Abstract

The health of children in Ghana has improved in recent years. However, the current prevalence rates of malnutrition remain above internationally acceptable levels. This study, therefore, revisits the determinants of child health by using Ghana’s Multiple Indicator Cluster Survey to investigate the effect of infant feeding practices on child health. We used the World Health Organization’s Infant and Young Children Feeding guidelines to measure dietary quality. The econometric analyses show that dietary diversity may cause improvement in children’s health in Ghana. This suggests that educational campaigns on proper infant feeding and complementary dieting could be an effective means of improving the health of children in Ghana.

Keywords: Medicine, Pediatrics, Public health

1. Introduction

The importance of nutrition has been emphasized for the intellectual and physical development of children. It is, therefore, important to ensure that children have adequate diet as it will ensure a healthy and productive population in future. The benefits of adequate nutrition to the economy come directly in the form of reduced public health expenditure on health care and indirectly through improved health, which may lead to economic growth (Hoddinott et al., 2008). Because of the importance of nutrition in human and economic development, pragmatic steps,
both at sub-national, national and international levels, have been taken to reduce the incidence of malnutrition. The importance development practitioners attach to nutrition is reflected in targets 1C and 4A of the first Millennium Development Goal’s (MDG), which identify the need to reduce hunger and mortality among children under five years of age. In spite of the various interventions, about 870 million people were malnourished globally between 2010 and 2012 (FAO, 2012), with a sizeable proportion of this is found in sub-Saharan Africa and Asia (UNICEF, WHO & World Bank, 2015). Also, women and children tend to be the most affected (Bain et al., 2013). According to UNICEF, WHO & World Bank’s (2016) joint child malnutrition estimates, about 32 percent of children in Africa are stunted whilst another 8 percent are wasting. Malnutrition at the early stages of life does not only affect health outcomes of the child, but it also has a serious adverse impact on the determinants of their livelihoods, such as physical and intellectual growth, school performance and eventual future earnings and productivity (Hoddinott et al., 2008; Strauss and Thomas, 1998). As individuals get locked up in a vicious cycle of poor health, lower learning capacity, reduced physical activity, and lower productivity as a result of poverty, malnutrition and poor child health nexus, the gains from previous economic growth may be threatened (Bagriansky, 2010).

Some countries in Africa, including Ghana, have made marginal, but steady, gains in reducing malnutrition among children less than five years (ICF Macro, 2010). However, according to the last Multiple Indicator Cluster Survey (MICS4), 13 percent of children in Ghana are moderately or severely underweight, 23 percent are stunted (too short for their age.), and 6 percent are wasting (too thin for their height.) (Ghana Statistical Service (GSS), 2011). Fig. 1 presents the nutritional status of children according to the Ghana Demographic Health Survey (GDHS,
rounds I – V) and MICS4. The graph shows varying trends for overweight, stunting, underweight and wasting among children aged 5 to 59 months in Ghana. The graph shows that child stunting and underweight have reduced since 2003, even though the proportion of children who are stunted in Ghana is still higher than the global average of 25 percent (UNICEF, 2013). On the other hand, child wasting and overweight rose between 2003 and 2008. Both indicators increased by 1 percent between 2003 and 2008. Similarly, the GDHS estimate of child wasting is higher than the global estimate of five (5) percent (UNICEF, 2013). Whilst these figures are encouraging when they are benchmarked against other African countries (UNICEF, WHO & World Bank, 2016), they are still above the World Health Organization’s (WHO) classification of low prevalence. Thus, notwithstanding this progress, there is the need to investigate the drivers behind malnutrition in Ghana. This has become necessary given the fact that there has not been a steady downward trend for some indicators.

Following UNICEF’s (1990) conceptual framework on the causes of malnutrition, researchers have attempted to explain the role of quality diet in reducing child malnutrition. The empirical literature is replete with the assessment of complementary feeding and its effect on children’s health and nutrition (Dewey and Adu-Afarwuah, 2008; Saha et al., 2008 and Vaahtera et al., 2001). The results from these studies suggest that proper complementary feeding could be effective in improving the health of children below the age of five years. In line with these findings, this paper studies the effect of dietary diversity as means of improving child health in Ghana.

Whilst UNICEF’s (1990) conceptual framework links food security to child nutrition, the relationship is not as simple as demonstrated by the framework. Given the fact that food security as a concept is multifaceted, the transmission mechanism of food security to better nutrition can either run from food availability in terms of quantity and quality or sustainability. Thus, policy intervention aimed at improving nutrition through food security may have different impacts, based on which aspect is targeted. In addition, the relationship between food security and child nutrition could be more complex, based on the level of the analysis and the interactions of social, environmental and cultural practices. Government policy can improve child nutrition by ensuring food security at the household or at the individual (child and mother) level. However, depending on which level is targeted, the transmission mechanism will differ and the desired impact may be achieved at different time intervals. In view of these complexities, the current study seeks to test the hypothesis that the consumption of a diversified diet leads to better child nutrition. To the best of our knowledge, this study is different from other studies conducted on the subject to the extent that we take care of the endogeneity between dietary diversity and child health outcomes.
The next section of the paper discusses the methodology, then we present results and discussion and finally draw conclusions from the study.

2. Methodology

2.1. Data

Data for the study was obtained from the fourth round of the Ghana Multiple Indicator Cluster Survey (MICS4) collected in 2011. The MICS4 was conducted by the GSS as part of a broader international household survey designed by the UNICEF. The aim of the survey is to provide current information on the socio-economic circumstances of children and women by measuring key indicators relating to the MDGs (GSS, 2011). MICS4 is, therefore, a cross-sectional survey that provides current information on the health, social and economic circumstances of women, children and other household members. To obtain the sample for the survey, rural and urban areas in the ten administrative regions of Ghana were used as the main sampling strata. The final sample was selected in two stages. In the first stage, enumeration areas were selected with the probability of selection being proportional to the size. Then 15 households in each enumeration area were systematically selected. Eventually, 12,150 households were successfully sampled and interviewed. This consists of 11,925 households, 10,627 women aged 15 to 49 year and 7550 under the age of five years (GSS, 2011). After cleaning a merging the various data files, we 6598 children remained for the regression analysis.

