Enhancing labour productivity by improving nutrition in Kenya: micro-econometric estimates for dynamic CGE model calibration

Estefanía Custodio (Instituto de Salud Carlos III, Centro Nacional de Medicina Tropical, Madrid, Spain
Sofía Jiménez (Departamento de Análisis Económico, Universidad de Zaragoza, Zaragoza, España).
María Priscila Ramos (Universidad de Buenos Aires. Facultad de Ciencias Económicas. Departamento de Economía & CONICET-Universidad de Buenos Aires, Instituto Interdisciplinario de Economía Política de Buenos Aires, Buenos Aires, Argentina)
Martina Sartori (European Commission, Joint Research Centre (JRC), Seville, Spain)
Emanuelle Ferrari (European Commission, Joint Research Centre (JRC), Seville, Spain)

"…the government should allocate more resources to human development [the link nutrition, education, growth and health status] in order to enhance productivity and boost economic growth."
(Raji, 2020, p.1).

Abstract

Kenya is particularly concerned about the achievement of the Sustainable Development Goal #2 (SDG #2: zero hunger), and its associated consequences for society. Malnutrition in all its forms (stunting, wasting, micronutrient deficiencies and/or overweight/obesity) can compromise human development and economic growth through different pathways. In this context, it is possible to identify at least two pathways through which improving FS&N could enhance labour productivity. Improving the dietary nutrients intake (calories, macro and micronutrients) could allow for better (i) learning capacity and (ii) the reinforcement of health conditions. Besides, education and good health improve labour productivity. Thus, the aim of this paper is to provide insights about the linkages between FS&N indicators and labour productivity for dynamic pathways in a CGE framework, particularly modelling baseline's drivers about L-productivity and growth. Moreover, the estimates would also allow performing food policy scenarios to get positive impacts over nutrition and health and thus, on economic growth. Our results show that, indeed, daily micronutrients (iron, zinc, calcium, vitamins B2 and A) intakes are significant and positive to explain labour productivity improvement (wage increase), as well as education, while disabilities and/or diseases impact negatively and significantly on labour performance. We also note that in the case of vitamins C and B12 the relation is negative when all the variables are included in the regression but positive when we consider them separately. All in all, results confirm the virtuous cycle between health, nutrition, education and labour productivity.

Keywords: labour productivity, micronutrients, micro-econometric estimation, CGE model baseline insights, Kenya.

1. Introduction

Kenya is particularly concerned about the achievement of the Sustainable Development Goal #2 (SDG #2: zero hunger), and its associated consequences for society. Boulanger et al. (2020) and Ramos et al. (2020; 2021) evaluated the impact of agricultural policies on food access, food sufficiency and food quality at the household level. Moreover, those papers set the methodological techniques to assess the food security and nutrition (FS&N) consequences of the COVID-19 pandemic, lockdown waves and policies to compensate for the crisis in Kenya (Nechifor et al., 2021).

Going further in the links between FS&N and the economic performance, malnutrition in all its forms (stunting, wasting, micronutrient deficiencies and/or overweight/obesity) can compromise human development and economic growth through different pathways. Undernutrition is associated with an increased risk of infectious diseases (Walson & Berkley, 2018), and overweight and obesity are risk factors for cardiovascular diseases, diabetes and other chronic diseases (Kearns et al., 2014). Also, stunting in early life is associated with a reduced stature in adulthood (Stein et al 2002); and adult height has been positively correlated to labour market outcomes (Schultz et al., 2002). Undernutrition in early childhood has an important impact on the neurocognitive development (Kar et al., 2008) with long term consequences in learning capacities (Case & Paxon, 2008) and years of schooling (Victoria et al., 2008), which in turn affect the L-productivity and earning capacities of future adults (Hanushek & Wobmann, 2008). And although these relationships have mostly been shown for protein-calorie malnutrition, the role of micronutrients such as iron on neurological development (Carter et al., 2010) and L-productivity (Wenberger, 2004) has also been described.

Thus, it is possible to identify at least two pathways through which improving FS&N could enhance labour productivity. Improving the dietary nutrients intake (calories, macro and micronutrients) could allow for better (i) learning capacity and (ii) the reinforcement of health conditions.

Education and good health improve labour productivity, one of the drivers for economic growth, particularly in developing countries where FS&N are unsolved basic wealth problems. In terms of the UN-SDGs, the purpose of this paper is to quantify the impact of an improvement of SDG#2 (no hunger) with the SDG#8 (decent work and economic growth) (Fonseca et al., 2020; Raji, 2020).

