RESEARCH ARTICLE

Relationship between stunting in children 6 to 36 months of age and maternal employment status in Peru: A sub-analysis of the Peruvian Demographic and Health Survey

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Abstract

Objectives
This study aimed to determine the relationship between stunting in children 6 to 36 months old and maternal employment status in Peru.

Methods
A secondary data analysis was conducted using information from the Demographic and Health Survey (DHS) in Peru. We used a representative sample of 4637 mother-child binomials to determine the association between stunting in children 6 to 36 months of age and the employment status of their mothers.

Results
The prevalence of stunting among children was 15.9% (95% CI: 13.9–16.7). The prevalence of working mothers was 63.7%. No association was found between maternal employment status and the presence of stunting in children [prevalence ratio (PR) = 1.04; 95% confidence interval (95% CI): 0.9 to 1.2; p = 0.627). However, on multivariate analysis we found that the prevalence of stunting was significantly higher among children of mothers performing unpaid work (12.4%) (PR = 1.38; 95% CI: 1.2–1.6; p < 0.001) compared with those of paid working mothers.

Conclusion
No significant association was found between maternal employment status and the presence of stunting in children 6 to 36 months of age. However, children of mothers doing
unpaid work are at higher risk of stunting. These findings support the implementation of educational programs and labour policies to reduce the prevalence of stunting among children.

Introduction

Child nutritional status, especially undernutrition, is still an important public health problem, specifically in developing countries\cite{1–5}. The last publication of The State of World’s Children reported that 25.0% of children under 5 years old are stunted worldwide\cite{1}. In Latin America, the average frequency of stunting was 6.6% in 2016\cite{1,5}, while in Peru the prevalence of stunting in children under 5 years of age was 14.6%\cite{6}, being above the Latin American average. This prevalence suggests that stunting is one of the main nutritional problems to combat in our country\cite{7–8}.

Inadequate dietary intake is not the only underlying cause of stunting in children (UNICEF-2013)\cite{1–2,6}. It has been suggested that maternal employment status plays a critical role, possibly due to early initiation of complementary feeding \cite{9–10}. Economic, social, and cultural changes have led to increased participation of women in the labour market, which can indirectly influence the development and growth of their children\cite{11}. In the last ten years, the proportion of working women in Peru has increased from 58.0% to 68.4%\cite{12–13}.

The association between child stunting and the employment status of mothers is controversial. Some studies have reported that the presence of stunting in children is higher when the mother is working\cite{14–16}. By contrast, other studies in Asian\cite{17–18} and Latin American countries\cite{19–20} show that the prevalence of stunting decreases with working mothers.

In these studies, in addition to having a higher prevalence of stunted children in common, these mothers also belong to families from rural areas of developing countries with low economic income and a low wealth index. Some examples of unpaid labour include working for family members or neighbours taking care of livestock and crops.

Although the majority of mothers in Peru are active workers\cite{12–13}, no study has evaluated the potential association between child stunting and maternal employment status.

Methods

We conducted a secondary analysis using data from the Demographic Health Survey in Peru (DHS-Peru) collected by the Instituto Nacional de Estadística e Informática (INEI) in 2014. This was a probabilistic, stratified, two-stage, independent, and self-weighted survey conducted by a department that collected information from 29,941 households. For the present study, we used a representative sample for analysis to provide indicators of nutritional status of children. Each child was used as a primary sampling unit in order to analyse all possible mother-child binomials. Participants lacking data on exposure, outcome or control variables were not included in the analysis (Fig 1).

Outcome variables

According to the World Health Organization (WHO) stunting is defined as a height for age (H/A) value less than 2 standard deviations (SD) of the WHO Child Growth Standards median\cite{21}. The measurement of children’s length and height from the DHS-Peru was performed by trained personnel\cite{22}.
Exposure variables

We generated two outcome variables: First, we categorized mothers who had not worked for 12 months prior to the survey as “non-working” and those working at the time of the survey or during the previous 12 months as “working”. Women exclusively dedicated to homemaking were considered as “non-working”. Second, the variable remuneration was categorized as: paid in money and/or in-kind, unpaid and non-working mothers.

Co-variables of interest

We analysed the sociodemographic variables of mothers including: age (15 to 24 years, 25 to 34 years, and 35 to 49 years), level of education (without education, primary, secondary, superior), marital status (with or without partner), economic status (very poor/poor or medium/rich/very rich), region of residence (coast, Andes highland, amazon basin), area of residence (rural or urban), and number of children under 5 years old (1, 2, 3 or more). We also analysed the characteristics of the children including: current age in months (6 to 12 months, 13 to 18 months, 19 to 24 months, 25 to 30 months, from 31 to 36 months), gender (male or female), birth order (1st child, 2nd - 4th, 5th or more) and use of antiparasitic drugs (no or yes). Finally, in order to more accurately describe how extreme poverty is significantly associated with unpaid work and stunting, we used the original Wealth Index of the DHS-Peru that consists in

Fig 1. Exclusion flow chart of the population from the DHS-Peru 2014 for the study sample.

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five levels (very poor, poor, medium, rich, very rich) for the association between the type of
remuneration of working mothers and the presence of stunting in children from 6 to 36
months of age.

Power analysis
For the secondary analysis 4637 records with complete data from the DHS-Peru were available,
with a power ≥ 80.0% to detect a prevalence ratio ≥1.2, assuming a prevalence of stunted chil-
dren from working women of 27.0% and an r2 of 0.2[19]. The analysis was performed using
the PASS 11.0 program (NCSS, LLC. Kaysville, Utah, USA).

Data analysis
The analyses were performed using Stata 14, statistical software for Windows (StataCorp, Col-
lege Station, TX, US). We took into account the survey design of the study as sample strata,
primary sampling units and population weights[6]. The Chi-squared test was used to deter-
mine the association between categorical variables. Bivariate and multivariate analysis for our
two outcome variables were conducted using Poisson regression models to calculate the unad-
justed prevalence ratio (PR(u)) and the adjusted prevalence ratio (PR(a)), respectively. All sta-
tistical analyses were conducted with 95% confidence interval and a level of significance less
than 0.05.

Ethical standards disclosure
The Institutional Research Board (IRB) of the Universidad Peruana de Ciencias Aplicadas
(CEI/UPC 681 PI278) approved the study. The databases are available on the website of INEI
(http://iinei.inei.gob.pe/micrordatos/). These databases are anonymous and do not allow the
identification of participants.

Results
Characteristics of the study population
The survey included a representative sample of 4,637 children from 6 to 36 months of age and
their mothers. (Fig 1)

Tables 1 and 2 show the characteristics of the mothers between 15 to 49 years old. Only
61.1% had completed secondary education, 86.4% lived with their partners, 59.7% were poor
or very poor, 37.5% inhabited the coastal region, and 59.8% lived in an urban setting. Regard-
ing employment status, 63.7% were working mothers, and of this group, 53.4% were paid with
money, whereas 12.4% did not receive any type of remuneration.

