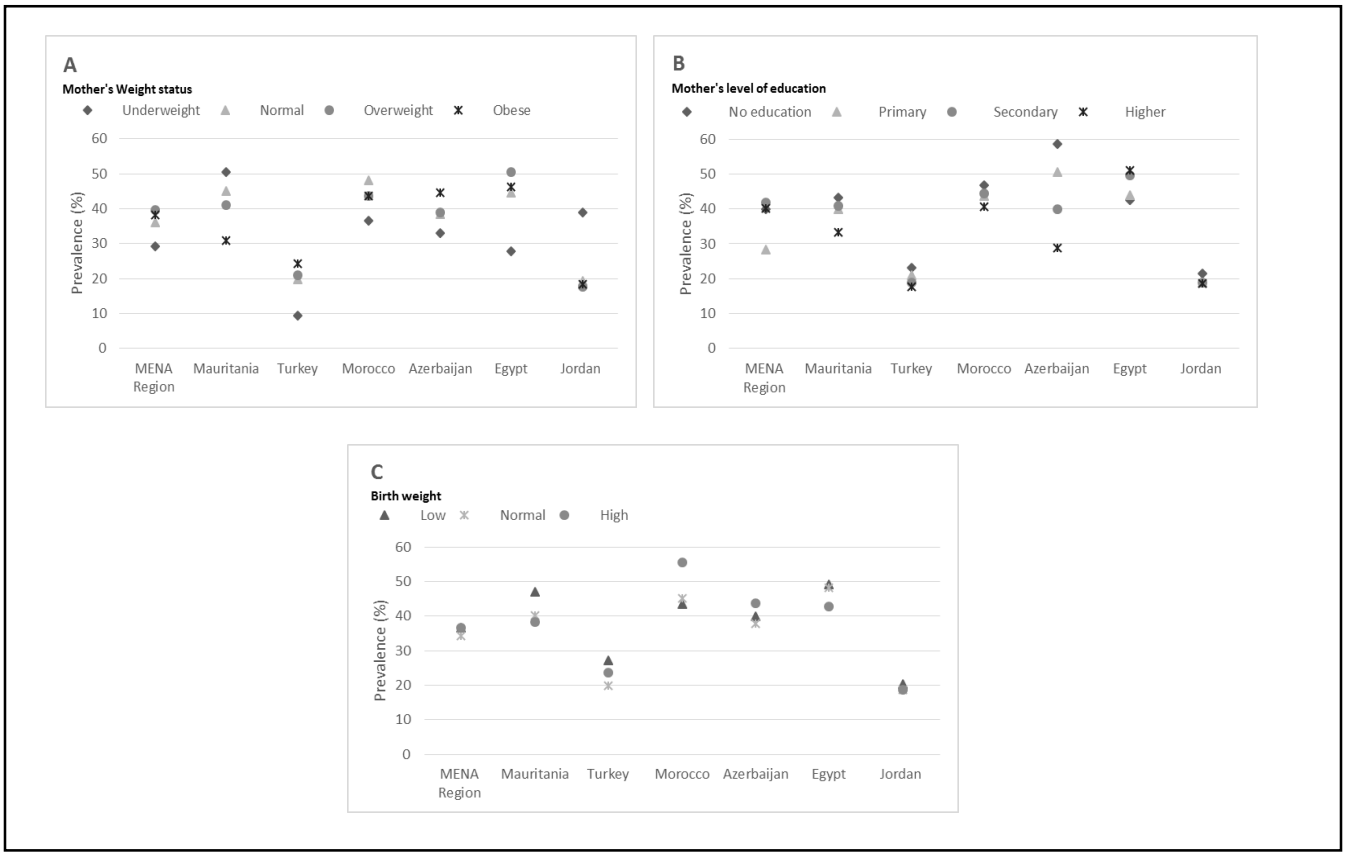
Figure 1. Prevalence of overweight among children (0-5 years) by **A)** Mother's Weight Status, **B)** Mother's Education, **C)** Father's Education, and **D)** Birth Weight



Note: Data Source: Demographic and Health Surveys (2001-2012) from the Middle East and North Africa countries.

a. All estimates are survey-adjusted.
b. Data are from the most recent DHS in each country.
c. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < - 2; normal defined as BMI-for-age-z-score ≥ -2 and < 1; at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2; overweight defined as BMI-for-age-z-score defined as ≥ 2.
d. Using CDC BMI standards for adult:, underweight defined as < 18.5 kg/m^2; normal defined as 18.5-24.9 kg/m^2; overweight defined as 25.0-29.9 kg/m^2; obese defined as ≥ 30 kg/m^2.
e. Using WHO birth weight categories: low birth weight defined as < 2.5 kg; normal birth weight defined as 2.5-4.5 kg; high birth weight defined as > 4.5 kg.

Figure 2. Prevalence of unhealthy weight children (0-5 years) by **A)** Mother's Weight Status, **B)** Mother's Education, **C)** Birth Weight



Note: Data Source: Demographic and Health Surveys (2001-2012) from the Middle East and North Africa countries.

a. All estimates are survey-adjusted.
b. Data are from the most recent DHS in each country.
c. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < - 2; normal defined as BMI-for-age-z-score ≥ -2 and < 1; at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2; overweight defined as BMI-for-age-z-score defined as ≥ 2; unhealthy weight defined as children categorized as either thin or overweight.
d. Using CDC BMI standards for adults: underweight defined as < 18.5 kg/m^2; normal defined as 18.5-24.9 kg/m^2; overweight defined as 25.0-29.9 kg/m^2; obese defined as ≥ 30 kg/m^2.
e. Using WHO birth weight categories: low birth weight defined as < 2.5 kg; normal birth weight defined as 2.5-4.5 kg; high birth weight defined as > 4.5 kg.

Table 2. Survey-adjusted analysis of nutritional status of children under 5 years in the MENA region using most recent DHS country surveys (2001-2012).

	MENA Region					
	Thin		At Risk of Overweight		Overweight	
	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]
Child Characteristics						
Area						
Urban	0.78*	(0.64, 0.96)	0.92	(0.78, 1.09)	92	(0.76, 1.12)
Rural	ref		ref		ref	
Birth weight						
Low (<2.5 kg)	1.41*	(1.08, 1.84)	0.80	(0.62, 1.02)	0.80	(0.58, 1.11)
Normal (2.5-4.5 kg)	ref		ref		ref	
High (> 4.5 kg)	0.72	(0.42, 1.24)	1.35	(0.93, 1.97)	1.32	(0.87, 1.99)
Birth Order, %						
1	ref		ref		ref	
2	1.29*	(1.02, 1.62)	1.11	(0.91, 1.35)	0.97	(0.79, 1.20)
3-4	1.12	(0.86, 1.45)	0.89	(0.72, 1.11)	0.78	(0.61, 1.01)
5+	0.97	(0.66, 1.44)	1.06	(0.79, 1.42)	0.53*	(0.37, 0.76)
Parent's Characteristics						
Mother's BMI						
Underweight (<18.5 kg/m^2)	0.73	(0.48, 1.11)	0.52*	(0.31, 0.86)	0.62	(0.36, 1.07)
Normal (18.5-24.9 kg/m^2)	ref		ref		ref	
Overweight (25.0-29.9 kg/m^2)	0.99	(0.84, 1.16)	1.11	(0.96, 1.28)	1.25*	(1.05, 1.48)
Obese (≥30.0 kg/m^2)	0.74*	(0.59, 0.91)	1.35*	(1.15, 1.58)	1.59*	(1.31, 1.93)
Mother's age						
15-24	ref		ref		ref	
25-29	1.07	(0.83, 1.39)	1.01	(0.82, 1.24)	1.00	(0.77, 1.29)
30-34	0.98	(0.73, 1.32)	0.86	(0.67, 1.11)	0.95	(0.71, 1.26)
35 +	1.18	(0.84, 1.66)	0.85	(0.64, 1.13)	1.12	(0.81, 1.56)
Mother's level of education						
No education	1.80*	(1.31, 2.49)	1.17	(0.92, 1.48)	1.29	(0.97, 1.71)
Primary	ref		ref		ref	
Secondary	1.56*	(1.20, 2.01)	1.20	(0.98, 1.47)	1.39*	(1.07, 1.80)
Higher	1.26	(0.85, 1.86)	1.18	(0.88, 1.59)	1.43*	(1.02, 2.00)
Father's level of education						
No education	1.58*	(1.18, 2.10)	0.76	(0.57, 1.002)	1.16	(0.84, 1.62)
Primary	ref		ref		ref	
Secondary	0.99	(0.76, 1.26)	0.73*	(0.60, 0.90)	0.89	(0.68, 1.17)
Higher	1.23	(0.89, 1.70)	0.82	(0.62, 1.08)	0.98	(0.70, 1.39)

Note: Data Source: Demographic and Health Surveys (2001-2012) from the Middle East and North Africa countries.

a. All estimates are survey-adjusted.

b. Data are from the most recent DHS in each country.

c. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < - 2; normal defined as BMI-for-age-z-score ≥ -2 and < 1; at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2; overweight defined as BMI-for-age-z-score defined as ≥ 2; normal weight used as reference in regression analysis.

Supplemental Table. Survey-adjusted analysis of nutritional status of children under 5 years by country in the MENA region using most recent DHS country surveys (2001-2012).

