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Prevalence and Determinants of Malnutrition and Intestinal Infections among Children and their Mothers in the Jordan Valley

EXECUTIVE SUMMARY

The Jordan Valley comprises approximately 30% of the land area of the West Bank, occupied Palestinian territories (oPt), and is home to an estimated 60,000 Palestinians. The ongoing Israeli occupation creates widespread consequences for Palestinians in the area, including movement restrictions, limited access to potable water, poverty, persistent threats of forced relocation and home demolitions, and lack of minimal human security measures.[1] Furthermore, since much of the Jordan Valley lies within Israeli-controlled Area C, nearly 87% of the land is under full Israeli military or settlement jurisdiction and is prohibited for Palestinian use.[2] These factors have a significant impact on healthcare quality and access, affecting the overall health status of the population. Because of these unique political, economic, and social circumstances, there is an urgent need to better characterize and improve the health status of the population in the Jordan Valley.

Our aim in this research project was to examine the prevalence and determinants of malnutrition and intestinal infections among children and their mothers living in the Jordan Valley. We utilized a structured household survey implemented from November 2014–March 2015. We gathered data at the child, maternal, household, and community levels to examine factors associated with our primary outcomes of interest: childhood stunting, anemia, underweight, overweight/obesity, and intestinal infections as well as maternal anemia and obesity. In addition to anthropometric measures, we examined clinical data derived from stool and blood samples.

Our final study sample consisted of 1,501 children from 587 households in 25 localities of the Jericho, Nablus, and Tubas districts. More than 75% of the children in our sample lived in the Jericho district, and more than 67% of the families in our survey reported living below the poverty line.

Our main findings suggest that 11.3% of children in the Jordan Valley are stunted (16% in the <5 population), approximately half (49.3%) of children are anemic (27.3% moderately or severely anemic), 8.4% are obese or overweight, and 2.3% of children <10 years of age are underweight. Among mothers, we found that 19.1% were anemic and 40.2% were obese. In our study of parasitic infection rates among children, 8.9% of the sample tested positive for Giardia cyst, the highest percentage among the parasitic infections, and 16.5% tested positive for any parasite and/or worm in the stool. No children in our study sample tested positive for Taenia worm, 0.4% of children tested positive for Shigella, 0.9% tested positive for Salmonella, and 1.8% tested positive for Hymenolepis nana (H.nana) worm.

Children residing in Bedouin communities had a higher prevalence of stunting compared to children in villages and camps. Similarly, children in households exposed to any form of forced displacement had higher prevalence of stunting than children who had never been forcibly displaced. There was significant variability in stunting status by maternal education level. Children whose mothers had no schooling or less than a high school education had higher rates of stunting than children whose mothers had a high school education or more.

We also found that anemia was more prevalent among children in the Jericho district compared to those in Nablus and Tubas, and children in Bedouin and village communities had a higher prevalence of anemia than children living in camps. Children whose mothers had completed beyond a high school education had lower prevalence of anemia compared to their counterparts.

In terms of overweight and obesity, children whose mothers were overweight or obese also had a higher prevalence of overweight or obesity. Additionally, prevalence of overweight/obesity differed by the following factors: self-reported anemia, diarrhea in the two weeks prior to the survey, child stunting, district of residence, type of residence, and maternal obesity. In terms of double burden at the household level, of the 587 total households in our study, 45% included children that were anemic and children that were overweight/obese, and 11% of households included children that were stunted and children that were overweight/obese.

A higher prevalence of children living in households exposed to any form of forced displacement tested positive for a Giardia cyst infection. Children living in the Nablus district had higher prevalence of infection compared to children in Jericho and Tubas, and children living in Bedouin communities had greater prevalence of infection compared to children living in village and camp localities. We found no evidence of an association between rates of Salmonella and households raising cattle or poultry, and source of drinking water was not associated with self-reports of diarrhea.

With respect to maternal health, there was a high prevalence of anemia in the sample of mothers. Although only 19.1% of mothers self-reported anemia, based on blood tests taken for the study, **58.1% of all 587 mothers in the sample had confirmed anemia. Specifically, 1.5% had severe anemia, 31.9% had moderate anemia, and 24.7% had mild anemia.** The prevalence of overweight (defined as a BMI ≥25 and <30) and obesity (defined as a BMI ≥30) in the study sample of mothers was 33.6% and 40.2%, respectively. The prevalence of central obesity (defined as a waist circumference ≥ 88cm) was 66.4%.

In summary, our study on the prevalence and determinants of malnutrition in the Jordan Valley found rates of anemia among children and rates of obesity and anemia among mothers to be of serious concern, as current trends could have a potentially devastating public health impact. The coexistence of malnutrition and obesity among members of the same household presents an important challenge for the Palestinian public health system. Further research to inform effective public health interventions to address this complicated double burden should be encouraged. Ultimately, a political solution is necessary in the Jordan Valley and in the occupied Palestinian territories in order to address the structural barriers—including the persistent exposure to violence meted out by the Israeli occupation—that make full achievement of health difficult at best and unattainable at worst. Concerted and coordinated efforts by both governmental and nongovernmental organizations to holistically address the proximate and distal causes of malnutrition and obesity in this population is warranted.

ACKNOWLEDGEMENTS

This research project would not have been possible without the dedicated efforts of so many fieldworkers, physicians, nurses, and researchers from the Palestinian National Institute of Public Health (PNIPH) and the Palestinian Ministry of Health. The Palestinian Central Bureau of Statistics has been particularly helpful in facilitating study sample selection and generously providing their expertise.

Dr. Salwa Massad of PNIPH served as principal investigator and research team leader, with assistance from Hadil Dalloul (PNIPH), field manager. Dr. Danya Qato, University of Maryland-Baltimore, conducted the data analysis and wrote the final report.

Dr. Rand Salman of PNIPH and Dr. Assad Ramlawi, Deputy Minister of Health, have been critical to the support and development of this project. In addition, many thanks are owed to Ilham Shamasneh, the Head of the Mother and Child Division of the Ministry of Health. We also extend our thanks to the Directors of Primary Healthcare Directorates, Directors of Nursing, and Director of Laboratories from the Jericho, Nablus, and Tubas districts, as well as the Central Public Health Laboratory in Ramallah.

We thank all of the Ministry of Health fieldworkers, nurses, drivers, and lab technicians who dedicated so much of their time to make this project a reality and success. Most importantly, sincere gratitude is owed to all of the children and mothers of the Jordan Valley who sacrificed their time and energies, and without whom this research project would not have come to fruition.

INTRODUCTION

Maternal and child malnutrition have important consequences for morbidity and mortality, incidence of acute and chronic diseases, healthy development, and the economic productivity of individuals and societies.[3] Childhood malnutrition, including fetal growth restriction, suboptimal breastfeeding, stunting, wasting, and Vitamin A and zinc deficiencies, is an underlying cause of an estimated 45% of all deaths among children under 5 and is a predictor of poor physical and cognitive development later in life.[4] Policymakers and public health researchers have been increasingly focused on child malnutrition, especially since its incorporation into the United Nations Millennium Development Goals.[5] Oftentimes, growth indicators are used in order to assess the nutritional status of children and a population more broadly.[6]

Stunting is one such growth indicator. Stunting is defined as a low height-for-age as compared to the global median for children of the same age. Stunting reflects the cumulative effects of undernutrition and infections in utero and after birth. This measure can therefore be interpreted as an indication of poor environmental conditions that restrict the long-term growth potential of the child, resulting in delayed mental development, poor school performance, and reduced intellectual capacity.[7]

Similarly, the prevalence of anemia is an important indicator of nutritional status of a population. Anemia is a condition in which the number of red blood cells is insufficient to meet the physiological needs of the body. Chronic anemia can lead to delayed growth and impaired neurodevelopment. The most common cause of anemia globally is iron deficiency, but other nutritional deficiencies (including folate and vitamin B12) and parasitic infections can also cause anemia.[8]

Underweight is defined as a low weight-for-age according to international standards and is calculated for children under 10 years.[9] Mortality rates for children who are even mildly underweight are higher than for other children in their age group, and severely underweight children are at even greater risk.[10] In 2014, around 16% or 95 million children under 5 in less developed regions were underweight.[11]

Until recently, nutrition assessments in the developing world tended to focus on undernutrition. Yet given global changes in dietary patterns and the shift towards more sedentary lifestyles, more attention has been directed towards addressing the increasing prevalence of overweight and obesity among both children and adults in the developing world.[12] Childhood overweight is highly correlated with adult obesity, diabetes, and other non-communicable diseases.[13] Maternal overweight and obesity result in increased maternal morbidity and infant mortality. In addition, a greater number of countries, individuals, households, and communities are beginning to face a double burden of both malnutrition (defined by stunting and anemia for example) and obesity,[14] complicating governmental and nongovernmental efforts to create public health interventions that can effectively address these dual epidemics.

It has also been widely accepted that certain infections have profound influence on nutritional status, mediated by changes in dietary intake, absorption, nutritional requirements (especially for energy and protein), and loss of endogenous nutrients, for example through diarrhea.[15] Rotavirus is the most common cause of severe diarrheal disease in infants and young children globally, resulting in approximately 453,000 deaths among children under 5 each year.[16]

Food Security in the Occupied Palestinian Territories and Jordan Valley

Food security is defined as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life."[17] It is built on the pillars of availability, access, and appropriate use of food and has important ramifications for health status via its direct linkage to the nutritional conditions of the population. Nutrition, malnutrition, and overall food security are critical components of public health programs, especially in chronically stressed environments such as Palestine. More than one-third of households or about 1.6 million people in the West Bank and Gaza Strip are food insecure according to a 2013 survey.[18] In Gaza, over half the population is estimated to be food insecure (57%) compared to one-fifth of the population in the West Bank. In a survey conducted in the Bedouin community in Palestine, UNRWA and UNICEF found that up to 79% of families are food insecure and only 6.7% of children consume the recommended meals per day.[19]

Currently, Israeli settlements sit on more than 50% of the Jordan Valley land area, and closed military zones and nature reserves take up an additional 44% of the area.[20] Thus, despite abundant land, agricultural, and water resources, Israeli military restrictions and settlements prevent Palestinians from accessing about 94% of the Jordan Valley. Furthermore, limited access to land and resources results in increased food costs. [21] These conditions predispose this population to higher levels of food insecurity and therefore potentially higher rates of malnutrition than other Palestinians living in the occupied territories.

RESEARCH OBJECTIVES

Complex political, socioeconomic, and structural factors have had a profound impact on population and child health in the Jordan Valley. While there has been significant development work in the area by local and international organizations, there has been a lack of rigorous research aimed at understanding the prevalence and determinants of child and maternal nutrition. For example, specific estimates for key malnutrition indicators do not exist.

Therefore, the primary aim of this research study was to address the gap in research and examine the prevalence and determinants of malnutrition among children ages 1–12 and their mothers living in Jordan Valley area. The study focused on children because they are most vulnerable to the long-term effects of malnutrition. We also examined their mothers because maternal nutrition is a key determining factor of a child's health status.[22] In addition, we sought to quantify the prevalence of parasitic infections among children and their mothers and to identify the linkages between parasitic infections and environmental factors.

Such work can assist policymakers and advocates in promoting evidence-based public health and policy interventions and political programs that encourage acute and long-term improved health outcomes in children and mothers in the Jordan Valley and Palestine more generally.

METHODOLOGY

STUDY DESIGN

This cross-sectional study utilized a structured household survey implemented from November 2014–March 2015. In addition to anthropometric measures, we used clinical data derived from stool and blood samples to determine the prevalence and distribution of malnutrition and intestinal infections among children and their caretakers. In this report, caretakers are referred to as mothers since over 99% of female heads of household, save for two, were the mothers of the children in the study. We used data at the child, maternal, household, and community levels to examine factors associated with our primary outcomes of interest: stunting, anemia, underweight, obesity and overweight, and intestinal infections.

STUDY POPULATION

The target study population was children living in Areas B or C (i.e., under partial or full Israeli jurisdiction, respectively) in the Jordan Valley. As a partner in our study, the Palestinian Central Bureau of Statistics (PCBS) estimated the sample size based on the projected prevalence of malnutrition and intestinal infections among children and expected non-response. Based on the PCBS estimation, the target sample size was 1,500 children between ages 1–12.

Random sampling techniques were used to determine the formulation of the study sample. Based on the UN Office for the Coordination of Humanitarian Affairs (OCHA) definitions, PCBS randomly selected a list of 26 localities in the Jordan Valley (Annex 1). The total number of households selected in each locality depended on the size of the locality. Households were randomly selected based on PCBS maps, identifying the starting point for selection (area sampling). Khirbet ar Ras al Ahmar was dropped from the study because children from the area relocate to Tubas city during the school year. As a result, only 25 localities were part of the final study sample.

INCLUSION CRITERIA

All children between the ages of 1–12 years who had been living in the 25 localities of the Jordan Valley for a minimum of 12 months prior to the study and their mothers were eligible to be chosen from each randomly selected household. Community leaders from each locality were identified for ascertainment of specific community characteristics and to introduce the study to the community.

DATA COLLECTION

We utilized two study questionnaires: one for the mothers and another for each eligible child in the household. The study was led by the Palestinian National Institute of Public Health (PNIPH) in partnership with the Palestinian Ministry of Health. Fieldwork was carried out by nurses from the Ministry of Health, under the supervision of PNIPH field supervisors. Seven fieldwork teams (four in the Jericho district, one in the Nablus district, and two in the Tubas district) were responsible for the data collection. For each child and mother, anthropometric measures were taken, blood tests were conducted, and two stool samples were collected within 2–3 days of each other, and the closest laboratory promptly examined each stool sample. The study was pilot tested among ten children from each of the seven localities. More detailed information about the study protocol may be found in Annex 2.

ANTHROPOMETRIC MEASUREMENTS

The World Health Organization (WHO) Anthro software was used to calculate malnutrition indicators for children under five, and WHO AnthroPlus was used for children ages five and above. The software compares child height, weight, and age information to international reference values for nutrition and then calculates Z-scores for weight-for-age, height-for-age, and weight-for-height. These Z-scores were then used to assign a status of stunting, wasting, overweight, or underweight for children in our sample. We used WHO guidelines to delineate the cutoffs for these assignments.

PRIMARY OUTCOME VARIABLES

For the main analysis, the primary outcome variables of interest were the presence of stunting (binary), anemia (binary), underweight (binary), and overweight and obesity (binary) among children.

Stunting was defined as having a height-for-age Z-score <-2 from the international reference median value, and severe stunting was defined as having a height-for-age Z-score <-3.

Anemia was based on hemoglobin (Hb) blood levels read by the HemoCue tool and was defined and classified based on cutoff levels established by the WHO. In general, child anemia is defined as a Hb concentration below the following cutoffs: <11 g/dl in children ages 6–59 months, <11.5 g/dl in children ages 5–11 years, and 12 g/dl in children ages 12–14 years. [23] In children 6–59 months, severe anemia is defined as a Hb level <7 g/dl and in children ages 5–11 years the cutoff is <8 g/dl.

Overweight was defined as having a BMI-for-age Z-score >+2 from the international reference standard, and obesity in children was defined as having a BMI-for-age Z-score >+3 from the international standard.

Underweight (calculated for children under 10 years of age) was defined as having a weight-for-age Z-score <-2 from the international reference median value, and **wasting** (calculated only for children under 5) was determined as having a weight-for-height Z-score <-2 from the international reference standard.

Intestinal infections assignment was based on two stool sample readings from our study.

We tested for Giardia cyst, Giardia trophozoite, Entamoeba cyst, Entamoeba trophozoite, Salmonella, Rotavirus, Enterobius worm, Ascaris worm, Hymenolepsis nana, and Taenia worm.

Enterobius vermicularis, more commonly known as pinworm, is not typically tested using stool readings but rather using a tape test to the perianal area, which is then read under a microscope to verify infection. Although there were only few cases of pinworm in our sample, we included them here because the presence of pinworm in stool is evidence of a severe infestation.

MATERNAL ANEMIA AND OBESITY

We also estimated the prevalence of anemia, overweight and obesity, central obesity (waist circumference over 88 cm), and intestinal infections among mothers in our study sample.

MATERNAL ANEMIA

Maternal anemia was classified based on adult Hb reference levels as per WHO recommendations. For non-pregnant women 15 years of age and above, an Hb level less than 12 g/dl is considered anemic, while for pregnant women an Hb level <11 g/dl is classified as anemic.[24]

MATERNAL OBESITY

Body Mass Index (BMI) was calculated from the weight and height information measured by field nurses, and BMI classifications of underweight, normal, and overweight or obese were based on WHO standards (underweight: BMI<18.5; normal range: BMI 18.5–24.99; overweight: 25≤BMI<30; and, obese: BMI≥30).

ADDITIONAL COVARIATES

We chose the following additional covariates at the individual, maternal, household, and community levels based on previous research on the determinants of child health and malnutrition:

Individual level: Covariates defined at the child level were the following: age (continuous and categorical), sex, self-reported anemia, diarrhea in the two weeks prior to the survey, low birth weight (defined as <2.5 kg), disability status, and self-reported infection in the previous year.

Maternal factors: The maternal health factors we examined included education level (categorical), employment status (categorical), maternal self-reported anemia (binary), marital status (categorical), maternal anemia based on Hb (binary), and maternal height (cm).