2.2. Measurement of dietary diversity

To measure dietary quality, we adopt the WHO’s Infant and Young Children Feeding guidelines (IYCF), because they are designed to measure dietary diversity for both breastfed and non-breastfed children. Also, the dataset used in the analysis contains information on the food items that can be used to calculate this indicator. The section of the survey on children collected information on food and liquids a child consumed in the previous day. We categorized these food items into seven major food groups based on the WHO’s IYCF guidelines (Swindale and Bilinsky, 2006). These food groups are: (i) grains, roots, and tubers; (ii) legumes and nuts; (iii) flesh foods (meat, fish, poultry and liver/organ meats); (iv) eggs; (v) vitamin A rich fruits and vegetables; (vi) dairy products (milk, yogurt, cheese); (vii) other fruits and vegetables. If a child consumed at least one food item from a food group, the group was assigned a value of one for that child. The group scores are then summed to obtain the dietary diversity score, which ranges from zero to seven, where zero represents non-consumption of any of the food items and seven represents the highest level of diet diversification.
2.3. Definition of nutrition status (anthropometric indicators)

In this study, the child’s nutritional status is measured by the WHO’s (2006) anthropometric indicators: height-for-age (HAZ) is used to measure chronic malnutrition due to prolonged food deprivation; weight-for-height (WHZ) captures undernutrition due to recent food deprivation and malnutrition. Weight-for-age which is measures the child’s body mass relative to her chronologic age is used as a proxy for underweight.

2.4. Model specification and estimation technique

Based on the reviewed literature and the objective of this study we estimate the following model:

\[
y_{ij} = \beta_0 + \beta_1 \text{sex}_i + \beta_2 \text{age}_i + \beta_3 \text{f ever}_i + \beta_4 \text{numchildren}_i + \beta_5 \text{urban}_i \\
+ \beta_6 \text{mage}_i + \beta_7 \text{medu}_i + \beta_8 \text{wealth}_i + \beta_9 \text{water}_i + \beta_{10} \text{toilet}_i + \beta_{11} \text{food}_i \\
+ \beta_{12} \text{Bmilk}_i + \beta_{13} \text{ethnic}_i + \beta_{14} \text{region}_i + \epsilon_i
\]  

(1)

where: sex = sex of child; age = age of child; numchildren = number of children in household; urban = whether household is in an urban area; mage = mother’s age; medu = mother’s education; wealth = wealth quintile; water = source of water; toilet = type of toilet; food = food diversity score; Bmilk = child ever breastfed; ethnic = ethnicity of household head; region = which administrative region household is located in; \(y_{ij} = (\text{WAZ}, \text{HAZ}, \text{WHZ})\) are the raw z-score of the respective indicator; and \(i\) indexes individual children.

Estimating Eq. (1) with ordinary least squares (OLS) can yield a consistent estimate of the effect of dietary diversity on child health if dietary diversity is exogenous; that is uncorrelated with the error term in the model. However, this may not be the case because of the bi-causal relationship between the two variables. This bi-causal relationship is likely to arise because parents and caregivers may adopt different feeding practices depending on the current health status of the child. In this instance, the direction of causality could also run from child health to dietary diversity. If this is the case, the OLS estimates will no longer be consistent. To resolve this problem, we employed the Two Stage Least Square (TSLS) estimator to identify the causal effect of dietary diversity on child health. We used the number of chicken owned as well as household ownership of pigs as instruments for dietary diversity. We assume our instruments have no direct effect on child health outcomes but they indirectly influence it by improving the quality of diet consumed. Based on these considerations we estimate the following equations:

\[
\text{food}_i = \alpha_0 + \alpha_1 \text{sex}_i + \alpha_2 \text{age}_i + \alpha_3 \text{f ever}_i + \alpha_4 \text{numchildren}_i + \alpha_5 \text{urban}_i \\
+ \alpha_6 \text{mage}_i + \alpha_7 \text{medu}_i + \alpha_8 \text{wealth}_i + \alpha_9 \text{water}_i + \alpha_{10} \text{toilet}_i \\
+ \alpha_{11} \text{Bmilk}_i + \alpha_{12} \text{ethnic}_i + \alpha_{13} \text{region}_i + \alpha_{14} \text{pig}_i + \alpha_{15} \text{chicken}_i + \psi_i
\]  

(2)
\[ y_{ij} = \phi_0 + \phi_1 \text{sex}_i + \phi_2 \text{age}_i + \phi_3 \text{fever}_i + \phi_4 \text{numchildren}_i + \phi_5 \text{urban}_i \]
\[ + \phi_6 \text{mage}_i + \phi_7 \text{medui}_i + \phi_8 \text{wealth}_i + \phi_9 \text{water}_i + \phi_{10} \text{toilet}_i + \phi_{11} \text{food}_i \]
\[ + \phi_{12} \text{Bmilk} + \phi_{13} \text{ethnic}_i + \phi_{14} \text{region}_i + \epsilon_i \tag{3} \]

where \( \text{food}_i \) is the linearly predicted food diversity score from Eq. (2); \( \text{pig} \) and \( \text{chicken} \) are the number of pigs and chicken owner by the household.

3. Results and discussion

Table 1 presents the bivariate relationship between children’s nutritional outcomes, on the one hand, and individual and household characteristics, on the other hand. We find that approximately 25 percent of male children are stunted as compared to 20 percent of females. Similarly, 7.6 percent and 15.6 percent of male children are wasted and considered underweight respectively, whilst 5.2 and 11 percent of female children are wasted and underweight. In all cases, the incidence of malnutrition tends to be higher among male children than female children. This situation could be attributed to differences in biological composition and caregiving; and possibly due to daughter preference (Fuse, 2010).

