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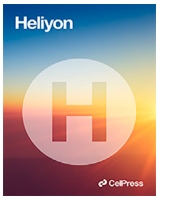

Research article

# Gender wage gap and child malnutrition in Ethiopia: A probit instrumental variable method ☆

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ABSTRACT

*Objective*: Child malnutrition is a widespread concern in Sub-Saharan Africa. Previous studies mainly focus on the association between women's employment status and child malnutrition, however, the aim of this study is to examine the causal effect of household gender wage gap on child malnutrition in Ethiopia.

*Methods*: This study relies on a data set consisting of 2066 children under 5 years of age using 2018/19 Living Standards Measurement Study data for Ethiopia. A probit instrumental variable (IV) method is applied to determine the causal effect.

*Results*: Persistent gender wage gap of approximately 35% has been observed across various sectors in Ethiopia. Estimated results show that the decrease in household gender wage gap significantly enhances child growth outcomes, especially for younger girls and children in households with limited access to market. Specifically, one percentage point increase in gender wage gap is associated with a 0.74% ($p < 0.05$) increase in the probability of stunting and a 0.42% ($p < 0.05$) increase in the likelihood of wasting. Three mechanisms have been identified as contributing factors: more allocation of health resources to children, improved dietary diversity in the household, and increased household income.

*Conclusions*: Policy interventions aiming at improving the children nutrition status in Ethiopia are expected to narrow down gender wage inequality accordingly. Further research is needed to explore the association using reliable and large-scale data source in other countries.

## 1. Introduction

Child malnutrition remains a critical issue in low and middle countries (LMICs), with a particular emphasis on the sub-Saharan African region [1–3]. The 2019 Ethiopia Mini Demographic and Health Survey (EMDHS) revealed alarming statistics: approximately 37% of children under five years old were stunted, while around 7% were wasting. The economic implications of malnutrition are severe, as it undermines a country's economic prospects [4,5] and diminishes household welfare by escalating child mortality rates and perpetuating inter-generational disadvantages [6–10]. Therefore, reducing the child malnutrition is of great significance for eliminating poverty and promoting economic growth. The determinants that could potentially influence child malnutrition include sanitation and hygiene practices, breastfeeding, socio-economic factors, cultural norms, public policies [11–14]. Among these

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factors, persistent gender wage differences within households are a key factor that has not been adequately addressed in the literature.[1]

This paper fills the research gap by identifying the impact of gender wage gap on child malnutrition in Ethiopia, and elucidating several mechanisms that may link gender wage disparities to child nutritional conditions. Our work adds to the strand of the literature that relates to the relationship between child malnutrition and maternal employment, which has yielded mixed results dependent on the context. Evidence from Nepal suggests that improving women's empowerment is a pathway to better long-term child nutrition status in communities with limited production diversity [17]. Conversely, some scholars find negative correlation between maternal employment and child nutritional outcomes. They emphasize that working mothers, especially in low-paying or time-intensive jobs, would face constraints in providing optimal childcare, which exacerbates malnutrition risks among children [18–20].[2] However, multivariate analyses of child malnutrition determinants in Bangladesh and Pakistan indicate that the maternal employment does not play a significant role in child malnutrition [21,22].

The observed variations in the direction and magnitude of the association between maternal employment and child nutrition may result from the opposing decomposed effects of maternal employment: namely, income effects and substitution effects. Income effects refer to the potential benefits derived from a mother's earnings, which can enhance children's welfare through the purchase of nutritious foods, hiring of childcare providers, and fostering positive human development outcomes [23]. On the other hand, substitution effects denote the potential reduction in a mother's caregiving time for her family, which may in turn decrease breastfeeding duration, compromise the quantity and quality of hygienic foods, and reduce quality time dedicated to children's cognitive development [14]. If the substitution effect outweighs the income effect, a negative effects of maternal employment on children's nutritional conditions would have a higher probability of being observed. However, previous studies, which define maternal employment status solely based on whether women in the household are employed, do not provide clear evidence as to when the income effects might surpass the substitution effects. These studies may not accurately assess the overall effects of maternal employment on child nutrition outcomes, especially given the persistent gender wage differences even if women have participated in the labor market.

This study contributes to the related literature by considering the intrahousehold gender wage gap while investigating the relationship between child malnutrition and maternal employment in Ethiopia. Our findings suggest that the substitution effects could be compensated by enhancing income effects originated from less gender wage gap. This could potentially mitigate the negative impacts, or even result in positive effects, of maternal employment on children's nutritional status. In addition, most of the previous studies fail to deal with the potential endogeneity problem, which is fully addressed in this study.[3] Moreover, this study supplements the series of empirical evidence on the association between maternal employment and child malnutrition, an area of research that has been particularly sparse in the context of Ethiopia.