Household factors: Household characteristics included in the analysis were: residence type (village, camp, Bedouin); exposure to forced displacement (past forced relocation or threat of relocation, past home demolition or current threat of home demolition); raising poultry or cattle; household size (categorical); type of kitchen and bathroom (none, inside house, outside house); monthly income (tertiary: monthly income ≤1000, >1000–2000, >2000 New Israeli Shekels); and, source of drinking water (Israeli network, Palestinian network, tank, well, other).

Health access measures: With respect to health access measures, we relied primarily on three questions to reflect disparities in access to health services: 1) Do you have to cross a checkpoint to reach your nearest health facility? (binary); 2) How many minutes does it take you to walk to the nearest healthcare facility? (continuous); 3) How many minutes by car does it take you to reach the nearest hospital? (continuous).

STATISTICAL ANALYSIS

We determined the prevalence of stunting, anemia, underweight, overweight and obesity, and Giardia cyst status in our full sample by district and for each key sociodemographic, economic, household, and maternal health subgroup. We used chi-square tests or t-tests to compare the characteristics of children in each outcome group. For comparisons with expected frequencies of 5 or less, such as those for the parasitic infections subgroup, Fisher's exact test was used to compute p-values. Bivariate analyses were also conducted to examine differences among subgroups in the mothers with and without our outcome of interest. We also described the household characteristics derived from the household survey.

Multivariate logistic regression was employed in order to examine factors associated with malnutrition indicators in the study sample. For our fully-adjusted analysis, we fit a series of models for each primary outcome of interest and included sex, age (categorical), and covariates that were found to be significantly different between the subgroups of interest in the univariate analysis and are grounded in previous research on determinants of child malnutrition and health. All variables were tested for noncollinearity. For each of our four primary outcomes of interest, we ran stratified adjusted analyses with the same set of covariates for children under the age of 5 and children ≥ 5 years of age.

In the analysis, we accounted for clustering of children at the household level. Stata 14.0 software was used for data analysis.

ETHICAL APPROVAL

This study received Institutional Review Board approval from the Helsinki Ethical Review Committee based in the Gaza Strip. Study participants with positive results for any intestinal infection and those who were found to be anemic were notified and referred to Ministry of Health or UNRWA clinics. In addition, we notified the Ministry of Health and UNRWA of children with malnutrition and intestinal infections for follow-up and treatment.

RESULTS

Our final study sample consisted of 1,501 children from 587 households in 25 localities of the Jericho, Nablus, and Tubas districts in the Jordan Valley.

SOCIOECONOMIC CHARACTERISTICS OF THE HOUSEHOLDS

Table 1a summarizes the characteristics of the 587 households included in the study. About 75.8% (n=445) of the households are in the Jericho district, 19.1% are in the Tubas district (n=112), and 5.1% (n=30) are in the Nablus district. The majority of the households are in villages (61.5%, n=361), and the median household size is between 5–6 residents. When asked about their primary healthcare facility, 73.3% of the households indicated that they seek treatment primarily at a Ministry of Health facility (n=430), while about 20.1% (n=118) of the households indicated that they rely principally on an UNRWA facility. Almost 67% (n=456) of the households in the sample have incomes below 2,000 New Israeli Shekels (NIS) per month, and 22.3%

(n=131) have household incomes below 1,000 NIS per month. **More than 67% of the households in our survey are living below the poverty line.**

Approximately one-fifth of the households have been exposed to some form of forced displacement by the Israeli military in the past (n=103), while 13.3% (n=78) have been exposed to multiple threats of forced displacement. More specifically, at least one-tenth of the households in the study have had their homes destroyed by the Israeli military (n=58), while almost 12% of the households (n=70) were under threat of demolition. Similarly, 10.2% (n=60) of the households had been forced to relocate, while about 14.7% (n=86) were under threat of forced relocation.

MATERNAL SOCIODEMOGRAPHIC CHARACTERISTICS

Sociodemographic characteristics and health status of mothers in the total sample and by district are included in **Table 7a**. Of the 587 mothers in the study, the majority were between the ages of 30–39 years old (44.5%, n=261) and the mean age was 33.7 years (SD: 7.7 years). The vast majority of mothers were married (98.1%, n=573), 87.9% (n=515) of mothers were not employed, and 48 mothers (8.2%) were pregnant. The majority of mothers reported having a less than high school education (64.9%, n=381) or no education (6.1%, n=36).

For the 36 mothers who reported no formal education, the median age was 43.5 years with a range of 23–51 years and a mean of 41.4 years (SD: 7.7 years). By district, 8 of the women were from Tubas, 5 were from Nablus, and 23 were from Jericho. By residence type, 18 were from villages, 10 were from camps, and 8 were from Bedouin communities.

HEALTH STATUS OF CHILDREN

Total unadjusted prevalence rates for our outcomes of interest are displayed by locality in **Table 1b**. Stunting rates ranged from 0% (Az Zubeidat) to 34% (Badiw al Mu'arrajat); anemia levels ranged from 12.5% (Khirbet Yarza) to 78% (Badiw al Mu'arrajat); overweight/obesity rates ranged from 0% (Khirbet Yarza, Khirbet 'Atuf, Kardala, Al Farisiya) to 27.3% (Marj al Ghazal); underweight levels ranged from 0% (Marj al Ghazal, Tell al Khashaba, Khirbet Tana, Bardala, Az Zubeidat, Ein el Beida, Khirbet 'Atuf, Kardala, Al Farisiya) to 16.7% (Al Malih); and Giardia cyst rates ranged from 0% (Marj al Ghazal, Tell al Khashaba, Khirbet Tana, Bardala, Ein el Beida, Khirbet 'Atuf, Kardala, Al Farisiya, Ibziq, Al 'Aqaba, Khirbet Yarza) to 58.8% (An Nabi Musa). Using population weights, we also calculated the population-adjusted prevalence for our primary outcomes of interest in the total sample and by district.

Sociodemographic, maternal, household, and health status characteristics of the children in the entire study sample are presented in Table 2a by age group (under age 5 years, ≥ 5 years), **Table 2b** by district (Tubas, Nablus, Jericho), **Table 3a** by stunting status, **Table 4a** by anemia status, **Table 5a** by overweight/obese status, and **Table 6a** by underweight status.

Table 2a

The mean age of children in the entire study sample was 73.5 months (SD: 36.9 months), and the total sample was evenly divided between boys (50.7%) and girls (49.3%). In terms of age, 40.2% of the final study sample was under 5 years of age (n=603) and 59.8% of the sample was ≥5 years of age (n=898). Stunting is less common among children over 5 compared to children under 5. **Among children under 5, total stunting and severe stunting were prevalent in 16% (n=97) and 5.9% (n=36) of the sample, respectively. In children ≥ 5, total stunting and severe stunting were found in 8% (n=72) and 1.3% (n=12) of the group, respectively.** Ten children (1.7%) in our sample suffered from wasting, 8 of whom were from Jericho and 2 from Tubas, and 10.2% of the total study sample (n=153) reported diarrhea in the two weeks prior to the survey, 14.5% (n=87) among children under 5 and 7.4% (n=66) among children ≥5 years.

As compared to children ≥5 years of age, children under 5 were more likely to self-report anemia, have confirmed anemia or severe anemia, be stunted or severely stunted, be overweight or obese, and have suffered from diarrhea in the two weeks prior to the survey.

In terms of double burden at the individual level, 1.7% (n=25) of children in the sample were both stunted and overweight or obese, and 5% (n=75) were anemic and overweight or obese. There were significant differences in double burden rates at the individual level between the under 5 and ≥5 age groups: 7.5% (n=45) of the under 5 age group were anemic and overweight or obese, while the rate was 3.3% (n=30) in the ≥5 age group.

In the total sample, 7.7% (n=115) of children were stunted and had a mother who was overweight or obese, while 36.8% (n=553) of children were anemic and had a mother who was overweight or obese. There was a significant difference in rates of coexistent child stunting and maternal overweight/obesity between the age groups, with a rate of 10.8% (n=65) in the under 5 age group and 5.6% (n=50) in the ≥5 age group.

In terms of double burden at the household level, of the 587 total households in our study, 265 (45%) included children who were anemic and children who were overweight/obese, while 66 households (11.2%) included children who were stunted and children who were overweight/obese.

INTESTINAL INFECTIONS

In our examination of intestinal infection rates, 9.6% (n=145) of children reported suffering from an infection in the year prior to the survey. Furthermore, 8.9% (n=133) of the children in the sample tested positive for Giardia cyst, the highest percentage among the parasitic infections, and 16.5% (n=248) tested positive for any parasite and/or worm in the stool. No children in our study sample tested positive for Taenia worm, 6 (0.4%) children tested positive for Shigella, and 27 tested positive for H. nana (1.8%).

SOCIODEMOGRAPHIC AND HEALTH CHARACTERISTICS OF THE STUDY SAMPLE BY LOCALITY

As documented in **Table 2b**, the majority of children in the study sample were from localities in the Jericho district (76.9%: n=1155), while 17.5% (n=263) were from the Tubas district and 5.5% (n=83) were from the Nablus district. Sociodemographic and household characteristics were similar across districts for most of the categories. Notable exceptions were as follows: percentages of children with self-reported anemia, confirmed anemia, and moderate or severe anemia were greatest in the Jericho district; children in the Nablus district had the greatest percentage of diarrhea, overweight/obesity, and all parasitic infections (except for Entamoeba Trophozoite). For the parasitic infections, the prevalence counts were very low in all districts making comparisons unreliable.

STUNTING IN CHILDREN

Unadjusted Prevalence and Determinants of Stunting

The prevalence of total stunting and severe stunting in the entire study sample (n=1,501) was 11.3% (n=169) and 3.2% (n=48), respectively (Table 3a). After adjusting for sampling weights, the total prevalence of stunting in the study sample was 12.2%. Based on the study, children who were stunted were more likely to have confirmed moderate or severe anemia, report a form of physical, mental, or psychological disability in the six months prior to the survey, be overweight/obese, live in a household with lower monthly income, live in a household with an outside bathroom or no bathroom, live in a household with an outside kitchen or no kitchen, have a mother of shorter stature, and live in a household that raised poultry or cattle.

There were two notable differences among children within the stunting group. First, children residing in Bedouin communities (23.3%, n=39) had a higher prevalence of stunting compared to children in villages (10.1%, n=95) and camps (8.8%, n=35). Similarly, children in households exposed to any form of forced displacement had a higher prevalence of stunting than children whose households had not been exposed to forced displacement. We found that 27.5% (n=13) of the severely stunted and 32.2% (n=39) of the moderately stunted had been exposed to forced displacement compared to 17.1% (n=228) of children not stunted.

There was significant variability in stunting status by maternal education level. Children whose mothers had no schooling or less than a high school education had higher rates of stunting than children whose mothers had a high school education or more. Of the 169 children with stunting, 82.8% had mothers with no schooling or less than a high school education compared to 69.7% of the 1,332 children not stunted.

To examine clustering of stunting within households, we calculated the number of households with one or more stunted child. We found that among the 130 households with at least 1 stunted child, 104 families had only 1 stunted child, 17 households had 2 stunted children, 5 households had 3 stunted children, and 4 households had 4 stunted children.

Multivariate Adjusted Determinants of Stunting

Table 3b summarizes our findings for the adjusted multivariate logistic regression models to examine the determinants of stunting among children. In the fully adjusted model, we accounted for sex, age, child's anemic status based on blood test, household exposure to any form of forced displacement, type of residence, monthly household income, bathroom type, maternal anemic status, maternal height (continuous), reported minutes of walk to nearest healthcare facility (continuous), and household size. Because maternal stature was a stronger predictor of stunting than maternal education, and due to high collinearity between stature and education, we dropped maternal education from the final model.

We found that the highest two age categories, 5–10 years (OR 0.38, 95% CI: 0.21, 0.69) and >10 years (OR 0.43, 95% CI: 0.21, 0.87), were significantly associated with lower odds of stunting as compared to the referent youngest age category (<2 years). We also found that maternal height predicted child stunting, with each additional centimeter in maternal height reducing the odds of child stunting by 6% (OR 0.94, 95% CI: 0.91, 0.98). Notably, 28% (n=164) of mothers in our sample were shorter than 155 cm.

Stunting in Children Under 5 Years Old

In the analysis of children under the age of 5, we included the same covariates described in the full sample for stunting, and the only variable significantly associated with stunting was maternal height. Each additional centimeter in the mother's height was associated with about a 5% decrease in the odds of stunting (OR 0.95, 95% CI: 0.92, 0.98).

Stunting in Children ≥5 Years Old

Similarly, for children over 5, maternal height was also found to be significantly associated with the odds of child stunting in the multivariate analysis. Each additional centimeter in the mother's height reduced the odds of stunting by about 7% (OR 0.93, 95% CI: 0.89, 0.97).

ANEMIA IN CHILDREN

Unadjusted Prevalence and Determinants of Anemia in Children

Anemia was widely prevalent among the children in the sample, with more than half of the children classified as anemic based on blood tests (Table 4a). Although only 9.9% (n=149) of children self-reported anemia (via head of household report), about 51.8% (n=778) were classified as anemic based on their Hb levels, with 0.8% (n=12) having severe anemia, 26.5% (n=397) having moderate anemia, and 24.6% having mild anemia (n=369). After adjusting for sample weights, the total prevalence of anemia in the sample was 49.3%. In children under 5, anemia levels were 57.4% (n=346), with 1.7% (n=10) classified as having severe anemia and 28.7% (n=173) as having moderate anemia. In the sample of children 5 and older, 48.1% (n=432) were classified as having anemia, with 0.2% (n=2) and 24.9% (n=224) classified as having severe anemia and moderate anemia, respectively.

There were significant differences in anemia prevalence by district of residence, residence type, maternal education level, household size, primary healthcare provider, and maternal anemia status.

Anemia was most prevalent among children in the Jericho district: 53.8% (n=624) of children in Jericho were anemic compared to 48.2% (n=40) in Nablus and 43.3% (n=114) in Tubas. Similarly, children in Bedouin and village communities had a higher prevalence of anemia than children living in camps: 55.1% (n=92/167) and 54.9% (n=515/938), respectively, compared to 43.2% (n=171/396).

Children whose mothers had completed beyond a high school education had a lower prevalence of anemia than their counterparts: 42.1% compared to 53.2% among children whose mothers were not formally educated. Of note, there was little difference in anemia levels for children with mothers in the lowest three categories of education: prevalence of anemia was 53.2% (n=42/79 total in subgroup), 52.5% (520/990 total in subgroup), and 56.5% (n=134/237 total in subgroup) in the no education, less than high-school education, and high-school education groups, respectively.

Multivariate Adjusted Determinants of Anemia

Table 4b summarizes our findings for the multivariate logistic regression analysis to determine factors associated with child anemia in the total sample and by age group. In the fully adjusted models, we accounted for sex, age, Giardia cyst status, maternal anemia, walking distance to closest healthcare facility (by minutes, continuous), district of residence, residence type, household size (categorical), mother's employment status, and primary healthcare provider. We found that older children were less likely to be anemic, whereas children with anemic mothers (based on Hb), children who were residents of Jericho, and children with unemployed mothers showed a higher likelihood of being anemic.

Of the age groups, children <2 years of age were most likely to be anemic. Children of anemic mothers had 1.44 the odds (95% CI: 1.11, 1.86) of being anemic themselves compared to children with mothers who were not anemic. Furthermore, children from the Jericho district were 1.8 times as likely (95% CI: 1.23, 2.63) to have anemia as those from the Tubas district. Children of unemployed mothers had 1.57 times the odds (95% CI: 1.08, 2.28) of being anemic compared to children of employed mothers.

When we ran a logistic model that only included sex, age, and maternal education, we found significantly lower rates of anemia among children with mothers who had completed more than a high school education as compared to children with mothers who were not formally educated (0.55 OR, 95% CI: 0.30, 0.99). There were no differences between the other lower education groups and the no education group.

Anemia in Children <5 Years Old

Among children under 5 years of age, maternal anemia (1.97 OR, 95% CI: 1.33, 2.91) and compared to the reference Tubas group, residence in the Jericho district (2.88 OR: 95% CI 1.64, 5.06) were the greatest predictors of anemia. Children in the 2–4 years category were 0.52 times as likely (95% CI: 0.33, 0.80) to have anemia compared to children in the <2 years reference group.

Anemia in Children ≥ 5 Years Old

Among children 5 years of age or older, the only factor in adjusted analysis related to child anemia was place of residence, with children living in Bedouin communities having 2.28 greater odds (95% CI: 1.00, 5.23) of being anemic than children living in villages.

OBESITY AND OVERWEIGHT IN CHILDREN

Unadjusted Prevalence and Determinants of Overweight and Obesity in Children

The overall prevalence of overweight (including obesity) in our sample was 9.3% (n=139) and the prevalence of obesity was 2.9% (n=44) (Table 5a). After adjusting for sampling weights, the total prevalence of overweight (including obesity) in our sample was 8.4%. There were significant differences in overweight and obesity by the following factors: self-reported anemia, diarrhea in the two weeks prior to the survey, child stunting, district of residence, type of residence, and maternal obesity. By district, 9.9% (n=114) of the children in Jericho, 14.4% (n=12) of children in Nablus, and 4.9% (n=13) of children in Tubas were overweight or obese. Children living in Bedouin (12.5%, n=21/167 total in Bedouin) and camp (12.4%, n=49/396 total in camp) communities had a higher prevalence of overweight or obesity than children living in villages (7.3%, n=69/938 total in villages).