	Mauritania 2000-2001						Turkey 2003						Morocco 2004					
	Thin		At risk of overweight		Overweight		Thin		At risk of overweight		Overweight		Thin		At risk of overweight		Overweight	
	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]
Child Characteristics																		
Area																		
Urban	1.81*	(1.004, 3.26)	0.63	(0.23, 1.71)	1.98	(0.51, 7.69)	0.94	(0.54, 1.64)	1.07	(0.76, 1.51)	1.44	(0.90, 2.30)	0.68*	(0.48, 0.97)	1.31	(0.95, 1.80)	0.89	(0.62, 1.30)
Rural	ref		ref		ref		ref		ref		ref		ref		ref		ref	
Birth weight																		
Low (<2.5 kg)	1.34	(0.85, 2.12)	0.51	(0.23, 1.12)	0.98	(0.38, 2.57)	1.78	(0.79, 4.01)	0.82	(0.52, 1.29)	1.37	(0.83, 2.27)	1.20	(0.77, 1.85)	0.88	(0.55, 1.41)	0.74	(0.46, 1.19)
Normal (2.5-4.5 kg)	ref		ref		ref		ref		ref		ref		ref		ref		ref	
High (> 4.5 kg)	0.23*	(0.08, 0.67)	0.20	(0.02, 2.04)	0.00001*	(0,0)	0.62	(0.07, 5.31)	1.57	(0.84, 2.94)	1.34	(0.64, 2.82)	1.10	(0.54, 2.24)	1.11	(0.56, 2.18)	1.66	(0.95, 2.91)
Birth Order, %																		
1	ref		ref		ref		ref		ref		ref		ref		ref		ref	
2	1.31	(0.76, 2.26)	1.32	(0.49, 3.57)	1.34	(0.38, 4.65)	1.11	(0.59, 2.09)	1.19	(0.85, 1.66)	1.26	(0.78, 2.05)	1.29	(0.89, 1.86)	1.03	(0.73, 1.48)	1.02	(0.67, 1.57)
3-4	1.10	(0.59, 2.08)	1.58	(0.54, 4.62)	1.40	(0.39, 5.11)	0.61	(0.25, 1.45)	0.84	(0.55, 1.28)	1.27	(0.72, 2.25)	1.39	(0.90, 2.14)	0.97	(0.64, 1.48)	1.02	(0.66, 1.56)
5+	1.00	(0.47, 2.11)	1.24	(0.45, 3.43)	1.11	(0.26, 4.80)	0.95	(0.23, 3.91)	1.21	(0.65, 2.28)	0.78	(0.31, 1.96)	0.91	(0.49, 1.66)	1.19	(0.66, 2.13)	1.02	(0.55, 1.92)
Parent's Characteristics																		
Mother's BMI																		
Underweight (<18.5 kg/m^2)	0.59	(0.29, 1.20)	2.90*	(0.999, 8.44)	0.29	(0.03, 2.65)	0.09*	(0.01, 0.67)	0.47	(0.17, 1.34)	0.68	(0.22, 2.08)	0.58	(0.30, 1.12)	0.58	(0.32, 1.08)	0.35	(0.12, 1.01)
Normal (18.5-24.9 kg/m^2)	ref		ref		ref		ref		ref		ref		ref		ref		ref	
Overweight (25.0-29.9 kg/m^2)	0.81	(0.51, 1.30)	1.13	(0.52, 2.46)	0.96	(0.40, 2.28)	0.86	(0.53, 1.38)	1.32*	(1.02, 1.69)	1.21	(0.83, 1.78)	0.87	(0.67, 1.12)	1.07	(0.84, 1.36)	0.78	(0.59, 1.03)
Obese (≥30.0 kg/m^2)	0.41*	(0.25, 0.67)	1.36	(0.65, 2.86)	0.81	(0.33, 1.97)	0.62	(0.30, 1.25)	1.68*	(1.26, 2.25)	2.09*	(1.35, 3.22)	0.58*	(0.39, 0.86)	1.27	(0.90, 1.80)	1.35	(0.94, 1.94)
Mother's Age																		
15-24	ref		ref		ref		ref		ref		ref		ref		ref		ref	
25-29	1.26	(0.62, 2.53)	1.05	(0.34, 3.21)	0.37	(0.11, 1.24)	1.32	(0.64, 2.72)	1.10	(0.76, 1.59)	0.73	(0.42, 1.26)	1.03	(0.68, 1.56)	0.79	(0.51, 1.21)	0.80	(0.52, 1.21)
30-34	1.03	(0.50, 2.11)	1.71	(0.61, 4.74)	0.74	(0.27, 2.04)	0.68	(0.23, 2.01)	0.88	(0.56, 1.39)	0.50*	(0.27, 0.92)	1.25	(0.78, 2.02)	0.81	(0.48, 1.37)	0.72	(0.45, 1.15)
35 +	1.54	(0.71, 3.38)	3.25*	(1.00, 10.52)	0.84	(0.26, 2.70)	1.56	(0.45, 5.34)	0.90	(0.51, 1.58)	0.65	(0.31, 1.37)	1.09	(0.67, 1.79)	0.72	(0.43, 1.22)	0.54*	(0.33, 0.90)
Mother's level of education																		
No education	1.16	(0.78, 1.74)	0.41	(0.15, 1.12)	0.96	(0.32, 2.86)	0.99	(0.33, 3.00)	1.20	(0.80, 2.11)	1.08	(0.56, 2.10)	1.00	(0.67, 1.49)	0.88	(0.59, 1.31)	1.07	(0.71, 1.61)
Primary	ref		ref		ref		ref		ref		ref		ref		ref		ref	
Secondary	0.99	(0.64, 1.53)	1.06	(0.42, 2.71)	1.21	(0.41, 3.53)	0.42*	(0.20, 0.88)	1.37	(0.99, 1.92)	0.92	(0.56, 1.52)	0.93	(0.58, 1.49)	1.05	(0.60, 1.82)	1.34	(0.87, 2.08)
Higher	0.21	(0.04, 1.07)	0.44	(0.10, 2.01)	1.05	(0.10, 10.47)	0.80	(0.19, 3.31)	0.88	(0.45, 1.74)	0.76	(0.28, 2.11)	0.48	(0.21, 1.07)	1.04	(0.48, 2.26)	1.31	(0.64, 2.71)
Father's level of education																		
No education	1.59	(0.84, 3.02)	1.48	(0.53, 4.15)	0.95	(0.21, 4.40)	1.35	(0.23, 7.99)	0.95	(0.37, 2.45)	1.52	(0.45, 5.15)	0.93	(0.63, 1.36)	0.61*	(0.41, 0.92)	0.76	(0.51, 1.14)
Primary	ref		ref		ref		ref		ref		ref		ref		ref		ref	
Secondary	0.81	(0.39, 1.68)	1.05	(0.37, 3.01)	0.82	(0.22, 3.11)	0.61	(0.34, 1.07)	0.70*	(0.52, 0.95)	0.98	(0.61, 1.57)	0.87	(0.56, 1.34)	0.77	(0.46, 1.29)	0.74	(0.51, 1.14)
Higher	0.70	(0.41, 1.21)	0.84	(0.32, 2.19)	0.65	(0.14, 3.01)	0.61	(0.21, 1.77)	0.92	(0.56, 1.49)	0.73	(0.34, 1.57)	1.22	(0.68, 2.17)	0.38*	(0.20, 0.71)	0.92	(0.54, 1.57)