## 2. Literature review and hypothesis

The relationship between child malnutrition and women's empowerment has been extensively studied by scholars across various domains of women's empowerment [24–27], such as social support networks, workload and time availability, autonomy and control of household resources. Each of these aspects is characterized by unique indicators and measurement approaches [28,12]. However, a prominent element of women's empowerment, gender wage gap, has received little attention in research exploring the impact of women's empowerment on child nutrition. Previous studies which delve into the implications of gender wage gap generally concentrate on how changes in the gap influence macro-level economic outcomes [29–31]. While a few studies have examined the impact of gender wage gap on household-level outcomes, they mainly concentrate on women's welfare and household welfare [32,33]. This paper indicates that the benefits of changes in gender wage gap are not only limited to women's welfare but also have significant implications for children's welfare.[4] Next, we propose three mechanisms which are tested subsequently in the empirical analysis based on existing literature.

The first mechanism pertains to parents' heterogeneous weights of care for children. Studies have shown that mothers often value children's healthcare more than fathers do. Therefore, as the gender wage gap narrows and women gain greater control over household resources, they are able to allocate more healthcare resources to children. This, in turn, can lead to an improvement in children's nutritional status [35,36].

**Hypothesis 1.** More resource allocations to children in response to decreased gender wage gap improve children's nutrition status.

The second mechanism is related to the diet diversity within the household. On one hand, women may increase the diversification of food groups within the households when they own more decision-making power associated with decreasing gender wage gap

[1] The incomes of female are, on average, no more than two-thirds of that of male in Ethiopia and the gender wage gaps are mainly underpinned by unequal access to high-paying sectors [15,16].

[2] The underweight risk of children due to maternal employment may vary based on different population characteristics, such as employment sectors, timing within the child's first five years [19], poverty level of communities [18], birth intervals, and maternal educations [20].

[3] Endogeneity problem is a common econometric issue in the scope of economics. Details about the reasons for endogeneity and the potential solutions are provided in Section 3.2.

[4] Although [34] examine the association between gender wage gap and expenditure on children's education in China, they primarily pay attention to educational investment. In contrast, our paper focuses on the nutritional impact of gender wage gap on children, and suggests how decreased gender wage gap may affect child malnutrition.

[37–40]. On the other hand, women with higher incomes are often better educated and possess more nutritional knowledge, which equips them to make healthful food choices and diversify food consumption within the households [41,26,42].

**Hypothesis 2.** Greater diet diversity in response to decreased gender wage gap improves children's nutrition status.

The last mechanism is associated with the household income. An increase in total household income driven by higher earnings from women enables households to purchase necessary resources from the market, thereby ensuring the nutritional wellbeing of children. [43,14].

**Hypothesis 3.** Higher household income in response to decreased gender wage gap improves children's nutrition status.

## 3. Methods and materials

### 3.1. Data and variables

**ESS Data and sample.** The study relies on the secondary data from Ethiopia Socioeconomic Survey (ESS) administered under the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) of World Bank in collaboration with the Central Statistical Agency of Ethiopia.[5] The survey collects data on household over the period 2011–2019 in four waves (2011/12, 2013/14, 2015/16 and 2018/19). The primary sampling unit is an enumeration area (EA), which is the particular region of Ethiopia in the charge of one or more census representatives (known as enumerators).[6] The first wave of data collection in 2011/12 includes only rural and small town areas, whereas the sample is expanded to all urban areas since the second wave of data collection.[7]

The study primarily utilizes data from wave 2018/19 for the main regression, while data from wave 2015/16 is used for robustness checks. The survey data collected encompasses all the information we need for estimating the impact of gender wage gap within households on child malnutrition in the empirical analysis. Detailed information collected includes household demographics, children's anthropometric measurements, housing conditions, food and non-food consumption expenditure, and wealth conditions, etc. The survey also solicits community-level information on access to services, such as infrastructure and markets.

**Child nutrition measures.** Child malnutrition or growth conditions are measured using height-for-age (HAZ) and weight-for-height (WHZ) z-scores, constructed from anthropometric measures of children under five years of age obtained from the ESS data. These z-score indicators describe the number of standard deviations from 2006 WHO child growth standard, which allow us to compare individual data to the growth standard among children of different ages and genders [44]. In order to identify stunting (a long-term indicator of child nutritional status) and wasting (a short-term indicator of acute malnutrition) in children, WHO recommends a z-score cut-off point of -2. This recommendation is based on extensive epidemiological research, which indicates that children with z-scores below -2 standard deviations face significantly higher health risks, including increased morbidity and mortality rates [45–47]. A child with a height-for-age z-score less than -2 is classified as stunted, while one with a weight-for-height z-score less than -2 is defined as wasted. Table A1 presents the summary statistics for child growth outcomes. The average values of height-for-age z-score and weight-for-height z-score are -1.65 and -0.32, respectively, which indicate the prevalence of stunting and wasting growth among children under 5 years of age in Ethiopia until 2018.