Children whose mothers were overweight or obese had a higher prevalence of overweight or obesity compared to children whose mothers were not overweight or obese: 81.3% (n=113) versus 72.6% (n=989), respectively. Overweight or obesity was less prevalent among children with low birth weight than children with normal birth weight.

Multivariate Adjusted Determinants of Overweight and Obesity

Table 5b presents the results of the multivariate logistic regression analysis to determine factors related to overweight and obesity in our study sample. In the adjusted analysis, we controlled for sex, age category, low birth weight, stunting status, maternal overweight and obesity, district of residence, and residence type. We found that older children and children with a low birth weight had lower odds of being overweight or obese. Maternal overweight or obesity and residence in a camp locality were associated with higher odds of being overweight or obese. Children with mothers who were overweight or obese were 1.83 times as likely of being overweight or obese compared to children who did not have overweight or obese mothers.

Overweight and Obesity in Children <5 Years Old

Among children under 5 years of age, 2- to 4-year-olds were less likely to be overweight or obese than children under 2. The strongest predictors of overweight and obesity in the <5 age group were stunting, maternal overweight or obesity, residence in the Nablus district, and residence in a camp locality.

Overweight and Obesity in Children ≥ 5 Years Old

Among children 5 and over, we found that children in the oldest age category (>10 years) and children living in a camp locality were more likely to be overweight than the reference groups.

UNADJUSTED PREVALENCE AND DETERMINANTS OF UNDERWEIGHT IN CHILDREN

Among children less than 10 years of age, 3.5% were underweight (n=46/1307 total in subgroup) (Table 6a). After adjusting for sample weights, the total prevalence of underweight in our sample was 2.3%. Children who were underweight were on average older and had a higher prevalence of low birth weight and disability. Children living in a Bedouin community, children living in a household that raised poultry, and children living in a household with either a bathroom or kitchen outside the house or none at all, all had a higher prevalence of underweight. In addition, children of mothers with a less than high school education had a significantly higher prevalence of underweight compared to their counterparts: 86.9% (n=40/46) compared to 69% (n=871/1261) of children who were not underweight. The prevalence of underweight among children in Bedouin communities was 7.6% (n=11/144), as opposed to 3.4% in camps (n=11/343) and 2.9% in villages (n=24/820).

Multivariate Adjusted Determinants of Underweight in Children

In the logistic analysis undertaken to determine predictors of underweight, we adjusted for sex, age category, disability status, stunting status, length of walk to the nearest health clinic, residence type, maternal education, and the need to cross a checkpoint to reach the nearest health facility (**Table 6b**). We found that children with no reported disability and children of mothers with at least some level of education were all less likely to be underweight than their peers.

Underweight in Children <5 Years Old

In logistic analysis in the under 5 population, we were unable to find evidence of any predictors of underweight aside from reported disability.

Underweight in Children ≥ 5 Years Old

In the population of children 5 years of age and above, we found children of mothers with any form of education were all less likely to be underweight than children of mothers with no education. We also found that children with a reported disability were more likely to be underweight.

CORRELATES OF INTESTINAL INFECTIONS AND GIARDIA CYST

To better understand household, maternal, and community level factors that may be associated with intestinal infections in children, **Table 8** summarizes the bivariate analysis utilizing chi-square tests to examine the linkages between these factors and positive Giardia cyst infection.

The main factors that are statistically significantly associated with Giardia cyst infection among children under 5 are: exposure to forced displacement, district, type of residential locality, source of water and electricity, maternal education, birth weight, and, current anemia status. After adjusting for sample weights, the total prevalence of Giardia cyst infection in our sample was 9.4%. **A higher prevalence of children living in households exposed to any form of forced displacement tested positive for a Giardia cyst infection (18.6% compared to 7.8% among children in non-exposed households).** Children living in the Nablus district had higher prevalence of infection than those in Jericho and Tubas (31.7% compared to 10.2% and 2.3%, respectively). Children living in Bedouin communities also had a greater prevalence of infection than those living in village and camp localities (32.5% compared to 8.2% and 5.6%, respectively). Children living in households relying on water tanks and other sources for water (primarily springs) had higher rates of infection than those in households connected to Israeli or Palestinian water networks

(18.1% compared to 10.8% and 7.1%, respectively). About 25.4% of children whose mothers had no schooling had a Giardia cyst infection compared to 7.2% among children whose mothers completed high school. Children with confirmed anemia were also more likely to have an infection (11.9% compared to 7.4%).

Table 9 summarizes the bivariate analysis utilizing chi-square tests to examine the linkages between intestinal infections and household characteristics for children with any parasitic or worm infection versus those with none. District of residence, residence type, bathroom type, kitchen type, water source, raising poultry, and raising cattle were all factors significantly correlated with having an intestinal infection of any kind.

Raising Livestock and Salmonella

We found no evidence of an association between Salmonella and households raising cattle or poultry. The total number of children who tested positive for Salmonella in our sample was 14. Of these, 50% (n=7) were living in a household that raised poultry. Of the 1,487 children without Salmonella, 36.4% (n=537) were from a household that raised poultry. In addition, 15.4% of children with Salmonella (n=2) were from a household that raised cattle, versus 33.2% (n=489) of children without Salmonella.

Source of Drinking Water and Diarrhea

Source of drinking water was not associated with self-reports of diarrhea. Children living in households with access to water from Israeli or Palestinian networks did not appear to have differentially reported diarrhea compared to households with water from tanks, wells, or other sources. Of the 153 children who reported diarrhea in the two weeks prior to our survey, 84.3% (n=129) relied on water from Israeli or Palestinian networks and 15.7% (n=24) relied on water from tanks, wells, or other sources. Of the 1,348 children who did not report diarrhea, 89.2% (n=1,203) relied on water from Israeli or Palestinian networks and 10.8% (n=145) relied on water from other sources.

NUTRITIONAL STATUS AND INTESTINAL INFECTIONS AMONG MOTHERS IN THE JORDAN VALLEY

Obesity, central obesity, and anemia are highly prevalent among the study sample of mothers in the Jordan Valley: about 40.2% (n=236) of mothers were obese; 66.4% (n=350) were centrally obese (waist circumference greater than 88 cm); and 58.1% (n=341) were anemic. The prevalence of parasitic infections among mothers was very low, with the most common being Entamoeba cyst, affecting 6.3% (n=36) of the women in the sample.

Maternal Obesity, Central Obesity, and Anemia

Prevalence of Obesity and Overweight in Mothers

As demonstrated in **Table 7b**, the prevalence of overweight (defined as a BMI ≥25 and <30) and obesity (defined as a BMI ≥30) in the study sample of mothers was 33.6% (n=197) and 40.2% (n=236), respectively. The prevalence of central obesity (defined as a waist circumference ≥ 88cm) was 66.4% (n=350). The prevalence of obesity and overweight did not differ markedly between districts, with the exception of Jericho where 37.7% (n=168) of women were overweight, compared to 20.5% (n=23) in Tubas and 20.0% (n=6) in Nablus.

The main variables statistically significantly associated with maternal obesity were: age, income, employment status, household size, and education level. Older women had higher rates of obesity compared to younger women: 23.5% (n=45) of women under 30 were obese compared to 39.4% (n=103) among women ages 30–39 and 65.2% (n=88) among women 40 years of age and over ($p<0.001$). Monthly income also affected the likelihood of obesity. In our study, 38.9% (n=92) of obese women lived in households with monthly incomes >2000 NIS compared to 29.3% (n=103) of women who were not obese.

Women in larger households were more likely to be obese than those in comparatively smaller households: 57.3% (n=59) of mothers in households >8 members, 43.6% (n=68) in households of 7–8 members, 35.3% (n=75) in households of 5–6 members, and 29.3% (n=34) in households of only 2–4 members. Women with no education had the highest prevalence of obesity: 55.5% compared to 41.9% among those with a less than high-school education, 31.2% among those with a high school education, and 35.1% among those with more than a high school education.

Prevalence of Central Obesity in Mothers

Table 7b summarizes the results of the bivariate analyses of central obesity among women in the Jordan Valley. **The main factors significantly associated with central obesity (large waist circumference) were: age, residence type, exposure to forced displacement, and maternal education.** Similar to obesity, the prevalence of central obesity increased with age: 48.8% (n=78) of women younger than 30 were centrally obese compared to 70.4% (n=174) of women 30–39 and 83.6% (n=110) of women 40 and over. Women who had been exposed to forced displacement had a higher prevalence of central obesity than women whose families had never been forcibly displaced (57.1% [n=52] versus 69.1% [n=310]). Bedouin women had the lowest prevalence of central obesity (47.1% [n=24]), in comparison to camp women (76.5% [n=121]) and village women (65.7% [n=217]). Central obesity was negatively correlated with maternal education, affecting 85.7% (n=30) of women with no formal education, 68.1% (n=239) of women with a less than high-school education, 64.7% (n=55) of women with a high-school education, and 55.8% (n=38) of women with more than a high-school education.

Prevalence of Anemia in Mothers

There was a high prevalence of anemia in the sample of mothers (**Table 7b**). Although only 19.1% (n=112) of mothers self-reported anemia, based on blood tests taken for the study, **58.1% of all 587 mothers in the sample had confirmed anemia (n=341). Specifically, 1.5% (n=9) had severe anemia, 31.9% (n=187) had moderate anemia,** and 24.7% (n=145) had mild anemia. Additionally, 30.8% (n=105) of anemic mothers reported taking iron supplements, while 25.2% (n=62) of non-anemic mothers reported iron-supplementation.

When stratifying by pregnancy status, we found 70.8% (n=34) of pregnant women had anemia. Specifically, 29.2% (n=14) had moderate anemia, 41.75% (n=20) had mild anemia, and none had severe anemia. Among pregnant women with anemia, 85.3% (n=29) reported taking iron supplements. Among non-pregnant mothers, 56.9% (n=307) had anemia: 1.7% (n=9) had severe anemia, 32.1% (n=173) had moderate anemia, and 23.2% (n=125) had mild anemia. Among non-pregnant mothers with anemia, 24.8% (n=76) reported taking iron supplements.

The bivariate analysis of anemia among women in the Jordan Valley indicates that the only factor associated with maternal anemia is whether the woman was anemic in the previous year. Women reporting that they were anemic (n=112) in the past year had a significantly higher prevalence of anemia compared to those not reporting anemia in the previous year (80.4% compared to 19.6%).

LIMITATIONS

Because of the cross-sectional design of the study, we were unable to make any causal link between our outcomes of interest and our covariates. Importantly, we did not measure dietary intake and nutritional histories of mothers and their children, which may be linked to our outcomes of interest. We also measured intestinal infections in the winter and spring months, when infection rates tend to be lower. Thus, the rates of parasitic and worm infections in our sample likely underestimate the total rates during prevalent seasons.

DISCUSSION

Our study sheds critical light on the current health predicament of Palestinian children and their mothers living in the Jordan Valley. We found that 11% of children were stunted, and 65 of the 169 children (38%) who were stunted were also anemic. The estimated global prevalence of stunting among children under 5 is 25.7%, and in low- to middle-income countries it is estimated to be over 28%. Based on the 2014 Multiple Indicator Cluster survey (or MICs) conducted by the PCBS, around 7.4% of children in the occupied Palestinian territories are moderately or severely stunted compared to 10.9% in 2010. [25] The prevalence of stunting in the Jordan Valley in the under 5 population was 16%, which is higher than stunting rates in other areas of the West Bank and in the neighboring country of Jordan (with a 7.8% stunting rate in the under 5 population),[26] but lower than the global average for developing countries.

A wealth of research suggests multifactorial determinants of childhood stunting and optimal growth patterns more generally. These factors may range from the "most distal socioeconomic and political determinants to the proximate level where food and disease have central roles." [27] Environmental factors such as poor sanitation and hygiene may also contribute to stunting.[28] In our study, the most prominent determinant of child stunting was maternal height. Research suggests that maternal height is an important proxy for genetic factors and can be a useful marker of a mother's cumulative health experience through her life course, especially the social and environmental exposures in her early childhood. [29] Furthermore, mothers who are short may themselves have been raised in poor socioeconomic conditions, which consequently can impact their children's environmental conditions and nutritional options. **This finding confirms the long-term cyclical nature of poor maternal nutrition on child growth outcomes, which have ramifications into adulthood**.

Aside from maternal stature and age, we did not find evidence of other factors significantly correlated with stunting after adjusting for important covariates. **However, after adjusting for only age and sex, we found maternal education was highly correlated with stunting. This finding reinforces extensive literature suggesting the same, as maternal education is correlated with maternal health and improved childcare practices related to health and nutrition.** Similar studies on malnutrition in the West Bank and Gaza have also been unable to confidently locate any child-level predictors of stunting other than age.[30] One explanation is that the overarching political and economic conditions fostered by the Israeli occupation make conditions uniformly challenging such that identifying specific correlates of disease related to the general psychosocial conditions experienced by the Palestinian population is difficult.

The prevalence of anemia in our sample was also higher than both the global rate and the overall rate in the West Bank. Alarmingly, we found that 51.9% of children in our study were anemic (57.4% among children younger than 5 and 48.1% among children 5 years and older), and 5% (n=75) of children were both anemic and either obese or overweight. According to the WHO, a prevalence of anemia greater than 40% at the population level is of serious public health concern. Globally, the percentage of children with anemia is estimated to be 18.1%. [31] Based on the recent Ministry of Health Micronutrient Survey, prevalence of anemia among children 6–59 months in the West Bank and Gaza Strip was 21.5% and 30.7%, respectively.[32] These rates persist despite the fact that the Ministry of Health provides iron supplements free of charge for children under 3 years.

Among the determinants of anemia in our sample, we found that children living in camp localities had a lower prevalence of anemia. Compared to other children in the Jordan Valley, children residing in refugee camps are more likely to have regular access to health services through UNRWA, and this may partially explain the lower levels of anemia among this group. Given the shared dietary patterns of mothers and children, the linkage between maternal anemia and child anemia is foreseeable. Furthermore, unemployment is linked to education level, which informs the nutritional decisions made at the household level.

As the majority of the Jordan Valley comprises Israeli-controlled Area C, Palestinians in the region are disproportionately confronted with an increasingly aggressive, systematic, and ongoing campaign of Israeli settlement development, forced displacement, and natural resource confiscation, making access to agricultural resources and the development of a robust economy nearly impossible. Therefore, it is no surprise that the stunting and anemia rates in the Jordan Valley are greater than those in the rest of Palestine. Additionally, over two-thirds of the Jordan Valley population lives in poverty (<2,000 NIS per month), according to PCBS. [33] In comparison, the overall poverty rate in Palestine was estimated to be 25.8% in 2011. [34] The resulting economic disparities and poor access to nutritious food help explain the higher rates of stunting and anemia in the Jordan Valley. At the same time, governmental and nongovernmental nutritional and financial interventions have helped limit the levels of stunting in the area to below those of the global averages for low- and middle-income countries. We also found distinctly higher rates of both stunting and anemia in the Bedouin community compared to village and camp communities—a situation that warrants further investigation and intervention.

The rates of overweight/obesity and underweight among children in the Jordan Valley are similar to overall rates in the occupied Palestinian territories. A 2014 study found the national rate of overweight in children under 5 to be 8.2%. [35] In our study, 6.3% of children were overweight and 2.9% were obese. We found that older children and children of low birth weight were less likely to be overweight/obese.

An estimated 40% of mothers in our study were obese, and we found that maternal overweight/obesity and residence in a camp locality were associated with higher odds of overweight/obesity in children. Previous research has confirmed obesity to be a "family affair," as factors in the family environment appear to be critical determinants of childhood obesity. These factors include: parental food preferences and beliefs about food; children's food exposure; role modeling; media exposure; and child-parent interactions around food. [36] In the Palestinian context, there is little research regarding family and community food environments and consequently scarce information about how such environments influence children's eating behaviors and risk for obesity.

The total rate of underweight among children younger than 10 was 3.5% (n=46/1307). According to PCBS, the national rate of underweight in the occupied territories was 3.7% and 1.4% in 2010 and 2014, respectively. The prevalence of underweight in the Palestinian territories is below the 10% population rate considered by the WHO to necessitate a swift policy-level response. In addition, while underweight is the most common indicator used to measure malnutrition at the population level, it comprises several potentially overlapping malnutrition conditions, such as stunting and wasting, making it difficult to establish determinants unique to it. The primary predictor of underweight in our adjusted analysis was maternal education, as children of educated mothers were less likely to be underweight than children of mothers with no formal education.

Calculated only for the under 5 population, we found that 1.7% (n=10) of children in that age group suffered from wasting. While the sample was too small to conduct any additional analysis, it is well known that infectious diseases such as diarrhea can cause acute wasting and have long-term effects on linear growth, including stunting. Of the 10 children that suffered from wasting, only 2 reported diarrhea in the two weeks prior to the survey. It is important to note, that estimates of prevalence of wasting in a population reflect a survival bias because only living persons are examined. Furthermore, wasting in early childhood has effects on later morbidity and mortality. [37]

Poor access to potable water and improper management of sewage and solid waste in the Jordan Valley create a greater vulnerability for intestinal infections, including parasitic and worm infections. Rotavirus is another important yet understudied health concern for children in the Jordan Valley. In a study conducted among a clinical sample of patients in northern Gaza, over 40% of the participants had an intestinal parasitic infection.[38] In a 2011 study among adolescents in the northern districts of the West Bank, the overall prevalence of parasitic infections was 22%. [39] We did not find high rates of all of the intestinal infections we studied. This may in part be due to the fact that intestinal infection rates tend to be higher in the summer months as compared to the winter and spring, when we undertook the study. However, we found that the prevalence of Giardia cyst infection is fairly common in the Jordan Valley, where about 10.5% of children under 5 and 7.8% of children 5 and older tested positive, double the rate of adolescent Giardia infection in the northern West Bank. Children whose mothers have no formal education are significantly more likely to have a Giardia cyst infection, which in turn increases the risk of parasitic infection generally. Additionally, these mothers are shepherding households in an area with poor sewage and waste management, making it challenging to foster the type of sanitary environment necessary for the prevention of infectious disease. Children in the Nablus district, children in households exposed to forced displacement, and Bedouin children are significantly more likely to have a Giardia cyst infection, which could result from either an irregular water supply and/or improper sewage management. Currently, there is no sewage network available for Palestinians living in the Jordan Valley, compelling residents to bury or burn their sewage, use a private septic hole, or have solid waste collected by municipal tractors or trucks.