One can also observe that the difference between the incidence of malnutrition over the different age groups is statistically significant. It is important to note that in all the three cases the proportion of malnourished children increases with age up to age 35 months and then falls, thus, suggesting a non-linear relationship between child age and nutritional status. Apart from stunting, we observe significant differences in the prevalence of wasting and underweight among children who had suffered from fever in the past two weeks and those who had not.

On the association between dietary diversity and child health, Table 1 shows that malnourishment varies significantly for the different levels of consumption. About a quarter of children who consumed at least four of the seven food items are stunted: 5 percent of this group were wasted and another 12 percent were underweight. The prevalence of wasting and child underweight begins to decline after the intake of two or more food items. Thus, child health improves as the intensity of dietary diversity increases.

Sanitation factors such as the type of toilet facility and the source of drinking water also tend to have a significant association with child health in Ghana. About 30 percent of children found in households where the bush or bucket are used as toilet facility is stunted, whilst only 10 percent of their counterparts in households with flush toilets are stunted. Similarly, only 4 percent of children found in households with flush toilets are wasted as compared to 7 percent of children found in households which neither use flush toilet nor pit latrine. The incidence of malnutrition decreases as the source of drinking water improves. For instance, the prevalence of child underweight falls from 17 percent among those who use...
Table 1. Bivariate analysis of socioeconomic variables and anthropometric indicators.

|                | Stunted % | No. of Children | Wasted % | No. of Children | Underweight % | No. of Children |
|----------------|-----------|-----------------|----------|-----------------|---------------|-----------------|
| Sex            |           |                 |          |                 |               |                 |
| Female         | 20        | 699             | 5.2      | 182             | 11.1          | 389             |
| Male           | 25.1      | 852             | 7.6      | 261             | 15.6          | 536             |
| Chi square     | 24.83     | 27.78           | 15.78    |                 |               |                 |
| Age            |           |                 |          |                 |               |                 |
| 0–5            | 7.8       | 62              | 11.3     | 89              | 6.6           | 52              |
| 6–11           | 12.5      | 88              | 11.3     | 80              | 15.9          | 113             |
| 12–23          | 26.5      | 365             | 7.9      | 108             | 16.6          | 231             |
| 24–35          | 29.2      | 412             | 5        | 70              | 14            | 199             |
| 36–47          | 26.8      | 373             | 2.7      | 38              | 13.1          | 185             |
| 48–59          | 20.7      | 251             | 4.8      | 58              | 11.9          | 145             |
| Chi square     | 207.77    | 140.20          | 68.14    |                 |               |                 |
| Child ill with fever in last 2 weeks |           |                 |          |                 |               |                 |
| No             | 22.1      | 1,235           | 5.9      | 330             | 12.3          | 693             |
| Yes            | 24.1      | 315             | 8.7      | 113             | 17.6          | 231             |
| Chi square     | 0.78      | 10.91           | 28.73    |                 |               |                 |
| Food diversity Score |         |                 |          |                 |               |                 |
| None           | 10.4      | 92              | 10.3     | 92              | 8.8           | 79              |
| Any one        | 18.9      | 91              | 11.8     | 57              | 16.1          | 78              |
| Any two        | 27.1      | 145             | 10       | 53              | 21.6          | 116             |
| Any three      | 24.2      | 427             | 5        | 88              | 14.2          | 252             |
| At least four  | 24.7      | 796             | 4.8      | 154             | 12.3          | 400             |
| Chi square     | 99.48     | 84.77           | 30.3136  |                 |               |                 |
| Main source of drinking water |         |                 |          |                 |               |                 |
| Pipe           | 15.8      | 478             | 5.9      | 178             | 10.5          | 318             |
| Protected      | 25.8      | 621             | 7.1      | 172             | 14.8          | 359             |
| Unprotected    | 30.8      | 452             | 6.3      | 93              | 16.6          | 247             |
| Chi square     | 93.33     | 10.70           | 106.60   |                 |               |                 |

(Continued)
### Table 1. (Continued)

| Type of toilet facility      | Stunted % | No. of Children | Wasted % | No. of Children | Underweight % | No. of Children |
|------------------------------|-----------|-----------------|----------|-----------------|---------------|-----------------|
| Flush                        | 9.7       | 83              | 4.4      | 38              | 6.6           | 56              |
| Pit latrine                  | 21.8      | 921             | 6.6      | 278             | 12.5          | 532             |
| Bush, bucket and other       | 30.2      | 547             | 7        | 128             | 18.3          | 337             |

Chi square: 104.37 (Pr = 0.000) 11.68 (Pr = 0.003) 63.35 (Pr = 0.000)

| Number of children | Stunted % | No. of Children | Wasted % | No. of Children | Underweight % | No. of Children |
|--------------------|-----------|-----------------|----------|-----------------|---------------|-----------------|
| 1–3                | 20.6      | 830             | 6        | 242             | 11.6          | 475             |
| 4–6                | 23.6      | 574             | 6.8      | 166             | 14.4          | 352             |
| 7–9                | 33.7      | 115             | 8.5      | 29              | 23.2          | 80              |
| More than 9        | 39.8      | 32              | 6.8      | 6               | 23.8          | 19              |

Chi square: 42.4681 (Pr = 0.000) 8.80 (Pr = 0.032) 53.84 (Pr = 0.000)

| Mother's education | Stunted % | No. of Children | Wasted % | No. of Children | Underweight % | No. of Children |
|--------------------|-----------|-----------------|----------|-----------------|---------------|-----------------|
| None               | 28.4      | 620             | 8.1      | 177             | 16.9          | 372             |
| Primary            | 25        | 383             | 5.3      | 82              | 13.7          | 212             |
| Middle/JSS         | 18.5      | 437             | 5.5      | 130             | 11.1          | 263             |
| Secondary +        | 13.7      | 111             | 6.9      | 55              | 9.6           | 78              |