**Gender wage gap.** This paper follows the approach developed by [48] to measure gender wage gaps within households. Accordingly, gender wage gaps are derived by determining the difference between the average earnings of male and female adult household members, with this difference then expressed as a percentage of the average earnings of male adult household members. The corresponding formula is as follows:

$$wage\_gap = \frac{mean\_earnings_{male} - mean\_earnings_{female}}{mean\_earnings_{male}} \tag{1}$$

The household member's income includes the total earnings from all types of work, such as working for employers, self-employment and agricultural activities.[8] However, the household member's agricultural income can not be directly acquired from the data set when the household member engages in agricultural activities.

Inspired by [49], the net production of a certain crop type within a household is estimated by subtracting the total crop consumption of the household from the total crop production for that crop type. The income generated by the household from this specific crop type is then determined by multiplying the net crop production by the average local market price of the corresponding crop[9] [50]. The total agricultural income of the household is ultimately derived from the summation of the household's income from all

[5] Data source: https://microdata.worldbank.org/index.php/catalog/3823/study-description.

[6] Wave 2018/19 covers all nine regional states (including Tigray, Afar, Amhara, Oromia, Somali, Benishangul Gumuz, Snnp, Gambela, Harar) and two administrative cities (Addis Ababa and Dire Dawa).

[7] The sampling method is a two-stage stratified probability sample. Initially, enumeration areas are selected using simple random sampling for rural areas and systematically with probability proportional to size for urban areas; subsequently, households are chosen within these areas through systematic random sampling, targeting 10 agricultural and 2 non-agricultural households per rural EA.

[8] We include all the households where both men and women have reported their income or their income could be estimated in the whole sample.

[9] Multiplying the net crop production by the local market average price level of the corresponding crop converts the physical quantity of the crop into a monetary value [50].

types of planted crops [51,52].[10] To allocate the income among household members based on their labor contributions, the total agricultural income is multiplied by the proportion of hours each household member dedicates to agricultural work.

Individuals surveyed may engage in various types of work simultaneously, such as full-time, part-time and temporary labor. The individual's total income accounts for the earnings from all types of work, and we do not discriminate between income derived from primary work or other work when developing our main regression results. Considering that primary work generally serves as a more stable and reliable income source for household members, we propose an alternative approach to calculating the gender wage gap. The approach is based on the household member's primary work type, determined by the survey question: "What is the main activity of the business where [NAME] works?". By focusing on the main work type, we aim to provide a more precise measurement of the gender wage gap.

**Independent variables.** The variable of concern in our study is gender wage gap within households.[11] The complex interactions between gender and wage dynamics are central to understanding the comprehensive effects of maternal employment and wage inequality within the household on child health outcomes. The choice of control variables relies on the previous theory and empirical literature based on data availability, including household characteristics and child characteristics. Child characteristics control for child age, child sex and parental education.[12] Household characteristics contain basic household demographics and composition (household size, sex of head, region and urban), wealth indicators (land size, owned asset), housing features (available rooms, access to improved water resources and electricity), proximity to services (roads, market) [21,54–56]. The summary statistics of these variables are reported in Table A1.

### 3.2. Probit method

**Model specification.** Considering the binary outcome variables of child nutrition status (stunting or wasting), linear probability models (LPM) are commonly used to estimate nonlinear response models [14]. An important concern is that households gender wage gap might be quite similar over time. If this gap remains relatively unchanged, it could lead to insufficient variation in our data, thereby resulting in statistically insignificant outcomes. Therefore, we apply the **probit model** to estimate the nonlinear relationship between gender wage gap and child malnutrition. The model is assumed to take the form:

$$Y_{ijz} = \begin{cases} 1, & \beta G_{jz} + \gamma X_{ijz} + \mu_z + \epsilon_{ijz} > 0 \\ 0, & \text{otherwise} \end{cases} \tag{2}$$

where the idiosyncratic error term is normally distributed $\epsilon_{ijz} \overset{i.i.d}{\sim} N(0,1)$, $Y_{ijz}$ represents the indicator of whether the child $i$ in household $j$ of enumeration area $z$ is stunting (wasting) or not. $G_{jz}$ provides measures of gender wage gap within households and $X_{ijz}$ is a vector of control variables, such as household characteristics and child characteristics. $\mu_z$ is the dummy variable to control for the enumeration area fixed effects, and potentially time invariant variables including regional aggregated shocks, labor demand changes and spatial differences in infrastructure and policy. Under this specification, $\beta$ characterizes the impact of gender wage gap on child malnutrition.