In addition to being at risk of stunting, anemia, overweight/obesity, and parasitic infections, Palestinian children in the Jordan Valley have limited access to quality health services, amplifying the short- and long-term consequences of food insecurity. According to the Jordan Valley solidarity website, there are only 24 health clinics serving the region's inhabitants.[40] These clinics are run by the Palestinian Ministry of Health, UNRWA, and civil society organizations, such as the Palestinian Medical Relief Committee and the Health Working Committee. Due to Israeli government construction restrictions in this area and the lack of financial and personnel resources, the services provided in these clinics are of poor quality and cannot meet the minimum needs of the population. Moreover, individuals seeking hospitalization must be transferred to hospitals in major cities, mainly Jericho and Nablus, and pass through several checkpoints along the way. While we did not find evidence of a correlation between our health access measures and outcomes of interest, we cannot discount the established link between structural determinants of health and environment. We relied on self-reported distances to health clinics and hospitals and thus did not have precise measures for these indicators.

Our investigation of maternal health in the Jordan Valley yielded two unsettling findings. First, over half the women in our study were anemic (58.1%), with 1.5% suffering from severe anemia. Additionally, the prevalence of anemia among pregnant women was 70.8% (n=34). Second, 40.2% of women in our study were obese and 33.6% were overweight. These findings confirm that many women face a double burden of being nutritionally deficient and overweight/obese. Similarly, almost two-thirds (66.4%) of women in the sample had central obesity, a primary risk factor for metabolic syndrome, which puts them at increased risk for diabetes, hypertension, and other cardiovascular diseases.

Despite assumptions that women in agriculturally dependent localities lead less sedentary lives, we found a rate of obesity among rural women that is of serious public health concern. Our estimates for maternal obesity reflect overall obesity rates in the Jordan Valley. However, our estimates are higher than the rates found in rural Palestinian communities but lower than the rates in urban Palestinian communities. A 2001 study of the urban Palestinian population found 49% of women were obese, [41] and a 2006 study among rural West Bank communities found a 37% obesity rate in women. [42] It is not clear what may explain these differences. However, as these rates are over a decade old, these shifts are not surprising given the rapidly changing dietary patterns globally.

SUMMARY

In our study of the prevalence and determinants of malnutrition and intestinal infections among children and their mothers in the Jordan Valley, we found rates of childhood anemia and rates of maternal obesity and anemia to be of serious public health concern. The coexistence of malnutrition and obesity among members of the same household presents an important challenge for the Palestinian public health system. Further research to inform the construction of effective public health interventions to address this complicated double burden should be encouraged. Ultimately, a political solution is necessary in the Jordan Valley and in the occupied Palestinian territories in order to address the structural barriers—including the persistent exposure to violence perpetuated by the Israeli occupation—that make full achievement of health challenging, and in some cases unattainable. This strategy should include measures to pressure the Israeli occupation regime to ease access to water and other natural resources that are critical to food security and overall well-being. **Concerted and coordinated efforts by both governmental and nongovernmental organizations to holistically address the proximate and distal causes of malnutrition and obesity in this population are not only warranted but are long overdue.**

POLICY RECOMMENDATIONS

- Given the alarming and increasing rates of anemia and obesity in the Jordan Valley, it is imperative that governmental and nongovernmental organizations cooperate to address the root political and socioeconomic causes of malnutrition among children and their mothers in the Jordan Valley, otherwise the potential impact of interventions will be muted.
- In cooperation with the Ministry of Health, primary health providers in the Jericho area should focus on interventions to proactively prevent and reduce anemia in the district, including the active provision of iron supplementation. Food supplementation could also be a potentially effective intervention in the Jordan Valley.
- Given that an estimated 40% of the mothers in our study were obese, any interventions that seek to address childhood malnutrition should dually focus on maternal health and nutrition. Such chronic disease interventions can incorporate

reliable and regular health screenings to address modifiable risk factors, including maternal gestational diabetes, high consumption of fatty and sweet foods, and low levels of physical activity.

- Our report discusses maternal education as an important predictor of child malnutrition, highlighting the need to educate families on the early signs of malnutrition. As noted, interventions targeting women, including awareness campaigns on proper nutrition and other chronic disease prevention, should be tailored to address the root causes of malnutrition in this population.
- We suggest research that may promote a better understanding of the role of family food environments as determinants of children's eating behavior.
- In addition, rigorous research to better understand the efficacy of interventions to prevent malnutrition in the Palestinian population more broadly should be encouraged to inform future evidence-based and context specific policies.

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Annex 1: Jordan Valley Study Sample Locality Counts

	Locality Name	Number of Persons Census 2007	Sample
Tubas			
1	Bardala	1,569	75
2	'Ein el Beida	1,114	60
3	Kardala	294	17
4	Ibziq	202	15
5	Al Farisiya	145	15
6	Al 'Aqaba	100	15
7	Al Malih	355	21
8	Khirbet ar Ras al Ahmar	171	15
9	Khirbet 'Atuf	164	15
10	Khirbet Humsa	168	15
11	Khirbet Yarza	39	
12			
Nablus			
12	'Ein Shibli	330	20
13	Furush Beit Dajan	758	44
14	Ar Rajman	16	9
15	Tall al Khashaba	26	15
Jericho			
16	Badiw al Mu'arrajat	708	41
17	Marj Na'ja	683	39
18	Az Zubeidat	1,357	75
19	Marj al Ghazal	193	15
20	Al Jiftlik	3,546	180
21	Fasayil	1,029	60
22	Al 'Auja	3,934	210
23	An Nuwei'ma	1,188	69
24	'Ein ad Duyuk al Fauqa	783	45
25	Aqbat Jaber Camp	6,851	389
26	An Nabi Musa	295	17
	Total	25,973	1,503

Annex 2: Jordan Valley Study Protocol

Research Problem

Although many local and international organizations focus their development work on the Jordan Valley, there is a significant lack of updated information regarding the nutritional status and parasitic infections among children in the area to guide policy makers.

Main Objective of the Study

To examine the prevalence of malnutrition and parasitic infections among children ages 1–12 years living in Jordan Valley and their mothers.

Methodology

Design

A cross-sectional household survey will be administered to determine the prevalence and distribution of malnutrition among Jordan Valley children and their mothers. From each randomly selected household, we will select all children 1–12 years old. For polygamous households where all wives live in the same house, we will select a wife and her children as follows: the first wife from the first polygamous household, the second wife from next household, the third wife from the next household, then back to the first wife from the next household, and so on.

Location

The study will be conducted in Areas B and C of the Jordan Valley as both areas entail various specificities in relation to health and access to health care.

Study Population and Sample

The study population is adolescents and their mothers in Areas B and C of the Jordan Valley. Random sampling techniques will be used to determine the study sample. The sample size was determined based on the estimated prevalence of malnutrition and parasitic infections among children and non-response. Based on a recent Ministry of Health micronutrient survey, the prevalence of anemia among children aged 9–12 months and among children in the West Bank is 45.5% and 8.6%, respectively. [1]Based on the Ministry of Health 2013 annual report, the prevalence of Salmonella

1 Palestinian National Authority Ministry of Health, Nutrition Department, National Nutrition Surveillance System (Ramallah: PA Ministry of Health, 2010).

in Palestine was 2%. Based on a study among school children in the northern West Bank, the prevalence of Amoeba was 9.7%, Giardia 4%, and Ascaris 3.8%[2] . Hence, the sample size will be 1,500 children ages 1–12 years and their mothers.

Entry Criteria

All children ages 1–12 years who have been living in the Jordan Valley for the past 12 months and their mothers will be chosen from a randomly selected household.

Study Variables

Dependent Variables

Malnutrition, measured as:

- Wasting: weight-for-height Z-score (WHZ) <-2
- Stunting: height-for-age <-2
- Underweight: weight-for-age <-2
- Anemia: low hemoglobinParasitic infections: Amoeba, Giardia, Salmonella, Shigella, ova, worms, etc.

Independent Variables

For Malnutrition: low socioeconomic status, large household size, no nutritional supplements, and poor maternal mental health.

For Parasitic Infections: lack of access to clean water, disconnected from a sewage system, low socioeconomic status, limited access to health care, and an infected sibling.

Study Tools

Maternal survey: Background information, access to water and electricity, mother's mental health.

Child survey: For each child in the study, we will administer a survey to determine the status of the child's health, recent infections and intake of antibiotics, intake of supplements, height, and weight.

HomoCue: To examine hemoglobin levels and anemia among children and their mothers.

Microscopic examination: To look for parasitic infections.

2 Ayman S. Hussein, "Prevalence of Intestinal Parasites among School Children in Northern Districts of West Bank-Palestine," Tropical Medicine and International Health 16, no. 2 (2011): 240–244.

Stool culture: To look for Salmonella and Shigella.
Measuring board: To measure standing height.
Electric balance: To measure weight.
Whirled measuring tape: To measure mother's waist.

Data Collection

The Palestinian National Institute of Public Health (PNIPH) research team prepared the study questionnaires in Arabic. There are two study questionnaires, one for children and one for their mothers. Seven fieldwork teams (4 in Jericho, 1 in Nablus, and 2 in Tubas) will be responsible for the data collection process, under the supervision of the PNIPH research team. For each child and their mother, we will gather anthropometric measures, administer a blood test, and examine 2 stool samples collected on different days.

The study will be pilot tested at 14 households, 2 per research team. Each team will sample up to 10 children from both households, making the sample size of the pilot study 70 children and 14 mothers. Following analysis of the pilot study, we will revise the study questionnaire and the methodology if needed.

Phase I: Preparatory Phase

Each one of the seven mobile clinics will be equipped with a microscope, HomoCue, a measuring board, an electric balance and measuring tape, stool cups, labels, and markers. The research team in each mobile clinic will comprise: a PNIPH supervisor, a nurse supervisor, a nurse, and a lab technician.

Phase II: Introducing the Study

Prior to the data collection phase, the nurse supervisors and PNIPH supervisors will visit the key persons, or "gate keepers," in each of the 26 localities. Through this visit the supervisors will introduce the research project to the key persons in the communities, aiming to facilitate the data collection process and increase the response rate.

Phase III: Data Collection

First household visit

The PNIPH supervisor will help the mobile team locate the randomly selected sample based on the map. In the first home visit, the nurse will take the anthropometric measures of the mother and her children and administer the blood test; the nurse supervisor will complete the questionnaires with the mother. Additionally, the nurse will explain to the mother how to take the stool sample and agree on a time the next morning to collect the stool. The nurse will label the stool cups with the number of the household, name of the child, and the stool sample number.

Second household visit

The lab technician will collect the first stool sample and administer the household stool cups marked with the correct house number and name of the child for the second stool test. The technician will do the microscopic stool exams. The stool samples will then be transported to the site labs assigned by each directorate for stool culture within 3 hours of the stool collection. The stool samples will not have any names or identifiers of the family; instead, we will use special ID numbers to ensure confidentiality. However, we will write the first name of each child on the stool cup to make sure that the mother knows which stool cup corresponds to which child. Meanwhile, the rest of the team will visit other households.

Transporting stool samples

A driver will be assigned to each directorate (Nablus, Jericho, and Tubas) to collect the stool samples from the households as scheduled with the nurses. The driver will transport each stool sample to the site labs for examination as quickly as possible in order to ensure the validity of the stool tests.

Blood tests

HemoCue B Hemoglobin Analyzer will be used to determine the hemoglobin levels as an indicator of anemia.

Lab results

The lab technicians will enter the test results on a form designed by the research team, and the research team will transfer the data to an Excel spreadsheet for analysis. The lab supervisor will oversee culture tests. Positive stool cultures will be sent to the central public health lab for final confirmation. If any test results indicate that an individual is at risk of a health issue, the research team will inform the individual immediately and secure their treatment at the Ministry of Health clinic in their area.

Field audit

The PNIPH research team will review each questionnaire for completeness before leaving the household.

Fieldwork team

Each field team will consist of one lab technician, one nurse, and a driver. The nurses' directors (one from each of the three directorates) will be supervising the nurses during the fieldwork, and the lab supervisors (one from each directorate) will oversee the lab technicians. PNIPH will also assign a field supervisor for each directorate.

Roles and responsibilities

A) Nurses:

1) Completing the questionnaires with the families
2) Measuring the height and weight of each participant
3) Administering cups for the stool sample
4) Scheduling appointments for the next visit to collect the stool samples

B) Lab technicians:

1) Collecting stool samples
2) Preforming the hemoglobin tests
3) Directing the examination of the stool samples in the assigned field sites
4) Preforming the stool culture tests
5) Writing the reports for each test

C) Nurse supervisors:

1) Assigning nurses for fieldwork
2) Coordinating with lab supervisors to schedule the team's field visits
3) Communicating with the nurses on a daily basis to receive their feedback on the field visits

D) Lab supervisors:

1) Assigning lab technicians for the field visits
2) Coordinating with the nurses' supervisors to schedule the field visits
3) Supervising the lab tests

4) Communicating with the lab technicians on a daily basis to receive their feedback on the field visits
5) Transferring positive (Shigella and Salmonella) stool samples to the Central Public Health Laboratory

E) Field supervisors:
1) Supervising the overall fieldwork process
2) Sending reports of the fieldwork process to the research manager
3) Ensuring that all fieldwork is being conducted according to defined standards

F) Central Public Health Laboratory:
1) Training lab technicians and supervisors on how to conduct lab tests
2) Providing technical support for lab work during the study
3) Providing the final confirmation of lab results

Quality Control

The research team will apply the following quality control measures to ensure maximum reliability and validity of the data collected:

- Each research team will be accompanied by a field supervisor who is experienced in reading blind maps, provided by the Palestinian Central Bureau of Statistics, to ensure the randomization of the sample and to ensure the completeness of the data collected on spot.
- The fieldwork team will undergo rigorous trainings on standardized procedures of data collection, anthropometric measures, and laboratory tests.
- The research team will examine two stool samples from each participant within 2–3 days to ensure validity of the data.
- The laboratory tests will be conducted in accordance with the standardized operation procedures adopted by the Ministry of Health.
- Clearly written guidelines and instructions will be given to all field workers prior to data collection.
- Random spot checks will be conducted by the laboratory supervisors to ensure the quality and accuracy of tests conducted by the lab technicians.
- The field workers will collect two anthropometric measures for each participant. If there is major discrepancy between measures, then a third measure is required.

- Routine maintenance of scales and measuring boards. Each day and after weighing a participant, the fieldworkers will check that the scales balance at zero. Scales and measuring boards will be cleaned every day they are in use.

Project Timeframe

The study (data collection, analysis, and report writing) will be carried out from November 2014 through March 2015.