Table 3 shows the characteristics of the children studied, with 22.6% being in the age group
of 6 to 12 months, and 54.0% were the second, third or fourth child.

Prevalence of child stunting and associated factors
Among a representative sample of 4,637 children 6 to 36 months old, the prevalence of stunt-
ing was 15.9% (95% CI: 13.9–16.7). Likewise, unadjusted analysis showed that child stunting
was associated with no education, very poor/poor economic status, residence in the Andes
highland, residence in rural areas, having 3 or more children at home, no remuneration, chil-
dren’s age ranging between 19 to 24 months, being males, being the fifth or more in the order
of birth and having consumed antiparasitic drugs in the last 6 months (p<0.005) (Tables 2
and 3).
Table 1. Sociodemographic characteristics of mothers with children between 6 to 36 months of age according to their employment status (N = 4637).

| Characteristics of mothers | Maternal employment | P-value |
|-----------------------------|---------------------|---------|
|                             | Work (n 3051)       | No work (n 1586) |
|                             | n (%)               | n (%)   |
| Age<sup>a</sup>             |                     |         |
| 15–24 years                 | 823 (26.6)          | 588 (36.5) |
| 25–34 years                 | 1429 (46.3)         | 683 (42.4) |
| 35–49 years                 | 799 (27.1)          | 315 (21.1) |
| Level of education<sup>a</sup> |                     |         |
| Without education           | 78 (1.9)            | 35 (2.0)  |
| Primary                     | 830 (21.9)          | 414 (22.2) |
| Secondary                   | 1795 (63.6)         | 1039 (68.9) |
| Superior                    | 348 (12.6)          | 98 (6.9) |
| Marital status<sup>a</sup> |                     |         |
| Without partner             | 498 (17.0)          | 122 (8.3)  |
| With partner                | 2553 (83.0)         | 1464 (91.7) |
| Economic level<sup>a</sup>  |                     |         |
| Very poor / poor            | 1782 (45.4)         | 948 (48.3) |
| Medium/ Rich / Very rich    | 1269 (54.6)         | 638 (51.7) |
| Region of Residence<sup>a</sup> |                     |         |
| Coast                       | 1067 (51.0)         | 698 (59.3) |
| Andes highland              | 1190 (32.3)         | 468 (25.2) |
| Amazon basin                | 794 (16.7)          | 420 (15.5) |
| Area of residence<sup>a</sup> |                     |         |
| Urban                       | 1772 (70.3)         | 1036 (74.2) |
| Rural                       | 1279 (29.7)         | 550 (25.8) |
| Number of Children < 5 years<sup>a</sup> |         |         |
| 1                           | 1855 (62.3)         | 901 (59.9) |
| 2                           | 976 (31.0)          | 564 (33.7) |
| 3+                          | 220 (6.7)           | 121 (6.4) |

<sup>a</sup> Chi-squared test for categorical variables

Association between maternal employment status and stunting in children 6 to 36 months of age

In the unadjusted and adjusted analyses, no significant association was found between maternal employment status and the presence of child stunting PR(u) = 1.14 (95% CI: 1.0–1.4), PR (a) = 1.04 (95% CI: 0.9–1.2), taking into account the multi-stage study design (Table 4).

Association between type of remuneration and stunting in children 6 to 36 months of age

Although the association between maternal employment status and the presence of child stunting was not significant, the unadjusted and adjusted analyses showed that the type of remuneration received by the mothers had a significant association with the presence of stunting (Table 5). Mothers who work and are unpaid had a PR(u) = 2.95 (95% CI: 2.5–3.6) in the unadjusted analysis and a PR(a) = 1.38 (95% CI: 1.2–1.6) in the adjusted analysis compared with working mothers paid in money and/or in-kind, taking into account the multi-stage study design (Table 5).
It was also shown that mothers who worked and did not receive any remuneration were mostly those who worked for a family member (82.1%).

Table 6 describes the socio-demographic characteristics of the mothers with children between 6 to 36 months of age according to the type of remuneration. Moreover, to more accurately describe the significant association between extreme poverty and unpaid work and stunting we used the original Wealth Index of the DHS-Peru that consists in five levels (very poor, poor, medium, rich, very rich).

Table 2. Sociodemographic characteristics of mothers with children 6 to 36 months of age according to the presence of stunting in children, taking into account the complex sample design (N = 4637).

| Characteristics of mothers | Presence of stunting in children aged 6 to 36 months | P-value | Unadjusted model |
|----------------------------|------------------------------------------------------|---------|------------------|
|                            | Yes (n 867)                                          | No (n 3770) | PR(u) | 95% CI | P-value |
| Agea                      |                                                      |          |       |       |         |
| 15–24 years               | 257 (14.8)                                           | 1154 (85.2) | 0.513 |         |
| 25–34 years               | 375 (14.7)                                           | 1737 (85.3) | 0.99  | 0.81–1.22 | 0.94 |
| 35–49 years               | 235 (16.5)                                           | 879 (83.5)  | 1.11  | 0.89–1.39 | 0.37 |
| Level of educationa       |                                                      |          |       |   <0.001 |   <0.001 |
| Without education         | 53 (49.2)                                            | 60 (50.8)  | 0.63  | 0.49–0.80 | <0.001 |
| Primary                   | 409 (30.8)                                           | 835 (69.2) | 0.22  | 0.17–0.28 | <0.001 |
| Secondary                 | 380 (10.6)                                           | 2454 (89.4) | 0.10  | 0.06–0.17 | <0.001 |
| Superior                  | 25 (4.8)                                             | 421 (95.2)  |       |         |         |
| Marital Statusa           |                                                      |          |       |       |         |
| Without partner           | 109 (13.0)                                           | 511 (87.0) | 1.20  | 0.93–1.55 | 0.162 |
| With partner              | 758 (15.6)                                           | 3259 (84.4) |       |         |         |
| Economic levela           |                                                      |          |       |   <0.001 |   <0.001 |
| Very poor / poor          | 724 (25.3)                                           | 2006 (74.7) | 0.26  | 0.20–0.33 | <0.001 |
| Medium/ Rich / Very rich  | 143 (6.5)                                            | 1764 (93.5) |       |         |         |
| Region of Residencea      |                                                      |          |       |   <0.001 |   <0.001 |
| Coast                     | 139 (6.9)                                            | 1626 (93.1) | 3.81  | 2.97–4.90 | <0.001 |
| Andes highland            | 452 (26.2)                                           | 1206 (73.8) | 3.32  | 2.54–4.34 | <0.001 |
| Amazon basin              | 276 (22.8)                                           | 938 (77.2)  |       |         |         |
| Area of residencea        |                                                      |          |       |   <0.001 |   <0.001 |
| Urban                     | 318 (9.3)                                            | 2490 (90.7) | 3.27  | 2.73–3.93 | <0.001 |
| Rural                     | 549 (30.3)                                           | 1280 (69.7) |       |         |         |
| Number of children < 5 years of agea |              |          |       |   <0.001 |   <0.001 |
| 1                         | 394 (11.0)                                           | 2362 (89.0) | 1.87  | 1.57–2.23 | <0.001 |
| 2                         | 372 (20.5)                                           | 1168 (79.5) | 2.63  | 1.98–3.50 | <0.001 |
| 3+                        | 101 (28.9)                                           | 240 (71.1)  |       |         |         |
| Employment statusa        |                                                      |          |       |   0.166 |         |
| Not working               | 257 (14.0)                                           | 1329 (86.0) |       |         |         |
| Working                   | 610 (15.9)                                           | 2441 (84.1) | 1.14  | 0.95–1.37 | 0.167 |
| Type of remunerationa     |                                                      |          |       |   <0.001 |   <0.001 |
| Paid in money and /or in-kind | 390 (12.7)                                           | 2085 (87.3) | 2.95  | 2.45–3.55 | <0.001 |
| Unpaid                    | 220 (37.3)                                           | 356 (62.7)  |       |         |         |
| Non-working               | 257 (14.0)                                           | 1329 (86.0) | 1.10  | 0.91–1.34 | 0.322 |