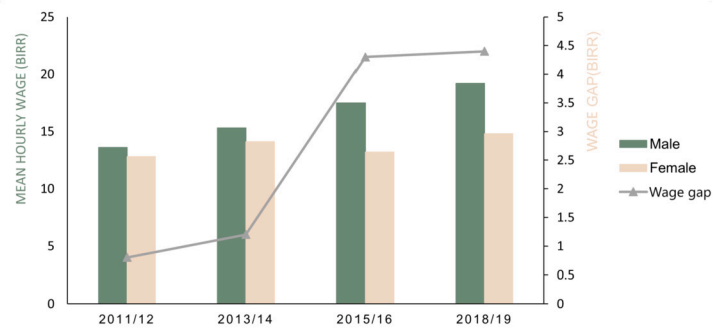
**Potential endogeniety.** The estimated impact of gender wage gap within households on child malnutrition might suffer from unobserved endogeneity for the following reasons. First, unobserved household characteristics, such as women's skills and healthcare access, could potentially introduce a selection bias in gender wage gap within households. Second, child malnutrition may affect gender wage gap due to reverse causality. Ignorance of these econometric issues could either overestimate or underestimate the real results of gender wage gap. Most of previous studies utilize the Ordinary Least Squares (OLS) method to estimate the impact of maternal employment on child health outcomes. While this method can yield unbiased estimations under the Gauss-Markov assumption, it can result in biased estimations if suffering from endogeneity issues. In such instances, a consistent estimation can be achieved using the Probit Instrumental Variable (IV) model with a large sample size dataset—a condition that is easily met in our study. Therefore, our paper adopts the Probit IV model to investigate the relationship between the gender wage gap and child malnutrition.

Previous studies have suggested several potential instruments for women's employment status, such as the local unemployment rate [57], and the cluster average of women's employment [58]. Women living in the same region, and facing the similar demographics, institutions and economic structures are likely to possess comparable human capital. As a result, they enter the same industries and earn similar wages [59,60]. Specifically, women living in neighborhoods with less gender discrimination may have easier access to higher-paying job opportunities. Thus, we are able to employ the average village gender wage gap as the instrumental variable for

[10] Aggregating income from all types of crops ensures that the total agricultural income accurately reflects the household's diverse agricultural activities. This holistic approach is crucial because it accounts for the impact of variations in seasons and crop types on the overall financial health of the household [51,52].

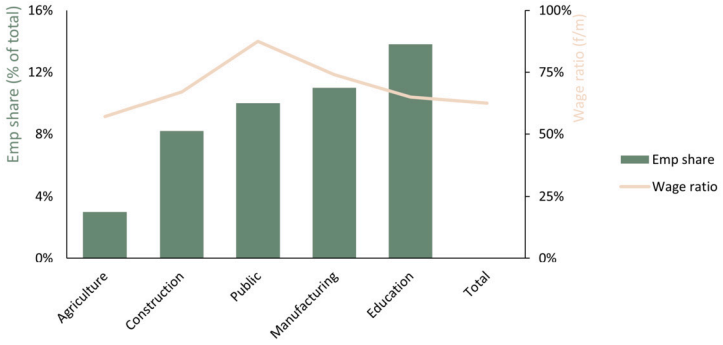
[11] The variable reflects one particular domain of women's empowerment, providing a more nuanced view of maternal employment status by comparing women's earnings relative to men's within households [53].

[12] The relationship between child malnutrition and child age may be nonlinear. More specific age period indicators are needed if we want to know the effects for each age period. However, our main concerned variable is gender wage gap, and we only need to include the continuous child age as control variable in our study.




*Notes*: Data source: LSMS 2011-19. Wage gap refers to the difference between mean hourly wage of male and that of female.

**Fig. 1.** Mean hourly wage of male and female.




*Notes*: Data source: LSMS 2011-19. Wage ratio presents the ratio of the average wage of women to that of men within one industry. Employment share denotes the proportion of the number of employment in the industry to the total number of employment.

**Fig. 2.** Wage ratio and employment share, by industries.

gender wage gaps using the available data in LSMS.[13] Table A4 shows the first stage regression results, and F-statistics are large enough to reject the weak instruments hypothesis.[14]

## 4. Results

### 4.1. Gender wage gap in the economic sectors of Ethiopia

As described in Table A1, the average gender wage gap for the sample data is around 35%, which implies that women earn 35% less than men on average. Fig. 1 shows the presence of little variation in gender wage gap across the four waves of LSMS by comparing average hourly wage of male with female in wage employment. Fig. 2 provides detailed information on the wage ratio of women to men by different sectors, which indicates that agriculture sector produces the largest wage gap, and the smallest gap remains in the public sector.