	Azerbaijan 2006						Egypt 2008						Jordan 2012					
	Thin		At risk of overweight		Overweight Children		Thin		At risk of overweight		Overweight		Thin		At risk of overweight		Overweight	
	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]
Child Characteristics																		
Area																		
Urban	0.84	(0.49, 1.44)	0.82	(0.49, 1.38)	1.01	(0.55, 1.87)	1.17	(0.84, 1.62)	0.76*	(0.57, 0.99)	1.12	(0.83, 1.50)	0.93	(0.68, 1.26)	0.81	(0.61, 1.06)	0.69*	(0.51, 0.93)
Rural	ref		ref		ref		ref		ref		ref		ref		ref		ref	
Birth weight																		
Low (<2.5 kg)	1.05	(0.47, 2.32)	0.60	(0.25, 1.44)	0.59	(0.21, 1.70)	1.19	(0.77, 1.83)	0.93	(0.61, 1.42)	0.53*	(0.32, 0.88)	1.17	(0.75, 1.81)	0.73	(0.46, 1.17)	0.60	(0.36, 1.01)
Normal (2.5-4.5 kg)	ref		ref		ref		ref		ref		ref		ref		ref		ref	
High (> 4.5 kg)	1.43	(0.36, 5.73)	3.88*	(1.02, 14.73)	2.10	(0.54, 8.19)	0.58	(0.24, 1.36)	0.79	(0.42, 1.50)	0.92	(0.46, 1.81)	0.50	(0.08, 3.24)	1.80	(0.92, 3.50)	2.28*	(1.22, 4.26)
Birth Order, %																		
1	ref		ref		ref		ref		ref		ref		ref		ref		ref	
2	1.39	(0.82, 2.35)	1.31	(0.81, 2.13)	0.73	(0.46, 1.17)	1.15	(0.80, 1.67)	1.08	(0.76, 1.53)	0.82	(0.60, 1.11)	1.41	(0.85, 2.35)	1.04	(0.70, 1.56)	0.98	(0.63, 1.52)
3-4	0.76	(0.36, 1.57)	0.96	(0.45, 2.07)	0.75	(0.37, 1.52)	0.80	(0.51, 1.25)	0.98	(0.67, 1.43)	0.44*	(0.30, 0.66)	1.57	(0.93, 2.66)	1.09	(0.68, 1.74)	1.05	(0.68, 1.62)
5+	0.54	(0.10, 2.80)	0.48	(0.07, 3.29)	0.24*	(0.06, 0.99)	0.78	(0.39, 1.56)	1.23	(0.69, 2.19)	0.46*	(0.26, 0.82)	1.31	(0.66, 2.60)	1.29	(0.77, 2.15)	0.71	(0.40, 1.23)
Parent's Characteristics																		
Mother's BMI																		
Underweight (<18.5 kg/m^2)	0.81	(0.37, 1.76)	0.33*	(0.12, 0.89)	0.76	(0.25, 2.28)	0.85	(0.25, 2.89)	0.73	(0.26, 2.05)	1.24	(0.44, 3.46)	2.97*	(1.51, 5.86)	0.42	(0.15, 1.19)	1.58	(0.23, 10.87)
Normal (18.5-24.9 kg/m^2)	ref		ref		ref		ref		ref		ref		ref		ref		ref	
Overweight (25.0-29.9 kg/m^2)	1.15	(0.74, 1.78)	1.00	(0.67, 1.51)	1.02	(0.64, 1.60)	0.88	(0.67, 1.16)	0.82	(0.64, 1.04)	1.05	(0.80, 1.36)	0.76	(0.55, 1.07)	1.38*	(1.02, 1.87)	1.52	(0.90, 2.57)
Obese (≥30.0 kg/m^2)	1.20	(0.66, 2.18)	1.20	(0.71, 2.04)	1.28	(0.60, 2.73)	0.58*	(0.41, 0.83)	0.91	(0.70, 1.19)	0.97	(0.73, 1.29)	0.82	(0.58, 1.14)	2.09*	(1.49, 2.93)	1.58*	(1.16, 2.15)
Mother's Age																		
15-24	ref		ref		ref		ref		ref		ref		ref		ref		ref	
25-29	1.23	(0.65, 2.33)	1.17	(0.67, 2.04)	1.85	(0.89, 3.85)	1.20	(0.82, 1.75)	0.88	(0.63, 1.24)	1.41	(0.98, 2.03)	0.84	(0.44, 1.58)	0.93	(0.60, 1.44)	1.10	(0.66, 1.84)
30-34	2.29*	(1.14, 4.62)	0.93	(0.40, 2.17)	2.58*	(1.04, 6.44)	1.12	(0.68, 1.86)	0.81	(0.52, 1.28)	1.83*	(1.15, 2.91)	0.87	(0.42, 1.80)	0.82	(0.49, 1.39)	1.25	(0.72, 2.16)
35 +	1.72	(0.74, 3.99)	0.52	(0.22, 1.22)	2.07	(0.76, 5.62)	1.26	(0.72, 2.21)	0.93	(0.57, 1.52)	2.36*	(1.40, 3.98)	0.82	(0.40, 1.67)	0.53*	(0.29, 0.96)	1.08	(0.59, 1.97)
Mother's level of education																		
No education	0.40	(0.02, 8.13)	0.74	(0.11, 4.96)	3.05	(0.22, 41.64)	0.92	(0.51, 1.67)	1.18	(0.65, 2.13)	0.59	(0.34, 1.01)	2.25	(0.69, 2.60)	1.14	(0.44, 2.91)	0.60	(0.19, 1.90)
Primary	ref		ref		ref		ref		ref		ref		ref		ref		ref	
Secondary	0.46	(0.07, 2.78)	1.50	(0.61, 3.72)	0.82	(0.09, 7.16)	0.97	(0.54, 1.73)	1.43	(0.84, 2.43)	1.05	(0.64, 1.73)	1.93	(0.97, 3.84)	1.51	(0.85, 2.69)	0.55*	(0.33, 0.90)
Higher	0.13	(0.02, 1.03)	1.75	(0.68, 4.53)	0.74	(0.08, 6.85)	0.69	(0.32, 1.50)	1.99*	(1.06, 3.72)	1.05	(0.56, 1.94)	1.48	(0.71, 3.08)	1.89*	(1.02, 3.52)	0.77	(0.44, 1.34)
Father's level of education																		
No education	0.11	(0.04, 3.19)	0.17	(0.04, 7.79)	1.01	(0.88, 1.14)	1.10	(0.61, 1.96)	0.90	(0.55, 1.47)	0.78	(0.47, 1.29)	1.69	(0.46, 6.25)	2.41	(0.84, 6.91)	0.66	(0.12, 3.79)
Primary	ref		ref		ref		ref		ref		ref		ref		ref		ref	
Secondary	0.16	(0.02, 1.69)	0.78	(0.05, 10.51)	2.44	(0.34, 17.30)	1.20	(0.73, 1.97)	1.01	(0.67, 1.52)	0.89	(0.58, 1.36)	0.82	(0.42, 1.58)	0.77	(0.49, 1.20)	1.32	(0.67, 2.60)
Higher	0.17	(0.01, 1.88)	0.98	(0.07, 13.86)	2.47	(0.33, 18.54)	1.53	(0.80, 2.92)	0.99	(0.59, 1.66)	1.01	(0.58, 1.75)	0.91	(0.44, 1.85)	0.87	(0.49, 1.52)	1.37	(0.58, 3.27)

Note: Data Source: Demographic and Health Surveys (2001-2012) from the Middle East and North Africa countries.

a. All estimates are survey-adjusted.
b. Data are from the most recent DHS in each country.
Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < - 2; normal defined as BMI-for-age-z-score ≥ -2 and < 1; at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2; overweight defined as BMI-for-age-z-score defined as ≥ 2.

Supplemental Table Discussion:

With the exception of Azerbaijan, every country had some aspect of mother's weight status significantly associated with child's weight status. Even when results were not significant, they showed a consistent differences between mother's weight status categories. Children with underweight mothers were more likely to be thin and less likely to be at risk of overweight and overweight. Children with obese mothers were less likely to be thin and more likely to be overweight. In Jordan children with underweight mothers were more likely to be thin (2.97[1.51, 5.86]), and children with obese mothers were more likely to be overweight (1.58[1.16, 2.15]). Birth weight as an indicator of unhealthy weight (thinness or overweight) was also a pattern seen across most countries. Children born with low birth weight were more likely to be thin, and conversely, children born categorized as high birth weight were more likely to be overweight.

Specific patterns within countries are demonstrated with child's weight status. The weight status of children in Turkey was primarily impacted by mother's weight status. In Egypt several other factors significantly affected child's weight status, including children with a higher birth order and older mothers more likely to be categorized as overweight. Jordan's population was impacted by regional differences with children living in urban environments less likely to be overweight, compared to children living in rural areas.

Chapter 5. Clustering of Unhealthy Weight in the Middle East and North African Region: Assessment of Nutritional Status and Associated Factors

ABSTRACT

Background: Previous studies have documented the emergence double-burden households, or households which have both underweight and overweight or obese persons. This study examines the weight status of mother-child pairs in the Middle East and North African (MENA) Region, one of the world regions most severely affected by emergence of overweight and obesity among adults.

Methods: We used nationally representative data from the most recent Demographic and Health Survey (2001-2012) in the six countries' in the MENA Region (n=30,209) with available data (Azerbaijan, Egypt, Jordan, Mauritania, Morocco, and Turkey). We examined prevalence of different types of weight status pairs among mother and their child under age 5 years old. We defined under-nutrition households as underweight mother and thin child; over-nutrition households as overweight or obese mother and overweight child; and double burden households as underweight mother and overweight child or overweight or obese mother and thin child). We used survey-adjusted logistic regression to quantify the independent predictors of these types of households.

Findings: Across the MENA region,7.8% of mother-child pairs were double burden and 8.3% were over-nutrition pairs, but only 0.7% were under-nutrition pairs. Children living in urban settings (2.31[1.29,4.16]) and small at birth (2.81[1.70,4.67]) were more likely to be in a under-nutrition household. Children with one or more older siblings were more likely to be in a double burden households. Households with older mothers, compared to mothers age 15-24, were more likely to be over-nutrition or double burden households.

Interpretation: 7.8% of households are experiencing both extremes of the malnutrition continuum, with the highest prevalence of double burden households in Mauritania and the lowest in Turkey. Characteristics of double-burden pairs included child's low birth weight and higher birth order and mother's older age, and lower education. The different associated factors of different household pairs underscores the need for research requiring novel and effective strategies aimed at reducing the gaps of those inequalities and promoting better nutrition for both mothers and children simultaneously.

Chapter 5. Clustering of Unhealthy Weight in the Middle East and North African Region: Assessment of Nutritional Status and Associated Factors

BACKGROUND

As many low- and middle-income countries are experiencing continued high prevalence of underweight while also seeing the emergence of overweight, the ideas of a double burden has been proposed(30, 31, 87, 88). Specifically this means that some communities and even households in countries undergoing the nutrition transition are seeing both underweight and overweight or obesity(29-31). The double burden of malnutrition has been hypothesized to be a manifestation of secular population-level shifts from underweight to overweight(31).

At the household level, the possibility of a double burden seems counter-intuitive, as household members share a home environment with common social, environmental, and economical factors(i.e. neighborhood walkability, socio-economic status, and number of home cooked meals). Mothers and children especially tend to share resources and are in closer contact than other household members and thus hypothesize to be less likely to differ in weight status(32). Indeed, double-burden households have been documented in Asia, Latin America, and Africa(29, 31, 59-62), with a prevalence between 2% in Bangladesh to 25% in Guatemala(63). Within countries, double burden households are more often found in urban areas among the highest income levels(30, 31). Dieffenbach & Stein hypothesize that double burden households, defined as stunted child/overweight mother, are not independent of the prevalence of overweight mothers and stunted children in the general population(64).

