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# Female eco-stability and severe malnutrition in children: Evidence from humanitarian aid interventions of Action Against Hunger in African, Asian and Latin American countries

## Ecoestabilidad femenina y malnutrición severa infantil: Evidencia a partir de intervenciones de ayuda humanitaria de Acción Contra el Hambre en países africanos, asiáticos y latinoamericanos

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## ABSTRACT

**Introduction:** Previous evidences reported sex differences in nutritional status between boys and girls of the same community, living under identical conditions of food deprivation. The aim of the present study is to analyze the sexual differences in the prevalence of severe malnutrition in children under 5 years of age, who were subjected to food crisis.

**Methods:** Data from humanitarian aid interventions carried out by Action Against Hunger between 2002 and 2010 in 24 countries were analyzed. These surveys were carried out in populations in Africa, Latin America and Asia that were in a serious food crisis. The sample consists of a total of 367,258 children (186,156 boys and 181,102 girls) aged (A) 6 to 59 months. Weight (W) and height (H) were measured according to SMART methodology. Prevalence of severe underweight (W/A <-3SD), wasting (W/H <-3SD) and stunting (H/A <-3SD) were calculated based on WHO Standards.

**Results:** On the whole sample, the proportion of boys with severe underweigh was 9.8% compared to 7.3% for girls ($p < 0.001$). Severe wasting affected 3.9% of boys versus 2.5% of girls ($p < 0.001$). Differences were also notable in chronic malnutrition: 19.5% of boys and 15% of girls ($p < 0.001$) suffered stunting.

**Conclusion:** The results support the idea of so-called female eco-stability, according to which females would be less sensitive to external factors that modulate ontogenetic development, while males would be most negatively affected by environmental aggressions.

## KEYWORDS

Underweight, Wasting, Stunting, under five children, Humanitarian aid, Female eco-estability.

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## RESUMEN

**Introducción:** Evidencias previas han reportado diferencias en la condición nutricional de niños y niñas pertenecientes a la misma comunidad y sometidos a idénticas condiciones de privación alimentaria. El objetivo del presente trabajo es analizar las diferencias sexuales en prevalencia de malnutrición severa en menores de 5 años, sometidos a situación de crisis alimentaria.

**Métodos:** Se analizaron datos recogidos en intervenciones de ayuda humanitaria llevadas a cabo por Acción Contra el Hambre entre 2002 y 2010 en 24 países. Dichas intervenciones se efectuaron en poblaciones de Africa, Latinoamérica y Asia que se encontraban en situación de grave crisis alimentaria. La muestra se compone de un total de 367.258 menores (186,156 niños y 181,102 niñas) con edad (E) entre 6 y 59 meses. Se midió el peso (P) y la talla (T) siguiendo la metodología SMART y se estimó la prevalencia de severo bajo peso (P/E <-3DE), desnutrición aguda severa (P/T <-3DE) y desnutrición crónica severa (T/E <-3DE) de acuerdo a los estándares de la OMS.

**Resultados:** Para el total de la muestra**,** la proporción de niños con severo bajo peso fue de 9,8% en comparación al 7,3% de niñas (p <0.001). La desnutrición aguda severa afectó al 3,9% de los niños frente al 2,5% de las niñas (p <0.001). Las diferencias también fueron notables en la desnutrición crónica: el 19, 5% de los niños frente al 15% de las niñas (p<0,001) presentaron crecimiento retardado.

**Conclusiones:** Los resultados avalan la idea de la denominada eco-estabilidad femenina, de acuerdo a la cual, las mujeres serian menos sensibles a los factores externos que modulan el desarrollo ontogénico, mientras los varones se verían más negativamente afectados por las agresiones medioambientales.



## PALABRAS CLAVE

Bajo peso, desnutrición aguda, desnutrición crónica, menores de 5 años, Ayuda Humanitaria, Eco-estabilidad femenina.