Table 1a. Household characteristics, total households, and households by district					
Characteristics % (n)		Total Sample (n=587)	Tubas (n=112)	Nablus (n=30)	Jericho (n=445)
Residence type					
	Village	61.5 (361)	75.0 (84)	56.7 (17)	58.4 (260)
	Camp	28.1 (165)	0.0 (0)	0.0 (0)	37.1 (165)
	Bedouin	10.4 (61)	25.0 (28)	43.3 (13)	4.5 (20)
Kitchen					
	Inside house	84.8 (497)	69.4 (77)	46.7 (14)	91.2 (406)
	Outside house	11.3 (66)	17.1 (19)	33.3 (10)	8.3 (37)
	No kitchen	3.9 (23)	13.5 (15)	20.0 (6)	0.4 (2)
Bathroom					
	Inside house	83.6 (490)	65.8 (73)	43.3 (13)	90.8 (404)
	Outside house	14.8 (87)	28.8 (32)	50.0 (15)	8.9 (40)
	No bathroom	1.5 (9)	5.4 (6)	6.7 (2)	0.2 (1)
Raise poultry					
	Yes	36.8 (215)	50.5 (55)	53.3 (16)	32.4 (144)
Raise cattle					
	Yes	33.1 (193)	54.1 (59)	66.7 (20)	25.7 (114)
Household size					
	2–4	19.8 (116)	14.3 (16)	6.7 (2)	22.0 (98)
	5–6	36 (212)	42.9 (48)	30.0 (9)	34.8 (155)
	7–8	26.6 (156)	26.8 (30)	36.7 (11)	25.8 (115)
	>8	17.5 (103)	16.1 (18)	26.7 (8)	17.3 (77)
Source of water					
	Israeli network	41.5 (243)	68.5 (76)	36.7 (11)	35.1 (156)
	Palestinian network	47.5 (278)	0.0 (0)	0.0 (0)	62.6 (278)
	Tank	7.9 (46)	28.8 (32)	16.7 (5)	2.0 (9)
	Well	1.2 (7)	2.7 (3)	13.3 (4)	0.0 (0)
	Other	1.9 (11)	0.0 (0)	33.3 (10)	0.2 (1)
Source of electricity					
	Israeli network	41.2 (240)	70.9 (78)	73.3 (22)	31.6 (140)
	Palestinian network	49.4 (288)	3.6 (4)	3.3 (1)	63.8 (283)
	Generator	0.2 (1)	0.9 (1)	0.0 (0)	0.0 (0)
	Other	9.3 (54)	24.6 (27)	23.3 (7)	4.5 (20)
Monthly income (NIS)					
	≤1000	22.3 (131)	29.5 (33)	40.0 (12)	19.3 (86)
	1001–2000	44.5 (261)	53.6 (60)	50.0 (15)	41.8 (186)
	>2000	33.2 (195)	16.9 (19)	10.0 (3)	38.9 (173)
Primary health provider					
	MOH clinic	73.3 (430)	83.0 (93)	56.7 (17)	71.9 (320)
	UNRWA	20.1 (118)	0.0 (0)	23.3 (7)	24.9 (111)
	Private clinic	5.1 (30)	14.3 (16)	3.3 (1)	2.9 (13)
	Mobile clinic	1.5 (9)	2.7 (3)	16.7 (5)	0.2 (1)

Exposure to forced displacement					
Forced to relocate in past					
	Yes	10.2 (60)	25.9 (29)	33.3 (10)	4.7 (21)
Under threat of relocation					
	Yes	14.7 (86)	39.3 (44)	56.7 (17)	5.6 (25)
Home destroyed in past					
	Yes	9.9 (58)	27.7 (31)	30.0 (9)	4.0 (18)
Home under threat of destruction	Yes	11.9 (70)	31.2 (35)	43.3 (13)	4.9 (22)
Any forced displacement exposurea	Yes	17.5 (103)	41.9 (47)	66.7 (20)	8.1 (36)
Multiple forced displacement exposuresb	Yes	13.3 (78)	32.1 (36)	50.0 (15)	6.1 (27)
Cross checkpoint to closest health facility	Yes	55.4 (325)	10.7 (12)	33.3 (10)	68.1 (303)

a. Forced displacement was calculated based on four measures: forced to relocate in the past, under threat of relocation, home destroyed, home under threat of destruction.

b. Multiple forced displacement was defined as more than one of the following exposures to forced displacement: forced to relocate in the past, under threat of relocation, home destroyed, home under threat of destruction.

Table 2a. Sociodemographic and health characteristics of children in Jordan Valley (sample, total (n=1,501) and by age group (under 5 years old/ 5 years and above

Characteristics % (n)	All children in sample (n=1,501)	Under 5 years old (10–59 months) 40.2% (n=603)	5 years and older (60–156 months) 59.8% (n=898)
Sex			
Female	49.3 (740)	47.3 (285)	50.7 (455)
Male	50.7 (761)	52.7 (318)	49.3 (443)
Age, months (mean, SD)	73.5 (36.9)	36.5 (14.1)	99.5 (23.6)
Age, categorical			
<2 years	8.6 (130)	21.6 (130)	--
2-<5 years	31.5 (473)	78.4 (473)	--
5–10 years	45.4 (682)	--	75.9 (682)
>10 years	14.4 (216)	--	24.6 (216)
Low birthweight (<2.5 kg)	9.8 (147)	9.9 (60)	9.7 (87)
Self-reported Anemia	9.9 (149)	15.1 (91)	6.5 (58)‡
Anemia, categorical, based on Hba			
Non-anemia (low)	48.2 (723)	42.6 (257)	51.9 (466)‡
Mild	24.6 (369)	27.0 (163)	22.9 (206)
Moderate	26.5 (397)	28.7 (173)	24.9 (224)
Severe	0.8 (12)	1.7 (10)	0.2 (2)
Stunting[b], categorical			
No stunting	88.7 (1332)	83.9 (506)	91.9 (826)‡
Moderate	8.1 (121)	10.1 (61)	6.7 (60)
Severe	3.2 (48)	5.9 (36)	1.3 (12)
Wasting (<5 years only)c	--	1.7 (10)	--
Overweight and obese[d]	9.2(139)	12.1 (73)	7.4 (66)‡
Overweight	6.3(95)	7.9 (48)	5.2 (47)†
Obese	2.9(44)	4.1(25)	2.1 (19)†
Underweight (<10 years only)[e]	3.5 (46/1,307)	2.8 (17/603)	4.1 (29/704)
Disability status[f]	1.7 (26)	1.5 (9)	1.9 (17)
Diarrhea (past two weeks)	10.2 (153)	14.4 (87)	7.4 (66)‡
Intestinal infections			
Self-reported infection last year	9.6 (145)	9.5 (57)	9.8 (88)
Giardia cyst	8.9 (133)	10.5 (63)	7.8 (70)
Giardia trophozoite	0.9 (13)	1.2 (7)	0.7 (6)
Entamoeba cyst	5.1 (77)	4.3 (26)	5.7 (51)
Entamoeba trophozoite	1.0 (15)	0.7 (4)	1.2 (11)
Salmonella	0.9 (14)	1.2 (7)	0.8 (7)

Shigella	0.4 (6)	0.33 (2)	0.4 (4)
Rotavirus (only for <5)	0.4 (6)	0.9 (6/603)	--
Any intestinal infection	16.5 (248)	16.6 (100)	16.5 (148)
Any worms	2.2 (34)	1.6 (10)	2.6 (24)
H. nana	1.8 (27)	1.2 (7)	2.2 (20)
Enterbius (pinworm)	0.4 (6)	0.3 (2)	0.5 (4)
Ascaris	0.1 (1)	0.2 (1)	0.0 (0)
Taenia	0 (0)	0 (0)	0 (0)
Double burden on individual			
Stunting and child overweight/obesity	1.7 (25)	3.9 (24)	0.1 (1)‡
Child anemia and child overweight/obesity	5.0 (75)	7.5 (45)	3.3 (30)‡
Double burden on household			
Stunting and maternal overweight/obesity	7.7 (115/169)	10.8 (65)	5.6 (50)‡
Child anemia and maternal overweight/obesity	36.8 (553/778)	38.3 (231)	35.9 (322)

Abbreviations: Hb, hemoglobin.
†Significant at P<0.05 for differences between <5 and ≥5 subgroups.
‡Significant at P<0.005 for differences between <5 and ≥5 subgroups.

a. Anemia classified based on Hb levels from blood tests during field visits. WHO guidelines were utilized to categorize levels of anemia.
b. Stunting defined as <-2 Standard Deviation (SD) units (Z-score) from the median of the reference international population for height-for-age; severe stunting defined as <-3 SD units below the median.
c. Wasting calculated for <5 years of age population only and defined as a <-2 SD units below the international reference median for weight-for-height.
d. Overweight defined as a weight-for-height >+2 SD units from the international reference median value; obese defined as >+3 SD units from the international reference for weight-for-height.
e. Underweight calculated for <10 years of age population only and defined as weight-for-age <-2 SD from the international reference median value.
f. Disability status self-reported via a questionnaire that asked the caretaker: "Has the child suffered from any form of physical, mental, or psychological disability for a period of more than 6 months that prevented him/her from participating fully in activities of daily living?"

Table 2b. Sociodemographic and health characteristics of children in Jordan (Valley sample, total (n=1,501) and by district (Tubas, Nablus, Jericho

Characteristics % (n)	All children in sample (n=1,501)	Tubas (n=263)	Nablus (n=83)	Jericho (n=1,155)
Sex				
Female	49.3 (740)	46.4 (122)	43.4 (36)	50.4 (582)
Male	50.7 (761)	53.6 (141)	56.6 (47)	49.6 (573)
Age, months (mean, SD)	73.6 (37.0)	76.9 (37.4)	75.3 (35.9)	72.6 (36.8)
Low birthweight (<2.5 kg)	9.8 (147)	6.5 (17)	13.3 (11)	10.3 (119)
Self-reported anemia	9.9 (149)	6.1 (16)	6.0 (5)	11.1 (128) †
Anemia, categorical, based on Hb[a]				
Non-anemic (low)	48.1 (723)	56.6 (149)	51.8 (43)	45.9 (531) ‡
Mild	24.6 (370)	26.2 (69)	28.9 (24)	23.9 (276)
Moderate	26.5 (398)	17.1 (45)	19.3 (16)	29.1 (336)
Severe	0.8 (12)	0.0 (0)	0.0 (0)	0.8 (12)
Stunting, categorical[b]				
No Stunting	88.6 (1,332)	88.2 (232)	86.7 (72)	89.0 (1,028)
Moderate	8.0 (121)	7.9 (21)	8.4 (7)	8.0 (93)
Severe	3.3 (50)	3.8 (10)	4.8 (4)	2.9 (34)
Wasting (<5 years only)[c]	--	2.0 (2/99)	0.0 (0/30)	1.7 (8/474)
Overweight and obese[d]	9.3 (139)	4.9 (13)	14.5 (12)	9.9 (114) †
Overweight	6.3 (95)	3.4 (9)	10.8 (9)	6.7 (77) ‡
Obese	2.9 (44)	1.5 (4)	3.6 (3)	3.2 (37)
Underweight (<10 years only)[e]	3.5 (46/1,307)	3.2 (7/222)	4.2 (3/72)	3.5 (36/1,013)
Disability status[f]	1.7 (26)	2.6 (7)	1.2 (1)	1.5 (18)
Diarrhea (past two weeks)	10.2 (153)	6.8 (18)	20.5 (17)	10.2 (118) ‡
Parasitic infections				
Self-reported infection last year	9.7 (145)	11.4 (30)	4.8 (4)	9.6 (111)
Giardia cyst	8.9 (133)	2.3 (6)	24.1 (20)	9.3 (107) ‡
Giardia trophozoite	0.9 (13)	0.0 (0)	3.6 (3)	0.9 (10) ‡
Entamoeba cyst	5.1 (77)	1.5 (4)	15.6 (13)	5.2 (60) ‡
Entamoeba trophozoite	1.0 (15)	2.3 (6)	6.0 (5)	0.3 (4) ‡
Salmonella	0.93 (14)	4.2 (11)	0.0 (0)	0.3 (3) ‡
Rotavirus (out of n=648)	2.3 (15)	11.5 (14)	0.0 (0)	0.2 (1) ‡
Any Worms	2.2 (34)	0.0 (0)	1.2 (1)	2.8 (33) ‡

Double burden on individual				
Stunting and child overweight/obesity	1.7 (25)	1.1 (3)	4.8 (4)	1.6 (18)
Child anemia and child overweight/obesity	5.0 (75)	2.3 (6)	8.4 (7)	5.4 (62) †
Double burden on household				
Stunting and maternal overweight/obesity	7.6 (115)	6.8 (18)	7.2 (6)	7.8 (91)
Child anemia and maternal overweight/obesity	36.8 (553)	24.3 (64)	27.7 (23)	40.3 (466) ‡

Abbreviations: Hb, hemoglobin.
†Significant at P<0.05.
‡Significant at P<0.005.

a. Anemia classified based on Hb levels from blood tests during field visits. WHO guidelines were utilized to categorize levels of anemia.
b. Stunting defined as <-2 Standard Deviation (SD) units (Z-score) from the median of the reference international population for height-for-age; severe stunting defined as <-3 SD units below the median.
c. Wasting calculated for <5 years of age population only and defined as a <-2 SD units below the international reference median for weight-for-height.
d. Overweight defined as a weight-for-height >+2 SD units from the international reference median value; obese defined as >+3 SD units from the international reference for weight-for-height.
e. Underweight calculated for <10 years of age population only and defined as weight-for-age <-2 SD from the international reference median value.
f. Disability status self-reported via a questionnaire that asked the caretaker “Has the child suffered from any form of physical, mental, or psychological disability for a period of more than 6 months that prevented him/her from participating fully in activities of daily living?”

Table 3a. Sociodemographic, health, and household characteristics in full study sample of children (n=1,501), by stunting status				
Characteristics % (n)		Severely stunted n=48	Moderately stunted n=121	Not stunted n=1,332
Sex	Female	50.0 (24)	40.5 (49)	50.1 (667)
	Male	50.0 (24)	59.5 (72)	49.9 (665)
Age, months (mean, SD)		49.8 (30.6)	68.5 (39.6)	74.8 (36.5) ‡
Age, categorical	<2 years	18.8 (9)	11.6 (14)	8.0 (107) ‡
	2–4 years	56.3 (27)	38.8 (47)	29.9 (399)
	5–10 years	22.9(11)	34.7 (42)	47.2 (629)
	>10 years	2.1 (1)	14.9 (18)	14.8 (197)
Low birthweight (<2.5 kg)		8.3 (4)	15.7 (19)	9.3 (124)
Self-reported anemia		18.8 (9)	14.1 (17)	9.2 (123) †
Anemia[a], categorical, based on Hb	Non-anemic	27.0 (13)	42.9 (52)	49.4 (658) ‡
	Mild	33.3 (16)	23.1 (28)	24.4 (325)
	Moderate	33.3 (16)	32.2 (39)	25.7 (342)
	Severe	6.3 (3)	1.6 (2)	0.5 (7)
Overweight and obese[b]		25.0 (12)	10.7 (13)	8.6 (114) ‡
Underweight (<10 years only)[c]		29.8 (14)	16.2 (17)	1.3 (15/1,155) ‡
Disability status[d]		6.3 (3)	5.8 (7)	1.2 (16) ‡
Diarrhea (past two weeks)		14.6 (7)	14.0 (17)	9.7 (129)
Any exposure to forced displacement[e]		27.1 (13)	32.2 (39)	17.1 (228) ‡
Multiple exposures to forced displacement[f]		16.7 (8)	26.5 (32)	12.9 (173) ‡
District	Jericho	70.8 (34)	76.9 (93)	77.2 (1,028)
	Nablus	8.3 (4)	5.8 (7)	5.4 (72)
	Tubas	20.8 (10)	17.4 (21)	17.4 (232)
Residence type	Village	58.3 (28)	55.4 (67)	63.3 (843) ‡
	Camp	16.7 (8)	22.3 (27)	27.1 (361)
	Bedouin	25.0 (12)	22.3 (27)	9.6 (128)
Caregiver education	None	6.3 (3)	7.4 (9)	5.0 (67) †
	Less than high school	70.8 (34)	77.7 (94)	64.7 (862)
	High school	16.7 (8)	7.4 (9)	16.5 (220)
	Diploma or greater	6.3 (3)	7.4 (9)	13.7 (183)

Household size			
4–2	22.9 (11)	13.2 (16)	11.4 (152) †
6–5	35.4 (17)	30.6 (37)	37.4 (498)
8–7	22.9 (11)	26.5 (32)	31.4 (418)
>8	18.7 (9)	29.8 (36)	19.8 (263)
Raise poultry			
Yes	50.0 (24)	43.8 (53)	35.4 (467) †
Raise cattle			
Yes	50.0 (24)	44.6 (54)	31.3 (413) ‡
Bathroom			
Inside house	70.2 (33)	73.6 (89)	84.5 (1,124) ‡
Outside house	27.7 (13)	23.9 (29)	13.9 (185)
No bathroom	2.1 (1)	2.5 (3)	1.6 (21)
Kitchen			
Inside house	74.5 (35)	71.9 (87)	86.3 (1,148) ‡
Outside house	21.3 (10)	23.1 (28)	10.1 (135)
No kitchen	4.3 (2)	4.9 (6)	3.53 (47)
Source of water			
Israeli network	39.1 (18)	45.8 (55)	42.3 (562) ‡
Palestinian network	39.1 (18)	39.2 (47)	47.5 (632)
Tank	19.6 (9)	9.2 (11)	7.2 (96)
Well	2.2 (1)	4.2 (5)	0.8 (11)
Other	0.0 (0)	1.7 (2)	2.1 (28)
Source of electricity			
Israeli network	36.9 (17)	36.7 (44)	42.8 (566) ‡
Palestinian network	41.3 (19)	43.3 (52)	49.1 (649)
Generator	2.2 (1)	1.7 (2)	0.0 (0)
Other	19.6 (9)	18.3 (22)	8.2 (108)
Monthly income (NIS)			
≤1,000	18.7 (9)	23.1 (28)	21.6 (288) †
1,000–2,000	60.4 (29)	53.7 (65)	44.1 (587)
>2,000	20.8 (10)	23.1 (28)	34.3 (457)
Primary health provider			
MOH clinic	79.2 (38)	80.2 (97)	74.2 (989)
UNRWA	12.5 (6)	14.9 (18)	19.7 (263)
Private clinic	4.2 (2)	4.1 (5)	4.4 (59)
Mobile clinic	4.2 (2)	0.8 (1)	1.6 (21)
Anemia, all mothers (pregnant and non-pregnant)	58.3 (28)	71.9 (87)	59.3 (789) †
Anemia, severe, all	0.0 (0)	1.7 (2)	1.5 (20)
Mother employed	12.5 (6)	7.4 (9)	11.6 (155)
Maternal height (cm) mean (SD)	156.2 (4.42)	155.4 (4.81)	157.8 (6.14) ‡
Access to health services			
Length of walk to closest health-care facility (minutes) mean (SD)	87.7 (122.4)	91.65 (117.2)	61.6 (92.6) †

Time by car to closest hospital (minutes) mean (SD)	35.6 (18.2)	35.2 (18.8)	32.8 (18.96)
Checkpoint in order to access healthcare services	52.1 (25)	61.9 (75)	55.07 (733)

Abbreviations: Hb, hemoglobin; MOH, Ministry of Health; UNRWA, United Nations Relief and Works Agency.