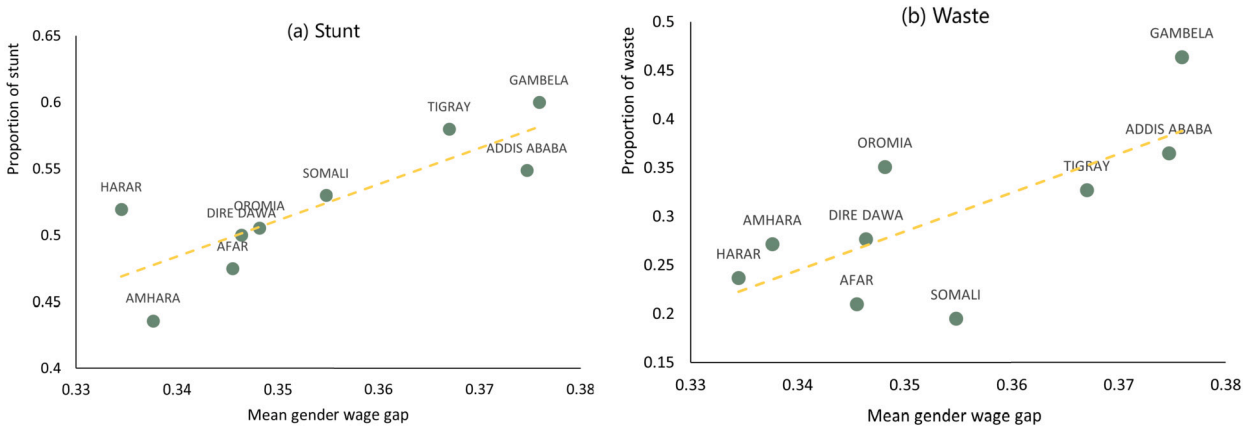
To figure out the potential relationship between gender wage gap and child nutrition outcomes, we provide the scatter plot between the average gender wage gap and the child nutritional status in seven regions and two city administrations (Addis Ababa and Dire-Dawa) in Fig. 3. Fig. 3(a) shows the relationship between gender wage gap and the proportion of child stunting, while Fig. 3(b) provides the scatter plot between gender wage gap and the proportion of child wasting. A pattern of the positive correlation between average gender wage gap and child malnutrition is apparently observed with upward trends. However, more rigorous regression analysis is needed to substantiate the effect of gender wage gap on child malnutrition in the following sections.

### 4.2. Gender wage gap and child malnutrition

In order to differentiate the impact of gender wage gap on child malnutrition across different working types, we employ a sub-sample that excludes households with members engaged in agricultural work or self-employment, in addition to the whole sample.

[13] We use alternative instruments as robustness checks in Appendix B.

[14] The first stage equation involved in the probit IV model takes the form: $G_{jz} = \phi Z_{ijz} + \mu_z + \upsilon_{ijz}$, where $G_{jz}$ is a measure of gender wage gap; $Z_{ijz}$ is a vector of control variables including household characteristics, child characteristics as well as instrumental variables for gender wage gap. $\mu_z$ is the enumeration area fixed effects. $\upsilon_{ijz}$ is the error term.




*Notes*: Observations are seven regions and two city administrations (Addis Ababa and Dire-Dawa) across Ethiopia. Gender wage gaps are derived by the difference between the mean earnings of male and female relative to the mean earnings of male. The dashed line is the fitted line regressing proportion of stunting or wasting on the mean gender wage gap.

**Fig. 3.** Mean gender wage gap and the proportion of malnutrition: (a) Stunt and (b) waste.

**Table 1**
Estimated impact of gender wage gap on child growth.

| | Stunt | | Waste | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| *Panel A. Whole sample* | | | | |
| Gender wage gap | 0.747** | 0.730** | 0.419** | 0.358* |
| | (0.303) | (0.301) | (0.213) | (0.190) |
| Enumeration area FE | Yes | No | Yes | No |
| Observations | 2066 | 2066 | 2066 | 2066 |
| *Panel B. Exclude agricultural work and self-employment* | | | | |
| Gender wage gap | 0.734*** | 0.679** | 0.383*** | 0.360* |
| | (0.264) | (0.339) | (0.143) | (0.202) |
| Enumeration area FE | Yes | No | Yes | No |
| Observations | 1845 | 1845 | 1845 | 1845 |

*Note*: Regression analysis is presented in this table. All regressions include child and household characteristics. Panel A reports the estimated effects using the whole sample and Panel B reports the estimated effects using the sample excluding the households engaged in agricultural work and self-employment. Standard errors are clustered at the individual level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$. "Enumeration area FE" refers to the enumeration area fixed effects $\mu_z$ in equation (2).