## ABBREVIATIONS

AAH: Action Against Hunger.

EPINUT-UCM: Epidemiological Nutrition Research Group, Complutense University of Madrid, Spain.

SMART: Standardized Monitoring and Assessment of Relief and Transitions methodology.

H/A: Height for Age or stunting.

W/H: Weight for Height or wasting.

W/A: Weight for Age or underweight.

WHO: World Health Organization.

SD: standard deviation.

## INTRODUCTION

Malnutrition is still a leading cause of morbidity and premature mortality among children in underdeveloped countries[1]. This problem has been linked to several factors, such as characteristics of mothers and community, socio-economic determinants and pre-and postnatal factors, which include low birth weight, inadequate care, poor nutrition, and recurrent infections[2,3]. This situation is highlighted in humanitarian crises, which unfortunately have multiplied in recent times. During the 21st century, droughts and other natural disasters resulting from climate change have led to high insecurity in a number of developing regions. Wars have led to the abandonment of crops, destroyed water and supply networks and displaced millions of people who need to feed away from their homes. The hunger in humanitarian crises especially affects children under five, the most vulnerable sector of the population. In this context of serious food insecurity and hunger, the data with which the present work was elaborated were taken[4].

This study was carried out under a Collaboration Agreement signed between Action Against Hunger (AAH) and Nutritional Epidemiology Research Group at the Complutense University of Madrid, Spain (EPINUT-UCM). AAH is an international non-governmental organization established in 1979 with the aim of eliminating hunger in the world and is present in over forty countries. Its areas of action are health, water and sanitation, food security and nutrition. In this field, AAH conducts intervention campaigns by focusing on nutritional status assessment, malnutrition prevention and its treatment.

Several studies have reported sex differences in the prevalence of malnutrition between children of the same community, living under identical conditions of food consumption[5,6]. These results support the hypothesis of the so-called feminine eco-stability, postulated by authors like Stini[7], which claims that girls are less susceptible to external factors that modulate ontogenetic development than boys, who are more adversely affected by environmental stressors. However, in the postnatal period the results are conditionated by cultural factors, such as the fact that boys receive better treatement in many societies[8,9]. The aim of this study is to analyze severe underweight, acute and chronic malnutrition in children under 5 years of age suffering food deprivation and to highlight the existing sex differences.

## METHODS

Data were obtained from previous field studies (humanitarian aid interventions) conducted by AAH between the years 2002 and 2010 in Afghanistan, Burundi, Central African Republic, Chad, Democratic Republic of Congo, Ethiopia, Guatemala, Guinea, Haiti, Ivory Coast, Kenya, Liberia, Mali, Mauritania, Myanmar, Nepal, Niger, Pakistan, Sierra Leone, Somalia, Sri Lanka, Sudan, Tajikistan, and Uganda.

The sample consisted of 367,258 children (186,156 boys and 181,102 girls) between the ages of 6 and 59 months, whose weight and height were measured following the standardized protocols established by Standardized Monitoring and Assessment of Relief and Transitions (SMART methodology)[10]. The children were recruited in humanitarian interventions made in response to famine caused by natural disasters, wars and other emergencies and come from different areas (urban, rural and refugee camps) of the related countries, as shown in Table 1. This study was carried out in accordance