A recent analysis of adult obesity trends using a combination of nationally-representative surveys, longitudinal studies, and literature reviews from 188 countries identified the Middle East and North African (MENA) region as an area particularly affected by overweight and obesity, with 3 countries in the region, Libya, Qatar, and Kuwait, having female (age 20 or older) obesity prevalence rates exceeding 50% (levels higher than the United States at 33%) (4). The

authors argue that the MENA region demonstrates ‘distinct regional patterns’ for weight status of adults as well as in child an adolescent obesity(4). Specific patterns included a prevalence of obesity in girls(ages 20 and under) at 10.2% for the region with individual country levels varying between 23%(Kuwait) and 5.7%(Turkey)(4). Estimates of overweight and obesity among children are also high, though in many countries in the region thinness continues to affect many children. The prevalence of overweight and obesity among children ages 6-18 years in the Khartoum state of Sudan has been estimated between 10-27% and 2-9% respectively(15); at the same time under-nutrition persists especially in Ethiopia and Morocco, with cross-sectional surveys reporting between 25% to 38% of children ages 0 to 5 being underweight(16).

The Middle East and North Africa (MENA) region consists of mainly middle-income countries (Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Yemen, United Arab Emirates, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Syria, and Tunisia, with broader definitions also including Armenia, Azerbaijan, Cyprus, Djibouti, Georgia, Mauritania, Somalia, Sudan, Turkey, and Western Sahara)(18, 36). These countries together constitute a complex region linked by broad similarities of climate, religion, and culture(17). Countries in the Middle East and North Africa constitute a complex region linked by broad similarities of climate, religion and culture(17). While the region is loosely united around these broad similarities, it is also true that subregional divisions derive from very different histories, cultural systems and political aspirations(17, 37). The most notable defining characteristics among MENA countries are the availability of oil resources and the size of their native populations(38). Based on these two factors, other researchers have suggested classifying the group into three main groups: resource-rich, labor-abundant countries; resource-rich, labor-importing countries; and resource-poor countries(38, 39). While the region is loosely united around these broad

similarities, it is also true that subregional divisions derive from very different histories, cultural systems and political aspirations(17, 37). The region is diverse, with some countries such as Syria, Iraq, Libya, and Yemen suffering from heavy violence (spilling over into Jordan and Lebanon), while others are in the midst of political transitions (Tunisia and Egypt) with slow economic growth(17, 37).

The MENA Region is hypothesized to be an area shifting from a population with a high proportion of underweight adults towards a high proportion obese adults(4, 33, 34); thus, the region is a potential area of research to examine the weight status of mother-child pairs. The few existing reports indicate high levels of both underweight and overweight ranging from 10% to 25% (59, 89, 90). Double burden of underweight and overweight within households present an even more complex problem because of the seemingly divergent interventions and target solutions employed for the two types of malnutrition. This study examines the weight status of mother-child pairs in the Middle East and North African (MENA) Region, one of the world regions most severely affected by emergence of overweight and obesity among adults.

METHODS

Data are from the Demographic and Health Survey (DHS) for 6 MENA countries where the surveys have been implemented and information collected on the health of women and children, including direct anthropometric measurements. DHS are nationally representative cross-sectional surveys conducted using, multi-stage probability sampling. The surveys have been fielded in low- and middle-income countries since 1985 and collect information on the health of women and children, including direct anthropometric measurements. DHS data were available for nine of the twenty-eight MENA countries: Azerbaijan (2006), Egypt (2008), Jordan (2012), Mauritania (2000-2001), Morocco (2004), and Turkey (2003). Armenia (2010), Tunisia

(1990), and Yemen (1992) were excluded from this analysis because anthropometric data on mothers were not collected.

Participants and Settings

DHS survey recruitment and measurements are discussed previously in Chapter 3(77). The final analytic sample for the mother / child pairs in the 6 MENA countries was 30,209.

Measurement and Variables

Anthropometric variables were recorded by trained personnel in all countries. Mothers' and children's weight were measured using solar-powered mother-baby scales with an accuracy of ± 100g. Specifications of the scale used and measurements are delineated in previously mentioned Chapter 3(77).

The study focuses on the weight patterns of mother-child pairs. We categorized mother-child pairs as under-nutrition household, double burden household, and over-nutrition household. Under-nutrition households were defined as an underweight mother with a thin child. Double burden households defined as 'discordant pairs' of mother-child pairs such as an obese mother with a thin child(n=747), an overweight mother with a thin child(n=1554), and an underweight mother with an overweight child(n=42). Over-nutrition households were defined as an overweight or obese mother with an overweight child. To characterize the other types of weight patterns for a fuller picture of the distribution of weight status, we also distinguished normal weight households, mixed household with one normal weight member, and mixed household with one over-nutrition member. Normal weight households were defined as a normal weight mother with a normal weight child. Mixed households with one normal weight member were defined as either a normal weight mother with a thin, at risk of overweight, or overweight child and normal weight children with underweight, overweight, or obese mothers. Mixed households

with one over-nutrition member were defined as a child who was at risk of overweight with either an overweight or obese mother.

Secondary variables included child and parent characteristic variables. Child characteristic variables included birth weight, region (urban versus rural), and birth order (i.e., 1, 2, 3-4, 5+). For birth weight, we categorized children using CDC birth weight categories: low birth weight was defined as < 2.5 kg, normal birth weight was defined as 2.5-4.5 kg, and high birth weight was defined as > 4.5 kg(78). Parent characteristic variables included mother's weight status, mother's age (i.e., 15-24, 25-29, 30-34, 35+), mother's level of education, and father's level of education. For mother's weight status: underweight was defined as < 18.5 kg/m^2, normal was defined as 18.5-24.9 kg/m^2, overweight was defined as 25.0-29.9 kg/m^2, an obese was defined as $\geq$ 30 kg/m^2. Mother's and father's education were left in the categories used by DHS: no education, primary, secondary, and higher.

Analysis

Descriptive analyses were conducted for all variables; prevalence and mean values for the variables were calculated.[4] The overall regional datafile was thus survey-adjusted. The prevalence of under-nutrition household, double-burden household, and over-nutrition household were calculated as the proportion of mother-child pairs in each country, as well as regionally.[5]

Individual country files were used for the country-level analyses and were survey-adjusted using standard DHS survey adjustments and all analyses was done using *svy* commands.

[4] Surveys since 2003 have included in the children's files the BMI-z score for sex and age produced by the WHO in 2006. For surveys done prior to 2003, DHS provided a separate datafile, "Height and Weight Scores," which provides the WHO child growth standards. These separate "Height and Weight Scores" files were merged with the children's original datafiles for each country survey year.

[5] Children data files were used for analysis and thus for household pairs containing mothers with multiple children under 5, there was a mother-child pair created and analyzed based upon each child.

A regional file was created by pooling all country files.[6] The overall regional datafile was survey-adjusted. In the analytic approach, multinomial logistic regression analyses (with all variables kept) was used to evaluate the associations between mother/child pairs and child/parent characteristics. Odds ratios were presented along with 95% confidence intervals.

All analyses were conducted using STATA version 13.0 software (STATA Corp, College Station, TX, US).

RESULTS

The demographic characteristics of children under five in under-nutrition, normal weight, mixed households with one normal weight member, mixed households with one over-nutrition member, over-nutrition, and double burden households for the MENA region are shown in Table 1.

In under-nutrition households, children were on average 2.03 years old, with 31% being first born children. The proportion of normal birth weight children was 69%. Under-nutrition households had a high prevalence of households in rural settings (67%). 57% of mothers in under-nutrition households were uneducated with a relatively equal distribution of ages for mothers. Under-nutrition households had a higher prevalence of uneducated fathers than all other levels of education (39%).

In normal weight households, children were on average 2.02 years old and 38% of children were first born. The proportion of normal birth weight children was 85%. Normal

[6]For the pooled regional file, the individual country children data files were de-normalized, and the provided sample weight was adjusted for overall population using the United States Census Bureau International Programs database(72). Once files were appended together, the cluster variable was modified so that each stratum could stand alone based upon the country.

weight households had a higher prevalence of father's with a secondary education than all other levels of education (41%). 7% of mothers in normal weight households had a higher education degree.

In mixed households with one normal weight member, children were on average 2.00 years old and 31% of children were first born. The proportion of normal weight children was 85%. These households had a higher prevalence of father's with a secondary education than all other levels of education (42%). 9% of mothers in these households had a higher education degree.

In mixed households with one over-nutrition member, children were on average 2.06 years old and 27% were first born. The proportion of normal weight children was 86%. These households had a higher prevalence of father's with a secondary education (44%). 10% of mothers in these households had a higher education degree.

In over-nutrition households, children were on average 1.89 years old and 29% of children were first born. The proportion of normal weight children was 85%. Over-nutrition households had a higher prevalence of father's with a secondary education(50%). 13% of mothers in these households had a higher education degree.

In double burden households, children were on average 1.75 years old and 29% were first born. The proportion of normal weight children was 83%. Double burden households had a higher prevalence of father's with a secondary education(45%). 9% of mothers in double burden households had a higher education degree.

(Place Table 1 here)

The characteristics of each mother-child pair stratified by country using the most current DHS Survey is illustrated in Table 2. Child and parent characteristics were diverse across the region.

Across settings, countries illustrates similar patterns in child birth weight amongst household types. All household types with the exception of under-nutrition (normal weight, mixed household with one normal weight member, mixed household with one over-nutrition member, over-nutrition, and double burden) had the highest prevalence of households with normal birth weight children. Under-nutrition households had the highest prevalence of households with low birth weight children.