Table 1 presents the estimated effects of gender wage gap on child malnutrition outcomes, obtained from the whole sample in panel A and the subsample in panel B. The results show that all coefficients are positive and statistically significant.[15] For the whole sample, one percentage increase in the relative gender wage gap within the households is associated with 0.75% and 0.42% increase in the probability of child stunting and wasting, respectively. The results are still robust when we turn to the subsample.

Since probit IV model does not allow us to utilize time dimension information in our regression,[16] we restrict our analysis to cross-sectional data from the 2018/19 wave. To ensure that our conclusion is not driven by any idiosyncratic shocks or policy changes in one particular year during the sample period, we re-estimate our model using LSMS-ISA data from wave 2015/16. The estimated results are shown in columns (3)-(4) of Table A3. The estimated coefficients are all significant, and the magnitude of the coefficients is similar to our baseline results using data from wave 2018/19, which provides evidence that the results are not driven by any time-varying idiosyncratic shocks affecting child nutrition status or gender wage gap.

### *4.3. Contextual factors in gender wage gap and malnutrition*

Next, we discuss the heterogeneous effects of household gender wage gap on child malnutrition in terms of age and sex of the child, and access to market. To identify the heterogeneity, we establish the interaction terms between household gender wage gap

[15] Columns (5) and (6) of Table A3 suggest that employing alternative definition of gender wage gap that only focuses on the individual's primary working type does not change our results. The details of other robustness checks, including alternative specification, measures of malnutrition, control of vulnerability rate, and migration are shown in the Appendix B.

[16] Unlike the linear model, eliminating the unobserved fixed effects is more complex with respect to the nonlinear probit model, which is still pending resolution.

**Table 2**
Heterogeneous impacts of gender wage gap on child growth, by child's demographics and access to market.

| Dependent variable | Stunt | | Waste | |
|---|---|---|---|---|
| | (1a) | (2a) | (3a) | (4a) |
| *Panel A: Sex and age of child* | | | | |
| Gender wage gap | 0.067** | 0.174 | 0.088* | 0.130 |
| | (0.031) | (0.305) | (0.045) | (0.112) |
| Gender wage gap∗ $Girl$ | 0.024* | 0.060* | 0.009* | 0.054 |
| | (0.014) | (0.035) | (0.005) | (0.051) |
| Gender wage gap∗ $Children < 3years$ | 0.075** | 0.019* | 0.041*** | 0.089* |
| | (0.036) | (0.010) | (0.002) | (0.050) |
| Enumeration area FE | Yes | No | Yes | No |
| Observations | 2066 | 2066 | 2066 | 2066 |
| | (1b) | (2b) | (3b) | (4b) |
| *Panel B: Access to market* | | | | |
| Gender wage gap | 0.046** | 0.158* | 0.105** | 0.078** |
| | (0.021) | (0.085) | (0.040) | (0.039) |
| Gender wage gap∗ $DistancetoMarket$ | 0.009** | 0.021 | 0.013 | 0.021 |
| | (0.004) | (0.033) | (0.065) | (0.058) |
| Enumeration area FE | Yes | No | Yes | No |
| Observations | 2066 | 2066 | 2066 | 2066 |

*Note*: Regression analysis is presented in this table. All regressions include child and household characteristics. Panel A presents the heterogeneous impacts of gender wage gap on child growth by sex and age of child and panel B represents the heterogeneous impacts by access to market. Standard errors are clustered at the individual level. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. "Enumeration area FE" refers to the enumeration area fixed effects $\mu_z$ in equation (2).

and various contextual factors, such as age and sex of the child, and access to market. These interaction terms are then incorporated as independent variables into equation (2). Table 2 presents the estimated results.

**Demographics.** Panel A of Table 2 shows that the marginal effects of household gender wage gap on girls' nutrition conditions are more pronounced than those on boys. One percentage increase in the gender wage gap results in an additional 0.024% and 0.009% increase in the probability of stunting and wasting in girls compared to boys. However, previous studies find that Chinese parents tend to invest more in sons rather than daughters when faced with a narrowing gender wage gap. One potential explanation for the differential impact of gender wage gap based on child sex is the expectation of greater returns from investments in their sons' education by Chinese parents in terms of future remittances and old-age support [34]. The results in panel A further indicate that the impact of increase in household gender wage gap on the risk of stunting and wasting is significantly larger for children under 3 years old compared to those under 5 years old. By investigating age group of participating children, our results supplement [19]'s finding that timing within the child's first five years plays an important role in the potential malnutrition related with maternal employment.