**Table 1.** Geographic origin of the sample.

| Cluster | Country | Region | Males (N) | Females (N) |
|---|---|---|---|---|
| Central America and Caribbean | Guatemala | Qhiché (Zona Reina) | 417 | 489 |
| | Haiti | Artibonite, Grande-Anse, Northeastern, Centre, Northwest, West, Southt and Southeast departments | 13919 | 13352 |
| Central Asia | Afghanistan | Northern Afghanistan,, Kapisa province, Kabul, and Central province | 7840 | 7643 |
| | Nepal | Mid Western (Karnali, Humla, Mugu, Bajhang and Kanchanpur districts) | 2332 | 2242 |
| | Pakistan | Sindh, North West Frontier, Punjab, Balouchistan provinces, and Latif Abad IDP camp). | 4853 | 4654 |
| | Tajikistan | Khatlon region (Kurgan Tyube zone) | 430 | 467 |
| South Coast of Asia | Myanmar | North Rakhine state and East Rakhine state | 4177 | 3948 |
| | Sri Lanka | North region ( Jaffna district) | 687 | 714 |
| East Africa | Burundi | Ruyigi, Kayanza and Ngozi provinces. | 1340 | 1325 |
| | Ethiopia | Gurage Zone (Mareko Woreda), Sidama Zone (Kanicha, Dalota, Gorpa, Wuzate, Watha Chido, Zabalae, Sigida, Dormele, Megaza, Geniko) | 4756 | 4479 |
| | Kenya | Eastern, North Eastern, Rift Valley and Coast province and Nairobi (slums) | 5302 | 5090 |
| | Somalia | Puntland (Nugaal region), Bakool (Wajid district) | 1415 | 1284 |
| | Uganda | Northen region ( Northen Apac, Inakkulu, Ngai and Otwal, Lira and Gulu districts). | 6931 | 6890 |
| West Coast of Africa | Ivory Coast | Danané and West departments | 1056 | 1024 |
| | Guinea | Conakry (Prefectures of Beyla, Yomou,and Kissidougou) | 2097 | 2059 |
| | Liberia | Grand Gedeh County, Rivergee | 884 | 1013 |
| | Sierra Leone | Northern, Kono and Bo districts | 2321 | 2303 |
| Central Africa | C. African Republic | Bossangoa and Bangui | 2540 | 2465 |
| | D.R. of Congo | Eastern, Kivu, Kasai, Maniema, Equateur and Katanga provinces | 39496 | 38778 |
| Sahel | Mali | Gao ( Gao, Gounzoureye, Gounzoureye, Sony Aliber, Menaka, Anderamboukane) Mopti ( Bandiagara, Diamnati) Kayes ( Kita, Gadougou) | 2438 | 2370 |
| | Mauritania | Gorgol and Guidimak regions | 663 | 647 |
| | Niger | Mayahi, Abalak, Keita and Tchintabaraden, Depts. | 4715 | 4616 |
| | Sudan | Port Sudan and the shanty areas; South Darfur, North Darfur, Southern Leech, Phou, Bahr el Ghazal, Southern Equatorial, Jonglei and Red Sea states. | 66890 | 64881 |
| | Chad | Tchad East, South Tchad, Noth East Chad (refugee camps of Treguine, Hadjer Hadid). | 8657 | 8369 |
| All countries | | | 186156 | 181102 |

with the code of ethics of the World Medical Association[11] and was approved by Ethical Committee of the Complutense University of Madrid, Spain.

Height for age (H/A), weight for height (W/H) and weight for age (W/A), were calculated according to the current World Health Organization (WHO) growth standards[12]. Low H/A, also known as stunting, is a marker for chronic undernutrition and low W/H, or wasting, is a good indicator for acute undernutrition. Furthermore, underweight or low W/A, is good predictor variable of mortality[13]. For any of these anthropometric indicators, subjects with a Z-score of 3 standard deviations (SD) below the reference were considered severely undernourished.

For both girls and boys, the sample was divided into three age groups: from 6 to 23 months, from 24 to 47 months, and from 48 to 59 months. In addition, the sample was separated into 7 groups according to cultural and geographic proximity: East Africa (Burundi, Ethiopia, Kenya, Somalia and Uganda), West Coast of Africa (Ivory Coast, Guinea, Liberia and Sierra Leone), Central Africa (Central African Republic and Democratic Republic of Congo), Sahel (Mali, Mauritania, Niger, Sudan and Chad), Central America and Caribbean (Guatemala and Haiti), South Coast of Asia (Myanmar and Sri Lanka) and Central Asia (Afghanistan, Nepal, Pakistan and Tajikistan).