The specific aim of this paper is to provide econometric estimates about the linkages between FS&N indicators (i.e., food consumption and nutritional status of households' members) and labour productivity (L-productivity). These estimates are insights for dynamic pathways in a CGE framework, particularly modelling baseline's drivers about L-productivity and growth. Moreover, the estimates would also allow performing food policy scenarios to get positive impacts over nutrition and health and thus, on economic growth.

The remaining paper is organized as follows. Section 2 discusses the literature of FS&N related to labour productivity enhancement focusing on the two pathways mentioned above. Section 3 presents the micro-econometric model used to estimate the contributions of nutrients into the labour productivity with an application to the Kenya country. Section 4 presents and comments the results and finally, section 5 concludes.

2. Food Security & Nutrition and labour productivity linkages: a literature review

Motivated by the goal to relate SGS #2 and SDG #8, Raji (2020) econometrically estimates the long run causality between nutrition and education, health and economic growth in the case of Nigeria. It finds a unidirectional causality that runs from nutrition intake to education in the short run, suggesting that a good nutrition and dietary energy supply tend to improve mental capacity, cognitive abilities and academic performance, which ultimately leads to boosting L-productivity in the long run. Additionally, this paper also indicates a unidirectional causality relationship from nutrition intake to health in the short run, and a bidirectional causality relationship between the nutrition and the economic growth in the long run. Thus, the implication of these results is that the nutrition status of the workers has significant impact on the economic growth in the long run, and particularly, the easier the workers' access to dietary energy and protein supply, the more productive and active they are, which consequently might increase output growth of the economy.

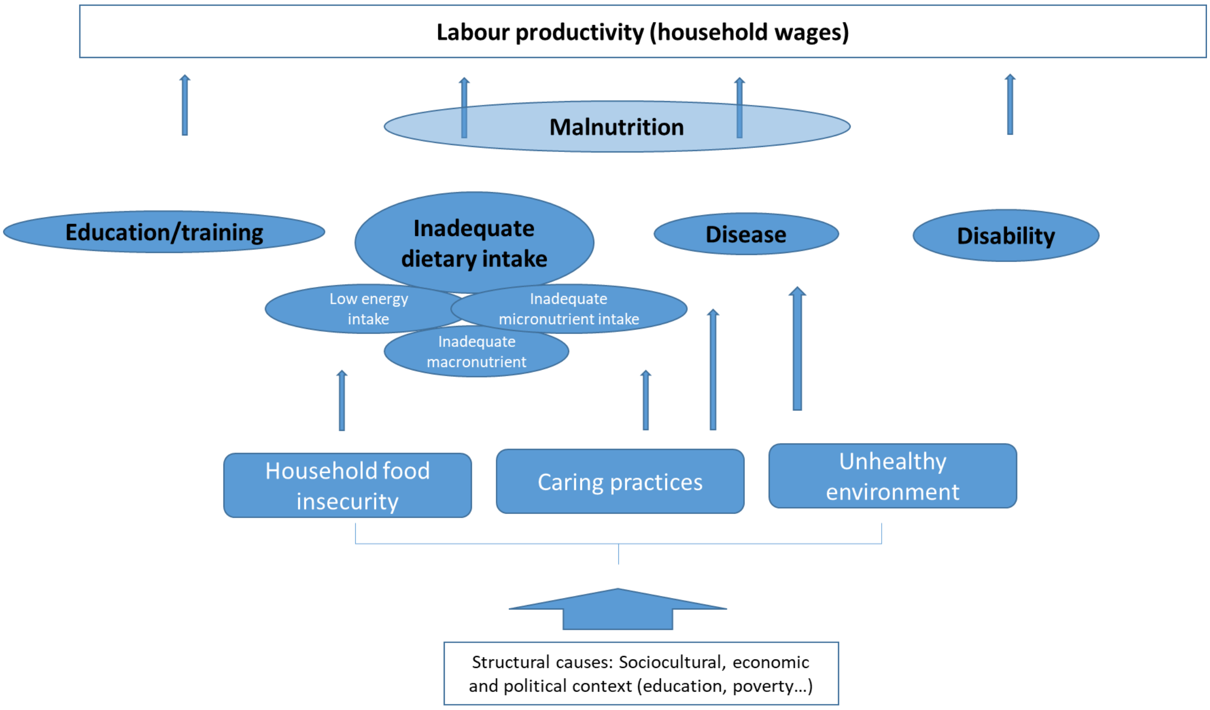
Moreover, this long run results fit also for nutrition in children. Hoddinott et al. (2008) find that improving nutrition in early childhood in Guatemala led to substantial increases in wage rates for adults, which suggests that investments in early childhood nutrition can be long-term drivers of economic growth. Galasso et al. (2019) also support these conclusions finding that a lower per capita income is today a result of some of its workers having been stunted in childhood - the per capita income penalty from stunting is around 7 percent on average - justifying nutrition interventions.