The majority of countries had a higher prevalence of over-nutrition and double burden households living in urban settings. In contrast, Egypt had a slightly higher prevalence of over-nutrition and double burden households living in rural settings.

In regards to parent characteristics, countries were diverse particularly when evaluating parental education.

Across the majority of countries, under-nutrition households had a high prevalence of uneducated mothers particularly in Egypt, Mauritania, and Morocco with percentages ranging between 57% and 79%. In contrast, Jordan's under-nutrition households had the highest prevalence of mothers with a secondary education (65%). Half of the countries in the region(Egypt, Azerbaijan, and Jordan), had double burden households with the highest prevalence of mothers holding a secondary education. In contrast, Mauritania and Morocco's double burden households had a high percentage of uneducated mothers.

Across household types, countries were consistent with the highest prevalence of father's education was the same level although the type of education differed between countries.

Mauritania, Azerbaijan, Egypt, and Jordan had all households with the highest prevalence of fathers holding a secondary degree. The pattern holds true for Morocco and Turkey however across household types in these countries the highest prevalence of fathers were uneducated and holding a primary degree respectively.

(Place Table 2 here)

Across the MENA region, 7.8% of mother-child pairs were double burden and 8.3% were over-nutrition pairs, but only 0.7% were under-nutrition pairs. Prevalence of each type of household pair differed by country. Mauritania had 12% of household pairs being categorized as double burden, while Turkey had the lowest double burden households at just over 2%. In regards to over-nutrition households, 15% of mother-child pairs in Egypt were over-nutrition versus less than 3%. Throughout all countries there was a small proportion of household pairs defined as under-nutrition households (Turkey: 0.04% to Mauritania: 3.1%).

(Place Figure 1 here)

Figure 2 shows relationships between mother-child pairs and child and family characteristics: **A.** child's birth weight, **B.** mother's age, **C.** child's birth order, and **D.** father's education.

Panel **A** shows the proportion of undernutrition households in the MENA region was highest among high birth weight children, (70%), and decreased considerably with each birth weight category. This pattern was consistent across other household types but with the highest proportion among high birth weight children between 80 and 90%.

As shown in Panel **B**, overnutrition and double burden households were most prevalent among households with mothers age 25-29 (between 30 and 40%). Normal weight households were most prevalent among households with mothers in the both age categories of 15-24 and 25-

29 (between 30 and 40%). Undernutrition households showed no major differences according to their mother's age.

Panel **C** shows the proportion of each household type according to child's birth order. For the majority of household types(normal, overnutrition, and double burden households) the lowest prevalence(10-20%) of each household was among those where the child has more older siblings, with slight increased differences. Between 20 and 30% of households were undernutrition with no major differences according to child birth order.

Panel **D** shows the proportion of each household type according to the father's education. For the majority of household types (normal, overnutrition, and double burden households), between 40 and 50% of households had father's with higher education. In contrast, the highest prevalence of undernutrition households was among households with uneducated fathers.

(Place Figure 2 here)

Table 2 shows the odds of a household being in one of the 3 unhealthy weight types- under-nutrition, over-nutrition, or double burden, relative to being in a normal-weight type. Households in urban areas were more likely to be under-nutrition households (2.31 [1.29, 4.16])). Households where the child had been small at birth were more likely to be under-nutrition (2.81 [1.70, 4.67]) or double burden households (1.25 [1.05, 1.50]) but less likely to be over-nutrition households (0.72 [0.58, 0.88]). Households where the child had been large at birth were more likely to be over-nutrition households (2.10 [1.54, 2.88]). Households where the child has more older siblings were more likely to be double burden (2: 1.21[1.01, 1.45]; 3-4: 1.50[1.24,1.82]; 5+: 1.40[1.09, 1.80]) or over-nutrition households (2: 1.22[1.03,1.45]; 3-4: 1.23[1.03,1.48]). Older mothers were more likely to be in over-nutrition (25-29:1.58[1.31,1.90]; 30-34: 2.03[1.65,2.50]; 35+:2.48[1.94,3.15]) or double burden households (25-

29:1.45[1.20,1.75]; 30-34: 1.65[1.33,2.05]; 35+: 2.33[1.83,2.97]). Mothers with no education (1.40[1.10,1.78]) or secondary education(1.35[1.11,1.64]) were more likely to be in double burden households compared to mothers with a primary education. Households where the father had no education (1.36 [1.04,1.78]) or a secondary degree (1.33[1.05,1.70]) were more likely to be double burden households compared to father's with a primary education.

(Place Table 3 here)

DISCUSSION

This study examines the weight status of mother-child pairs in the Middle East and North African (MENA) Region by providing the most recent evidence about weight distribution of mothers and young children in the MENA region using nationally representative data. We found that 17% of mother-child pairs are either both undernourished, both overnourished, or are experiencing a double burden. During 2001-2012, 7.85% of households were experiencing double burden of both extremes of the malnutrition continuum. The highest and lowest prevalence of double-burden households was in Mauritania and Turkey respectively. Characteristics of double-burden pairs included child's low birth weight and higher birth order and mother's older age, and lower education. Consistent with work in Africa on double burden households(91) , most of the double burden pairs consisted of an overweight or obese mother and an underweight child, in both regional and national estimates.

The prevalence of double burden households in the MENA region was not much higher than that found by other studies, with DHS data from Africa, Asia and Latin America estimating the percentage of households categorized as double burden generally below 10% (31, 91, 92). We found double burden households to consist more commonly of overweight mothers with thin children(n=1554) rather than obese mothers with thin children(n=742), which is consistent with

other research(25). Between countries the prevalence of each household differed considerably with Egypt having a prevalence of over-nutrition households near 16% versus close to 10% of households were categorized as double burden. In contrast Mauritania has a low prevalence of over-nutrition households (~2%) versus 12% categorized as double burden households.

Our findings demonstrate over-nutrition and double burden households have some similar and some differing child and parent characteristics. Figure 2 demonstrated similar patterns for over-nutrition and double burden households in regards to child's birth weight, child's birth order and mother's age. However, double burden households were more likely in households with mothers and fathers either having no education or a secondary degree, when compared to primary education. The small proportion of household pairs defined as under-nutrition households(0.4 % to 3.1%) across settings and at a regional level(0.7%) is hypothesized to be of lower priority in the region.

The coexistence of under- and over-nutrition in the same household is difficult to study; the concept of evaluating weight status based upon mother-child pairs has been recently challenged by Dieffenbach & Stein(64) The authors argue that double burden households types, such as overweight mothers with stunted children, are not independent and their prevalence depends on the prevalence of its components(64, 90). Despite this argument, the economic, biologic, and social process which contribute to the development of these household types should not be ignored(31, 64).

As mentioned in Chapter 3(77), a limitation of this study was the lack of current available DHS data for seventeen of the twenty-eight MENA countries. Libya, Qatar, and Kuwait, identified as having particularly high prevalence of female obesity in sub-national studies, nearing 50%, lacked DHS data(4). Even among the countries with DHS data, Tunisia and Yemen

had more 20 years old, providing a potentially outdated picture of weight status. Other sources of data that can be used to estimate weight status in many MENA include using other multi-country surveillance programs and a comprehensive search of nationally representative and sub-national surveys(4, 77). Despite this limitation, the significant child and parent independent predictors of child weight status in the region provide evidence for concern with this specific population.

Further studies need to be conducted with more up-to-date datasets used for analysis of household pairs in the MENA Region. Both the increasing prevalence of over-nutrition and under-nutrition remaining static shown in MENA by Chapter 3 and 4(93, 94) point to the possibility that double burden homes will be a growing problem. As nutrition-related disease distribution shifts, so must the objectives of policies and programs(32).

The different associated factors of different household pairs underscores the need for research requiring novel and effective strategies aimed at reducing the gaps of those inequalities and promoting better nutrition for both mothers and children simultaneously. Nutrition interventions also need to be aware of differences amongst settings(30, 95), with variations in terms of education of mothers in different countries and household pair composition. The extent to which cultural differences in patterns across countries with different levels of economic growth is not yet clear(30). Further exploration is needed to understand the specific causes of the double burden condition and to make appropriate policy recommendations.