The prevalence for severe underweight (W/A< -3SD), wasting (W/H<-3SD), and stunting (H/A<-3SD) were determined and Chi-square ($\chi^2$) tests were applied to explore the differences between age and geographic groups (signification level $p<0.05$). Statistical procedures were made using the statistic software SPSS 21.0.

## RESULTS

The results (Figure 1) show that severe chronic malnutrition is more prevalent than acute malnutrition and severe underweight. Furthermore, they show that, prevalence of malnutrition is higher for boys than for girls and this pattern is the same in all geographic and age groups (Tables 2 and 3). On the whole sample, the proportion of boys with severe underweigh (W/A <-3SD) was 9.8% compared to 7.3% for girls ($\chi^2$=64. 7; df = 151462; p <0.001). Differences were also notable in chronic malnutrition (H/A <-3SD), where 19.5% of boys and 15% of girls suffered stunting ($\chi^2$= 31. 7 df = 63465; p <0.001). Severe wasting (W/H <-3SD) affected 3.9% of boys versus 2.5% of girls ($\chi^2$= 24.8 df= 11787; p <0.001).

## DISCUSSION

In the analyzed sample, the acute malnutrition that reflects a very important lack of food at a recent period,

**Figure 1.** Prevalence of severe underweight (W/A < -3SD), wasting (W/H < -3SD) and stunting (H/A < -3SD) by geographic location.