Many papers suggest a positive link between calories intake and L-productivity at a particular sector level (Strauss, 1986); however, a complete analysis of the relationship between nutrition and L-productivity would require a detailed analysis of the macronutrients intake and the integration of micronutrients consumption in the analysis. Tiwasing et al. (2019) estimate a semi-log wage equation and Cobb–Douglas production function using 2SLS and non-linear 2SLS methods, respectively for an agricultural sector in Thailand. They find that while calorie intake only contributes to a higher farm output, enhancing micronutrients intake (iron, vitamin A) is an investment for improving L-productivity. Weinberger (2004) focuses on iron-deficiency anemia as a key micronutrient indicator for improving L-productivity of households engaged in the agricultural sector in India. She also applies a 2SLS estimation technique, and finds that L-productivity, measured in wages, is indeed affected by insufficient iron intake, and that wages would on average be 5 to 17.3% higher if households achieved recommended iron intake levels.

3. Methodological framework and application to Kenya

A food policy reform impacts on food prices changing households' decisions about food expenditure. Changes in food consumption, either in quantity or quality, impact on nutrition (kilocalories, macronutrients such as protein, fats or carbohydrates, and micronutrients such as iron or vitamins A, B12, D, etc.) and thus, on human capacity for learning and work. These relations are supported by the literature reviewed on nutrition, health and labour productivity particularly focused on agricultural sectors (Asenso-Okyere et al., 2011).

Scheme 1. Nutrition impact pathway for Labour productivity



Source: own elaboration

3.1. Variables and covariates

The output variable we use as a proxy for labour productivity is the household monthly income exclusively from the labour wage source. We apply a (natural) logarithm transformation in this monetary variable in order to estimate a semi log wage equation.

Given the literature evidence about the link between FS&N with labour productivity and growth, we will develop different FS&N indicators: the household food insecurity experience scale, and a battery of new indicators based on micronutrients intake to econometrically estimate these relationships for Kenya using household survey data. Estimates could serve to improve the dynamic baseline mechanisms for FS&N policy simulation models as we will run for Kenya.

For the calculation of the FIES at household level we follow the FAO guidelines (Cafiero et al. 2018; Cafiero et al. 2016).[1]

Regarding nutrients' intake we develop only indicators based on micronutrients intake, as indicators for energy and macronutrients were already estimated in a previous publication (Moltedo et al., 2021). To develop these FS&N indicators at the households level we require two datasets for the application to Kenya:

(i) the 2015/2016 Kenya Integrated Household Budgetary Survey (KIHBS) from the (Kenya National Bureau of Statistics, 2018). This survey provides information for 21,773 households about: 7-days

[1] More information about FIES can be found in:
https://www.fao.org/in-action/voices-of-the-hungry/using-fies/en/

consumption quantities by food item at household level, source of origin, total; food expenditure; labour income (national average, per activity);

(ii) the 2018 Kenya Food Composition Tables (FCT KEN2018). It provides biochemical contents: energy; macronutrients and micronutrients of food items allowing for the calculation of FS&N indicators when combined with the quantities consumed in each household (FAO and Government of Kenya 2018). In order to match the nutrient contents in the FCT with the consumed food items collected in the KIHBS, we constructed the Kenya Nutrient Content Table (KNCT) following Moltedo et al.(2014; 2018)'s methodology.

Once the nutrients intake were calculated at household level, and in order to have an estimate of micronutrient intake at individual level, we computed the daily consumption of each micronutrient per adult male equivalent.

The other covariates introduced in the model are related to education, based on the highest degree of any member of the household in active age, and to health status, by referring to the number of active members in a household which suffers from any chronic diseases and/or disability. These variables built at the household level are provided by the KIHBS 2015/2016 as well as other households' characteristics.

3.2. Analysis

We performed descriptive statistics of all variables introduced in the model and constructed non-parametric regressions between the nutrients variables across percentiles of per capita expenditure (in log) and across percentiles of calories consumed per day per AME at the household level (DEC). This analysis allows us to identify the relations between the nutrients (and their deficits) across economic and dietary characteristics of households in Kenya.