Chapter 5. Tables and Figures

Table 1. Characteristics of mother-child pairs in MENA region pooling six most current DHS country surveys (2001-2012)

	Under-Nutrition Household	Normal Weight Household	Mixed Household with one Normal Weight	Mixed Household with one Over-nutrition	Over-Nutrition Household	Double Burden Household
Child Characteristics						
Sex, %						
Male	51.9	48.0	50.4	51.2	51.9	53.9
Female	48.1	52.0	49.6	48.8	48.1	46.1
Age, y	2.03±0.12	2.02±0.02	2.00±0.02	2.06±0.03	1.89±0.03	1.75±0.04
Birth weight, %						
Low (<2.5 kg)	28.3	12.4	11.3	8.7	9.5	14.3
Normal (2.5-4.5 kg)	69.2	84.5	85.3	85.8	84.9	83.1
High (> 4.5 kg)	2.5	3.1	3.3	5.5	5.6	2.6
Area, %						
Urban	33.2	47.8	50.2	53.4	48.6	49.2
Rural	66.8	52.2	49.8	46.6	51.4	50.8
Birth Order, %						
1	31.0	38.0	31.4	27.4	28.7	29.1
2	21.7	27.6	26.7	25.9	27.9	24.9
3-4	25.5	22.3	27.5	30.7	31.2	31.7
5+	21.8	12.1	14.4	16.0	12.2	14.3
Parental Characteristics						
Mother's Age, %						
15-24	28.5	35.3	26.8	21.6	22.7	23.0
25-29	25.6	34.1	32.7	32.2	34.2	33.6
30-34	26.4	18.4	22.1	25.4	24.2	21.7
35 +	19.5	12.2	18.4	20.8	18.8	21.6
Mother's level of education, %						
No education	57.1	32.0	29.8	25.6	21.9	31.5
Primary	20.1	28.1	26.2	28.0	20.0	14.7
Secondary	18.2	32.6	35.2	36.5	45.6	44.6
Higher	4.6	7.4	8.9	10.0	12.6	9.1
Father's level of education, %						
No education	38.8	18.4	16.4	12.3	13.1	19.4
Primary	22.1	29.0	28.4	30.2	21.8	20.5
Secondary	25.3	40.9	41.9	44.5	49.8	44.8
Higher	13.8	11.7	13.2	13.0	15.3	15.3
n	220	6182	15145	3790	2503	2342

Note: Data Source: Demographic and Health Surveys (2001-2012) from the Middle East and North Africa countries.

a. All estimates are survey-adjusted.
b. Data are from the most recent DHS in each country (n=6).
c. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < - 2; normal defined as BMI-for-age-z-score ≥ -2 and < 1; at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2; overweight defined as BMI-for-age-z-score defined as ≥ 2.
d. Using CDC BMI standards for adults: underweight defined as < 18.5 kg/m^2; normal defined as 18.5-24.9 kg/m^2; overweight defined as 25.0-29.9 kg/m^2; obese defined as ≥ 30 kg/m^2.
e. Under-nutrition households were defined as underweight mothers with thin children. Normal weight households were defined as normal weight mothers with normal weight children. One normal weight households were defined as households containing at least one of the mother/child pair being normal weight (normal weight mothers with thin, at risk of overweight, or overweight children and normal weight children with underweight, overweight, or obese mothers). One overweight/obese member households were defined as children who were at risk of overweight with either overweight or obese mothers. Over-nutrition households were defined as overweight or obese mothers with overweight children. Double burden households defined as discordant pairs of mother/children such as obese mothers with thin children(n=747), overweight mothers with thin children(n=1554), and underweight mothers with overweight children(n=42).

Table 2. Characteristics of mother-child pairs by individual country using the most current DHS country survey (2001-2012)

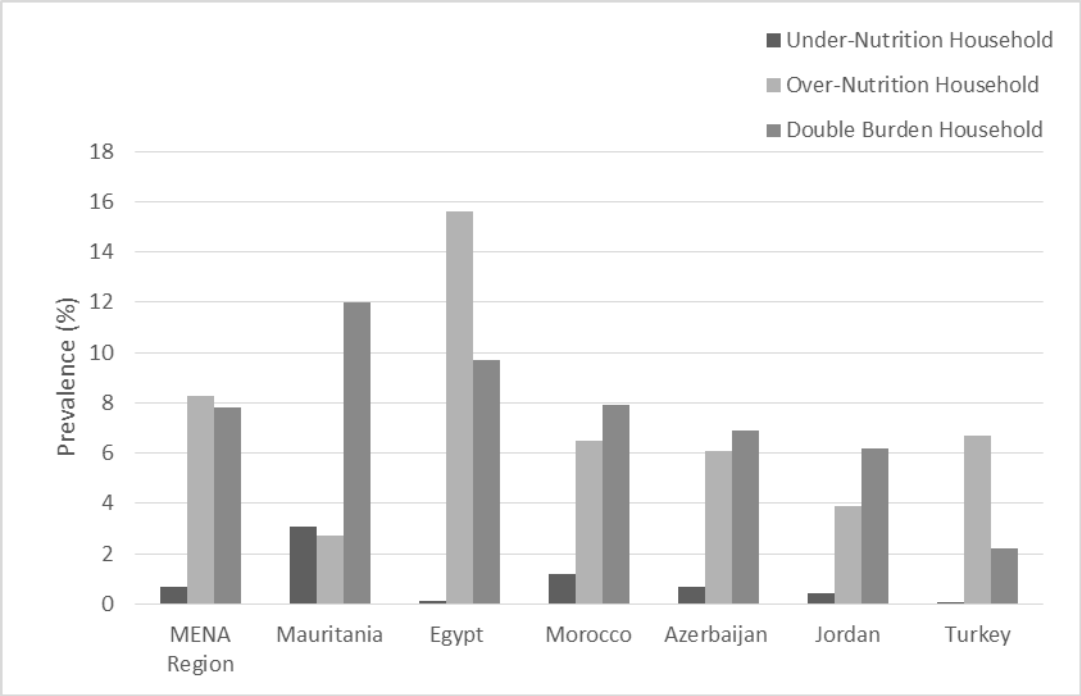
	Mauritania 2000-2001						Turkey 2003						Morocco 2004					
	Under-Nutrition Household	Normal Weight Household	Mixed Household with one Normal Weight	Mixed Household with one Over-nutrition	Over-Nutrition Household	Double Burden Household	Under-Nutrition Household	Normal Weight Household	Mixed Household with one Normal Weight	Mixed Household with one Over-nutrition	Over-Nutrition Household	Double Burden Household	Under-Nutrition Household	Normal Weight Household	Mixed Household with one Normal Weight	Mixed Household with one Over-nutrition	Over-Nutrition Household	Double Burden Household
Child Characteristics																		
Sex, %																		
Male	53.5	48.8	50.2	54.9	47.8	57.0	50.0	48.3	52.0	50.2	61.4	58.0	46.7	48.5	49.2	48.8	54.3	50.1
Female	46.5	51.2	49.8	45.1	52.2	43.0	50.0	51.7	48.0	49.8	38.6	42.0	53.3	51.5	50.8	51.2	45.7	59.9
Age, y	1.70±0.16	1.99±0.06	1.84±0.04	1.97±0.10	1.65±0.16	1.57±0.10	1.50±0.50	2.05±0.05	2.09±0.04	2.18±0.05	1.79±0.09	1.26±0.22	1.92±0.18	2.17±0.04	2.03±0.03	2.03±0.07	1.84±0.07	2.07±0.07
Birth weight, %																		
Low (<2.5 kg)	61.0	33.1	30.0	22.6	21.8	34.3	0	11.9	11.8	7.3	12.5	8.6	25.0	12.7	11.7	9.1	5.9	9.4
Normal (2.5-4.5 kg)	39.0	64.9	68.9	75.9	71.3	63.6	100	84.9	84.4	85.3	80.4	91	69.8	83.0	84.3	83.9	79.2	84.5
High (> 4.5 kg)	0	2.0	1.3	1.5	6.9	2.1	0	3.1	3.8	7.3	7.2	0	5.2	4.2	4.0	7.0	14.9	6.0
Area, %																		
Urban	21.5	36.0	45.2	54.7	47.6	59.7	100	64.0	66.4	66.2	67.9	60.3	24.6	42.9	49.5	64.7	61.1	59.5
Rural	78.5	64.0	54.8	45.3	52.4	40.3	0	36.1	33.6	33.8	32.1	39.7	75.4	57.1	50.5	35.3	38.9	40.5
Birth Order, %																		
1	30.1	21.4	18.6	14.9	17.0	15.3	50.0	42.4	32.2	26.0	27.1	33.4	30.0	29.7	27.8	24.5	19.9	17.1
2	16.7	17.5	17.6	13.8	6.9	14.9	0	28.8	28.5	26.1	25.3	20.7	26.5	22.9	25.1	20.4	25.4	23.0
3-4	19.5	28.0	26.5	35.1	39.5	30.0	50.0	17.8	25.4	28.9	30.4	29.5	23.8	27.5	26.5	35.8	34.0	37.3
5+	33.8	33.2	37.4	36.3	36.5	39.8	0	11.0	14.0	18.9	17.2	16.3	19.7	20.0	20.6	19.4	20.8	22.6
Parental Characteristics																		
Mother's Age, %																		
15-24	38.3	28.1	23.9	16.5	11.0	14.3	0	37.2	27.0	21.5	23.8	37.5	18.7	23.8	23.3	16.4	16.6	11.0
25-29	15.0	26.8	22.8	21.7	38.3	26.4	0	36.0	34.0	33.0	29.9	30.3	35.0	26.8	25.4	20.8	26.4	24.0
30-34	25.4	21.7	25.6	25.7	31.5	24.1	100	19.1	23.2	27.1	28.8	13.5	20.0	24.3	23.7	26.4	23.8	25.7
35 +	21.4	23.3	27.8	36.0	19.2	35.3	0	7.7	15.7	18.4	17.5	18.8	26.3	25.0	27.6	36.4	33.2	39.3
Mother's level of education, %																		
No education	79.4	68.9	63.3	59.7	60.0	60.4	0	19.5	20.9	24.9	22.4	26.9	67.3	65.4	63.7	50.5	52.0	62.9
Primary	18.0	24.8	25.0	26.8	23.9	24.5	50.0	51.2	56.6	52.0	62.1	49.7	23.6	17.6	17.2	23.5	18.8	18.7
Secondary	2.3	5.7	10.7	12.2	10.8	13.7	0	24.0	18.3	20.4	11.4	21.1	9.0	13.3	15.8	21.1	24.3	15.4
Higher	0.3	0.6	1.0	1.3	5.3	1.4	50.0	5.4	4.2	2.6	4.0	2.3	0	3.7	3.3	4.9	4.9	3.0
Father's level of education, %																		
No education	41.8	38.0	34.5	18.9	12.4	22.6	0	6.4	5.7	5.4	7.0	6.0	46.2	47.1	44.9	35.6	35.5	49.3
Primary	9.8	10.6	9.9	12.1	7.9	8.3	0	44.3	51.3	50.1	46.1	52.8	43.9	28.9	29.3	30.8	26.8	28.2
Secondary	6.3	9.2	13.1	14.2	13.3	20.4	50.0	38.6	34.6	37.0	39.1	35.1	9.9	17.2	19.0	25.4	28.2	15.9
Higher	42.1	42.4	42.6	54.8	66.4	48.7	50.0	10.7	8.4	7.5	7.8	6.1	0	6.7	6.8	8.2	9.5	6.7
n	103	792	1692	203	88	393	2	983	1918	748	268	89	62	1216	2789	493	345	422