*a Chi-squared test for categorical variables and Poisson regression in the unadjusted model with a 95% confidence interval taking into account the complex sample design: probabilistic, stratified, two-stage, independent, and self-weighted survey conducted by department.

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It was found that 42.3% of unpaid mothers are mainly between 25 to 34 years old, 51.7% had completed only primary education, 90.8% lived with their partners, 83.5% were poor to very poor, 47.6% inhabited the Andes highland region, 75.7% lived in a rural setting and most (53.1%) only had one child. It should be noted that on classifying the economic level into 5 levels we observed that 70.5% of the mothers who worked without being paid were from the lower wealth quintile, and 56.5% only had a primary education.

Finally, Table 7 compares the presence of stunting in children from 6 to 36 months with the two models under study, maternal employment status, and type of remuneration.

**Discussion**

**Main findings**

In this population-based study, the prevalence of stunting in children from 6 to 36 months of age was 15.9% (95% CI: 13.9–16.7). No significant association was found between the employment status of the mother and the presence of child stunting in the unadjusted and adjusted analyses. On the other hand, we found that unpaid mothers had a higher prevalence of children with stunting than those who work and are paid in money and/or in-kind.

**Comparison with other studies**

The prevalence of stunting in Peru has been decreasing annually, indicating an improvement in the nutritional status of the children. Indeed, in the last 14 years, the percentage of stunting decreased from 31.0% to 14.6%[6]. Stunting in the first stages of life has an important impact on child growth and development. Although no association was found between maternal

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**Table 3. Characteristics of children between 6 and 36 months of age according to the presence of stunting, taking into account the complex sample design (N = 4637).**

| Characteristics of the children          | Presence of stunting in children aged 6 to 36 months | P-value   | Unadjusted model |
|-----------------------------------------|-----------------------------------------------------|-----------|------------------|
|                                         | Yes (n 867)                          | No (n 3770) | PR(u) 95% CI P-value |
|                                         | n (%)                               | n (%)       |                   |
| **Child age**                           |                                     |            |                   |
| 06–12 months                            | 139 (11.5)                          | 901 (88.5)  | 0.002             |
| 13–18 months                            | 175 (15.8)                          | 753 (84.2)  |                   |
| 19–24 months                            | 215 (18.7)                          | 684 (81.3)  | 0.014             |
| 25–30 months                            | 158 (13.9)                          | 716 (86.1)  | <0.001            |
| 31–36 months                            | 180 (16.7)                          | 716 (83.3)  | 0.004             |
| **Gender**                              |                                     |            |                   |
| Male                                    | 505 (17.0)                          | 1880 (83.0) | 0.002             |
| Female                                  | 362 (13.3)                          | 1890 (86.7) |                   |
| **Birth order**                         |                                     |            | <0.001            |
| First child                             | 188 (9.2)                           | 1326 (90.8) | Ref.              |
| 2nd–4th child                           | 460 (15.6)                          | 2043 (84.4) |                   |
| 5th child or greater                    | 219 (33.2)                          | 401 (66.8)  | 0.001             |
| **Consumption of antiparasitic drugs in the last 6 months** |                                     |            | <0.001            |
| No                                      | 585 (13.8)                          | 2811 (86.2) | ref               |
| Yes                                     | 282 (19.7)                          | 959 (80.3)  |                   |

* Chi-squared test for categorical variables and Poisson regression in the unadjusted model with a 95% confidence interval taking into account the complex sample design: probabilistic, stratified, two-stage, independent, and self-weighted survey conducted by department.

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| Associated factors | Stunting | Unadjusted Model | Adjusted Model |
|--------------------|----------|------------------|---------------|
|                     | Yes (%)  | PR(u) 95% CI     | P-value       |
|                     |          | PR(a) 95% CI     | P-value       |
| Characteristics of mothers |          |                  |               |
| Age<sup>a</sup>            |          |                  |               |
| 15–24 years           | 257 (14.8) | Ref.             | Ref.          |
| 25–34 years           | 375 (14.7)  | 0.99 0.81–1.22  | 0.94          |
| 35–49 years           | 235 (16.5)   | 1.11 0.89–1.39  | 0.37          |
| Level of education<sup>a</sup> |          |                  |               |
| Without education    | 53 (49.2)    | Ref.             | Ref.          |
| Primary              | 409 (30.8)   | 0.63 0.49–0.80  | <0.001        |
| Secondary            | 380 (10.6)   | 0.22 0.17–0.28  | <0.001        |
| Superior             | 25 (4.8)     | 0.10 0.06–0.17  | <0.001        |
| Marital Status<sup>b</sup> |          |                  |               |
| Without partner      | 109 (13.0)   | Ref.             | Ref.          |
| With partner         | 758 (15.6)   | 1.20 0.93–1.55  | 0.162         |
| Economic level<sup>b</sup> |          |                  |               |
| Very poor / poor     | 724 (25.3)    | Ref.             | Ref.          |
| Medium / Rich / Very rich | 143 (6.5) | 0.26 0.20–0.33  | <0.001        |
| Region of Residence<sup>b</sup> |          |                  |               |
| Coast                | 139 (6.9)    | Ref.             | Ref.          |
| Andes highland       | 452 (26.2)   | 3.81 2.97–4.90  | <0.001        |
| Amazon basin         | 276 (22.8)   | 3.32 2.54–4.34  | <0.001        |
| Area of residence<sup>b</sup> |          |                  |               |
| Urban                | 318 (9.3)    | Ref.             | Ref.          |
| Rural                | 549 (30.3)   | 3.27 2.73–3.93  | <0.001        |
| Number of children < 5 years of age<sup>b</sup> |          |                  |               |
| 1                   | 394 (11.0)   | Ref.             | Ref.          |
| 2                   | 372 (20.5)   | 1.87 1.57–2.23  | <0.001        |
| 3+                  | 101 (28.9)   | 2.63 1.98–3.50  | <0.001        |
| Employment status<sup>b</sup> |          |                  |               |
| Working              | 257 (14.0)   | Ref.             | Ref.          |
| Not Working          | 610 (15.9)   | 1.14 0.95–1.37  | 0.167         |
| Characteristics of children |          |                  |               |
| Child Age<sup>b</sup> |          |                  |               |
| 06–12 months         | 139 (115)    | Ref.             | Ref.          |
| 13–18 months         | 175 (15.8)   | 1.38 1.07–1.76  | 0.014         |
| 19–24 months         | 215 (18.7)   | 1.63 1.28–2.07  | <0.001        |
| 25–30 months         | 158 (13.9)   | 1.21 0.92–1.60  | 0.174         |
| 31–36 months         | 180 (16.7)   | 1.45 1.13–1.87  | 0.004         |
| Gender<sup>b</sup>   |          |                  |               |
| Male                 | 505 (17.0)   | Ref.             | Ref.          |
| Female               | 362 (13.3)   | 0.78 0.66–0.91  | 0.002         |
| Birth order<sup>b</sup> |          |                  |               |
| First child          | 188 (9.2)    | Ref.             | Ref.          |
| 2<sup>nd</sup> – 4<sup>th</sup> child | 460 (15.6) | 1.70 1.38–2.09  | <0.001        |
| 5<sup>th</sup> child or greater | 219 (33.2) | 3.61 2.86–4.55  | <0.001        |
| Consumption of antiparasitic drugs in the last 6 month<sup>b</sup> |          |                  |               |