†Significant at P<0.05.

‡Significant at P<0.005.

a. Anemia classified based on Hb levels from blood tests during field visits. WHO guidelines were utilized to categorize levels of anemia.

b. Overweight defined as a weight-for-height >+2 SD units from the international reference median value; obese defined as >+3 SD units from the international reference for weight-for-height.

c. Underweight calculated for <10 years of age population only and defined as weight-for-age <-2 SD from the international reference median value.

d. Disability status self-reported via a questionnaire that asked the caretaker: "Has the child suffered from any form of physical, mental, or psychological disability for a period of more than 6 months that prevented him/her from participating fully in activities of daily living?"

e. Forced displacement was calculated based on four measures: forced to relocate in the past, under threat of relocation, home destroyed, home under threat of destruction.

f. Multiple forced displacement was defined as more than one of the following exposures to forced displacement: forced to relocate in the past, under threat of relocation, home destroyed, home under threat of destruction.

Table 3b. Crude and multivariate logistic regression, odds ratios (OR) for determinants of stunting in children of the Jordan Valley, Palestine, in total (n=1,501) and by age group				
Characteristics	**Unadjusted OR (95% CI)** †	**Adjusted OR (95%CI)**	**Adjusted OR (95%CI) under 5 (n=617)**	**Adjusted OR (95%CI) >5 Years (n=886)**
Sex				
Male	Reference	Reference	Reference	Reference
Female	0.76 (0.54, 1.1)	0.80 (0.56,1.15)	0.92 (0.57, 1.51)	0.65 (0.39, 1.10)
Age, years				
<2 years	Reference	Reference	Reference	--
2–4 years	0.86 (0.53, 1.40)	0.81 (0.47, 1.38)	0.78 (0.46, 1.32)	--
5–10 years	0.39 (0.22, 0.68)†	0.38 (0.21, 0.69)	--	Reference
>10 years	0.45 (0.24, 0.85)†	0.43 (0.20, 0.87)	--	1.14 (0.64, 2.03)
Any exposure to forced displacement				
No	Reference	Reference	Reference	Reference
Yes	2.15 (1.37, 3.39)†	1.02 (0.47, 2.2)	0.44 (0.13, 1.46)	1.98 (0.88, 4.44)
Anemia (based on hemoglobin)				
No	Reference	Reference	Reference	Reference
Yes	1.56 (1.11, 2.20)†	1.44 (0.98, 2.11)	1.41 (0.85, 2.35)	1.43 (0.83, 2.47)
Monthly income (NIS)				
≤1,000	Reference	Reference	Reference	Reference
1,000–2,000	1.25 (0.79, 1.95)	1.41 (0.86, 2.30)	1.16 (0.64, 2.09)	1.80 (0.78, 4.17)
>2,000	0.65 (0.39. 1.08)	0.95 (0.54, 1.66)	0.74 (0.37, 1.45)	1.36 (0.52, 3.54)
Residence type				
Village	Reference	Reference	Reference	Reference
Camp	0.86 (0.52, 1.39)	0.81 (0.47, 1.37)	0.81 (0.44, 1.5)	0.81 (0.37, 1.77)
Bedouin	2.70 (1.64, 4.46)†	1.96 (0.79, 4.84)	3.2 (0.84, 12.5)	1.74 (0.56, 5.39)
Household size				
2–4	Reference	Reference	Reference	Reference
5–6	0.61 (0.36, 1.03)	0.82 (0.45, 1.47)	0.93 (0.46, 1.78)	0.62 (0.15, 2.62)
7–8	0.58 (0.33, 1.02)	0.70 (0.38, 1.29)	0.63 (0.29, 1.34)	0.66 (0.16, 2.69)
>8	0.96 (0.54, 1.77)	1.17 (0.59, 2.31)	1.55 (0.73, 3.32)	0.83 (0.19, 3.50)
Bathroom				
Inside house	Reference	Reference	Reference	Reference
Outside house	2.09 (1.29, 3.37)†	0.84 (0.40,1.77)	0.59 (0.16, 2.17)	1.28 (0.52, 3.18)
No bathroom	1.75 (0.64, 4.81)	0.55 (0.11, 2.67)	0.40 (0.06, 2.9)	1.25 (0.13, 11.8)
Maternal anemia				
Yes	Reference	Reference	Reference	Reference
No	1.46 (0.98, 2.18)	1.23 (0.81, 1.86)	1.2 (0.71, 2.1)	1.26 (0.66, 2.41)
Maternal height (cm)	0.95 (0.92, 0.98)†	0.94 (0.91, 0.98)	0.95 (0.92, 0.98)	0.93 (0.89, 0.97)
Length of walk to closest health clinic (minutes)	1.00 (1.00, 1.00)‡	1.00 (0.99, 1.00)	1.00 (0.99, 1.00)‖	1.00 (0.99, 1.00)‖

Abbreviations: OR, Odds Ratio; CI, confidence interval; MOH, Ministry of Health; UNRWA, United Nations Relief and Works Agency.
†Except where noted, confidence intervals that do not cross 1 are significant at P<0.05.
‡Confidence interval does not cross 1, significant at P<0.005.
‖ Confidence interval crosses 1, not significant at P<0.05.

Table 4a. Sociodemographic, health, and household characteristics in full study sample of children (n=1,501) by anemia status as determined by hemoglobin levels from HemoCue test

Characteristics % (n)		Anemic n=778	Not anemic n=723
Sex			
	Female	46.9 (365)	51.9 (375)
	Male	53.1 (413)	48.1 (348)
Age, months (mean, SD)		68.8 (37.1)	78.5 (36.0) ‡
Age, categorical			
	<2 years	11.4 (89)	5.7 (41) ‡
	2–4 years	33.0 (257)	29.9 (216)
	5–10 years	43.6 (339)	47.4 (343)
	>10 years	11.9 (93)	17.0 (123)
Low birthweight (<2.5 kg)		10.5 (82)	8.9 (65)
Self-reported anemia		13.4 (104)	6.2 (45) ‡
Overweight and obese[a]		9.6 (75)	8.9 (64)
Underweight (<10 years only)[b]		3.6 (25/693)	3.4 (21/614)
Disability status[c]		1.3 (10)	2.2 (16)
Any intestinal infection[d]		18.3 (142)	14.7 (106)
Diarrhea (past two weeks)		10.8 (84)	9.5 (69)
Any parasitic infection only[e]		16.5 (128)	13.4 (97)
Any exposure to forced[g] **displacement**[f]		18.4 (143)	18.9 (137)
Multiple exposures to forcedg displacement		14.5 (113)	13.8 (100)
District			
	Jericho	80.2 (624)	73.4 (531) ‡
	Nablus	5.1 (40)	5.9 (43)
	Tubas	14.7 (114)	20.6 (149)
Residence type			
	Village	66.2 (515)	58.5 (423) ‡
	Camp	21.9 (171)	31.1 (225)
	Bedouin	11.8 (92)	10.4 (75)
Caregiver education			
	None	5.4 (42)	5.1 (37) †
	Less than high school	66.8 (520)	65.0 (470)
	High school	17.2 (134)	14.2 (103)
	Diploma or greater	10.5 (82)	15.6 (113)
Household size			
	2–4	14.1 (110)	9.6 (69) †
	5–6	35.1 (273)	38.6 (279)
	7–8	30.0 (233)	31.6 (228)

	>8	20.8 (162)	20.2 (146)
Raise poultry		38.6 (297)	34.4 (247)
Raise cattle		35.2 (271)	30.6 (220)
Bathroom			
	Inside house	82.2 (639)	84.2 (607)
	Outside house	16.6 (129)	13.6 (98)
	No bathroom	1.2 (9)	2.2 (16)
Kitchen			
	Inside house	83.8 (651)	85.8 (619)
	Outside house	12.9 (100)	10.1 (73)
	No kitchen	3.3 (26)	4.0 (29)
Source of water			
	Israeli network	42.7 (331)	42.2 (304)
	Palestinian network	47.2 (367)	45.8 (330)
	Tank	6.5 (50)	9.2 (66)
	Well	1.2 (9)	1.1 (8)
	Other	2.3 (18)	1.7 (12)
Source of electricity			
	Israeli network	41.1 (317)	43.2 (310)
	Palestinian network	48.8 (376)	47.9 (344)
	Generator	0.4 (3)	0.0 (0)
	Other	9.7 (75)	8.9 (64)
Monthly income (NIS)			
	≤1,000	22.4 (174)	20.9 (151)
	1,001–2,000	47.0 (366)	43.6 (315)
	>2,000	30.6 (238)	35.6 (257)
Primary health provider			
	MOH clinic	78.4 (610)	71.1 (514) ‡
	UNRWA	15.9 (124)	22.5 (163)
	Private clinic	4.8 (37)	4.0 (29)
	Mobile clinic	0.9 (7)	2.3 (17)
Anemia, all mothers		64.5 (502)	55.7 (402) ‡
Anemia, severe, all mothers		1.5 (11)	1.4 (11)
Mother employed		9.3 (72)	13.6 (98)
		Access to health services	
Length of walk to closest health-care facility (minutes), mean (SD)		60.19 (92.84)	69.73 (99.53) †
Time by car to closest hospital (minutes), mean (SD)		33.87 (18.02)	32.2 (19.84)
Checkpoint in order to access healthcare services		54.5 (424)	56.6 (409)

Abbreviations: Hb, hemoglobin; MOH, Ministry of Health; UNRWA, United Nations Relief and Works Agency.
†Significant at P<0.05
‡Significant at P<0.005

a. Overweight defined as a weight-for-height >+2 SD units from the international reference median value; obese defined as >+3 SD units from the international reference for weight-for-height.
b. Underweight calculated for <10 years of age population only and defined as weight-for-age <-2 SD from the international reference median value.
c. Disability status self-reported via a questionnaire that asked the caretaker: "Has the child suffered from any form of physical, mental, or psychological disability for a period of more than 6 months that prevented him/her from participating fully in activities of daily living?"
d. Any intestinal infection defined as any positive reading for any of the parasitic or worm infections in either of the two stool sample
e. Any parasitic infection defined as any positive reading for any of the parasitic infections only in either of the two stool samples.
f. Forced displacement was calculated based on four measures: forced to relocate in the past, under threat of relocation, home destroyed, home under threat of destruction.
g. Multiple forced displacement was defined as more than one of the following exposures to forced displacement: forced to relocate in the past, under threat of relocation, home destroyed, home under threat of destruction.

Table 4b. Crude and multivariate logistic regression, odds ratios (OR) for determinants of anemia in children of the Jordan Valley, Palestine, total (n=1,501) and by age group

Characteristics	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI) under 5 (n=617)	Adjusted OR (95% CI) ≥5 years
Sex				
Male	Reference	Reference	Reference	Reference
Female	0.82 (0.67, 1.01)	0.83 (0.66, 1.03)	0.91 (0.63, 1.30)	0.75 (0.57, 0.99) ‡
Age, years				
<2 years	Reference	Reference	Reference	--
2–4 years	0.55 (0.36, 0.82)	0.52 (0.33, 0.77)	0.52 (0.33, 0.80)‡	--
5–10 years	0.45 (0.31, 0.68)	0.47 (0.29, 0.69)	--	Reference
>10 years	0.35 (0.22, 0.56)	0.35 (0.20, 0.54)	--	0.75 (0.55, 1.03)
Child Giardia cyst				
No	Reference	Reference	Reference	Reference
Yes	1.61 (1.11, 2.32)	1.29(0.87, 1.90)	1.67 (0.92, 3.05)	1.05(0.61, 1.80)
Maternal anemia (based on hemoglobin)				
No	Reference	Reference	Reference	Reference
Yes	1.44 (1.13, 1.85)	1.44 (1.11, 1.86)	1.97 (1.33, 2.91) ‡	1.17 (0.85, 1.60)
Length of walk to closest healthcare facility (minutes)	Reference	Reference	Reference	
	0.99 (0.99, 1.00)‖	0.99 (0.99, 1.00)‖	0.99 (0.99, 1.00)‖	0.99 (0.99, 1.00)‖
District of residence				
Tubas	Reference	Reference	Reference	Reference
Nablus	1.21 (0.74, 1.99)	1.13 (0.62, 2.05)	0.84 (0.31, 2.26)	1.37 (0.61, 3.07)
Jericho	1.54 (1.11, 2.12)	1.80 (1.23, 2.63)	2.88 (1.64, 5.06)‡	1.32 (0.84, 2.08)
Residence type				
Village	Reference	Reference	Reference	Reference
Camp	0.62 (0.47, 0.82)	0.69 (0.46,1.02)	0.48 (0.25, 0.92)‡	0.87 (0.52, 1.44)
Bedouin	1.01 (0.68, 1.51)	1.67 (0.92, 3.05)	1.24 (0.50, 3.11)	2.28 (1.00, 5.23)‡
Household size				
2–4	Reference	Reference	Reference	Reference
5–6	0.61 (0.42, 0.89)	0.70 (0.47, 1.04)	0.63 (0.38, 1.01)	1.03 (0.49, 2.17)
7–8	0.64 (0.44, 0.94)	0.77 (0.51, 1.16)	0.66 (0.39, 1.11)	1.15 (0.55, 2.41)
>8	0.70 (0.45, 1.07)	0.83 (0.53, 1.31)	0.82 (0.43, 1.58)	1.19 (0.54, 2.62)
Mother employed				
Yes	Reference	Reference	Reference	Reference
No	1.53 (1.08, 2.18)	1.57 (1.08, 2.28)	1.32 (0.74, 2.38)	0.93 (0.64, 1.36)
Primary health provider				
MOH clinic	Reference	Reference	Reference	Reference
UNRWA	0.63 (0.47, 0.86)	0.76 (0.51, 1.13)	0.80 (0.43, 1.51)	0.80 (0.47, 1.35)

Private clinic	1.07 (0.59, 1.91)	1.66 (0.89, 3.08)	1.34 (0.51, 3.52)	1.55 (0.75, 3.2)
Mobile clinic	0.34 (0.15, 0.79)	0.47 (0.18, 1.24)	0.31 (0.02, 3.74)	0.44 (0.14, 1.38)

Abbreviations: OR, Odds Ratio; CI, confidence interval; MOH, Ministry of Health; UNRWA, United Nations Relief and Works. Agency.

- Except where noted, confidence intervals that do not cross 1 are significant at P<0.05.
- Confidence interval does not cross 1, significant at P<0.05.
- Confidence interval crosses 1, not significant at P<0.05.

Table 5a. Sociodemographic, health, and household characteristics in full study sample of children (n=1,501) by overweight/obese status and underweight status

			<10 years only (n=1,307)	
Characteristics % (n)	Overweight and obese n=139	Not overweight or obese n=1,362	Underweight n=46	Not underweight n=1,261
Sex				
Female	43.2 (60)	49.9 (680)	56.5 (26)	48.6 (613)
Male	56.8 (79)	50.1 (682)	43.5 (20)	51.4 (648)
Age, months (mean, SD)	65.6 (41.8)	74.3 (36.3)	74.2 (30.5)	64.5 (31.2)
Low birthweight (<2.5 kg)	2.9 (4)	10.5 (143)‡	23.9 (11)	9.6 (121) ‡
Self-reported anemia	15.8 (22)	9.3 (127)†	15.2 (7)	10.3 (130)
Anemia, based on hemoglobin	53.9 (75)	51.6 (703)	54.3 (25)	52.9 (668)
Anemia, categorical[a]				
Non-anemic (low)	46.0 (64)	48.4 (659)	45.6 (21)	47.0 (593)
Mild	24.5 (34)	24.6 (335)	28.3 (13)	24.9 (315)
Moderate	29.5 (41)	26.1 (356)	26.1 (12)	27.0 (341)
Severe	0.0 (0)	0.9 (12)	0.0 (0)	0.9 (12)
Disability status[b]	2.9 (4)	1.6 (22)	13.0 (6)	1.4 (18) ‡
Diarrhea (past two weeks)	15.1 (21)	9.7 (132) †	13.0 (6)	10.7 (135)
Stunting[c]	17.9 (25)	10.6 (144) ‡	67.4 (31)	9.6 (121) ‡
Any intestinal infection[d]	12.2 (17)	16.9 (231)	26.1 (12)	16.6 (209)
Any exposure to forced displacement[e]	14.4 (20)	19.1 (260)	28.3 (13)	18.3 (231)
Multiple exposures to forced displacement[f]	12.9 (18)	14.3 (195)	21.7 (10)	13.9 (175)
District				
Jericho	82.0 (114)	76.4 (1,041) †	78.3 (36)	77.5 (977)
Nablus	8.6 (12)	5.2 (71)	6.5 (3)	5.5 (69)
Tubas	9.4 (13)	18.4 (250)	15.2 (7)	17.0 (215)
Residence type				
Village	49.6 (69)	63.8 (869) ‡	52.2 (24)	63.1 (796) †
Camp	35.3 (49)	25.5 (347)	23.9 (11)	26.3 (332)
Bedouin	15.1 (21)	10.7 (146)	23.9 (11)	10.6 (133)
Caregiver education				
None	4.3 (6)	5.4 (73)	19.6 (9)	4.3 (54) ‡
Less than high school	63.3 (88)	66.2 (902)	67.4 (31)	64.8 (817)
High school	12.9 (18)	16.1 (219)	6.5 (3)	16.7 (211)
Diploma or greater	19.4 (27)	12.3 (168)	6.5 (3)	14.2 (179)
Household size				
2–4	15.2 (21)	11.6 (158)	17.4 (8)	13.1 (165)
5–6	34.8 (48)	36.9 (504)	26.1 (12)	38.8 (489)
7–8	31.2 (43)	30.7 (418)	28.3 (13)	29.4 (370)