Chi square: 109.61 (Pr = 0.000) 13.41 (Pr = 0.004) 59.10 (Pr = 0.000)

| Region            | Stunted % | No. of Children | Wasted % | No. of Children | Underweight % | No. of Children |
|-------------------|-----------|-----------------|----------|-----------------|---------------|-----------------|
| Western           | 23        | 157             | 7.6      | 53              | 14.5          | 100             |
| Central           | 22.2      | 148             | 5.6      | 38              | 13.3          | 90              |
| Greater Accra     | 13.5      | 137             | 3.4      | 35              | 8             | 81              |
| Volta             | 22.1      | 121             | 9.1      | 50              | 10.9          | 60              |
| Eastern           | 20.7      | 159             | 7        | 54              | 10.8          | 83              |
| Asante            | 22.2      | 289             | 6.6      | 86              | 11.7          | 154             |
| Brong Ahafo       | 18.4      | 115             | 3.4      | 21              | 12.3          | 78              |
| Northern          | 37.1      | 286             | 8.4      | 65              | 23.9          | 185             |
| Upper East        | 30.9      | 93              | 7.5      | 23              | 20.3          | 62              |
| Upper West        | 22.5      | 46              | 9.7      | 20              | 15.1          | 32              |

Chi square: 184.54 (Pr = 0.000) 31.45 (Pr = 0.000) 143.05 (Pr = 0.000)

Wealth index quintile (Continued)
unprotected water sources to 11 percent among those who use pipe-borne water. Good sanitation and water supply improve health by reducing infections and malnutrition (Cuesta, 2007).

We also find that wealthier households have children with better nutritional status than poorer households. About a third of children born to poor parents are stunted. Equally, one-fifth of children born into poor households are underweight compared to only 6 percent of those in the richest households. A similar pattern was observed by Urke et al. (2011), who found that wealth status and maternal education are positively associated with child health outcomes. In addition, we observe a positive relationship between maternal education and child health outcomes. The effect of dependence and competition for care is also felt through the number of children in the household. Table 1 shows that child nutritional status worsens as the number of children increases. This could be because of competition for care and resources in the household.

Table 1. (Continued)

| Ethnicity of household head | Stunted % | No. of Children | Wasted % | No. of Children | Underweight % | No. of Children |
|----------------------------|-----------|-----------------|---------|-----------------|---------------|----------------|
| Akan                       | 20        | 564             | 5.6     | 159             | 11.7          | 332            |
| Ga/Dangme                  | 19.4      | 106             | 5.5     | 30              | 12.8          | 70             |
| Ewe                        | 18.7      | 171             | 6.6     | 61              | 9.8           | 90             |
| Guan                       | 27.4      | 67              | 5.4     | 13              | 18.8          | 46             |
| Gruma                      | 37.3      | 158             | 6       | 26              | 18.3          | 78             |
| Mole-Dagbani               | 25.6      | 344             | 8.2     | 110             | 16.9          | 230            |
| Grusi                      | 31.4      | 87              | 7.3     | 20              | 17.6          | 50             |
| Mande                      | 15        | 18              | 7       | 8               | 7.5           | 9              |
| **Chi square**             | 116.18 (Pr = 0.000) | 20.11 (Pr = 0.005) | 67.48 (Pr = 0.000) |
| **Total**                  | 22.5      | 1,550           | 6.4     | 444             | 13.3          | 925            |

Source: Authors’ Computation from MICS4, 2011.
3.1. Feeding pattern in Ghana by child age groups

Fig. 2 provides a description of dietary diversity across different child age groups and it shows that in Ghana a majority of children (47%) consume a minimum of four out of the seven food groups. About a quarter of them had three food groups whilst 13 percent had none of the food groups. In addition, more than 80 percent of infants, aged zero to five months, can be assumed to be undergoing exclusive breastfeeding since they consumed none of the food items. Observable from Fig. 2 is how food diversity increases with child age. For instance, whilst only 0.5 percent of children who are under 6 months of age had at least four of the food items, the proportions increased to 49 percent among those aged 12 to 23 months and 61 percent among those aged 48 to 59 months. The pattern portrayed by this graph indicates that parents and caregivers see the need to vary their children’s diet within the first five years.

3.2. Maternal education and food diversity

In Table 2 we test whether dietary diversity for children is statistically different across levels of maternal education. The table shows that children born to parents with higher levels of education had a more diversified diet. We found that children whose mothers have primary, middle/Junior High School (JHS) or at least secondary school education are significantly likely to consume more diversified diet than those whose mothers have no education. However, we fail to find any statistical difference in child feeding among those whose parents had received some form of formal education. Thus, as far as child feeding is concerned the feeding pattern of children who are born to parents with only primary education is
3.3. Regional distribution of food diversity among children under 6 years

In terms of regional differences in dietary pattern, Fig. 3 shows that children in the Volta region had the most diversified diet. This is followed by Greater Accra, which is the national capital. One would have expected regions like Eastern and Western to have better food diversity than Upper West and Upper East regions since the poverty rates in the former are lower than the latter region; however, the graph portrays a different picture. This could be as a result of the fact that most of the households in the Upper East and West regions are peasant farmers who grow a wide range of crops and, rear different domestic animals which serve to improve dietary diversity. The average dietary diversity of children in the Northern, 

Table 2. Dietary diversity across levels of maternal education.

|                | None | Primary | Middle/JHS | Secondary | Mean |
|----------------|------|---------|------------|-----------|------|
| None           | 0.00 |         |            |           | 3.00 |
| Primary        | -0.22*** | 0.00 |            |           | 3.18 |
| Middle/JHS     | -0.27*** | -0.04  | 0.00       |           | 3.22 |
| Secondary sch. | -0.32*** | -0.10  | -0.06      | 0.00      | 3.28 |

*p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001. Source: Authors’ Computation from MICS, 2011.

Fig. 3. Distribution of Food Diversity by Administrative Regions in Ghana. (Source: Authors’ Computation from MICS, 2011).
Western and Eastern regions are less than the national average of 3.12. The implication of this pattern on children’s nutrition is seen in Table 1, where the regions with low dietary diversity are also the ones with a high incidence of child malnutrition.