(Continued)
employment status (working and non-working), there was a significant association between the type of remuneration of working mothers and the nutritional status of their children, suggesting that a higher income can provide children with a better quality of life.

While the association between child stunting and maternal employment status was not significant in the present analysis, some publications have shown a lower prevalence of stunting among children of working mothers. A previous study carried out in a rural area of Peru found that children of non-working mothers had a higher prevalence of stunting than those of paid working mothers \( (p < 0.001) \)[20]. Moreover, a Colombian study found that the prevalence of stunting in children of working mothers was lower compared with non-working mothers \( (p = 0.012) \)[19]. Furthermore, Asian and African studies have found that the prevalence of stunted children is higher in those of non-working mothers than of those of working mothers \( (p < 0.01) \)[17,18,23], likely because the latter have greater access to and acquire better sources of food for their children[17–20,23].

In contrast, in a Latin-American study of a Brazilian suburb, a higher prevalence of stunting was found among children in the groups of working mothers compared with non-working mothers \( (p = 0.04) \)[14]. Likewise, in two Indian studies, working mothers had a higher prevalence of stunted children than non-working mothers \( (p < 0.05) \)[15,24], similar to what was described in an Ethiopian study \( (p < 0.001) \)[16]. These results are due to the lack of time that working mothers have to breastfeed, feed and look after their children[14–16,24–25].

Before the 21st century, women did not usually work outside the home, and therefore, did not participate actively in bringing external resources to the household economy. Nowadays, women have entered the labour market for several reasons; some for personal achievement or in order to have an independent income, while others work due to the necessity of raising the economic and social status of their families. In addition, a better economic status allows mothers to obtain access to better sources of food for themselves and their children[20]. Nonetheless, working can decrease the time mothers have to breastfeed, feed and look after their children. Some studies have suggested that in many developing countries poor women have multiple roles in family income-generating activities which, in many cases, reduces childcare time, affecting the nutritional status of the children[26–28].

An important fact found in our study is that 82.1% of the unpaid working mothers works for their family members. These women work to help their families doing agricultural or other activities with no monetary or in-kind payment which lead to an increase in the prevalence of children with stunting as found in our study. This may be due to the lack of time unpaid working mothers have to care for their children and a lack of money and/or food to adequately feed them.

Other important characteristics of unpaid working mothers are that 75.7% lived in a rural setting, 47.6% inhabited the Andes highland and 37.3% in the amazon basin. It should be

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**Table 4. (Continued)**

| Associated factors | Stunting | Unadjusted Model | Adjusted Model |
|--------------------|---------|-----------------|---------------|
|                    | Yes (%) | PR(u) 95% CI    | P-value       | PR(a) 95% CI P-value^a |
| No                 | 585 (13.8) ref |                 |               | 1.18 (1.00–1.39) 0.056 |
| Yes                | 282 (19.7) | 1.43 1.20–1.70 | <0.001       | 1.18 1.00–1.39 0.056 |

^a Adjusted to mother’s age, educational level, marital status, economic level, region, place of residence, number of children under 5 years old, child age, child sex, birth order, current/antecedent condition of breastfeeding and antiparasitic drug consumption in the last six months.

^b Chi-squared test for categorical variables and Poisson regression in the unadjusted and adjusted model both with a 95% confidence interval taking into account the complex sample design: probabilistic, stratified, two-stage, independent, and self-weighted survey conducted by department.

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Table 5. Association between the type of remuneration of working mothers (Model 2) and the presence of stunting in children from 6 to 36 months of age after adjustment of both for control variables, taking into account the complex sample design.

