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# Letter to the Editor

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**Farm production diversity and individual-level dietary diversity. Response to: 'Not all dietary diversity scores can legitimately be interpreted as proxies of diet quality' by Verger *et al.***

Madam

In a recent article we showed that smallholder farm production diversity in Malawi is positively associated with dietary diversity measured at household level and individual level for children under 5 years of age and their mothers[1]. We also showed that the effects are relatively small in magnitude and that access to markets and use of productivity-enhancing farm inputs are more important for dietary diversity than further increasing the number of crop species produced on each farm. We had calculated dietary diversity scores at household and individual levels using the twelve food groups recommended for the Household Dietary Diversity Score (HDDS)[2]. In their recent letter, Verger *et al*. have questioned this approach, arguing that HDDS is a proxy indicator for household economic access to food and not for dietary quality[3]. In reality, the HDDS with twelve food groups is often used as an indicator of dietary quality at the household level[4–6], while there is no international consensus on which food groups to include in studies regarding individual diets[7,8]. One of the objectives of our article was to directly compare household-level and individual-level results. Such comparison is most straightforward when the same indicators are used. Hence, we decided to use the same twelve food groups also for the individual-level calculations.

We are aware of the fact that other dietary diversity scores exist that may be more appropriate to use when the focus is on dietary quality of specific target groups rather than comparisons between groups and between household and individual levels. We also agree with Verger *et al*. that it could be interesting to see whether our results change when using such food group classifications recommended for individual dietary diversity scores. We carried out additional analyses with such alternative indicators. For children in our sample, we used the Child Dietary Diversity Score (CDDS) for infants and young children, which can be calculated with seven or eight food groups[9]. For mothers in our sample, we used the Women Dietary Diversity Score (WDDS), which is calculated with nine food groups[2]. Table 1 shows details of the calculations of these alternative indicators, as well as their correlation with the twelve-food-group indicators that we had used in the original study. The correlation coefficients are positive and relatively large, suggesting that the original study indicators were not such a bad proxy for individual dietary quality.

We also ran the regression models with the alternative indicators to analyse the association between farm production diversity and dietary diversity. Table 2 shows results without other control variables included, comparing the original estimates with the new ones obtained. The effects of production diversity on individual dietary diversity are even smaller when the alternative recommended indicators are used. Only the coefficient for children with the eight-food-group CDDS is statistically significant: one additional food group produced on a farm is associated with a 0·072 higher CDDS.

These results do not change much when controlling for other factors that may also influence dietary diversity (Table 3). The effects of production diversity on individual dietary diversity remain small. The estimates in Table 3 also underline the significant role of market participation (e.g. share of maize sold), use of productivity-enhancing

**Table 1** Description of individual dietary diversity scores

| Variable | Description | Mean | SD | Correlation with original study DDS† |
|---|---|---|---|---|
| CDDS (7 FG) | Child dietary diversity score for infants and young children, calculated with the following 7 FG: grains, roots and tubers; legumes and nuts; dairy products; flesh foods (meat, fish, poultry, liver/organ meats); eggs; vitamin A-rich fruits and vegetables; other fruits and vegetables | 2·80 | 1·22 | 0·812*** |
| CDDS (8 FG) | Child dietary diversity score for infants and young children, calculated with 8 FG: 7 FG mentioned plus fats and oils | 3·09 | 1·44 | 0·872*** |
| WDDS (9 FG) | Women dietary diversity score for mothers, calculated with the following 9 FG: starchy staples (cereals, white roots and tubers); dark green leafy vegetables; other vitamin A-rich fruits and vegetables; other fruits and vegetables; organ meat; meat and fish; eggs; legumes, nuts and seeds; dairy products | 3·41 | 1·16 | 0·770*** |

DDS, Dietary Diversity Score; CDDS, Child Dietary Diversity Score; FG, food groups; WDDS, Women Dietary Diversity Score.
The number of children in the sample is 519; the number of mothers in the sample is 408.
***$P < 0·01$.
†In the original study, 12 FG were used for DDS calculations[1].

**Table 2** Association between production diversity score and alternative individual dietary diversity scores in smallholder farm households, Malawi, 2014

| | Original indicators | | | | Alternative indicators | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | DDS children (12 FG) | | DDS mothers (12 FG) | | CDDS (7 FG) | | CDDS (8 FG) | | WDDS (9 FG) | |
| | Estimate | SE | Estimate | SE | Estimate | SE | Estimate | SE | Estimate | SE |
| Production diversity score | 0·168*** | 0·056 | 0·114** | 0·048 | 0·025 | 0·031 | 0·072** | 0·038 | 0·041 | 0·033 |
| No. of observations | 519 | | 408 | | 519 | | 519 | | 408 | |
| $\chi^2$ | 9·084*** | | 5·565** | | 0·64 | | 3·62* | | 1·51 | |
| $\alpha$ estimates of equidispersion test | −0·0813 | 0·0167 | −0·0807*** | 0·0117 | −0·168*** | 0·017 | −0·107*** | 0·017 | −0·178*** | 0·011 |

DDS, Dietary Diversity Score; FG, food groups; CDDS, Child Dietary Diversity Score; WDDS, Women Dietary Diversity Score.
Models are comparable to those in Table 2 of the original study[1] with alternative DDS indicators as dependent variables. Marginal effects are shown with their village cluster-corrected SE. Based on equidispersion test results, all models except for the first were estimated with a generalized Poisson estimator. The first model (DDS children, 12 FG) was estimated with a standard Poisson estimator.
*$P < 0·1$, **$P < 0·05$, ***$P < 0·01$.