>8	18.8 (26)	20.7 (282)	28.3 (13)	18.7 (236)
Raise poultry				
Yes	42.5 (59)	35.9 (485)	56.5 (26)	35.9 (449) ‡
Raise cattle				
Yes	31.7 (44)	33.1 (447)	45.6 (21)	32.2 (402)
Bathroom				
Inside house	85.6 (119)	82.9 (1,127)	65.2 (30)	83.6 (1,053) ‡
Outside house	13.7 (19)	15.3 (208)	32.6 (15)	14.6 (184)
No bathroom	0.7 (1)	1.8 (24)	2.2 (1)	1.7 (22)
Kitchen				
Inside house	85.6 (119)	84.7 (1,151)	67.4 (31)	85.5 (1,077) ‡
Outside house	10.8 (15)	11.6 (159)	28.3 (13)	11.0 (139)
No kitchen	3.6 (5)	3.7 (50)	4.4 (2)	3.4 (43)
Source of water				
Israeli network	36.7 (51)	43.1 (584)	34.8 (16)	42.7 (537)
Palestinian network	53.2 (74)	45.9 (623)	43.5 (20)	46.7 (587)
Tank	5.8 (8)	8.0 (108)	17.4 (8)	7.5 (94)
Well	2.2 (3)	1.0 (14)	0.0 (0)	1.1 (14)
Other	2.2 (3)	1.9 (27)	4.4 (2)	1.9 (25)
Source of electricity				
Israeli network	34.5 (48)	42.9 (579)	30.4 (14)	42.5 (533) ‡
Palestinian network	55.7 (76)	47.7 (644)	47.8 (22)	48.4 (607)
Generator	0.0 (0)	0.2 (3)	2.2 (1)	0.2 (2)
Other	10.8 (15)	9.2 (124)	19.6 (9)	8.9 (111)
Monthly income (NIS)				
≤1,000	20.1 (28)	21.8 (297) p=0.617	21.7 (10)	22.1 (279)
1,001–2,000	43.2 (60)	45.6 (621)	54.4 (25)	45.1 (569)
>2,000	36.7 (51)	32.6 (444)	23.9 (11)	32.8 (413)
Primary health provider				
MOH clinic	69.1 (96)	75.5 (1,028)	65.2 (30)	75.7 (955)
UNRWA	24.5 (34)	18.6 (253)	23.9 (11)	18.9 (239)
Private clinic	2.9 (4)	4.6 (62)	8.7 (4)	3.9 (49)
Mobile clinic	3.6 (5)	1.4 (19)	2.2 (1)	1.4 (18)
Anemia, all mothers	60.1 (83)	60.3 (821)	52.2 (24)	60.2 (758)
Anemia, severe, all mothers	0.7 (1)	1.5 (21)	0.0 (0)	1.6 (20)
Maternal BMI				
Normal or underweight	18.7 (26)	27.4 (373) †	36.9 (17)	27.3 (344)
Overweight or obese	81.3 (113)	72.6 (989)	63.0 (29)	72.7 (917)
Access to health services				
Length of walk to closest health-care facility (minutes) mean (SD)	79.8 (96.1)	63.2 (96.1)	97.2 (140.5)	61.6 (91.4) ‡
Time by car to closest hospital (minutes) mean (SD)	30.5 (19.7)	33.3 (18.8)	34.2 (19.7)	33.0 (18.8)

Checkpoint in order to access healthcare services	68.1 (94)	54.3 (739)‡	60.9 (28)	54.8 (691)

Abbreviations: Hb, hemoglobin; MOH, Ministry of Health; UNRWA, United Nations Relief and Works Agency.

†Significant at P<0.05.

‡Significant at P<0.005.

a. Anemia classified based on hemoglobin levels from blood tests during field visits. WHO guidelines were utilized to categorize levels of anemia.

b. Disability status self-reported via a questionnaire that asked the caretaker: "Has the child suffered from any form of physical, mental, or psychological disability for a period of more than 6 months that prevented him/her from participating fully in activities of daily living?"

c. Stunting defined as <-2 Standard Deviation (SD) units (Z-score) from the median of the reference international population for height-for-age; severe stunting defined as <-3 SD units below the median.

d. Any intestinal infection defined as any positive reading for any of the parasitic or worm infections in either of the two stool samples

e. Forced displacement was calculated based on four measures: forced to relocate in the past, under threat of relocation, home destroyed, home under threat of destruction.

f. Multiple forced displacement was defined as more than one of the following exposures to forced displacement: forced to relocate in the past, under threat of relocation, home destroyed, home under threat of destruction.

Table 5b. Crude and multivariate logistic regression, odds ratios (OR) for determinants of overweight/obesity in children of the Jordan Valley, Palestine, total (n=1,501) and by age group

Characteristics	Unadjusted OR (95% CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI) under 5 (n=617)	Adjusted OR (95%CI) ≥5 years (n=898)
Sex Male	Reference	Reference	Reference	Reference
Female	0.76 (0.53, 1.1)	0.75 (0.52, 1.08)	.89 (0.54, 1.48)	0.63 (0.37, 1.07)
Age, years <2 years	Reference	Reference	Reference	--
2–4 years	0.41 (0.24, 0.71) ‡	0.39 (0.22, 0.69)‡	0.39 (0.22, 0.70)‡	--
5–10 years	0.26 (0.15, 0.45) ‡	0.26 (0.14,0.45)‡	--	Reference
>10 years	0.43 (0.23, 0.82) ‡	0.42 (0.22, 0.83)‡	--	1.81 (1.05, 3.13) ‡
Low birthweight (<2.5kg) No	Reference	Reference	Reference	--[b]
Yes	0.25 (0.09, 0.69) ‡	0.26 (0.09, 0.72)‡	0.53 (0.18, 1.56)	--
Stunting[a] No	Reference	Reference	Reference	Reference
Yes	1.85 (1.13, 3.03) ‡	1.67 (1.00, 2.78) †	2.87 (1.57, 5.29) ‡	0.18 (0.03, 1.27)
Maternal overweight/obesity No	Reference	Reference	Reference	Reference
Yes	1.64 (0.98, 2.73) ‡	1.79 (1.03, 3.10) ‡	1.55 (0.82, 2.95)	2.11 (0.72, 6.16)
District of residence Tubas	Reference	Reference	Reference	--[c]
Nablus	3.3 (1.25, 8.4) ‡	2.91 (1.11, 7.61) ‡	1.09 (0.31,3.79)	--
Jericho	2.1 (1.18, 3.74) ‡	1.94 (0.98, 3.83)	1.06 (0.44, 2.54)	--
Residence type Village	Reference	Reference	Reference	Reference
Camp	1.77 (1.17, 2.69) ‡	1.75 (1.13, 2.72) ‡	1.16 (0.61, 2.19)	2.39 (1.27, 4.51) ‡
Bedouin	1.81 (0.96, 3.40)	1.93 (0.95, 3.91)	2.10 (0.83, 5.29)	1.22 (0.31, 4.78)

*All estimates reported as odds ratios.
†Except where noted, confidence intervals that do not cross 1 are significant at P<0.05.
‡Confidence interval does not cross 1, significant at P<0.05.
‖ Confidence interval crosses 1, not significant at P<0.05.

a. Stunting defined as <-2 Standard Deviation (SD) units (Z-score) from the median of the reference international population for height-for-age; severe stunting defined as <-3 SD units below the median.
b. This variable was omitted from the model because it was collinear.
c. The sample size in this subgroup was too low for adjusted analysis.

Table 6a. Sociodemographic, health, and household characteristics in full study sample of children (n=1,501) by underweight status, <10 years only (n=1,307)		
Characteristics % (n)	Underweight n=46	Not underweight n=1,261
Sex		
Female	56.5 (26)	48.6 (613)
Male	43.5 (20)	51.4 (648)
Age, months (mean, SD)	74.2 (30.5)	64.5 (31.2)
Low birthweight (<2.5 kg)	23.9 (11)	9.6 (121) ‡
Self-reported anemia	15.2 (7)	10.3 (130)
Anemia, based on Hb	54.3 (25)	52.9 (668)
Anemia, categorical[a]		
Non-anemic (low)	45.6 (21)	47.0 (593)
Mild	28.3 (13)	24.9 (315)
Moderate	26.1 (12)	27.0 (341)
Severe	0.0 (0)	0.9 (12)
Disability status[b]	13.0 (6)	1.4 (18) ‡
Diarrhea (past two weeks)	13.0 (6)	10.7 (135)
Stunting[c]	67.4 (31)	9.6 (121) ‡
Any intestinal infection[d]	26.1 (12)	16.6 (209)
Any exposure to forced displacement[e]	28.3 (13)	18.3 (231)
Multiple exposures to forced displacement[f]	21.7 (10)	13.9 (175)
District		
Jericho	78.3 (36)	77.5 (977)
Nablus	6.5 (3)	5.5 (69)
Tubas	15.2 (7)	17.0 (215)
Residence type		
Village	52.2 (24)	63.1 (796) †
Camp	23.9 (11)	26.3 (332)
Bedouin	23.9 (11)	10.6 (133)
Caregiver education		
None	19.6 (9)	4.3 (54) ‡
Less than high school	67.4 (31)	64.8 (817)
High school	6.5 (3)	16.7 (211)
Diploma or greater	6.5 (3)	14.2 (179)
Household size		
2–4	17.4 (8)	13.1 (165)
5–6	26.1 (12)	38.8 (489)
7–8	28.3 (13)	29.4 (370)
>8	28.3 (13)	18.7 (236)

Raise poultry		
Yes	56.5 (26)	35.9 (449) ‡
Raise cattle		
Yes	45.6 (21)	32.2 (402)
Bathroom		
Inside house	65.2 (30)	83.6 (1,053) ‡
Outside house	32.6 (15)	14.6 (184)
No bathroom	2.2 (1)	1.7 (22)
Kitchen		
Inside house	67.4 (31)	85.5 (1,077) ‡
Outside house	28.3 (13)	11.0 (139)
No kitchen	4.4 (2)	3.4 (43)
Source of water		
Israeli network	34.8 (16)	42.7 (537)
Palestinian network	43.5 (20)	46.7 (587)
Tank	17.4 (8)	7.5 (94)
Well	0.0 (0)	1.1 (14)
Other	4.4 (2)	1.9 (25)
Source of electricity		
Israeli network	30.4 (14)	42.5 (533) ‡
Palestinian network	47.8 (22)	48.4 (607)
Generator	2.2 (1)	0.2 (2)
Other	19.6 (9)	8.9 (111)
Monthly income (NIS)		
≤1,000	21.7 (10)	22.1 (279)
1,001–2,000	54.4 (25)	45.1 (569)
>2,000	23.9 (11)	32.8 (413)
Primary health provider		
MOH clinic	65.2 (30)	75.7 (955)
UNRWA	23.9 (11)	18.9 (239)
Private clinic	8.7 (4)	3.9 (49)
Mobile clinic	2.2 (1)	1.4 (18)
Anemia, all mothers	52.2 (24)	60.2 (758)
Anemia, severe, all mothers	0.0 (0)	1.6 (20)
Maternal BMI		
Normal or underweight	36.9 (17)	27.3 (344)
Overweight or obese	63.0 (29)	72.7 (917)
Length of walk to closest health-care facility (minutes) mean (SD)	97.2 (140.5)	61.6 (91.4) ‡
Time by car to closest hospital (minutes) mean (SD)	34.2 (19.7)	33.0 (18.8)

Abbreviations: Hb, hemoglobin; MOH, Ministry of Health; UNRWA, United Nations Relief and Works Agency.

†Significant at P<0.05.

‡Significant at P<0.005.

a. Anemia classified based on hemoglobin levels from blood tests during field visits. WHO guidelines were utilized to categorize levels of anemia.
b. Disability status self-reported via a questionnaire that asked the caretaker: "Has the child suffered from any form of physical, mental, or psychological disability for a period of more than 6 months that prevented him/her from participating fully in activities of daily living?"
c. Stunting defined as <-2 Standard Deviation (SD) units (Z-score) from the median of the reference international population for height-for-age; severe stunting defined as <-3 SD units below the median.
d. d. Any intestinal infection defined as any positive reading for any of the parasitic or worm infections in either of the two stool samples
e. Forced displacement was calculated based on four measures: forced to relocate in the past, under threat of relocation, home destroyed, home under threat of destruction.
f. Multiple forced displacement was defined as more than one of the following exposures to forced displacement: forced to relocate in the past, under threat of relocation, home destroyed, home under threat of destruction.

Table 6b. Crude and multivariate logistic regression, odds ratios (OR) for determinants of underweight in children of the Jordan Valley, Palestine, total (n=1,307) and by age group

Characteristics	Unadjusted OR (95% CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI) under 5 (n=603)	Adjusted OR (95%CI) 5–10 Years (n=704)
Sex				
Male	Reference	Reference	Reference	Reference
Female	1.37 (0.76, 2.49)	1.43 (0.77, 2.66)	1.52 (0.49, 4.69)	1.45 (0.66, 3.15)
Age, years				
<2 years	--	--	--	--
2–4 years	0.78 (0.09, 6.29)	1.37 (0.07, 27.76)	--	--
5–10 years	0.89 (0.11, 7.10)	1.41 (0.07, 27.82)	--	Reference
>10 years	--	--	--	0.76 (0.08, 15.8)
Disability status[a]				
Yes	Reference	Reference	Reference	Reference
No	0.09 (0.04, 0.25) ‡	0.11 (0.04, 0.32) ‡	0.06 (0.01, 0.26)†	0.19 (0.05, 0.81)†
Length of walk to closest healthcare facility (minutes)	1.00 (1.00, 1.00)†	1.00 (0.99, 1.00)‖	1.00 (0.99, 1.01)	0.99 (0.99, 1.01)
Residence type				
Village	Reference	Reference	Reference	Reference
Camp	1.09 (0.52, 2.3)	0.95 (0.45, 1.99)	0.61 (0.16, 2.28)	1.04 (0.39, 2.82)
Bedouin	2.74 (1.24, 6.06) ‡	1.52 (0.56, 4.14)	0.88 (0.09, 8.48)	1.87 (0.53, 6.6)
Maternal education				
None	Reference	Reference	Reference	Reference
Less than high school	0.22 (0.09, 0.52)‡	0.26 (0.11, 0.64)‡	--	0.15 (0.05, 0.43)
High school	0.08 (0.022, 0.33)‡	0.11 (0.02, 0.44)‡	--	0.08 (0.02, 0.45)
Diploma and above	0.10 (0.03, 0.38)‡	0.14 (0.04, 0.55) ‡	--	0.06 (0.00, 0.53)

Abbreviations: Hb, hemoglobin; MOH, Ministry of Health; UNRWA, United Nations Relief and Works Agency.
†Significant at P<0.05.
‡Significant at P<0.005.
‖ Confidence interval crosses 1, not significant at P<0.05.
a. Disability status self-reported via a questionnaire that asked the caretaker: "Has the child suffered from any form of physical, mental, or psychological disability for a period of more than 6 months that prevented him/her from participating fully in activities of daily living?"