| Associated factors | Stunting | Unadjusted Model | Adjusted Model |
|--------------------|----------|-----------------|---------------|
|                    | Yes (%)  | PR(u) 95% CI     | P-value       | PR(a) 95% CI | P-value* |
| **Characteristics of mothers** |          |                 |               |             |          |
| **Age**<sup>b</sup> |          |                 |               |             |          |
| 15–24 years        | 257 (14.8) | Ref.            | Ref.          |             |          |
| 25–34 years        | 375 (14.7) | 0.99 0.81–1.22  | 0.94          | 0.89        | 0.72–1.09 | 0.250    |
| 35–49 years        | 235 (16.5) | 1.11 0.89–1.39  | 0.37          | 0.93        | 0.73–1.18 | 0.541    |
| **Level of education**<sup>b</sup> |          |                 |               |             |          |
| Without education  | 53 (49.2) | Ref.            | Ref.          |             |          |
| Primary            | 409 (30.8) | 0.63 0.49–0.80  | <0.001        | 0.81        | 0.63–1.05 | 0.106    |
| Secondary          | 380 (10.6) | 0.22 0.17–0.28  | <0.001        | 0.57        | 0.43–0.75 | <0.001   |
| Superior           | 25 (4.8)  | 0.10 0.06–0.17  | <0.001        | 0.37        | 0.22–0.65 | <0.001   |
| **Marital Status**<sup>b</sup> |          |                 |               |             |          |
| Without partner    | 109 (13.0) | Ref.            | Ref.          |             |          |
| With partner       | 758 (15.6) | 1.20 0.93–1.55  | 0.162         | 0.92        | 0.73–1.18 | 0.520    |
| **Economic level**<sup>b</sup> |          |                 |               |             |          |
| Very poor / poor   | 724 (25.3) | Ref.            | Ref.          |             |          |
| Medium/ Rich / Very rich | 143 (6.5) | 0.26 0.20–0.33  | <0.001        | 0.56        | 0.41–0.77 | <0.001   |
| **Region of residence**<sup>b</sup> |          |                 |               |             |          |
| Coast              | 139 (6.9)  | Ref.            | Ref.          |             |          |
| Andes highland     | 452 (26.2) | 3.81 2.97–4.90  | <0.001        | 2.17        | 1.62–2.89 | <0.001   |
| Amazon basin       | 276 (22.8) | 3.32 2.54–3.43  | <0.001        | 1.61        | 1.20–2.15 | <0.001   |
| **Area of residence**<sup>b</sup> |          |                 |               |             |          |
| Urban              | 318 (9.3)  | Ref.            | Ref.          |             |          |
| Rural              | 549 (30.3) | 3.27 2.73–3.93  | <0.001        | 1.16        | 0.93–1.44 | 0.018    |
| **Number of children < 5 years of age**<sup>b</sup> |          |                 |               |             |          |
| 1                  | 394 (11.0) | Ref.            | Ref.          |             |          |
| 2                  | 372 (20.5) | 1.87 1.57–2.23  | <0.001        | 1.42        | 1.20–1.68 | <0.001   |
| 3+                 | 101 (28.9) | 2.63 1.98–3.50  | <0.001        | 1.71        | 1.32–2.20 | <0.001   |
| **Type of remuneration**<sup>c</sup> |          |                 |               |             |          |
| Paid in money and/or in-kind | 390 (12.7) | Ref.            | Ref.          |             |          |
| Unpaid             | 220 (37.3) | 2.95 2.45–3.55  | <0.001        | 1.38        | 1.17–1.64 | <0.001   |
| Not working        | 257 (14.0) | 1.10 0.91–1.34  | 0.322         | 1.05        | 0.87–1.26 | 0.614    |
| **Characteristics of children** |          |                 |               |             |          |
| **Age of infant**<sup>b</sup> |          |                 |               |             |          |
| 06–12 months       | 139 (115)  | Ref.            | Ref.          |             |          |
| 13–18 months       | 175 (15.8) | 1.38 1.07–1.76  | **0.014**     | 1.46        | 1.14–1.86 | **0.003** |
| 19–24 months       | 215 (18.7) | 1.63 1.28–2.07  | **0.001**     | 1.56        | 1.25–1.95 | **0.001** |
| 25–30 months       | 158 (13.9) | 1.21 0.92–1.60  | 0.174         | 1.26        | 0.96–1.66 | 0.098    |
| 31–36 months       | 180 (16.7) | 1.45 1.13–1.87  | **0.004**     | 1.36        | 1.07–1.72 | **0.012** |
| **Gender of infant**<sup>b</sup> |          |                 |               |             |          |
| Male               | 505 (17.0) | Ref.            | Ref.          |             |          |
| Female             | 362 (13.3) | 0.78 0.66–0.91  | **0.002**     | 0.75        | 0.66–0.86 | **0.001** |
| **Birth order**<sup>b</sup> |          |                 |               |             |          |
| First child        | 188 (9.2)  | Ref.            | Ref.          |             |          |
| 2nd– 4th child     | 460 (15.6) | 1.70 1.38–2.09  | **0.001**     | 1.34        | 1.06–1.69 | **0.015** |
| 5th child or greater | 219 (33.2) | 3.61 2.86–4.55  | **0.001**     | 1.48        | 1.08–2.02 | **0.014** |

(Continued)
Table 5. (Continued)

| Associated factors                                      | Stunting | Unadjusted Model | Adjusted Model |
|----------------------------------------------------------|----------|------------------|----------------|
|                                                          | Yes (%)  | PR(u)            | 95% CI | P-value | PR(a) | 95% CI | P-value |
| Consumption of antiparasitic drugs in the last 6 monthsb |          |                  |        |         |        |        |         |
| No                                                       | 585 (13.8) | 1.43 | 1.20–1.70 | <0.001  | 1.17  | 0.99–1.39 | 0.063  |
| Yes                                                      | 282 (19.7) | Ref.            | Ref.   |         |        |        |         |

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a Adjusted to mother’s age, educational level, marital status, economic level, region, place of residence, number of children under 5 years old, child age, child sex, birth order, current/antecedent condition of breastfeeding and antiparasitic drug consumption in the last six months.

b Chi-squared test for categorical variables and Poisson regression in the unadjusted and adjusted model both with a 95% confidence interval taking into account the complex sample design: probabilistic, stratified, two-stage, independent, and self-weighted survey conducted by department.

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Table 6. Socio-demographic characteristics of mothers with children between 6 to 36 months of age according to the type of remuneration (N = 4637).

| Characteristics of mothers | Type of remuneration | Paid in money and/or in-kind | Unpaid | Not working | P-value |
|---------------------------|----------------------|-------------------------------|--------|-------------|---------|
|                           |                      | (n 2475)                      | (n 576) | (n 1586)    |         |
|                           |                      | n (%)                         | n (%)  | n (%)       |         |
| Agea                     |                      |                               |        |             |         |
| 15–24 years              | 636                  | (25.6)                        | 187    | 588         | <0.001  |
| 25–34 years              | 1181                 | (47.0)                        | 248    | 683         | (24.3)  |        |         |
| 35–49 years              | 658                  | (27.4)                        | 141    | 315         | (21.1)  |        |         |
| Level of educationa      |                      |                               |        |             |         |
| Without education        | 42                   | (1.2)                         | 36     | 35          | (6.0)   |        |         |
| Primary                  | 519                  | (17.4)                        | 311    | 414         | (24.5)  |        |         |
| Secondary                | 1572                 | (67.0)                        | 223    | 1039        | (41.2)  |        |         |
| Superior                 | 342                  | (14.4)                        | 6      | 98          | (1.1)   |        |         |
| Marital statusa          |                      |                               |        |             |         |
| Without partner          | 460                  | (18.2)                        | 38     | 122         | (9.2)   |        |         |
| With partner             | 2015                 | (81.8)                        | 538    | 1464        | (90.8)  |        |         |
| Economic levela          |                      |                               |        |             |         |
| Very poor                | 575                  | (15.8)                        | 438    | 451         | (70.5)  |        |         |
| Poor                     | 692                  | (23.9)                        | 77     | 497         | (13.0)  |        |         |
| Medium                   | 510                  | (23.3)                        | 34     | 318         | (7.6)   |        |         |
| Rich                     | 392                  | (20.4)                        | 19     | 210         | (5.8)   |        |         |
| Very rich                | 306                  | (16.6)                        | 8      | 110         | (3.1)   |        |         |
| Region of residencea     |                      |                               |        |             |         |
| Coast                    | 1019                 | (56.4)                        | 48     | 698         | (15.1)  |        |         |
| Andes highland           | 898                  | (30.0)                        | 292    | 468         | (47.6)  |        |         |
| Amazon basin             | 558                  | (13.6)                        | 236    | 420         | (37.3)  |        |         |
| Area of residencea       |                      |                               |        |             |         |
| Urban                    | 1668                 | (77.3)                        | 104    | 1036        | (24.3)  |        |         |
| Rural                    | 807                  | (22.7)                        | 472    | 550         | (75.7)  |        |         |
| Number of Children < 5 years of agea |          |                               |        |             |         |
| 1                        | 1159                 | (63.7)                        | 296    | 901         | (33.1)  |        |         |
| 2                        | 768                  | (30.3)                        | 208    | 564         | (35.1)  |        |         |
| 3+                       | 148                  | (6.0)                         | 72     | 121         | (11.8)  |        |         |

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a Chi-squared test for categorical variables

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noted that the majority of mothers who worked in those areas did not have a formal employment controlled by labour laws.