Following Tiwasing et al. (2019) and other nutrition-earning literature we will estimate the semi-log wage equation for the national average in Kenya, where the FIES at the household level and the micronutrients intake variables will be the explanatory one. The variables related to education and health will also be introduced in the regressions as control variables.

In order to avoid collinearity problems we only include in the models variables correlated below 0.6 according to Pearson's correlation. Following this criteria we introduced in the model only the heme form of iron (coming from animal sources) and excluded vit B1 and vit B9 (folate). All other micronutrients showed correlation values below 0.6 with the rest of micronutrient variables as well as with the covariates included in the model.

In expression (1) we show the regression that we finally estimate

$$lnWame = \alpha + \beta_{1,n}Nut_n + \beta_2 FIES + \beta_{3,e}Educ_e + \beta_4 DnD + \mu$$

where *lnWame* is the natural logarithm of monthly wages computed per adult male equivalent (AME) at the household level; the *n* nutrients (*Nut*) are Calcium, Heme Iron, Zinc, Vitamin C, Vitamin B2 and Vitamin A daily consumed per AME; *FIES* is the indicator of food insecurity perception of the household which corresponds to the self-reported food-related behaviors, perception and experiences associated with increasing difficulties in accessing food due to resource constraints (FAO); *Educ* refers to the ratio between the active household's members that have achieve a particular level of education and we consider the following *e* levels: university (postgraduates and graduates), secondary school complete and primary school complete that also includes other non formal education; finally, the variable *DnD* refers to the number of active households members that presents a chronic disease or a disability. µ is the disturbance term with the usual properties.

4. Data & Results

The table 1 shows the descriptive statistics of the variables introduced in the model.

Table 1: Summary of descriptive statistics

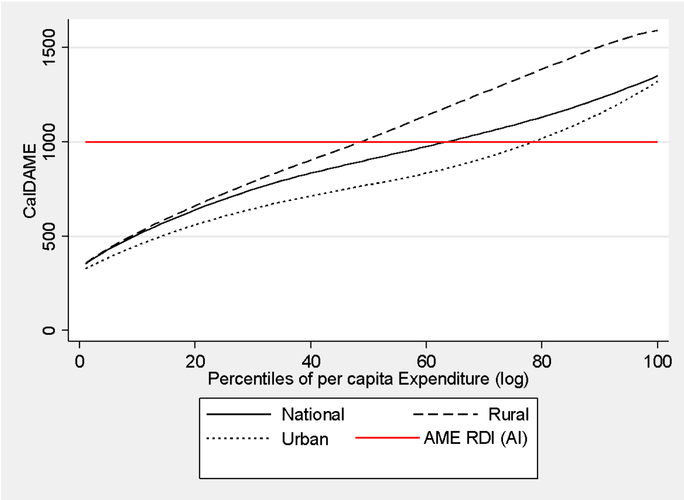
Variable	Obs	Mean	Std. Dev.	Min	Max
Labour Productivity					
ln WageAME	16,346	10.33699	1.302104	3.772261	15.78959
Micronutrients					
Calcium (mg/day/AME)	16,346	827.845	570.7055	0	5849.908
Heme Iron (mg/day/AME)	16,346	1.931763	2.280014	0	28.72333
Zinc (mg/day/AME)	16,346	17.25478	16.44215	0	275.2943
Folate (mg/day/AME)	16,346	950.5068	672.5974	0	7606.352
Vitamin C (mg/day/AME)	16,346	130.8478	126.5033	0	1691.946
Vitamin B2 (mg/day/AME)	16,346	1.780715	1.397158	0	30.04409
Vitamin A (mg/day/AME)	16,346	568.7834	956.0026	0	27055.91
Vitamin B12 (mcg/day/AME)	16,346	4.719269	7.511784	0	119.0382
Food Insecurity					
FIES	16,346	3.96519	3.165905	0	8
Education					
University (ratio)	15,891	0.4554287	0.4040319	0	1
Secondary (ratio)	15,891	0.0124931	0.0869789	0	1
Primary (ratio)	15,891	0.396437	0.4058608	0	1
Health					
DcronD	16,346	2.100147	1.418944	0	14

Source: own elaboration.

We observe that the mean of ln WageAME is 10.33, while the minimum is 3.77 and the maximum is 15.78. For the nutrients we obtain extreme values as minimum and maximum values. This is due to the existence of outliers. However, on average, values are as expected with a higher consumption of Folate and Vitamin A (expressed in RAE). We should note that the standard deviation of all micronutrients are relatively high, that is, there is a high dispersion in our sample. In relation to education, on average, the percentage of persons in the household with a university degree is around 45%, while in primary school it is 39%. However, in both cases the dispersion is higher than in secondary. Finally, on average, two persons per household have a disability or chronic disease.