Table 7a. Sociodemographic and health characteristics of mothers or female heads of household, total (n=587) and by district				
Sociodemographic characteristics				
% (n)	Total sample (n=587)	Tubas (n=112)	Nablus (n=30)	Jericho (n=445)
Age, years (mean, SD)	33.7(7.7)	34.8 (7.6)	33.8 (6.3)	33.4 (7.8)
Age, years, categorical				
≤29	32.5 (191)	28.6 (32)	20.0 (6)	34.4 (153)
30–39	44.5 (261)	43.8 (49)	66.7 (20)	43.1 (192)
≥40	23.0 (135)	27.7 (31)	13.3 (4)	22.5 (100)
Maternal height, cm, mean (SD)	157.4 (6.17)	157.2 (5.6)	158.4 (4.4)	157.43 (6.4)
Caregiver education[a]				
None	6.1 (36)	7.1 (8)	16.7 (5)	5.2 (23) †
Less than high school	64.9 (381)	60.7 (68)	80.0 (24)	64.9 (289)
High school	15.8 (93)	15.2 (17)	0.0 (0)	17.1 (76)
Diploma or greater	13.1 (77)	16.9 (19)	3.3 (1)	12.8 (57)
Marital status[b]				
Not married	0.3 (2)	0.0 (0)	3.3 (1)	0.2 (1)
Married	98.1 (573)	98.2 (108)	96.7 (29)	98.2 (436)
Widowed	0.7 (4)	0.0 (0)	0.0 (0)	0.9 (4)
Divorced	0.9 (5)	1.8 (2)	0.0 (0)	0.7 (3)
Employment				
Government	3.9 (23)	2.7 (3)	0.0 (0)	4.5 (20)
Private sector	2.9 (17)	0.0 (0)	0.0 (0)	3.8 (17)
Business owner	1.5 (9)	4.5 (5)	0.0 (0)	0.9 (4)
Laborer	3.2 (19)	9.9 (11)	3.3 (1)	1.6 (7)
Student	0.2 (1)	0.0 (0)	0.0 (0)	0.2 (1)
Housewife	87.9 (515)	82.8 (92)	93.3 (28)	88.8 (395)
Retired	0.2 (1)	0.0 (0)	3.3 (1)	0.0 (0)
Unemployed	0.2 (1)	0.0 (0)	0.0 (0)	0.2 (1)
Employment status				
Yes	11.6 (68)	16.7 (19)	3.3 (1)	10.8 (48)
Leishmaniasis in past year in family				
Yes	5.3 (31)	5.4 (6)	6.7 (2)	5.2 (23)
Scorpion bite in past year in family				
Yes	15.2 (89)	16.1 (18)	46.7 (14)	12.8 (57) ‡
Caretaker (mother, head of household) health characteristics				
Currently pregnant	8.2 (48)	9.8 (11)	10.0 (3)	7.6 (34)
Anemia, self-reported	19.1 (112)	17.0 (19)	23.3 (7)	19.4 (86)
Anemia, all mothers[c]	58.1 (341)	52.7 (59)	73.3 (22)	58.4 (260)

Severe anemia, total	1.53 (9)	1.8 (2)	0.0 (0)	1.6 (7)
Severe anemia, not pregnant	1.7 (9/539)	1.9 (2)	0.0 (0)	1.7 (7)
Severe anemia, pregnant	0.0 (0/48)	0.0 (0)	0.0 (0)	0.0 (0)
Taking iron supplements	28.5 (167)	33.9 (38)	43.3 (13)	26.1 (116)
Not pregnant	23.6 (127/539)	28.7 (29/101)	37.1 (10/27)	21.4 (88/411)
Pregnant	83.3 (40/48)	81.8 (9/11)	100.0 (3/3)	82.4 (28/34)
Diarrhea, past 2 weeks	6.8 (40)	6.2 (7)	23.3 (7)	5.8 (26)
Body Mass Index (BMI) Underweight <18.5	2.2 (13)	0.9 (1)	0.0 (0)	2.7 (12) ‡
Normal (BMI 18.5-24.99)	24.0 (141)	35.7 (40)	36.7 (11)	20.2 (90)
Overweight (BMI ≥25.00)	33.6 (197)	20.5 (23)	20.0 (6)	37.7 (168)
Obese (BMI ≥30.00)	40.2 (236)	42.9 (48)	43.3 (13)	39.3 (175)
Waist circumference (central obesity) <88 cm	33.6 (177)	43.4 (43)	29.6 (8)	31.4 (126)
≥ 88cm	66.4 (350)	56.6 (56)	70.4 (19)	68.6 (275)
Parasitic infections				
Infection last year	4.1 (24)	5.4 (6)	10.0 (3)	3.4 (15)
Giardia cyst	1.9 (10)	0.0 (0)	13.8 (4)	1.5 (6)
Giardia trophozoite	0.2 (1)	0.0 (0)	3.4 (1)	0.0 (0)
Entamoeba cyst	6.3 (36)	1.8 (2)	17.2 (5)	6.8 (29)
Entamoeba trophozoite	1.3 (7)	1.9 (2)	3.4 (1)	0.9 (4)
Salmonella	1.2 (7)	4.5 (5)	0.0 (0)	0.5 (2)
Shigella	0.4 (2)	0.0 (0)	0.0 (0)	0.5 (2)

Abbreviations: Hb, hemoglobin; MOH, Ministry of Health; UNRWA, United Nations Relief and Works Agency.
†Significant at $P<0.05$.
‡Significant at $P<0.005$.

a. Of the 36 mothers with no education, 8 were from Bedouin communities, 10 from camps, and 18 from villages.
b. The two unmarried caretakers were the sister and aunt of the children in the household.
c. Anemia classified based on hemoglobin levels from blood tests during field visits. WHO guidelines were utilized to categorize levels of anemia.

Table 7b. Prevalence of obesity, anemia, and central obesity in mothers of Jordan Valley (n=587)

Characteristics % (n)	Obese[a] n=236	Not obese n=351	Anemic[b] n=341	Not anemic n=246	Centrally obese[c] n=362	Not centrally obese n=177
Age, years (mean, SD)	36.8(7.6)	31.6 (6.9)	33.8 (7.6)	33.5 (7.8)	35.7 (7.4)	31.1 (7.2) ‡
Age, years, categorical						
≤29	19.1 (45)	41.6 (146) †	30.2 (103)	35.8 (88)	21.5 (78)	46.3 (82) ‡
30–39	43.6 (103)	45.0 (158)	45.5 (155)	43.1 (106)	48.1 (174)	41.2 (73)
≥40	37.3 (88)	13.4 (47)	24.3 (83)	21.1 (52)	30.4 (110)	12.4 (22)
District						
Jericho	74.2 (175)	76.9 (270)	76.3 (260)	75.2 (185)	78.7 (285)	71.2 (126)
Nablus	5.5 (13)	4.8 (17)	6.5 (22)	3.3 (8)	5.3 (19)	4.5 (8)
Tubas	20.3 (48)	18.2 (64)	17.3 (59)	21.5 (53)	16.0 (58)	24.3 (43)
Residence type						
Village	60.6 (143)	62.1 (218)	60.7 (207)	62.6 (154)	59.9 (217)	63.8 (113)‡
Camp	31.8 (75)	25.6 (90)	26.9 (92)	29.7 (73)	33.4 (121)	20.9 (37)
Bedouin	7.6 (18)	12.3 (43)	12.3 (42)	7.7 (19)	6.6 (24)	15.3 (27)
Caregiver education						
None	8.5 (20)	4.6 (16) †	5.9 (20)	6.5 (16)	8.3 (30)	2.8 (5) †
Less than high school	67.8 (160)	62.9 (221)	65.9 (225)	63.4 (156)	66.0 (239)	63.3 (112)
High school	12.3 (29)	18.2 (64)	16.7 (57)	14.6 (36)	15.2 (55)	16.9 (30)
Diploma or greater	11.4 (27)	14.3 (50)	11.4 (39)	15.5 (38)	10.5 (38)	16.9 (30)
Marital status						
Not married	0.0 (0)	0.6 (2)	0.3 (1)	0.4 (1)	0 (0)	1.1 (2) †
Married	98.3 (229)	98.0 (344)	99.4 (337)	96.3 (236)	98.3 (355)	97.2 (172)
Widowed	0.0 (0)	1.1 (4)	0.3 (1)	1.2 (3)	0.28 (1)	1.7 (3)
Divorced	1.7 (4)	0.3 (1)	0.0 (0)	2.0 (5)	1.4 (5)	0 (0)
Household size						
2–4	14.4 (34)	23.4 (82) ‡	18.2 (62)	21.9 (54)	12.9 (47)	27.1 (48)‡
5–6	31.8 (75)	39.0 (137)	34.3 (117)	38.6 (95)	37.3 (135)	33.9 (60)
7–8	28.8 (68)	25.1 (88)	29.3 (100)	22.8 (56)	29.6 (107)	25.9 (46)
>8	25.0 (59)	12.5 (44)	18.2 (62)	16.7 (41)	20.2 (73)	12.9 (23)
Raise poultry						
Yes	36.6 (86)	37.1 (129)	36.4 (123)	37.6 (92)	35.5 (128)	38.1 (67)
Raise cattle						
Yes	31.9 (75)	33.9 (118)	33.7 (114)	32.2 (79)	29.6 (107)	36.9 (65)
Exposure to forced displacement						
Yes	17.4 (41)	17.7 (62)	18.2 (62)	16.7 (41)	14.4 (52)	22.0 (39)†
Bathroom						
Inside house	84.7 (199)	82.9 (291)	82.9 (282)	84.5 (208)	87.5 (316)	77.9 (138) ‡
Outside house	13.6 (32)	15.7 (55)	16.2 (55)	13.0 (32)	11.9 (43)	19.2 (34)
No kitchen	1.7 (4)	1.4 (5)	0.9 (3)	2.4 (6)	0.5 (2)	2.8 (5)

Kitchen						
Inside house	86.4 (203)	83.8 (294)	83.8 (285)	86.2 (212)	87.5 (316)	80.2 (142)
Outside house	9.4 (22)	12.5 (44)	11.8 (40)	10.6 (26)	9.7 (35)	14.1 (25)
No kitchen	4.3 (10)	3.7 (13)	4.4 (15)	3.3 (8)	2.7 (10)	5.7 (10)
Source of water						
Israeli network	38.3 (90)	43.7 (153)	41.8 (142)	41.2 (101)	39.3 (142)	43.7 (77)
Palestinian network	51.5 (121)	44.9 (157)	47.1 (160)	48.2 (118)	51.5 (186)	43.7 (77)
Tank	6.4 (15)	8.9 (31)	7.4 (25)	8.6 (21)	5.5 (20)	10.2 (18)
Well	0.8 (2)	1.4 (5)	1.5 (5)	0.8 (2)	1.4 (5)	1.1 (2)
Other	2.9 (7)	1.1 (4)	2.4 (8)	1.2 (3)	2.2 (8)	1.1 (2)
Source of electricity						
Israeli network	41.0 (96)	41.3 (144)	40.7 (138)	41.8 (102)	40.6 (146)	40.0 (70) †
Palestinian network	51.3 (120)	48.1 (168)	48.4 (164)	50.8 (124)	53.3 (192)	46.3 (81)
Generator	11.4 (0)	0.3 (1)	0.0 (0)	0.4 (1)	0.0 (0)	0.6 (1)
Other	7.7 (18)	10.3 (36)	10.9 (37)	6.9 (17)	6.1 (22)	13.1 (23)
Monthly income (NIS) ≤1,000	17.8 (42)	25.4 (89) †	20.8 (71)	24.4 (60)	19.6 (71)	24.9 (44) †
1,001–2,000	43.2 (102)	45.3 (159)	47.5 (162)	40.2 (99)	41.7 (151)	49.2 (87)
>2,000	38.9 (92)	29.3 (103)	31.7 (108)	35.4 (87)	38.7 (140)	25.9 (46)
Primary health provider MOH clinic	72.0 (170)	74.1 (260)	75.1 (256)	70.7 (174)	69.9 (253)	78.5 (139)
UNRWA	21.2 (50)	19.4 (68)	18.2 (62)	22.8 (56)	23.2 (84)	15.8 (28)
Private clinic	4.2 (10)	5.7 (20)	4.9 (17)	5.3 (13)	5.5 (20)	5.1 (9)
Mobile clinic	2.5 (6)	0.8 (3)	1.8 (6)	1.2 (3)	1.4 (5)	0.6 (1)
Maternal health characteristics						
Anemia, self-reported	19.9 (47)	18.6 (65)	26.4 (90)	8.9 (22)‡	17.1 (62)	21.0 (37)
Anemia, based on Hbb	59.3 (140)	57.2 (201)	--	--	59.1 (214)	52.5 (93)
Taking iron supplements	29.7 (70)	27.6 (97)	30. 8(105)	25.2 (62)	23.8 (86)	23.2 (41)
Parasitic infections						
Infection last year	3.8 (9)	4.3 (15)	4.9 (17)	2.8 (7)	4.1 (15)	5.1 (9)
Any parasitic infection, stool	8.5 (20)	8.6 (30)	7.9 (27)	9.3 (23)	8.0 (29)	7.9 (14)

†Significant at P<0.05.
‡Significant at P<0.005.

a. Obesity defined as Body Mass Index (BMI) ≥30.00.
b. Anemia classified based on hemoglobin levels from blood tests during field visits. WHO guidelines were utilized to categorize levels of anemia.
c. Central obesity (waist circumference >88 cm) was only calculated for non-pregnant women in our sample.

Table 8. Sociodemographic, health, and household characteristics in full study sample of children (n=1,501) by Giardia cyst status		
Characteristics % (n)	Giardia cyst positive n=133	No Giardia cyst n=1,368
Sex		
Female	46.6 (62)	49.6 (678)
Male	53.4 (71)	50.4 (690)
Age, months (mean, SD)	67.4 (35.1)	74.1 (37.0)
Low birthweight (<2.5 kg)	14.3 (19)	9.4 (128)
Self-reported anemia	6.8 (9)	10.2 (140)
Anemia, based on Hb	62.4 (83)	50.8 (695)†
Anemia, categorical[a]		
Non-anemic (low)	37.6 (50)	49.2 (673) †
Mild	27.1 (36)	24.3 (333)
Moderate	35.3 (47)	25.6 (350)
Severe	0.0 (0)	0.9 (12)
Disability status[b]	1.5 (2)	1.75 (24)
Diarrhea (past two weeks)	15.0 (20)	9.7 (133)
Stunting[c]	15.0 (20)	10.9 (149)
Any exposure to forced displacement[e]	33.1 (44)	17.3 (236) ‡
Multiple exposures to forced displacement[f]	30.8 (41)	12.6 (172)‡
District		
Jericho	80.5 (107)	76.6 (1,048) ‡
Nablus	15.0 (20)	4.6 (63)
Tubas	4.5 (6)	18.8 (257)
Residence type		
Village	53.4 (71)	63.4 (867) ‡
Camp	15.8 (21)	27.4 (375)
Bedouin	30.8 (41)	9.2 (126)
Caregiver education		
None	12.0 (16)	4.6 (63) ‡
Less than high school	73.4 (98)	65.2 (892)
High school	12.0 (16)	16.1 (221)
Diploma or greater	2.3 (3)	14.0 (192)
Household size		
2–4	9.8 (13)	12.1 (166)
5–6	38.4 (51)	36.7 (501)
7–8	29.3 (39)	30.9 (422)
>8	22.6 (30)	20.3 (278)
Raise poultry		
Yes	51.5 (68)	35.1 (476) ‡
Raise cattle		
Yes	49.2 (65)	31.4 (426) ‡

Bathroom		
Inside house	66.9 (89)	84.8 (1,157) ‡
Outside house	33.1 (44)	13.4 (183)
No bathroom	0.0 (0)	1.8 (25)
Kitchen		
Inside house	71.4 (95)	86.1 (1,175) ‡
Outside house	25.6 (34)	10.2(139)
No kitchen	3.0 (4)	3.7(51)
Source of water		
Israeli network	46.6 (62)	42.1 (573) ‡
Palestinian network	34.6 (46)	47.8 (651)
Tank	14.3 (19)	7.1 (97)
Well	0.0 (0)	1.3 (17)
Other	4.5 (6)	1.8 (24)
Source of electricity		
Israeli network	45.1 (60)	41.8 (567)‡
Palestinian network	36.8 (49)	49.5 (671)
Generator	0.0 (0)	0.2 (3)
Other	18.1 (24)	8.5 (115)
Monthly Income (NIS)		
≤1,000	30.8 (41)	20.8 (284) ‡
1,001–2,000	46.6 (62)	45.3 (619)
>2,000	22.6 (30)	33.9 (465)
Primary Health Provider		
MOH clinic	81.9 (109)	1,015 (74.2)
UNRWA	16.5 (22)	19.4 (265)
Private clinic	0.8 (1)	4.8 (65)
Mobile clinic	0.8 (1)	1.7 (23)
Anemia, all mothers	67.7 (90)	59.6 (814)
Anemia, severe, all mothers	3.0 (4)	1.3 (18)†
Maternal BMI		
Normal or underweight	30.8 (41)	26.2 (358)
Overweight or obese	69.2 (92)	73.8 (1,010)
Length of walk to closest healthcare facility (minutes) mean (SD)	85.2 (104.0)	62.8 (95.2) †
Time by car to closest hospital (minutes) mean (SD)	36.2 (17.2)	32.8 (19.1) †

†Significant at P<0.05.
‡Significant at P<0.005.

a. Anemia classified based on hemoglobin levels from blood tests during field visits. WHO guidelines were utilized to categorize levels of anemia.
b. Obesity defined as Body Mass Index (BMI) ≥30.00.

Table 9. Intestinal infections, localities, and household characteristics in Jordan Valley study sample (n=1,501)

% (n)	Any intestinal infection* (n=248)	No intestinal infection (n=1,250)
District		
Tubas	10.9 (27)	18.8 (236) ‡
Nablus	13.3 (33)	3.9 (50)
Jericho	75.8 (188)	77.2 (967)
Locality		
Village	62.9 (156)	62.4 (782) ‡
Camp	16.5 (41)	28.3 (355)
Bedouin	20.6 (51)	9.3 (116)
Bathroom		
Inside house	76.2 (189) ‡	84.6 (1,057)
Outside house	23.4 (58)	13.5 (169)
None	0.4 (1)	1.9 (24)
Kitchen		
Inside house	79.8 (198) †	85.8 (1,072)
Outside house	17.3 (43)	10.4 (130)
None	3.7 (55)	3.8 (48)
Source of water		
Israeli network	49.6 (123)	41.1 (512) ‡
Palestinian network	32.6 (81)	49.4 (616)
Tank	10.9 (27)	7.1 (89)
Well	1.6 (4)	1.0 (13)
Other	5.2 (13)	1.4 (17)
Raising poultry		
Yes	43.3 (106)	35.2 (438) †
Raising cattle		
Yes	38.4 (94)	31.9 (397) †

* Any intestinal Infection was defined as having any of the following parasitic or worm infections in the stool: Giardia cyst, Giardia Trophozoite, Entamoeba cyst, Entamoeba Trophozoite, Salmonella, Rotavirus, Enterbius worm, Ascaris worm, or Taenia worm.

†Significant at P<0.05.

‡Significant at P<0.005.