As an example, Peru has the law No. 29896 that establishes the implementation of breastfeeding in the public and private sector institutions promoting an hour of breastfeeding during the first 24 months of the child’s life. Moreover, a mandatory 98-day maternity leave is established by the law No. 30367. Unfortunately, both of these laws are not followed in the absence of a formal job. This situation occurs constantly in small cities or rural areas where mothers work for small business. There exists a Peruvian law on equal opportunities for women and men; however this is rarely applied in rural areas far away from the main cities. Due to these inequalities, marches against discrimination against women are increasingly being carried out in our country.

Finally, as in other studies, some of our co-variables showed a significant association between stunting and confounding variables such as “no education” compared to mothers with education[16–17,23,25,28–37]. In addition, belonging to a “very poor” economic status is associated with the presence of stunting compared to a “medium”, “rich” or “very rich” economic status[14,16,19,20,23,31–34,36,38]. Compared to residing on the “coast”, residing in the “Andes highland” is associated with the presence of stunting[37], and residing in “rural” areas increases the prevalence of stunting compared to residing in “urban” areas[16,20,32,38–41]. Furthermore, having 3 or more children at home[14,31,37,39] and being the fifth or more in the order of birth, increases the prevalence of stunting[16,30,34–35,37–38]. All of these variables were independently associated with the outcome in our analyses. As found in other studies with similar results, these associations contribute to the validity of our analysis.

**Strengths and limitations**

Among the strengths of the present study, it should be highlighted that this was a population-based study, including a representative nationwide sample. Likewise, the data of the DHS-Peru was collected by trained personnel, ensuring reliable results. Adjustment of the different weighted control variables to a multistage study, provided the most accurate results about a possible association between the exposure and outcome variables.

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**Table 7. Comparison between mother’s work (Model 1), type of remuneration of working mothers (Model 2) and the presence of stunting in children from 6 to 36 months of age after adjustment of both for control variables, taking into account the complex sample design.**

| Associated factors | Stunting | Unadjusted Model | Adjusted Model |
|--------------------|----------|------------------|---------------|
|                    | Yes (%)  | PR(u) 95% CI     | P-value       | PR(a) 95% CI | P-value |
| **MODEL 1**        |          |                  |               |              |         |
| Work^b             |          |                  |               |              |         |
| Not working        | 257 (14.0) | Ref.             |               |              |         |
| Working            | 610 (15.9) | 1.14 0.95–1.37 0.167 |     | 1.04 0.88–1.23 0.627 |         |
| **MODEL 2**        |          |                  |               |              |         |
| Type of remuneration^b |        |                  |               |              |         |
| Paid in money and/or in-kind | 390 (12.7) | Ref.             |               |              |         |
| Unpaid             | 220 (37.3) | 2.95 2.45–3.55 <0.001 | | 1.38 1.17–1.64 <0.001 |         |
| Not working        | 257 (14.0) | 1.10 0.91–1.34 0.322 |     | 1.05 0.87–1.26 0.614 |         |

^a Adjusted to mother’s age, educational level, marital status, socioeconomic level, region, place of residence, number of children under 5 years-old, child age, child sex, birth order, current/antecedent condition of breastfeeding and antiparasitic drug consumption in the last six months.

^b Chi^2 test for categorical variables and Poisson regression in the unadjusted and adjusted model both with 95% confidence interval taking into account the complex sample design: probabilistic, stratified, two-stage, independent, and self-weighted survey conducted by department.

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Nonetheless, our study has some limitations. Since it was based on a secondary source we included some variables that were not evaluated in the DHS-Peru, but which were considered in other studies, such as the working hours of the mother, the actual amount of remuneration, family income and knowledge of the mother about nutrition. There are also other variables with incomplete data that could not be included in our analyses, such as who is the caregiver of the child, who feeds the child, the presence of fever, diarrhoea and acute respiratory infections in the last 2 weeks, among others. However, their distribution may not present bias due to poor classification. Nevertheless, a previous analysis with these variables did not alter the results of the study, and therefore, they are unlikely to present a bias.

Moreover, self-reported data collection was used in the DHS-Peru, which may have produced an information bias with errors in the information provided by the mothers due to a lack of memory.

**Implications**

The high prevalence of stunting among infants of unpaid working mothers suggests the need to implement educational programs on the possible consequences of unpaid work and how these could impact in the nutritional status of children. Several studies provide evidence about the effectiveness of pregnancy counseling in the improvement of quality of life for mothers and children through primary prevention[42]. It is important to provide counselling before and during pregnancy to all women about the importance of an adequate nutrition and supplementation as well as about childcare during the early years with the aim of decreasing the high prevalence of stunting, which carries several repercussions in adulthood[42–44]. Moreover, educating mothers during pregnancy is associated with positive maternal behaviors that could reduce the amount of unpaid work which has been associated with the presence of stunting in the present study[43]. Finally, adequate labour policies are also needed to ensure a greater number of paid jobs for this population in order to reduce the prevalence of stunting among children. These laws should be monitored to ensure that they are enforced or executed. Further studies would confirm the findings of an association presented here.

**Conclusions**

No significant association was found between maternal employment status and the presence of stunting in children 6 to 36 months of age. However, the prevalence of child stunting increased among infants of unpaid working mothers compared with those of mothers who are paid with money and/or in-kind.