**Access to market.** The study tests whether the impact of gender wage gap on child growth differs based on the household's access to market, determined by the survey question regarding the household's distance to the nearest market measured by road. The results in panel B of Table 2 reveal that decreasing household gender wage gap has a larger positive and significant effect on reducing child stunting and wasting among households that live away from the market. Combined with [9]'s and [61]'s findings which demonstrate that the effect of crop diversification on child malnutrition is stronger for children in households with limited market access, we may naturally infer that crop diversification and dietary diversity is a possible pathway through which gender wage gap makes a difference in improving child nutrition status. We further investigate this potential mechanism in the next section.

## 5. Discussion

To test the three hypotheses through which gender wage gap influences child malnutrition, we estimate equation (2) by replacing dependent variables using the appropriate variables.

The estimated results of Table 3 verify **Hypothesis 1**. The results imply that the health resources allocated to children are significantly and negatively associated with the household gender wage gap.[17] One percentage increase in the relative household gender wage gap will result in 0.811% decrease in the probability of healthcare consultation and 0.464% decrease in the probability of child's enrolling into health insurance. Our results echo with [62]'s findings that children whose mothers have medium decision-making power are more likely to seek complete immunization for their children compared to those with low decision-making power using cross-sectional data from 26 countries in sub-Saharan Africa. To determine whether larger allocation of health resources to children resulting from decreasing gender wage gap has transformed into lower probability of stunting or wasting, we add the measurements of child health resources as independent variables into equation (2) and estimate the equation. The coefficients of the correspond-

[17] If the child in the household has checked up or consulted for other preventive care or the women in the household have prenatal checkups, healthcare consultation is equal to 1, otherwise it is 0. Health insurance equals to 1 if the child is enrolled in any type of health insurance, and 0 otherwise.

**Table 3**
Mechanisms I: allocation of health resources.

| | Healthcare consultation | Health insurance | Stunt | | Waste | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Gender wage gap | -0.811*** | -0.464*** | 0.620* | 0.633* | 0.838** | 0.781** |
| | (0.041) | (0.031) | (0.355) | (0.329) | (0.403) | (0.373) |
| Healthcare consultation | | | -0.943* | | -0.864* | |
| | | | (0.483) | | (0.487) | |
| Health insurance | | | | -0.422*** | | -0.229* |
| | | | | (0.135) | | (0.121) |
| Enumeration area FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1483 | 1569 | 1483 | 1569 | 1483 | 1569 |

*Note*: Regression analysis is presented in this table. The dependent variables in columns (1)-(2) are healthcare consultation and health insurance, respectively, and the dependent variables in columns (3)-(6) are the dummy variables of stunting and wasting. Standard errors are clustered at the household level. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. "Enumeration area FE" refers to the enumeration area fixed effects $\mu_z$ in equation (2).

**Table 4**
Mechanisms II: dietary diversity.

| | Food diversity | Crop diversity | Meal outside | Stunt | | | Waste | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Gender wage gap | -0.942*** | -0.874*** | -0.053*** | 0.396*** | 0.399*** | 0.045** | 0.393*** | 0.239* | 0.241** |
| | (0.082) | (0.081) | (0.014) | (0.129) | (0.129) | (0.019) | (0.147) | (0.135) | (0.120) |
| Food diversity | | | | -0.144* | | | -0.109*** | | |
| | | | | (0.074) | | | (0.419) | | |
| Crop diversity | | | | | -0.418*** | | | -0.211** | |
| | | | | | (0.135) | | | (0.095) | |
| Meal outside | | | | | | -0.018* | | | -0.111* |
| | | | | | | (0.010) | | | (0.059) |
| Enumeration area FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 2066 | 1054 | 2038 | 2066 | 1054 | 2038 | 2066 | 1054 | 2038 |

*Note*: Regression analysis is presented in this table. The dependent variables in columns (1)-(3) are food diversity, crop diversity and meal outside, respectively, and the dependent variables in columns (3)-(9) are the dummy variables of stunting and wasting. Standard errors are clustered at the household level. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. "Enumeration area FE" refers to the enumeration area fixed effects $\mu_z$ in equation (2).

ing variables are all significant and negative, which substantiates that more allocation of health resources to children is one of the channels through which decreased gender wage gap contributes to less probability of child malnutrition.

To test **Hypothesis 2**, we adopt three variables to measure dietary diversity in the households, i.e., crop diversity, food diversity, and the times of meals outside.[18] The results show a significantly positive relationship between reduction in gender wage gap and dietary diversity within the households measured by the three dimensions. Specifically, the regression result shows that one percentage increase in gender wage gap is associated with a decrease in food diversity by 0.942 percentage points. The results are consistent with previous studies that suggest empowered mothers are positively correlated with children's dietary diversity [63,64].[19] The significance of the coefficients in columns (4)-(9) of Table 4 further elucidates that the increased household's dietary diversity has enabled children to get access to more balanced dietary and necessary nutrition.