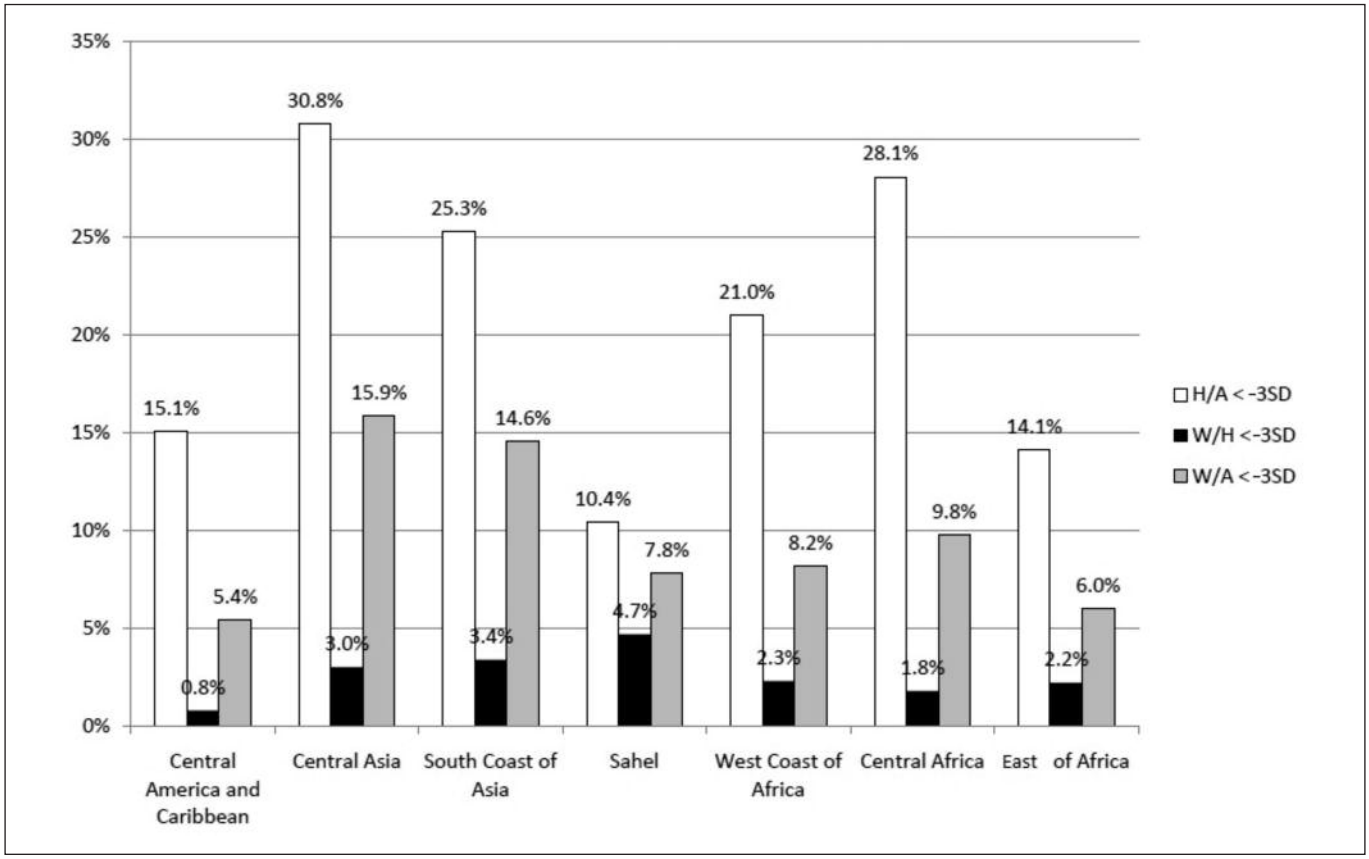

**Table 2.** Prevalence of severe underweight (W/A<-3SD), severe wasting (W/H<-3SD) and severe stunting (H/A<-3SD) by sex and geographic location.

| Cluster | Sex | | H/A < -3SD | | W/H < -3SD | | W/A < -3SD | |
|---|---|---|---|---|---|---|---|---|
| | | | Prevalence % | P | Prevalence % | p | Prevalence % | P |
| Central America (N=28177) | Male | (50.90%) | 17.10 | <0.001 | 0.90 | <0.05 | 6.00 | <0.001 |
| | Female | (49.10%) | 13.10 | | 0.60 | | 4.90 | |
| Central Asia (N=30461) | Male | (50.60%) | 32.50 | <0.001 | 3.70 | <0.001 | 16.60 | <0.001 |
| | Female | (49.40%) | 29.10 | | 2.20 | | 15.20 | |
| South Coast of Asia (N=9526) | Male | (51.10%) | 27.50 | <0.001 | 4.10 | <0.001 | 15.40 | <0.05 |
| | Female | (48.90%) | 22.90 | | 2.60 | | 13.80 | |
| Sahel (N=164246) | Male | (49.90%) | 11.90 | <0.001 | 5.70 | <0.001 | 9.20 | <0.001 |
| | Female | (50.10%) | 8.90 | | 3.70 | | 6.40 | |
| West coast of Africa (N=12757) | Male | (49.90%) | 23.50 | <0.001 | 2.60 | <0.05 | 9.10 | <0.001 |
| | Female | (50.10%) | 18.60 | | 2.00 | | 7.40 | |
| Central Africa (N=83279) | Male | (50.50%) | 32.00 | <0.001 | 2.30 | <0.001 | 11.40 | <0.001 |
| | Female | (49.50%) | 24.20 | | 1.40 | | 8.20 | |
| East Africa (N=38812) | Male | (50.90%) | 16.10 | <0.001 | 2.70 | <0.001 | 6.80 | <0.001 |
| | Female | (49.10%) | 12.00 | | 1.70 | | 6.10 | |
| All countries (N= 67258) | Male | (50.68%) | 19.5 | <0.001 | 3.9 | <0.001 | 9.8 | <0.001 |
| | Female | (49.32%) | 15.0 | | 2.5 | | 7.3 | |