In next figures we show each micronutrient intake per day and per AME across the percentiles of per capita expenditure both at the household level. The red line represents the micronutrient requirement per day for a young male adult (19-30 years old) as reference.

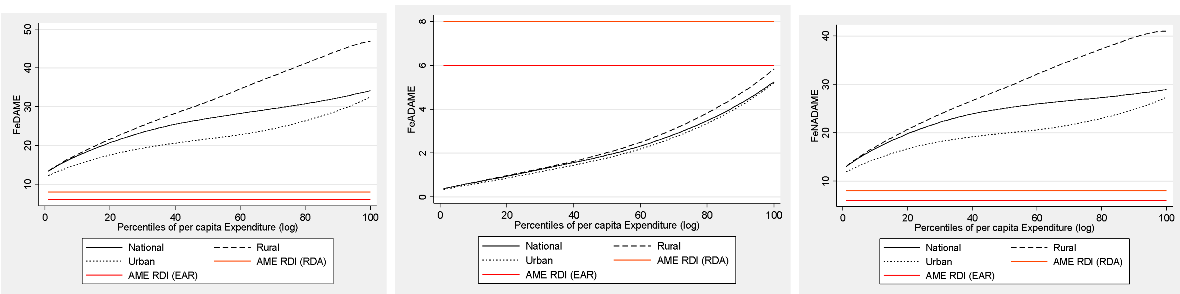
Figure 1: Calcium intake per AME across percentiles of per capita expenditure at the HH level



Source: own elaboration.

The consumption of Calcium per AME is higher among households within the higher percentiles of per capita expenditure, and higher for the rural population as compared with the urban one. Below the 50th percentile of per capita expenditure the consumption of Calcium is below the average intake for a young male adult as reference (Figure 1).

Figure 2: Iron (total, heme & non-heme) intake per AME across percentiles of per capita expenditure at the HH level

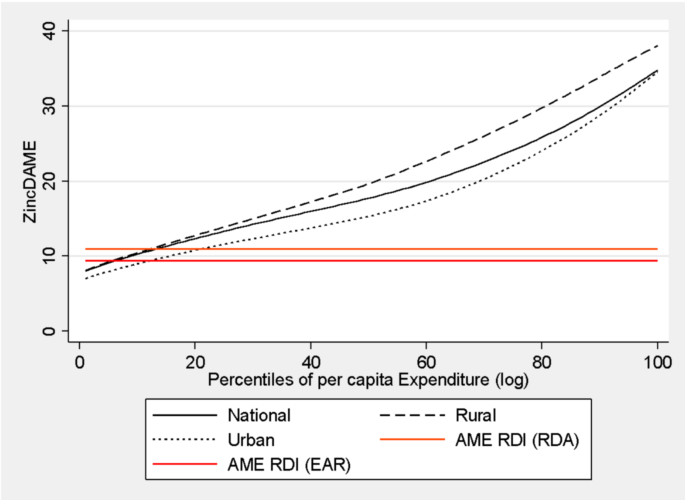


(a) Total iron (b) Heme iron (c) Non-heme iron

Source: own elaboration.

The (total) iron intake increases with higher per capita expenditures at household level, although they seem to be above estimated average requirements (EAR) for all households surveyed, and higher among the rural ones (Figure 2, panel a). However, a detailed analysis of the sources of iron show us a different picture. All households show heme-iron (from animal sources) intakes below the EAR and with a very similar pattern between rural and urban populations, all showing an increasing relation with the per capita expenditure at the household level (Figure 2, panel b). On the contrary, all households show non-heme-iron (origin from non-animal source) intakes above the iron's EAR, and a marked difference between rural and urban populations, with the rural one showing a higher intake than the urban one (Figure 2, panel c). Nevertheless, independently of the origin source of iron the estimated intakes are higher among households within the high percentiles of per capita expenditure.