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References
1. United Nations Children’s Fund. Improving child nutrition. The achievable imperative for global progress [Internet]. New York, USA; 2013. Available from: https://www.unicef.org/gambia/Improving_Child_Nutrition_-_the_achievable_imperative_for_global_progress.pdf
2. Arocena Canazas VM (2009) Factores asociados a la desnutrición crónica infantil en el Peru, 1996–2007. Centro de investigación y desarrollo del Instituto Nacional de Estadística e Investigación (INEI), pp. 7–73. Available from: https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib0893/Libro.pdf
3. Córdova-Villalobos JA, Barriague-Meléndez JA, Lara-Esqueda A, Barquera S, Rosas-Peralta M, Hernández-Avila M et al. (2008) Las enfermedades crónicas no transmisibles en México: sinopsis epide miológica y prevención integral. Salud Publica Mex 50, Suppl. 5, 419–27. Available from: http://www.scielo.org.mx/pdf/spm/v50n5/a15v50n5.pdf
4. World Health Organization. Enfermedades No Transmisibles [Internet].; 2015. Available from: http://www.who.int/mediacentre/factsheets/fs355/es/
5. World Health Organization. Global Health Observatory (GHO): Data Repository. Global and regional trends by WHO Regions, 1990–2016 Stunting [Internet].; 2016. Available from: http://apps.who.int/gho/data/view.main.NUTWHOSTUNTINGv?lang=en
6. Instituto Nacional de Estadística e Informática (2015) Perú: Encuesta Demográfica y de Salud Familiar 2014, 40 p. Available from: https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1211/pdf/Libro.pdf
7. Beltrán A, Seinfeld J (2009) Desnutrición Crónica Infantil en el Peru: Un problema persistente. Cent Investiga la Univ del Pacifico1, Suppl. 3, 1–54. Available from: http://repositorio.up.edu.pe/bitstream/handle/11354/349/DD0914-Beltran_Seinfeld.pdf?sequence=1&isAllowed=y
8. Sánchez-Abanto J (2012) Evolución de la desnutrición crónica en menores de cinco años en el Perú. Rev Peru Med Exp Salud Publica 29, Suppl. 3, 402–5. Available from: http://www.scielo.org.pe/pdf/rims/v29n3/a18v29n3.pdf
9. World Health Organization. Indicadores para evaluar las prácticas de alimentación del lactante y del niño pequeño [Internet]. Washington, DC, EE.UU.; 2008. Available from: http://apps.who.int/iris/bitstream/10665/44156/1/9789243596662_spa.pdf
10. World Health Organization. Protección de la lactancia materna en el Peru [Internet]. World Health Organization (WHO). World Health Organization (WHO); 2013. Available from: http://www.who.int/features/2013/peru_breastfeeding/es/
11. Duran Rojas BF (2009) La ocupación de la madre como factor determinante del estado nutricional de niños menores de 7 años de ciudad juarez. Tesis licenciatura, Universidad Autónoma de Ciudad de Juarez. Available from: http://www.uaq.mx/ICB/redcib/Publicaciones/TesisLicenciatura/Nutricion/Laocupacióndelamadrecomofactordeterminantelestadosnutricioneninfantilmenoresde7añosde ciudadJuárez.pdf
12. World Bank. Tasa de población activa, mujeres (% de la población femenina mayor de 15 años) (estimación modelado OIT) [Internet]. World Bank. 2016. Available from: http://datos.bancomundial.org/indicador/SL.TLF.CACT.FE.ZS
13. Oficina Técnica de Difusión del INEI. Nota de prensa [Internet]. Instituto Nacional de Estadística e Informática (INEI). Lima, Perú; 2014. Available from: http://www.inei.gob.pe/media/MenuRecursivo/noticias/nota-de-prensa-no-075-2014-inei.pdf
14. Vieira VL, Pacheco de Souza M, Cervato-Man cuso AM (2010) Insegura ncía alimentar, vínculo mãe-filho e desnutri cão infantil em área de alta vulnerabilidade social. Rev Bras Saúde Matern Infant 10, Suppl. 2, 199–207. Available from: http://www.scielo.br/pdf/rbmsi/v10n2/a07v10n2.pdf
15. Chowdhury R, Sinha B, Adhikary M, Mukherjee A, Lahiri SK (2013) Developing models to predict stunting among 6–59 months children in a slum of Kolkata. Indian J Community Heal 25, Suppl. 3, 251–6. Available from: http://www.iapsmupuk.org/journal/index.php/IJCH/article/viewFile/424/pdf
16. Woldemariam G, Timotiows G (2002) Determinants of the Nutritional Status of Mothers and Children in Ethiopia. Calverton, Maryland, USA, pp.1–36. Available from: https://dhaprogram.com/pubs/pdf/FA39/02-nutrition.pdf

17. Jesmin A, Yamamoto SS, Malik AA, Haque A (2011) Prevalence and Determinants of Chronic Malnutrition among Preschool Children: A Cross-sectional Study in Dhaka City, Bangladesh. J Health Popul Nutr 29, Suppl. 5, 494–9. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3225111/pdf/jhpn0029-0494.pdf

18. Sultan S (2014) Prevalence of stunting and thinness among school-age children of working and non-working mothers in rural areas of Aligarh district. Indian J Basic Appl Med Res 3, Suppl. 3, 51–7. Available from: http://ijbamr.com/pdf/51-57.pdf

19. Gamboa-Delgado EM, López-Barbosa N, Vera-Caia LM, Prada-Gómez GE (2002) Determinants of the Nutritional Status of Mothers and Children in Mexico. Nutrition 18, Suppl. 4, 493–501. Available from: http://www.scielo.org.mx/pdf/nutr/v18n4/1978.pdf

20. Delgado Sánchez HD, Tuesta Dorado P, Valqui Gatica IA (2015) Factores Maternos Asociados al Riesgo de Desnutrición Morona Cocha, Iquitos-Peru. Tesis licenciatura, Universidad Nacional de la Amazonia Peruana. Available from: http://dspace.unapiquitos.edu.pe/bitstream/unapiquitos/310/1/tesis.pdf

21. Organización Panamericana de la Salud, Organización Mundial de la Salud (2007) Los Nuevos Patrones de Crecimiento de la OMS. (Consultor) DCCV, [(OPS/OMS) DMMS, editors]. La Paz, Bolivia: Organización Panamericana de la Salud (OPS), 35 p. Available from: http://doi.org/10.1017/CBO9781107415324.004

22. Instituto Nacional de Estadística e Investigación (2012) Manual de La Antropometrista, Lima, Perú. Available from: http://www.minsa.gob.pe/portalweb/02estadistica/encuestas_INEI_2012/BddatosDocumentosMetodologicosManuales/MANUALDELAANTROPOMETRISTA2012.pdf

23. Seedhom AE, Mohamed ES, Mahfouz EM (2014) Determinants of stunting among preschool children, Minia, Egypt. Int Public Heal Forum 1, Suppl. 2, 6–9. Available from: http://researchpub.org/journal/iphf/number/vol1-no2/vol1-no2-2.pdf

24. Grover N, Kumar Goyal M, Garg R, Saroha H, Masand R (2015) A comparative study of exclusivity of breast feeding and subsequent growth patterns among working and nonworking mothers. Indian J Basic Appl Med Res 5, Suppl. 1, 657–62. Available from: http://ijbamr.com/pdf/December2015657-662.pdf

25. Grijbovski AM, Bygren LO, Yngve A, Sjöström M (2004) Social variations in infant growth performance in Severodvinsk, Northwest Russia: community-based cohort study. Croat Med J 45, Suppl. 6, 757–63. Available from: http://www.cmj.hr/2004/45/6/15578812.pdf