reaches its greatest proportion, especially in males, between 6 and 23 months. It is this period that the rapid growth rate exposes children at greater risk conditions and, moreover, it is very possible that they are also children of malnourished mothers who cannot ensure an adequate breastfeeding. In fact, pregnancy and the first two years of the child, known as the 1000 critical days represent the most sensitive period to food deprivation[13]. The increased vulnerability of males in the youngest group, could be explained because the immune and the endocrine system exhibit significant sex-especicific differences that appear contribute to increased infectious diseases[14]. In this sense, Webruge and Wingard[15] report that during early childhood boys have a worse health profile than girls, although this trend would not stay in later ages, when the care of childrens prevails over genetic factors[16]. On the other hand, chronic malnutrition in both sexes is maximal between 24 and 47 months. This indicator represents an insufficient food intake for an extended time. Therefore, it is logical that it increase its percentage from two years of age, when children begin to reflect the consequences of poor complementary nutrition after weaning.

Several authors have obtained similar results to ours in terms of sex differences in child malnutrition, although the hunger situation was not as rigorous as in the samples that compose the present study. In a review developed by Marcoux[17] girls show low prevalence of wasting in multiple studies conducted in different countries in America, Africa and Asia, from 1987 to 2000. The above mentioned author found only three countries where girls are more affected by low W/H than boys (India, Jamaica and Venezuela). The same trend was observed in the case of low H/A, where a study carried out in China (among studies conducted in 25 countries) was the only one with higher stunting in girls, possibly due to cultural aspects. Furthermore, underweight was also found to be more prevalent in boys than in girls, with the exception of cases in China, India and Sri Lanka.

A study conducted in Malawi[18] with children between one and two years of age showed that the malnutrition-associated

**Table 3.** Prevalence of severe malnutrition by age categories and geographic.

| | | Age: 6-23 months | | | Age: 24-47 months | | | Age: 48-59 months | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | H/A <-3SD % | W/H <-3SD % | W/A <-3SD % | H/A <-3SD % | W/H <-3SD % | W/A <-3SD % | H/A <-3SD % | W/H <-3SD % | W/A <-3SD % |
| Central America and Caribbeann | Male (N= 14336) | 13.1 | 1.4 | 5.2 | 19.6 | 0.7 | 6.1 | 19.2 | 0.6 | 6.7 |
| | Female (N=13841) | 8.5 | 0.9 | 3.7 | 15.0 | 0.4 | 4.9 | 16.2 | 0.5 | 6.3 |
| Central Asia | Male (N=15455) | 28.1 | 7.7 | 20.5 | 41.6 | 2.4 | 18.8 | 27.5 | 1.1 | 10.7 |
| | Female (N=15006) | 21.6 | 4.6 | 17.0 | 38.6 | 1.6 | 19.1 | 26.2 | 0.5 | 9.3 |
| South Coast of Asia | Male (N=4864) | 23.6 | 6.6 | 18.1 | 31.2 | 2.9 | 15.8 | 27.1 | 2.5 | 11.3 |
| | Female (N=4662) | 15.5 | 3.8 | 11.4 | 27.6 | 2.1 | 15.9 | 25.7 | 2.0 | 13.8 |
| Sahel | Male (N=83363) | 13.6 | 9.0 | 13.9 | 15.9 | 4.2 | 10.0 | 5.6 | 3.8 | 3.2 |
| | Female (N=80883) | 8.2 | 5.3 | 8.4 | 12.9 | 2.5 | 7.9 | 5.0 | 3.5 | 2.7 |
| West coast of Africa | Male (N=6358) | 19.3 | 5.3 | 12.8 | 28.2 | 1.5 | 8.6 | 22.0 | 0.7 | 5.0 |
| | Female (N=6399) | 10.8 | 3.7 | 8.1 | 24.8 | 1.4 | 8.0 | 20.2 | 0.3 | 5.4 |
| Central Africa | Male (N=42036) | 28.0 | 3.1 | 11.3 | 33.9 | 1.8 | 10.3 | 35.1 | 1.8 | 13.0 |
| | Female (N=41243) | 17.6 | 1.8 | 6.8 | 27.1 | 1.0 | 8.2 | 29.6 | 1.2 | 10.2 |
| East Africa | Male (N= 19744) | 15.9 | 3.4 | 8.1 | 20.4 | 2.6 | 8.0 | 11.5 | 2.0 | 4.1 |
| | Female (N=19068) | 8.8 | 1.8 | 4.9 | 16.3 | 1.5 | 6.5 | 10.5 | 1.8 | 3.8 |
| All countries | Male (N= 186156) | 18.2 | 6.0 | 12.2 | 23.6 | 3.5 | 10.0 | 16.1 | 3.2 | 6.1 |
| | Female (N=181102) | 12.5 | 3.7 | 7.3 | 17.1 | 2.5 | 7.5 | 13.5 | 3.1 | 5.4 |