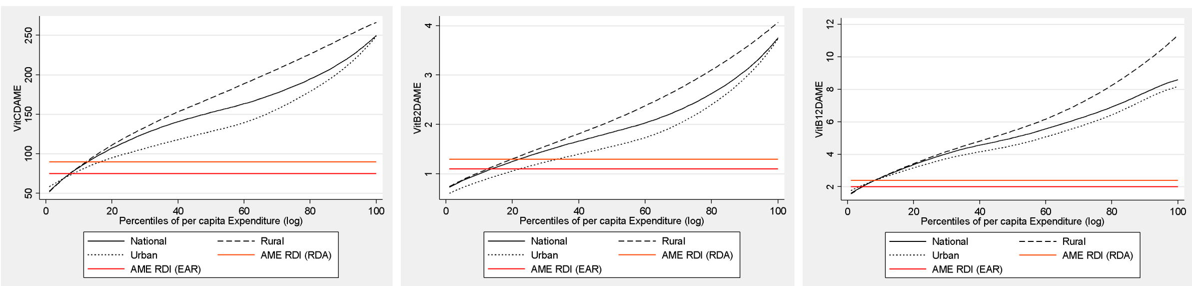
Figure 3: Zinc intake per AME across percentiles of per capita expenditure at the HH level



Source: own elaboration.

In Figure 3 we see that the daily zinc intakes per AME also increase with the percentiles of per capita expenditure and are higher among the rural population. From the 20th percentile of expenditure onwards all households seem to have an intake of zinc above the EARs.

Figure 4: Water-soluble vitamins (C, B2, B12) intake per AME across percentiles of per capita expenditure at the HH level

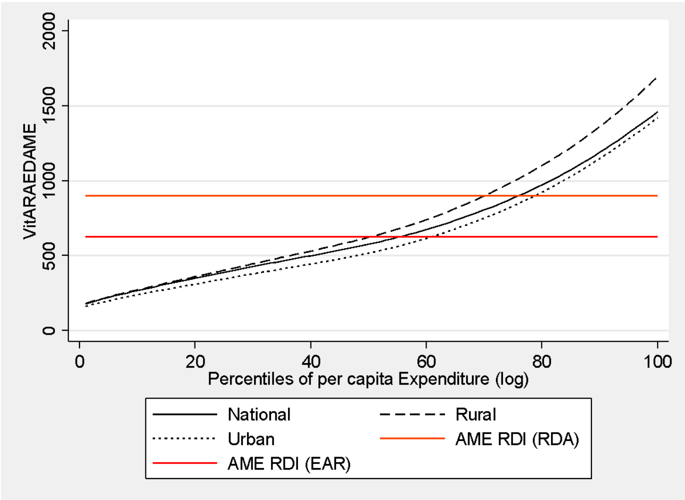


(a) Vitamin C (b) Vitamin B2 (c) Vitamin B12

Source: own elaboration.

For all the water-soluble vitamins introduced in the model (vit C, vit B2 and vit B12) the pattern is similar, with estimates of intake increasing with the per capita expenditure at the household level and being higher among the rural population (with differences between rural and urban populations starker within high percentiles of per capita expenditure); and with most of the households showing estimates of individual intake per AME above the EARs (Figure 4, panel a, b & c). This is not unexpected, as it has already been shown that household survey data, typically found in HCES data, produce, for the whole population, higher estimates of average nutrient consumption than those obtained from individual-level data, as found by Karageorgou et al. (2018).

Figure 5: Lipid-soluble vitamins (A) intake per AME across percentiles of per capita expenditure at the HH level



Source: own elaboration.

For the the lipid-soluble vitamin A, expressed as Retinol Activity Equivalent (RAE), the pattern is similar in relation to expenditure, with increased intake among high percentiles of per capita expenditure households, but differences between rural and urban diminish, as well as the number of households showing an individual intake above the EARs.

The wage equation estimated (Table 2) shows that almost all explanatory variables are significant at the 1% of significance - the exception is the FIES (subjective perception of food insecurity), which is not significant even when the sign is expected. Thus, this model highlights that micronutrients are key variables to explain labour productivity through labour earnings, being iron from animal sources the. According to the wage-nutrient equation the β-estimates refers to semi-elasticities. For instance, in the case of the heme iron estimate, it could be read a 0.113% increase in the household labour earning (proxy of labour productivity) when the daily heme iron intake per AME increases in a unit measure (the same is applied to the rest of nutrients' estimates in the wage-nutrient equation). Moreover, when running a multivariable wage-nutrient model, including all vitamins mentioned above, vitamin B12 and vitamin C display a negative significant estimates which is an unexpected signed based on the literature, but interestingly enough the estimated associated to these two micronutrients become positive and always significant in a bivariable analysis to explain the labour productivity.