26. Deshmukh PR, Sinha N, Dongre AR (2013) Social determinants of stunting in rural area of Wardha, Central India. Med Journal, Armed Forces India 69, Suppl. 3, 213–7. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3862661/pdf/main.pdf

27. Said-Mohamed R, Allirot X, Sobgui M, Pasquet P (2009) Determinants of overweight associated with stunting in preschool children of Yaounde, Cameroon. Ann Hum Biol 36, Suppl. 2, 146–61. Available from: http://www.tandfonline.com/doi/full/10.1080/03014460802660526?scroll=top&needAccess=true

28. Suárez-López MG (2013) La asociación entre el empleo materno en el estado nutricional de los niños participantes en los Centros del Buen Vivir de las parroquias rurales del Cantón Pedro Moncayo. Tesis licenciatura, Universidad San Francisco de Quito. Available from: http://repositorio.usfq.edu.ec/bitstream/23000/2861/1/109767.pdf

29. Nakahara S, Poudel KC, Lopchan M, Ichikawa M, Poudel-Tandukar K, Jimba M et al. (2006) Availability of Childcare Support and Nutritional Status of Children of Non-working and Working Mothers in Urban Nepal. Am J Hum Biol, Suppl. 18, 169–81. Available from: http://onlineibrary.wiley.com/doi/10.1002/ajhb.20481/epdf?3_referer=vol&tracking_action=preview_click&show_checkout=1&purchase_referer=www.ncbi.nlm.nih.gov&purchase_site_license/LICENSE_DENIED

30. Sivakami M (1997) Female work participation and child health: an investigation in rural Tamil Nadu, India. Heal Transit Rev, Suppl. 7, 21–32. Available from: http://htc.anu.edu.au/pdfs/sivakami1.pdf

31. Powell CA, Grantham-McGregor S (1985) The ecology of nutritional status and development in young children in Kingston, Jamaica. Am J Clin Nutr 41, Suppl. 6, 1322–31. Available from: https://www.ncbi.nlm.nih.gov/pubmed/4003336

32. Zottarelli LK, Sunil TS, Rajaram S (2007) Influence of parental and socioeconomic factors in stunting in children under 5 years in Egypt. East Mediterr Heal J 13, Suppl. 6, 1330–42. Available from: http://applications.emro.who.int/ehmy/1306/13_6_2007_1330_1342.pdf

33. Keino S, Plassgui G, Ettyang G et al. (2014) Determinants of stunting and overweight among young children and adolescents in sub-Saharan Africa. Food Nutr Bull 35, Suppl. 2, 167–78. Available from: http://journals.sagepub.com/pdf/doi/10.1177/156482651403500203
34. Joshi N, Agho KE, Dibley M, Senarath U, Tiwari K (2012) Determinants of inappropriate complementary feeding practices in young children in Nepal: secondary data analysis of Demographic and Health Survey 2006. Matern Child Nutr 8, Suppl. 1, 45–59. Available from: http://doi.wiley.com/10.1111/j.1740-8709.2011.00384.x

35. Díaz A, Arana A, Vargas-machuca R, Antiporta D (2015) Situación de salud y nutrición de niños indígenas y niños no indígenas de la Amazonia peruana. Rev Panam Salud Pública 38, Suppl. 1, 49–56. Available from: http://www.scielo.org/pdf/rpsp/v38n1/v38n1a07.pdf

36. Ramos C V., Dumith SC, Cesar JA (2015) Prevalence and factors associated with stunting and excess weight in children aged 0–5 years from the Brazilian semi-arid region. J Pediatr (Rio J) 91, Suppl. 2, 175–82. Available from: http://ac.els-cdn.com/S0021755714001557/1-s2.0-S0021755714001557-main.pdf?_tid=94e79240-e11e-11e6-8443-00000aab0f6b&acdnat=148514394_5e099b2b147a4e271e9a8f43c774fd4

37. Mahyar A, Ayazi P, Falahi, Javadi THS, Farkhondehmehr B, Javadi A et al. (2010) Archive of SID Prevalence of Underweight, Stunting and Wasting Among. Iran J Pediatr Soc 2, Suppl. 1, 37–43. Available from: http://www.sid.ir/en/VEWSSID/ J_pdf/1025720100108.pdf

38. Fernald LC, Neufeld LM (2006) Overweight with concurrent stunting in very young children from rural Mexico: prevalence and associated factors. Eur J Clin Nutr 61 Suppl. 5, 623–32. Available from: http://www.nature.com/ejcn/journal/v61/n5/pdf/1602558a.pdf

39. Sobrino M, Gutíerrez C, Cunha AJ, Dávila M, Alarcón J (2014) Desnutrición infantil en menores de cinco años en Perú: tendencias y factores determinantes. Rev Panam Salud Pública 35, Suppl. 2, 104–12. Available from: http://www.scielo.org/pdf/rpsp/v35n2/a04v35n2.pdf

40. Forero Ramirez N, Gamboa LF, Bedi, Sparrow R (2014) Child malnutrition and prenatal care: evidence from three Latin American countries. Pan Am J public Heal 35, Suppl. 3, 163–71. Available from: http://www.scielo.org/pdf/rpsp/v35n3/a01v35n3.pdf

41. Mamabolo RL, Alberts M, Steyn NP, Delemare-van de Waal HA, Levitt NS (2005) Prevalence and determinants of stunting and overweight in 3-year-old black South African children residing in the Central Region of Limpopo Province, South Africa. Public Health Nutr 8, Suppl. 5, S01–8. Available from: https://www.cambridge.org/core/services/aop-cambridge-core/content/view/0EAA544ADB04A8EC3281CD1497675409/S136890050000698a.pdf/div-class-title-prevalence-and-determinants-of-stunting-and-overweight-in-3-year-old-black-south-african-children-residing-in-the-central-region-of-limpopo-province-south-africa-div.pdf

42. Williams L, Zapata LB, D’Angelo DV, Harrison L, Morrow B (2012) Associations between preconception counseling and maternal behaviors before and during pregnancy. Matern Child Health J, 16(9):1854–61. Available from: https://checkout.springer.com/checkout/cart?1&utm_source=spri ngerlink&utm_medium-referral&utm_campaign=sl-buybox_articlePage_article https://doi.org/10.1007/s10995-011-0932-4 PMID: 22173331

43. Wildschut Hl, van Vliet-Lachotzki EH, Boon BM, Lie Fong S, Landkroon AP, Steegers EA (2006) Preconception care: an essential part of the care for mother and child. Ned Tijschr Genesesk, 150 (24):1326–30. PMID: 16808362

44. Van der Zee B, de Beaufort I, Temel S, de Wert G, Denktas S, Steegers EA (2011) Preconception care: an essential preventive strategy to improve children’s and women’s health. E.J Public Health Policy, 32 (3):367–79. Available from: https://checkout.springer.com/checkout/cart?3&utm_source=springerlink&utm_medium-referral&utm_campaign=sl-buybox_articlePage_article https://doi.org/10.1057/jphp.2011.13 PMID: 21808249