3.4. Estimation results

This paper set out to study the effects of dietary diversity on child health outcomes. To this end, anthropometric indicators of child health were regressed on dietary diversity, maternal education, ethnicity and other covariates of child health. The OLS and TSLS result of the effect of dietary diversity on child anthropometric indicators are presented in Table 3. The first stage results for the TSLS are reported in column 7. Table 3 indicates that dietary diversity has a positive effect on child health outcomes. This relationship is observed in all the models, except for the IV model for weight-for-age. Thus, increasing the number of food groups a child consumes by one causes HAZ and WAZ to increase by 0.65 and 0.52 units respectively. Thus, we find a consistent positive association between dietary diversity and better child health outcomes.

On the effect of ethnicity on child health, we find in Table 3 that children from the Ewe, Grusi, Guan and Mole/Dagbani ethnic groups have better anthropometric scores than those from the Akan ethnic group. This result shows that ethnicity may have an important influence on child health in Ghana. This may be attributed to differences in feeding and post-partum practices across the different ethnic groups. Elsewhere, Adedini et al. (2015) and Annim and Imai (2014) have found that child health outcomes differ among children of different ethnic descent in Lao People’s Democratic Republic.

We also observe that an increase in the number of children in the household worsens the child’s health. The table shows that an additional child in the household is associated with a 0.2 lower WHZ and a 0.3 lower scores in both WAZ and HAZ. Annim, Awusabo-Asare, Amo-Adjei (2013) argued that as the number of children in a household increase, children may have to compete for both household resources and caregiving. This may cause each child to receive sub-optimal care and resources to achieve the desired nutritional status. In line with our observation in Table 1, male children tend to have lower weight-for-age and height-for-age than their female counterparts. The observed relationship between sex and nutritional status could be because of biological differences as well as socio-cultural differences. Socio-culturally, gender preferences, and preferential treatment may account for the observed coefficient. Indeed, Fuse (2010) has shown that daughter preference is slightly higher than son preference in Ghana.

In addition, children who had diarrhea have lower anthropometric scores compared to those who did not. Infections that lead to diarrhea and fever adversely affect
Table 3. Effects of food diversity, mother’s education and ethnicity on child health outcomes in Ghana (all children under 5 years).

|                      | (1) Weight-for-Height | (2) Height-for-Age | (3) Weight-for-Age | (4) Weight-for-Age | (5) First stage results |
|----------------------|-----------------------|--------------------|--------------------|--------------------|-------------------------|
|                      | (OLS)                 | (IV)               | (OLS)              | (IV)               |                         |
| IYCF score           | 0.029**               | 0.179              | 0.028**            | 0.613**            | 0.036*** 0.518**        |
|                      | (0.012)               | (0.190)            | (0.013)            | (0.301)            | (0.011) 0.236           |
| Child is male        | -0.051*               | 0.005              | -0.109***          | -0.052             | -0.076*** -0.001        |
|                      | (0.027)               | (0.036)            | (0.030)            | (0.048)            | (0.025) 0.039           |
| Child had diarrhea   | -0.082**              | -0.042             | -0.130***          | -0.089             | -0.132*** -0.079        |
|                      | (0.040)               | (0.047)            | (0.044)            | (0.061)            | (0.038) 0.051           |
| Child had fever      | -0.186***             | -0.219***          | 0.095**            | 0.111**            | -0.079** -0.092**       |
|                      | (0.032)               | (0.038)            | (0.037)            | (0.050)            | (0.031) 0.041           |
| No. of child. in HH  | -0.011*               | -0.015*            | -0.027***          | -0.025**           | -0.025*** -0.027***     |
|                      | (0.007)               | (0.008)            | (0.008)            | (0.010)            | (0.007) 0.008           |
| Urban residence      | 0.020                 | 0.052              | -0.041             | -0.133*            | -0.012 -0.039           |
|                      | (0.043)               | (0.056)            | (0.049)            | (0.071)            | (0.041) 0.060           |
| Mother’s age         | -0.002                | -0.002             | 0.009***           | 0.011***           | 0.004** 0.006**         |
|                      | (0.002)               | (0.002)            | (0.002)            | (0.003)            | (0.002) 0.003           |
| HH own agric. land   | -0.114***             | -0.103**           | -0.016             | 0.091              | -0.080** -0.002         |
|                      | (0.034)               | (0.049)            | (0.038)            | (0.069)            | (0.032) 0.054           |
| Child ever breastfed | -0.305**              | -0.255             | 0.048              | 0.255              | -0.189 -0.040           |
|                      | (0.153)               | (0.206)            | (0.179)            | (0.272)            | (0.145) 0.203           |
| Child Age (0–5 = 0)  |                       |                    |                    |                    |                         |
| 6–11                 | -0.465***             | -0.777**           | -0.444***          | -1.427***          | -0.546*** -1.369***     |
|                      | (0.073)               | (0.335)            | (0.076)            | (0.519)            | (0.065) 0.409           |
| 12–23                | -0.294***             | -0.828             | -1.224***          | -3.020***          | -0.713*** -2.215***     |
|                      | (0.071)               | (0.584)            | (0.079)            | (0.921)            | (0.064) 0.722           |
| 24–35                | -0.050                | -0.584             | -1.433***          | -3.487***          | -0.710*** -2.383***     |
|                      | (0.073)               | (0.678)            | (0.079)            | (1.066)            | (0.066) 0.838           |
| 36–47                | 0.075                 | -0.444             | -1.354***          | -3.478***          | -0.635*** -2.346***     |
|                      | (0.071)               | (0.678)            | (0.078)            | (1.072)            | (0.065) 0.841           |
| 48–59                | -0.004                | -0.499             | -1.326***          | -3.455***          | -0.705*** -2.400***     |
|                      | (0.072)               | (0.682)            | (0.079)            | (1.072)            | (0.065) 0.842           |
| Mother’s Educ. (None = 0) |                   |                    |                    |                    |                         |
| Primary              | 0.016                 | -0.004             | 0.021              | 0.024              | 0.024 -0.000           |
|                      | (0.040)               | (0.052)            | (0.044)            | (0.071)            | (0.038) 0.058           |