Table 2: Estimates of regression

VARIABLES	Labour Productivity (lnWame)
Micronutrients	
Calcium (mg/day/AME)	0.000101***
	(-0.0000385)
Heme Iron (mg/day/AME)	0.113***
	-6.81E-03
Zinc (mg/day/AME)	0.00409***
	(-0.000714)
Folate (mg/day/AME)	-4.11e-05**
	(-0.0000196)
Vitamin C (mg/day/AME)	-0.000891***
	(-0.000132)
Vitamin B2 (mg/day/AME)	0.0635***
	(-0.0113)
Vitamin A (mg/day/AME)	7.63e-05***
	(-0.0000177)
Vitamin B12 (mcg/day/AME)	-0.0241***
	(-0.00263)
Food Insecurity	
FIES	-0.00207
	(-0.00304)
Education	
University (ratio)	0.224***
	(-0.0379)
Secondary (ratio)	0.304***
	(-0.112)
Primary (ratio)	0.926***
	(-0.0378)
Health	
DcronD	-0.0931***
	(-0.00718)
Constant	9.811***
	(-0.0413)
Observations	15,891
R-squared	0.141

Notes: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: own estimation.

As mentioned before the FIES showed a negative but non-significant association with the labour productivity measured through wages in both a bivariate and multivariate models. That is, as the food insecurity experienced in the household increased the labour productivity decreased, but the association was not significant. We also tested for the FIES categorized by tertiles but the associations remained non-significant.

The other covariates introduced in the model behaved as expected, with households with higher proportion of members achieving secondary,university and primary educations showing higher productivity than those without any degree. Besides, it is interesting that we get the higher coefficient in primary education, which can be associated with the kind of work developed in Kenya and the kind of skills required. Besides, households with members with chronic diseases and/or disability are negatively associated with household productivity. That is, the presence of diseases and/or disabilities reduce labor productivity.

These results confirm the virtuous cycle between health, nutrition, education and labour productivity.

5. Discussion and conclusions

β-estimates of the incidence of FS&N indicators on wages (as a proxy of L-productivity) in Kenya provide new insights for nutrition-oriented policies simulations in order to enhance L-productivity as a growth driver linking SGD2 and SDG8 for Kenya. Estimates will allow running a first test-case with the DEMETRA CGE model calibrated for Kenya to show the impact of the FS&N L-productivity linkages in both the dynamic baseline and FS&N policy scenarios, giving continuity to the macro-microsimulation FS&N literature (Boulanger et al., 2020; Ramos et al. ,2020; 2021; Nechifor et al., 2021).

Our microeconometric results show that all micronutrients included in the wage-nutrient equation have a positive impact on labour productivity, except Vitamin C and Vitamin B12 in a multivariate model. When doing a bivariate analysis, the relation between wages and vitamins C and B12 becomes positive and always significant. Thus, the sign changes when they are combined with other variables. These results might show the importance of a diverse diet, where iron, zinc, calcium, vitamin B12 and A, are significant and positive micronutrients to explain labour productivity. Thus, improving nutrition could develop synergies to achieve SDG 2 of "no hunger" and SGD 8 of decent work and growth, being labour productivity one of the key growth drivers.

References

Asenso-Okyere, K., Chiang, C., Thangata, P., & Mekonnen, D. A. (2011). Understanding the interaction between farm labor productivity, and health and nutrition: A survey of the evidence. Journal of development and agricultural economics, 3(3), 80-90.

Cafiero, C., Viviani, S., & Nord, M. (2018). Food security measurement in a global context: The food insecurity experience scale. Measurement, 116, 146-152.

Cafiero, C., Nord, M., Viviani, S., Del Grossi, E., Ballard, T., Kepple, A., ... & Nwosu, C. (2016). Voices of the Hungry. Methods for estimating comparable prevalence rates of food insecurity experienced by adults throughout the world. Rome: FAO.

Carter et al 2010. Iron deficiency anemia and cognitive function in infancy. 2010. Pediatrics 126 (2).

FAO and Government of Kenya (2018). Kenya Food Composition Tables. Rome & Nairobi: The Food and Agriculture Organization of the United Nations & The Ministry of Health, Republic of Kenya & The Ministry of Agriculture and Irrigation, Republic of Kenya. ISBN: 978-92-5-130445-7. http://www.fao.org/3/I8897EN/i8897en.pdf

Fonseca, Luis M., José P. Domingues, and Alina M. Dima (2020). "Mapping the Sustainable Development Goals Relationships" Sustainability 12, no. 8: 3359. https://doi.org/10.3390/su12083359

Galasso, E., & Wagstaff, A. (2019). The aggregate income losses from childhood stunting and the returns to a nutrition intervention aimed at reducing stunting. Economics & Human Biology, 34, 225-238.