	Azerbaijan 2006						Egypt 2008						Jordan 2012					
	Under-Nutrition Household	Normal Weight Household	Mixed Household with one Normal Weight	Mixed Household with one Over-nutrition	Over-Nutrition Household	Double Burden Household	Under-Nutrition Household	Normal Weight Household	Mixed Household with one Normal Weight	Mixed Household with one Over-nutrition	Over-Nutrition Household	Double Burden Household	Under-Nutrition Household	Normal Weight Household	Mixed Household with one Normal Weight	Mixed Household with one Over-nutrition	Over-Nutrition Household	Double Burden Household
Child Characteristics																		
Sex, %																		
Male	57.0	44.4	55.0	66.9	62.5	52.8	53.2	47.1	49.4	51.7	48.5	54.3	61.1	52.0	49.6	54.6	63.4	52.9
Female	43.0	55.6	45.0	33.1	37.5	47.2	46.8	53.0	50.6	48.3	51.5	45.7	38.9	48.0	50.4	45.5	36.6	47.1
Age, y	2.00±0.40	1.95±0.07	1.87±0.06	2.11±0.15	2.53±0.11	1.37±0.15	2.23±0.37	1.89±0.04	1.93±0.02	1.97±0.04	1.91±0.04	1.77±0.05	2.57±0.43	2.09±0.06	2.17±0.04	1.94±0.09	1.79±0.17	1.90±0.12
Birth weight, %																		
Low (<2.5 kg)	0	12.8	7.8	3.9	6.5	13.8	14.9	10.0	9.7	11.0	8.9	16.0	39.9	16.3	13.5	7.8	6.7	17.7
Normal (2.5-4.5 kg)	100	85.6	89.9	83.2	88.7	83.6	85.1	86.4	87.4	87.1	87.8	81.7	59.0	82.1	83.9	87.3	88.5	80.4
High (> 4.5 kg)	0	1.7	2.3	12.8	4.7	2.6	0	3.6	2.9	1.9	3.3	2.3	1.1	1.6	2.6	4.9	4.8	1.9
Area, %																		
Urban	36.3	42.8	46.4	60.6	72.4	56.0	27.5	25.3	35.6	38.4	40.4	41.9	97.9	82.3	81.7	78.6	77.8	83.5
Rural	63.7	57.2	53.6	39.4	27.6	44.0	72.5	74.7	64.4	61.6	59.6	58.1	2.1	17.7	18.3	21.4	22.2	16.5
Birth Order, %																		
1	13.2	48.1	43.4	41.6	47.8	39.4	36.7	38.2	33.0	29.2	30.1	32.4	45.0	29.3	20.1	21.7	13.0	17.0
2	54.9	30.1	35.9	28.4	34.2	37.4	0	29.7	26.3	27.5	29.0	26.0	31.0	25.4	20.1	17.1	23.0	22.3
3-4	31.9	19.7	19.0	26.1	16.8	20.3	32.3	24.3	29.6	31.1	31.3	31.1	16.1	29.5	34.7	32.2	33.9	34.3
5+	0	2.1	1.7	3.9	1.2	0.3	31.0	7.9	11.1	12.1	9.6	10.5	7.8	15.9	25.0	28.9	30.0	26.4
Parental Characteristics																		
Mother's Age, %																		
15-24	53.1	45.2	34.2	28.8	21.8	28.8	39.5	40.3	28.8	23.3	23.6	24.3	24.3	23.5	14.2	12.0	9.9	17.1
25-29	30.0	33.0	35.0	24.9	43.8	32.9	4.6	37.2	35.4	34.5	36.3	37.8	48.1	30.6	26.9	28.6	27.7	21.4
30-34	11.9	14.9	19.0	27.1	21.0	21.4	40.3	13.2	20.2	23.4	23.0	21.5	24.5	25.8	27.0	31.2	28.2	29.1
35 +	5.0	6.9	11.7	19.1	13.4	16.9	15.6	9.4	15.7	18.8	17.1	16.4	3.1	20.1	31.8	28.2	34.2	32.4
Mother's level of education, %																		
No education	0	6.8	0.5	0	4.4	1.0	57.4	35.9	27.2	23.0	18.3	25.8	5.3	1.1	1.9	1.5	0.4	2.1
Primary	6.1	1.9	2.7	0.4	0	3.0	19.4	10.6	10.5	11.5	9.2	8.7	0	5.7	6.6	6.1	13.1	6.1
Secondary	94	84.3	83.7	79.8	78.4	89.1	23.3	44.8	50.0	50.2	57.0	54.1	47.6	64.2	61.5	58.0	53.0	63.5
Higher	0	13.1	13.1	19.7	17.2	6.8	0	8.7	12.4	15.2	15.5	11.4	47.2	29.0	30.0	34.4	33.6	28.4
Father's level of education, %																		
No education	0	0.4	0.6	0	0	0.7	57.4	22.2	15.7	14.5	12.5	15.7	0	0.8	1.1	0.9	0.2	1.2
Primary	0	0.1	0.4	0.1	0.3	0	0	17.8	15.8	16.5	15.4	15.5	3.1	9.6	10.8	9.1	9.6	13.8
Secondary	100	83.8	79.4	79.2	75.3	82.1	34.9	49.5	52.2	52.6	54.8	52.3	64.6	67.0	65.6	60.0	68.0	57.9
Higher	0	15.7	19.6	20.7	24.4	17.2	7.7	10.5	16.3	16.4	17.4	16.5	32.3	22.7	22.6	30.3	22.2	27.2
n	14	537	982	140	117	133	12	1319	4325	1397	1468	917	27	1335	3439	809	244	388

Note: Data Source: Demographic and Health Surveys (2001-2012) from the Middle East and North Africa countries.

a. All estimates are survey-adjusted.
b. Data are from the most recent DHS in each country.
c. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < - 2, normal defined as BMI-for-age-z-score ≥ -2 and < 1, at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2, overweight defined as BMI-for-age-z-score defined as ≥ 2.
d. Using CDC BMI standards for adults: underweight defined as < 18.5 kg/m^2, normal defined as 18.5-24.9 kg/m^2, overweight defined as 25.0-29.9 kg/m^2, obese defined as ≥ 30 kg/m^2.
e. Under-nutrition households were defined as underweight mothers with thin children. Normal weight households were defined as normal weight mothers with normal weight children. One normal weight households were defined as households containing at least one of the mother/child pair being normal weight (normal weight mothers with thin, at risk of overweight or overweight children and normal weight children with underweight, overweight, or obese mothers). One overweight/obese member households were defined as children who were at risk of overweight with either overweight or obese mothers. Over-nutrition households were defined as overweight or obese mothers with overweight children. Double burden households defined as discordant pairs of mother/children such as obese mothers with thin children(n=747), overweight mothers with thin children(n=1554), and underweight mothers with overweight children(n=42).

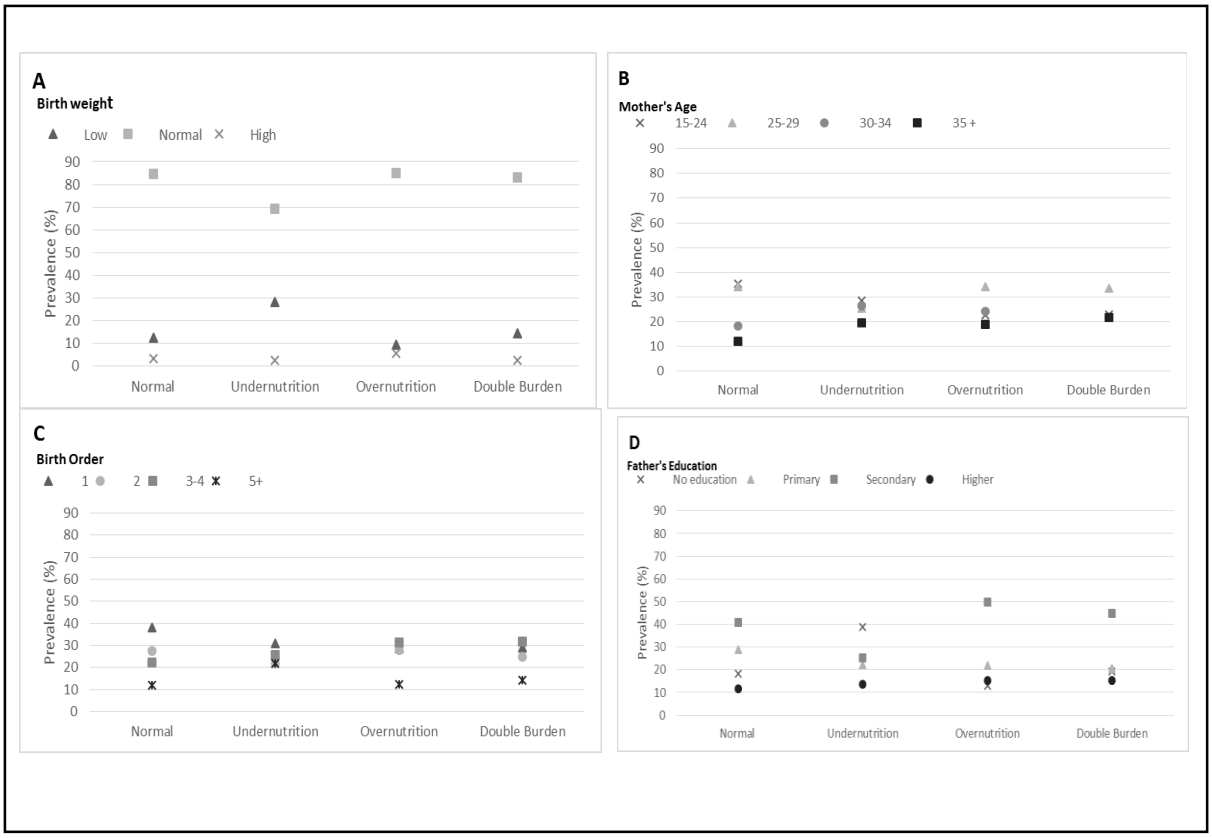
Figure 1. Prevalence of mother-child pairs in MENA region by country (2001-2012)