(Continued)
Table 3. (Continued)

| Weight-for-Height (OLS) | Height-for-Age (OLS) | Weight-for-Age (OLS) | First stage results | IYCF |
|-------------------------|----------------------|----------------------|---------------------|------|
| (1)                     | (2)                  | (3)                  | (4)                 | (5)  | (6)  | (7)          |
| Middle/JSS              | (1) -0.034           | 0.029                | -0.064              | -0.013 | -0.058 | 0.120*       |
|                         | (0.046)              | (0.053)              | (0.082)             | (0.043) | (0.066) | (0.062)      |
| Secondary and above     | (1) -0.123*          | 0.133*               | 0.057               | -0.021 | -0.125 | 0.247**      |
|                         | (0.070)              | (0.079)              | (0.161)             | (0.065) | (0.127) | (0.117)      |

Wealth quintile (Poorest = 0)

| Middle                  | (1) -0.056           | 0.127**              | 0.036               | 0.045  | -0.064 | 0.061       |
|                         | (0.057)              | (0.063)              | (0.089)             | (0.053) | (0.074) | (0.076)      |
| Fourth                  | (1) -0.076           | 0.412***             | 0.310***            | 0.196*** | 0.073  | 0.101       |
|                         | (0.067)              | (0.091)              | (0.114)             | (0.063) | (0.097) | (0.098)      |
| Fifth                   | (1) 0.065            | 0.493***             | 0.375**             | 0.356*** | 0.264*  | 0.145       |
|                         | (0.091)              | (0.147)              | (0.187)             | (0.081) | (0.156) | (0.170)      |

Water source (Pipe = 0)

| Water source (Pipe = 0) | (1) -0.004           | -0.036               | -0.052              | -0.033  | -0.055 | -0.045       |
|                         | (0.046)              | (0.053)              | (0.072)             | (0.040) | (0.059) | (0.051)      |
| Unprotected             | (1) 0.071            | -0.089               | -0.112              | -0.004  | -0.046 | -0.046       |
|                         | (0.050)              | (0.056)              | (0.080)             | (0.047) | (0.067) | (0.069)      |

Toilet type (Flush = 0)

| Toilet type (Flush = 0) | (1) -0.034           | 0.152*               | 0.077               | 0.078   | 0.028  | 0.058       |
|                         | (0.071)              | (0.131)              | (0.076)             | (0.181) | (0.065) | (0.146)     |
| Bush/bucket etc.        | (1) -0.047           | 0.144*               | -0.125              | -0.108  | 0.018  | -0.151      |
|                         | (0.079)              | (0.138)              | (0.086)             | (0.191) | (0.074) | (0.155)     |

Ethnicity (Akan = 0)

| Ethnicity (Akan = 0)    | (1) -0.020           | 0.152*               | 0.077               | 0.078   | 0.028  | 0.058       |
|                         | (0.085)              | (0.121)              | (0.086)             | (0.135) | (0.077) | (0.120)     |
| Ewe                     | (1) -0.105           | 0.324***             | 0.455***            | 0.105   | 0.128  | -0.106      |
|                         | (0.071)              | (0.107)              | (0.076)             | (0.120) | (0.064) | (0.104)     |
| Guan                    | (1) 0.057            | 0.125                | 0.298**             | 0.101   | 0.204* | -0.041      |
|                         | (0.084)              | (0.108)              | (0.089)             | (0.126) | (0.080) | (0.112)     |
| Gruma                   | (1) 0.056            | -0.012               | 0.070               | 0.028   | 0.069  | -0.024      |

(Continued)
Table 3. (Continued)

|          | (1) Weight-for-Height (OLS) | (2) Height-for-Age (OLS) | (3) Weight-for-Age (IV) | (4) First stage results |
|----------|------------------------------|--------------------------|-------------------------|-------------------------|
|          | (1)                         | (2)                      | (3)                     | (4)                     | (5)                     |
| Mole-Dagbani | -0.036 (0.063)              | 0.106 (0.088)            | 0.224** (0.067)         | 0.032 (0.058)           | 0.134 (0.058)           |
|          | (0.114) (0.058)             | (0.105)                  | (0.208*)                | (0.071)                 | (0.090)                 |
|          |                              |                          |                         |                         |                         |
| Grusi    | 0.097 (0.086)               | 0.154 (0.109)            | 0.158 (0.093)           | 0.048 (0.077)           | 0.208* (0.109)          |
|          | (0.100) (0.101)             |                          |                         |                         |                         |
| Mande    | -0.063 (0.105)              | 0.054 (0.131)            | 0.210* (0.125)          | 0.086 (0.099)           | 0.274* (0.141)          |
|          | (0.212) (0.121)             |                          |                         |                         |                         |
| Region (Western = 0) |                             |                          |                         |                         |                         |
| Central  | -0.080 (0.073)              | -0.234** (0.119)         | 0.012 (0.080)           | -0.059 (0.067)          | -0.291** (0.132)        |
|          | (0.192) (0.100)             |                          |                         |                         |                         |
| Greater Accra | -0.050 (0.095)            | -0.218 (0.179)           | 0.017 (0.103)           | -0.024 (0.086)          | -0.246 (0.192)          |
|          | (0.145) (0.182)             |                          |                         |                         |                         |
| Volta    | -0.232** (0.101)            | -0.317* (0.168)          | 0.199* (0.109)          | -0.050 (0.092)          | -0.356* (0.183)         |
|          | (0.186) (0.132)             |                          |                         |                         |                         |
| Eastern  | -0.037 (0.094)              | -0.269** (0.131)         | -0.030 (0.097)          | -0.051 (0.086)          | -0.325** (0.138)        |
|          | (0.237) (0.125)             |                          |                         |                         |                         |
| Ashanti  | 0.021 (0.088)               | -0.105 (0.145)           | 0.041 (0.094)           | 0.044 (0.079)           | -0.208 (0.152)          |
|          | (0.237) (0.112)             |                          |                         |                         |                         |
| Brong Ahafo | 0.064 (0.086)              | -0.112 (0.159)           | 0.143 (0.095)           | 0.114 (0.095)           | -0.262 (0.180)          |
|          | (0.242) (0.113)             |                          |                         |                         |                         |
| Northern | -0.152* (0.084)             | -0.278** (0.113)         | -0.338*** (0.091)       | -0.398*** (0.135)       | -0.311*** (0.078)       |
|          | (0.186) (0.135)             |                          |                         |                         |                         |
| Upper East | -0.266*** (0.091)          | -0.529*** (0.168)        | -0.184* (0.101)         | -0.604** (0.237)        | -0.292*** (0.084)       |
|          | (0.078) (0.112)             |                          |                         |                         |                         |
| Upper West | -0.197** (0.090)           | -0.428*** (0.165)        | 0.125 (0.099)           | -0.079 (0.083)          | -0.526*** (0.184)       |
|          | (0.237) (0.184)             |                          |                         |                         |                         |