Hanushek E.A. & Wößmann L. (2008) The role of cognitive skills in economic development. Journal of Economic Literature 46, 607–668.
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. The lancet, 371(9610), 411-416.

Institute of Medicine 2006. Dietary Reference Intakes: The Essential Guide to Nutrient Requirements. Washington, DC: The National Academies Press. https://doi.org/10.17226/11537.

Kar B.R., Rao S.L. & Chandramouli B.A. (2008) Cognitive development in children with chronic protein energy malnutrition. Behavioral and Brain Functions 4, 1–31.

Karageorgou, D., Imamura, F., Zhang, J., Shi, P., Mozaffarian, D. and Micha, R. (2018) 'Assessing dietary intakes from household budget surveys: A national analysis in Bangladesh', PLoS One. 2018/08/27, 13(8), p. e0202831. doi: 10.1371/journal.pone.0202831.

Kearns, K., Dee, A., Fitzgerald, A.P. et al. Chronic disease burden associated with overweight and obesity in Ireland: the effects of a small BMI reduction at population level. BMC Public Health 14, 143 (2014). https://doi.org/10.1186/1471-2458-14-143

Kenya National Bureau of Statistics (2018). Basic Report on the 2015/2016 Kenya Integrated Household Budget Survey. March. ISBN: 978-9966-102-03-4. Available at: https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/KNBS_-_Basic_Report.pdf

Moltedo, A., Jiménez, S., Álvarez-Sánchez, C., Manyani, T., Ramos, M. P., & Custodio, E. (2021). Raw versus cooked food matching: Nutrient intake using the 2015/16 Kenya Integrated Household Budget Survey. Journal of Food Composition and Analysis, 103879.

Moltedo, A., Troubat, N., Lokshin, M., & Sajaia, Z. (2014). Analyzing food security using household survey data: streamlined analysis with ADePT software. The World Bank. Available at: http://documents.worldbank.org/curated/en/488671468168574663/Analyzing-food-security-using-household-survey-data-streamlined-analysis-with-ADePT-software

Moltedo, A., Alvarez, C., Troubat, N., & Cafiero, C. (2018). Optimizing the use of ADePT-Food Security Module for Nutrient Analysis. ADePT-FSM Version 3. Rome: FAO Statistics Division (ESS), January. Available at: http://www.fao.org/fileadmin/templates/ess/foodsecurity/Optimizing_the_use_of_ADePT_FSM_for_nutrient_analysis.pdf

Nechifor, V., Ramos, M. P., Ferrari, E., Laichena, J., Kihiu, E., Omanyo, D., ... & Kiriga, B. (2021). Food security and welfare changes under COVID-19 in Sub-Saharan Africa: Impacts and responses in Kenya. Global food security, 28, 100514.

Raji, R. O. (2020). Nutrition Intake, Health Status, Education and Economic Growth: A Causality Investigation. Econometric Research in Finance, 5(2), 79-102.

Ramos, M., Custodio Cerezales, E., Jimenez Calvo, S., Mainar Causapé, A., Boulanger, P. and Ferrari, E., Assessing market incentive policies in Kenya with a food security and nutrition perspective: a macro-microsimulation approach, EUR 30034 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-14654-4 (online), doi:10.2760/925912 (online), JRC119390.

Ramos, M.P., Custodio, E., Jiménez, S., Mainar Causapé, A., Boulanger, P. and Ferrari, E. (2021). Do agri-food market incentives improve food security and nutrition indicators? a microsimulation evaluation for Kenya. Food Security. https://doi.org/10.1007/s12571-021-01215-2

Schultz T.P. (2002) Wage gains associated with height as a form of health human capital. The American Economic Review 92, 349–353.

Stein A.D., Wang M., Martorell R., Norris S.A., Adair L.S., Bas I. et al. (2010) Growth patterns in early childhood and final attained stature: data from five birth cohorts from low- and middle-income countries. American Journal of Human Biology 22, 353–359.

Strauss, J. (1986). Does better nutrition raise farm productivity?. Journal of political economy, 94(2), 297-320.

Tiwasing, P., Dawson, P., & Garrod, G. (2019). The relationship between micronutrient intake and labour productivity: Evidence from rice-farming households in Thailand. Outlook on Agriculture, 48(1), 58-65.

Walson J and Berkley J. (2018). The impact of malnutrition on childhood infections. Pediatric and neonatal infections, volume 31, number 3, June.

Weinberger, K. (2004). Micronutrient intake and labour productivity: Evidence from a consumption and income survey among Indian agricultural labourers. Outlook on AGRICULTURE, 33(4), 255-260.