mortality risk was twice as great in males than in females, and a survey carried out in Nigeria also found similar results, where being a male was a predictor variable for stunting[19]. Further studies done among African populations in Uganda[20,21], Ethiopia[22] and Kenya[23] included the infant's sex as an intrinsic factor that could potentially determine nutritional status. The survey by Garenne[6], conducted in sub-Saharan Africa, reveals that in the absence of any difference in vaccination, oral rehydration or feeding practices, mortality is higher and malnutrition is more prevalent in boys than girls. Similarly, Van de Poel et al.[24], asserts that males are more susceptible to undernutrition than females, and that this is related to breastfeeding habits in Ghana. In this way, some cultural habits that discriminate against female babies, such as exclusively breastfeeding girls for longer than boys are ultimately nutritionally beneficial for girls.

The review by Marino et al[5] provides a large amount of scientific literature that supports higher neonatal morbidity and mortality of males. Their study also highlights that in the womb boys grow faster than girls and are therefore at greater risk of becoming undernourished. In this regard, it is worth noting that girls have a lower mean birth weight than boys, a fact well documented in auxology[25,26]. A newborn male has a larger body size and, consequently, bringing up a male child requires a greater expenditure of energy than in the case of a female child. Moreover, experts who have worked in biological anthropology have supported the hypothesis of female eco-stability against nutritional stress, during growth and when they reach adult age[27,28]. The differences in body size and body composition may be responsible for a more resilient response to adverse environmental changes. A smaller size and greater adiposity from an early age[29] favor girls in conditions of food deprivation.

Authors such as Oyehenart et al[30] and Nikitobic & Bogin[31] had already asserted that men are more eco-sensitive and experience a much stronger response to prolonged food shortages, resulting in decreased sexual dimorphism in stature in undernourished populations. On the other hand, the differen-

tial effect of environmental factors on growth and development according to the sex of individuals and greater male susceptibility to the adverse effects of the environment is also a common phenomenon in other animal species. In birds and mammals, male growth seems to be more affected by nutritional and environmental stress and is the main cause of sexual body size dimorphism[32]. In addition, experimental studies conducted with primates have shown that malnutrition induced during pregnancy and the first weeks of life causes a greater delay in neurocraneal and facial growth in males than females[33]. The results obtained in the present study corroborate the evidence mentioned, showing that the different sex sensitivity to environmental conditions during human growth has quite possibly a biological basis. Although this work has been developed from a large sample that includes studies made in various countries, it has limitations. The nature of the surveys conducted by AAH, in emergency situations, does not allow us to have data about the socio-economic, cultural and gender patterns that play such an important role in the management of nutrition and child care.

The high number of subjects and the plurality of countries analyzed in the present study support the conclusion that acute and chronic severe malnutrition and underweight show a significantly higher prevalence among boys than girls, regardless of age group and geographic origin. These results further support the hypothesis of greater female eco-stability in adverse nutritional conditions. In order to control for the underlying causes of the situation described, both biological and gender aspects must be included in child nutrition studies.

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