Instruments

|          |                         |
|----------|-------------------------|
| Number of chicken | 0.064*** (0.001) |
| Number of pigs    | 0.011*** (0.004) |
| Constant          | 0.342 (0.213)         |
|                          | 0.335 (0.294)         |
|                          | -0.354 (0.237)        |
|                          | -0.590 (0.388)        |
|                          | -0.073 (0.198)        |
|                          | -0.259 (0.303)        |
|                          | 0.118 (0.314)         |

(Continued)
nutritional status by reducing dietary intake and intestinal absorption and increasing catabolism and sequestration of nutrients which are essential for growth (Brown, 2003). However, we fail to see this effect in the case of HAZ for children who had a fever. We also observe a negative relationship between child’s age and nutritional status.

As expected, household wealth positively correlates with height-for-age and weight-for-height. Children born to families within higher wealth quintiles tend to have better nutritional status as compared to those born to households within the poorest wealth quintile. For HAZ and WAZ, the effect of household wealth and child nutritional status falls between those in the second and middle quintiles but increases between the fourth and the richest quintiles. This suggests that the relationship between wealth and child health may not be linear. Conversely, weight-for-height is worse among children in the second and middle wealth quintiles as compared to those in the poorest wealth quintile.

Regional fixed effects are significant in explaining child nutrition. With the Western region as the base, we observe that except for Greater Accra, children in the other regions have lower weight-for-age than those in the Western region. Similarly, children in Northern, Upper East, and Upper West regions are worse off in terms of weight-for-height than their counterparts in the Western region. Interestingly the difference between the anthropometric score of children in the Western region and the three northern regions tends to be higher. This could be attributable to the high poverty and deprivation rates in this region.

Table 3. (Continued)

| (1) Weight-for-Height (OLS) | (2) Height-for-Age (OLS) | (3) Weight-for-Height (IV) | (4) Height-for-Age (IV) | (5) Weight-for-Height (OLS) | (6) Height-for-Age (IV) | (7) First stage results IYCF |
|---------------------------|--------------------------|---------------------------|-------------------------|---------------------------|-------------------------|----------------------------|
| N                         | 6598                     | 4727                      | 6598                    | 4727                      | 6598                    | 4727                      | 4727                      |
| $R^2$                     | 0.055                    | 0.045                     | 0.178                   | -0.101                    | 0.098                   | -0.200                    | 0.500                     |
| $F$                       | 9.581                    | 8.250                     | 34.969                  | 16.654                    | 16.851                  | 7.816                     | 326.701                   |
| Over ID (J-stat.)         | 0.625                    | 1.059                     | 1.899                   | [0.429]                   | [0.303]                 | [0.168]                   |
| Under ID (LM stat.)      | 17.293                   | 17.293                    | 17.293                  | [0.000]                   | [0.000]                 | [0.000]                   |
| Weak ID (F-stat.)        | 14.254                   | 14.254                    | 14.254                  | 14.254                    |                        |                           |
3.5. Proportional selection assumption test

Following Oster (Oster, 2014) we test whether the omission of unobservable factors may significantly bias the observed coefficients of dietary diversity in our models. The test assumes that an inference can be made about the possible bias that could be caused by the omission of unobservable factors by observing the movement of the coefficient by successively including observable independent variables. The idea of the test is that if the inclusion of additional explanatory variables improves the $R^2$ but leaves the coefficient relatively unchanged, then one can be confident that the coefficient is relatively stable. Based on this, it can be concluded that the coefficient will remain relatively unchanged if the unobservable factors were added. Table 4 contains the results of the test. We select an $R^2$ cutoff of 30 percent, because studies in this area usually report $R^2$ around 20 percent (see Arimond and Ruel (2004) for a cross-country study and the respective $R^2$). We found that, except for the WHZ model, the identified set always excludes zero. This means that even though these models do not include all the potential explanatory variables, the effect of dietary diversity will be different from zero if we were to observe these variables.

4. Discussion and conclusion

Because of the long-lasting effect of malnutrition on human development at later stages in life, children’s nutrition has engaged the attention of policy makers and researcher for several years. This has led to the prescription of various interventions to deal with child malnutrition, of which dietary diversity is an integral part. The association between dietary diversity and child health outcomes has been explored by researchers in some developing countries. In view of the evidence from these studies, the current study sought to investigate the causal effect of dietary diversity on child health outcomes in Ghana.

Table 4. Proportional Selection Assumption.

|                  | Weight-for-Height | Weight-for-Age | Height-for-Age |
|------------------|-------------------|----------------|----------------|
| IYCF uncontrolled| 0.045             | -0.029         | -0.132         |
| IYCF controlled  | 0.027             | 0.045          | 0.027          |
| $R^2$ uncontrolled| 0.004             | 0.002          | 0.026          |
| $R^2$ controlled | 0.054             | 0.093          | 0.172          |
| Identified set   | [0.027, -5.406]   | [0.045, 0.934] | [0.027, 0.349] |
| $N$              | 6655              | 6694           | 6643           |

$\delta = 1, R^2_{\text{max}} = 3$. 