The results in Table 5 show that households with less gender wage gap are typically accompanied with higher household income, which validates **Hypothesis 3**. One percentage increase in gender wage gap is associated with 0.218 percentage points decrease in household income, and one percentage increase in household income will thus reduce child stunting and wasting by 0.041 and 0.017 percentage points, respectively. These results coincide with the evidence from Canada, which suggests lower height percentiles for youth from low-income households [23].

Most of previous empirical analysis finds that maternal employment status exhibits a higher substitution effect than the income effect on children's nutritional conditions in developing countries, which leads to higher probability of child malnutrition risk after women enter into labor market. The findings of this paper that narrowing gender wage gap may contribute to decreasing child malnutrition provide a new insight to understand the relationship between maternal employment and child nutrition status. The mechanisms discussed above provide clear evidence of increased income effects of maternal employment with narrowing gender

[18] Previous literature documented that the diversity of crops planted by the rural households in Ethiopia is positively correlated with the food diversity in the households, thereby contributing to better child nutrition status [61].

[19] [63] suggest that empowerment in its binary form, group membership, and ownership of assets are the three indicators positively and moderately related to children's dietary diversity in Timor-Leste ($\beta = 0.3$; $P = 0.044$), ($\beta = 0.2$; $P = 0.040$), and ($\beta = 0.1$; $P = 0.047$), respectively. Based on [64]'s review of 167 findings for 24 unique nutrition outcomes in South Asia, 40 (24%) are reported with positive/significant findings.

**Table 5**
Mechanisms III: household income.

| | Household income | Stunt | Waste |
|---|---|---|---|
| | (1) | (2) | (3) |
| Gender wage gap | -0.218*** | 0.071* | 0.057** |
| | (0.084) | (0.042) | (0.026) |
| Household income | | -0.041* | -0.017 |
| | | (0.021) | (0.053) |
| Enumeration area FE | Yes | Yes | Yes |
| Observations | 2066 | 2066 | 2066 |

*Note*: Regression analysis is presented in this table. The dependent variable in column (1) is household income, and the dependent variables in columns (2)-(3) are the dummy variables of stunting and wasting. Standard errors are clustered at the household level. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$. "Enumeration area FE" refers to the enumeration area fixed effects $\mu_z$ in equation (2).

wage gap, including more allocation of health resources to children, more dietary diversity, and greater household income. The substitution effect may be compensated by the enhanced income effects, leading to higher women's and children's welfare.

## 6. Policy implications

The findings of this study underscore the need for policy interventions that target gender wage equality as a strategic approach to reduce child malnutrition. Policymakers are encouraged to consider developing comprehensive strategies that not only address wage disparities but also support women in balancing employment and caregiving responsibilities, when designing various social protection measures to improve the nutritional outcomes for children, such as productive safety net programs. The analysis highlights the significance of eliminating women's constraints to accessing to decent work. Policymakers should provide specific skill training opportunities to women, and enhance their prospects for higher education. It is equally important and necessary for the governments to raise gender equality awareness among employers and eradicate gender discriminatory across employment opportunities. Moreover, the heterogeneous results imply the significance of infrastructure and local market development for the policymakers aiming to improve the overall child growth in local communities.

## 7. Conclusion

This study reveals that gender wage gap plays a significant role in determining the relative magnitude of income effects to substitution effects when assessing the impact of maternal employment on child growth. The estimated results also examine three mechanisms through which gender wage gap impacts child nutrition status, including increasing allocation of health resource to children, more dietary diversity in the household and higher household income. One concern about our findings is that the results are mainly estimated based on self-reported survey data, which may suffer from the subjectivity of surveyed individuals. Another limitation of the study is that the empirical results on the association between maternal employment and child malnutrition in Ehiopia may not necessarily imply the same situations in other developing countries. More work should be done to examine the generalizability of findings using data from other countries. Further research is required to verify the child nutrition enhancing effects of an actual policy intervention aiming at decreasing gender wage gap, and compare the nutrition impacts of decreasing gender wage gap with other policies and interventions, which would help to identify complementary strategies that synergy with the policy of reducing gender wage gap to contribute to the child growth.

## CRediT authorship contribution statement

**Wenyi Lyu:** Writing – original draft, Visualization, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Leng Yu:** Writing – review & editing, Supervision, Project administration. **Haihong Lv:** Resources, Investigation, Funding acquisition.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data have been publicly deposited at *https://microdata.worldbank.org/index.php/catalog/3823/data-dictionary*.

## Appendix A. Supplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e37000.

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