Note: Data Source: Demographic and Health Surveys (2001-2012) from the Middle East and North Africa countries.

a. All estimates are survey-adjusted.
b. Data are from the most recent DHS in each country.
c. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < - 2, normal defined as BMI-for-age-z-score ≥ -2 and < 1, at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2, overweight defined as BMI-for-age-z-score defined as ≥ 2.
d. Using CDC BMI standards for adults: underweight defined as < 18.5 kg/m^2, normal defined as 18.5-24.9 kg/m^2, overweight defined as 25.0-29.9 kg/m^2, obese defined as ≥ 30 kg/m^2.
e. Under-nutrition households were defined as underweight mothers with thin children. Over-nutrition households were defined as overweight or obese mothers with overweight children. Double burden households defined as discordant pairs of mother/children such as obese mothers with thin children, overweight mothers with thin children, and underweight mothers with overweight children.

Figure 2. Prevalence of mother-child pairs by **A)** Child Birth Weight, **B)** Mother's Age, **C)** Birth Order, and **D)** Father's Education



Note: Data Source: Demographic and Health Surveys (2001-2012) from the Middle East and North Africa countries.

a. All estimates are survey-adjusted.
b. Data are from the most recent DHS in each country.
c. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < - 2, normal defined as BMI-for-age-z-score ≥ -2 and < 1, at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2, overweight defined as BMI-for-age-z-score defined as ≥ 2.
d. Using CDC BMI standards for adults: underweight defined as < 18.5 kg/m^2, normal defined as 18.5-24.9 kg/m^2, overweight defined as 25.0-29.9 kg/m^2, obese defined as ≥ 30 kg/m^2.
e. Using WHO birth weight categories: low birth weight defined as < 2.5 kg, normal birth weight defined as 2.5-4.5 kg, high birth weight defined as > 4.5 kg.
f. Under-nutrition households were defined as underweight mothers with thin children. Over-nutrition households were defined as overweight or obese mothers with overweight children. Double burden households defined as discordant pairs of mother/children such as obese mothers with thin children(n=747), overweight mothers with thin children(n=1554), and underweight mothers with overweight children(n=42).

Table 3. Adjusted analysis of mother-child pairs in the MENA region using most recent DHS country surveys (2001-2012).

	Under-Nutrition Household		Over-Nutrition Household		Double Burden Household	
	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]
Child Characteristics						
Area						
Urban	2.31*	(1.29, 4.16)	0.95	(0.83, 1.09)	1.00	(0.87, 1.15)
Rural	ref		ref		ref	
Birth weight						
Low (<2.5 kg)	2.81*	(1.70, 4.67)	0.72*	(0.58, 0.88)	1.25*	(1.05, 1.50)
Normal (2.5-4.5 kg)	ref		ref		ref	
High (> 4.5 kg)	1.21	(0.29, 5.11)	2.10*	(1.54, 2.88)	0.89	(0.59, 1.35)
Birth Order, %						
1	ref		ref		ref	
2	1.03	(0.55, 1.93)	1.22*	(1.03, 1.45)	1.21*	(1.01, 1.45)
3-4	1.05	(0.54, 2.05)	1.23*	(1.03, 1.48)	1.50*	(1.24, 1.82)
5+	1.15	(0.48, 2.76)	0.83	(0.64, 1.08)	1.40*	(1.09, 1.80)
Parental Charactersitics						
Mother's age						
15-24	ref		ref		ref	
25-29	1.11	(0.56, 2.19)	1.58*	(1.31, 1.90)	1.45*	(1.20, 1.75)
30-34	2.01	(0.99, 4.07)	2.03*	(1.65, 2.50)	1.65*	(1.33, 2.05)
35 +	0.96	(0.38, 2.43)	2.48*	(1.94, 3.15)	2.33*	(1.83, 2.97)
Mother's level of education						
No education	1.98	(0.90, 4.33)	0.79	(0.62, 1.02)	1.40*	(1.10, 1.78)
Primary	ref		ref		ref	
Secondary	1.00	(0.50, 2.00)	1.04	(0.87, 1.25)	1.35*	(1.11, 1.64)
Higher	0.99	(0.42, 2.34)	1.00	(0.79, 1.26)	0.97	(0.76, 1.25)
Father's level of education						
No education	1.48	(0.62, 3.52)	0.96	(0.72, 1.28)	1.36*	(1.04, 1.78)
Primary	ref		ref		ref	
Secondary	1.07	(0.53, 2.16)	0.98	(0.81, 1.18)	1.15	(0.94, 1.41)
Higher	1.23	(0.54, 2.79)	1.02	(0.80, 1.29)	1.33*	(1.05, 1.70)

Note: Data Source: Demographic and Health Surveys (2001-2012) from the Middle East and North Africa countries.

a. All estimates are survey-adjusted.
b. Data are from the most recent DHS in each country.
c. Using World Health Organization child growth reference standards: thinness defined as BMI-for-age-z-score < - 2, normal defined as BMI-for-age-z-score ≥ -2 and < 1, at risk of overweight defined as BMI-for-age-z-score ≥ 1 and ≤ 2, overweight defined as BMI-for-age-z-score defined as ≥ 2, normal weight used as reference in regression analysis.
d. Using CDC BMI standards for adults: underweight defined as < 18.5 kg/m^2, normal defined as 18.5-24.9 kg/m^2, overweight defined as 25.0-29.9 kg/m^2, obese defined as ≥ 30 kg/m^2.

e. Under-nutrition households were defined as underweight mothers with thin children. Normal weight households were defined as normal weight mothers with normal weight children. Over-nutrition households were defined as overweight or obese mothers with overweight children. Double burden households defined as discordant pairs of mother/children such as obese mothers with thin children(n=747), overweight mothers with thin children(n=1554), and underweight mothers with overweight children(n=42).

Chapter 6. Conclusion

Organizations such as the World Health Organization are encouraging stakeholders to recognize childhood over-nutrition as an urgent challenge in all countries(96), and recent global adult estimates bring the MENA region to the forefront as an increasing area of concern(4). Although increasing concern has been raised about child over-nutrition, the unfinished agenda in under-nutrition, cannot be forgotten(3, 10-14). A significant proportion of child morbidity and mortality in developing countries is attributable to child malnutrition(6, 7), including both over- and under-nutrition(65).

The prevalence of unhealthy weight in children under five appears to be a continuing problem. Thinness persists and heavily contributes to the unhealthy weight burden in the region; while overweight is increasing. Prevalence estimates from Chapter 3 demonstrate that thinness continues to affect 13.6% of children under 5 in the MENA region; at the same time 15.6% of children are experiencing overweight. Given the importance of early life weight status for long-term health and given that the levels of unhealthy weight in children under five in the MENA region has reached 36.3%, promoting healthy growth and improved nutrition is a priority in the region.

Findings from Chapter 4 bring to light preliminary parent and child characteristics relevant for weight status at young ages in the MENA Region, including perhaps most importantly mother's weight status. Analysis via the Social Ecological Model has emphasized the strong contribution of parent characteristics on child weight status, proposing that the mother is the link between the child and the environment(28, 49). Obese mothers and mothers with higher education were more likely to be overweight, while children who had been small at birth, or had

uneducated parents were more likely to be thin. These findings support the need to design evidence-based child health policy and strategies focusing on the needs of higher-risk children.

When examining weight within mother-child pairs, (Chapter 5), we found that 17% of mother-child pairs are either both undernourished(0.7%), both overnourished(8.3%), or are experiencing a double burden(7.8%). A priority will be to develop interventions that can address this complex set of needs within countries in the region. Different household pairs underscore the need for research requiring novel and effective strategies aimed at reducing the gaps of those inequalities and promoting better nutrition for both mothers and children simultaneously(63).

Full assessment of the evolving situation of nutrition and related health concerns via continual surveillance and implementation of interventions considering primary associated factors impacting childhood weight status within the region as well as within each individual country are necessary to prevent the continued increase of this phenomenon in the MENA Region. Our findings suggest the need to implement evidence-based child health policy and strategies, prioritizing the continual concern with child under-nutrition while increasing the attention of child over-nutrition in the area along with the new insight into the complex phenomenon of household and national-level double burden of malnutrition.

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