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Food diversity, the independent variable of interest, was captured as a continuous variable from the count of the number of food groups from which a child had food in the previous day before the survey. These food groups are based on the WHO’s IYCF guidelines. The dependent variable, child health, was measured with three anthropometric indicators: weight-for-age (wasting), weight-for-height (stunting) and weight-for-height (underweight). We employed both bivariate and multivariate analyses to evaluate the effect of dietary diversity on child health. We found that there is a general trend towards higher dietary diversity as the child grows in age. We consider this as a good trend for child nutrition, as parents and caregivers see the need to meet the nutritional requirements of their wards in the growth process.

Dietary diversity is also significantly higher for children from mothers with higher education. This was consistent with our apriori expectation since educated mothers know the importance of a balanced diet for their children. This also puts education as one of the important tools that policy makers can adopt to improve nutritional adequacy among infants and young children. This can be achieved by making nutrition awareness an integral part of the school curriculum, especially at the basic level. Since more than half of the respondents in our sample had had no formal education, we recommend that nutrition awareness should also be created outside the classroom through avenues like the mass media and informal education. The government of Ghana can take advantage of the existing information service department as well the flourishing community information centers to provide informal education on nutrition, especially in rural Ghana.

In general, our analysis shows that dietary diversity causes improvements in child health among under five-year-olds in Ghana. We interpret this results with caution because dietary diversity was measured over a one-day recall period which may not be an accurate reflection the dietary pattern for a longer period. Despite this limitation, our results show a consistent relationship across all the three anthropometric indicators. We recommend that public health officials should educate parents and caregivers on the importance of dietary diversity to their children. The government could also take advantage of the structures of the national school feeding program to diversify the diet of the school children. Our analysis of the effects of each individual food groups on child health shows that vitamin A rich food (pumpkin, yellow yam, green vegetables [kontomire] mangoes and pawpaw), eggs and other vegetables have a positive association with the weight-for-age score. Hence, given the right nutritional education, malnutrition among children in rural areas could be minimized at a relatively lower cost because these food items tend to be inexpensive in rural farming communities.
Declarations

Author contribution statement

Raymond Boadi Frempong, Samuel Kobina Annim: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

References

Adedini, S.A., Odimegwu, C., Imasiku, E.N., Ononokpono, D.N., 2015. Ethnic differentials in under-five mortality in Nigeria. Ethn. Health 20 (2), 145–162.

Annim, S.K., Imai, K.S., 2014. Nutritional Status of Children. Food Consumption Diversity and Ethnicity in Lao PDR (No. DP2014-17).

Annim, S.K., Awusabo-Asare, K., Amo-Adjei, J., ICF International, August 2013. Household Nucleation, Dependency and Child Health Outcomes in Ghana. DHS Working Papers. http://www.measuredhs.com/publications/publication-wp98-working-papers.cfm.

Arimond, M., Ruel, M.T., 2004. Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. J. Nutr. 134 (10), 2579–2585.

Bagriansky, J., 2010. The economics consequences of malnutrition in Albania. UNICEF, Albania.

Bain, L.E., Awah, P.K., Geraldine, N., Kindong, N.P., Sigal, Y., Bernard, N., Tanjeko, A.T., 2013. Malnutrition in Sub – Saharan Africa: burden, causes, and prospects. Pan Afr. Med. J. 15, 120.

Brown, K.H., 2003. Diarrhea and Malnutrition. J. Nutr. 133 (1), 328S–332S.
Cuesta, J., 2007. Child Malnutrition and the Provision of Water and Sanitation in the Philippines. Journal of the Asia Pacific Economy 12 (2), 125–157.

Dewey, K.G., Adu-Afarwuah, S., 2008. Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. Matern. Child Nutr. 4 (Suppl. 1), 24–85.

Fuse, K., 2010. Variations in attitudinal gender preferences for children across 50 less-developed countries. Demographic Research 23 (36), 1031–1048.

Ghana Statistical Service, 2011. Ghana Multiple Indicator Cluster Survey with an Enhanced Malaria Module and Biomarker, (Final Report). Ghana Statistical Service, Accra, Ghana.

Hoddinott, J., Maluccio, J.A., Behrman, J.R., Flores, R., Martorell, R., 2008. Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. Lancet 371 (9610), 411–416.

ICF Macro, 2010. Trends in demographic, family planning, and health indicators in Ghana, 1960-2008: Trend analysis of demographic and health surveys data. ICF Macro.

Saha, K.K., Frongillo, E.A., Alam, D.S., Arifeen, S.E., Persson, L.A., Rasmussen, K.M., 2008. Appropriate infant feeding practices result in better growth of infants and young children in rural Bangladesh. Am. J. Clin. Nutr. 87 (6), 1852–1859.

Strauss, J., Thomas, D., 1998. Health, nutrition, and economic development. J. Econ. Lit 36 (2), 766–817.

Swindale, A., Bilinsky, P., 2006. Household dietary diversity score (HDDS) for measurement of household food access: indicator guide. Food and Nutrition Technical Assistance Project, Academy for Educational Development, Washington, DC.

UNICEF, 2013. Improving child nutrition: The achievable imperative for global progress. UNICEF, New York.

UNICEF, WHO, World Bank, 2015. Levels and trends in child malnutrition: Key findings of the 2015 edition. Global Database on Child Growth and Malnutrition.

UNICEF, WHO, World Bank, 2016. Levels and trends in child malnutrition: Key findings of the 2016 edition. Global Database on Child Growth and Malnutrition.

Urke, H.B., Bull, T., Mittelmark, M.B., 2011. Socioeconomic status and chronic child malnutrition: Wealth and maternal education matter more in the Peruvian Andes than nationally. Nutr. Res. 31 (10), 741–747.
Vaahtera, M., Kulmala, T., Hietanen, A., Ndekha, M., Cullinan, T., Salin, M.L., Ashorn, P., 2001. Breastfeeding and complementary feeding practices in rural Malawi. Acta Paediatr. 90 (3), 328–332.