**Table 3** Associations between farm production diversity, market access, agricultural technology and alternative individual dietary diversity scores in smallholder farm households, Malawi, 2014

| | Market access models | | | | | | Market participation models | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CDDS (7 FG) | | CDDS (8 FG) | | WDDS (9 FG) | | CDDS (7 FG) | | CDDS (8 FG) | | WDDS (9 FG) | |
| | Estimate | SE | Estimate | SE | Estimate | SE | Estimate | SE | Estimate | SE | Estimate | SE |
| Production diversity score | 0·033 | 0·032 | 0·081** | 0·039 | 0·041 | 0·031 | 0·016 | 0·035 | 0·053 | 0·042 | 0·016 | 0·033 |
| Village market | 0·146 | 0·114 | 0·201 | 0·142 | 0·080 | 0·120 | | | | | | |
| Time to district market | −0·059 | 0·048 | −0·095 | 0·064 | −0·116** | 0·051 | | | | | | |
| Share of maize sold | | | | | | | 0·007* | 0·004 | 0·011** | 0·004 | 0·006* | 0·004 |
| Share of other food crops sold | | | | | | | 0·001 | 0·002 | 0·002 | 0·002 | 0·003** | 0·002 |
| Area share of non-food cash crops | | | | | | | −0·006 | 0·004 | −0·004 | 0·005 | −0·006** | 0·003 |
| Improved maize varieties | 0·067 | 0·134 | 0·134 | 0·159 | 0·135 | 0·140 | 0·019 | 0·137 | 0·071 | 0·158 | 0·0882 | 0·139 |
| Improved legume varieties | −0·036 | 0·117 | 0·064 | 0·144 | 0·003 | 0·116 | −0·066 | 0·117 | 0·016 | 0·144 | −0·067 | 0·116 |
| Chemical fertilizer | 0·538** | 0·227 | 0·534* | 0·297 | 0·702*** | 0·220 | 0·603*** | 0·225 | 0·592** | 0·290 | 0·768*** | 0·211 |
| Maize–legume intercropping | 0·132 | 0·114 | 0·181 | 0·142 | 0·164 | 0·111 | 0·118 | 0·117 | 0·191 | 0·146 | 0·151 | 0·111 |
| Off-farm income | 0·001*** | 0·000 | 0·001*** | 0·000 | 0·001*** | 0·000 | 0·001*** | 0·000 | 0·001*** | 0·000 | 0·001*** | 0·000 |
| Farm size | −0·041 | 0·040 | −0·029 | 0·049 | −0·026 | 0·036 | −0·047 | 0·041 | −0·046 | 0·049 | −0·036 | 0·038 |
| Household size | −0·036 | 0·039 | −0·090* | 0·049 | −0·022 | 0·032 | −0·030 | 0·038 | −0·078* | 0·046 | −0·016 | 0·032 |
| Age of head | 0·005 | 0·006 | 0·006 | 0·008 | 0·006 | 0·005 | 0·0072 | 0·006 | 0·010 | 0·008 | 0·010* | 0·006 |
| Male head | 0·043 | 0·166 | 0·057 | 0·209 | −0·160 | 0·162 | 0·062 | 0·164 | 0·073 | 0·203 | −0·119 | 0·160 |
| Education of head | 0·032* | 0·016 | 0·035* | 0·021 | 0·036** | 0·017 | 0·034** | 0·017 | 0·038* | 0·021 | 0·040** | 0·016 |
| No. of observations | 519 | | 519 | | 408 | | 519 | | 519 | | 408 | |
| $\chi^2$ | 34·49*** | | 51·04*** | | 47·88*** | | 35·49*** | | 51·27*** | | 65·11*** | |
| $\alpha$ estimates of equidispersion test | −0·180*** | 0·016 | −0·123*** | 0·016 | −0·186*** | 0·010 | −0·181*** | 0·016 | −0·124*** | 0·016 | −0·187*** | 0·010 |

CDDS, Child Dietary Diversity Score; FG, food groups; WDDS, Women Dietary Diversity Score; DDS, Dietary Diversity Score.
Models are comparable to those in Table 5 of the original study[1] with alternative DDS indicators as dependent variables. Marginal effects are shown with their village cluster-corrected SE. Based on equidispersion test results, all models were estimated with a generalized Poisson estimator.
*$P < 0·1$, **$P < 0·05$, ***$P < 0·01$.

inputs such as chemical fertilizer and off-farm income for individual dietary diversity. These findings are consistent with those obtained in the original study with both household- and individual-level models[1].

In conclusion, we do not argue that production diversity would have no role to play for improving dietary quality in specific situations. But promoting production diversity as the main strategy may not be effective everywhere, especially not when farm production diversity is already quite high, as often observed among African smallholders. Our results suggest that strengthening market linkages is a better strategy to improve dietary quality. Strengthening markets for foods of high nutritional quality is of particular importance, as this can help to improve diets of rural producers and urban consumers simultaneously.

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*References*

1. Koppmair S, Kassie M & Qaim M (2017) Farm production, market access and dietary diversity in Malawi. *Public Health Nutr* **20**, 325–335.
2. Kennedy G, Ballard T & Dop MC (2011) *Guidelines for Measuring Household and Individual Dietary Diversity*. Rome: FAO.
3. Verger EO, Dop MC & Martin-Prével Y (2016) Not all dietary diversity scores can legitimately be interpreted as proxies of diet quality (Letter to the Editor). *Public Health Nutr* (Epublication ahead of print version).
4. Jones AD, Shrinivas A & Bezner Kerr R (2014) Farm production diversity is associated with greater household dietary diversity in Malawi: findings from nationally representative data. *Food Policy* **46**, 1–12.
5. Snapp SS & Fisher M (2015) 'Filling the maize basket' supports crop diversity and quality of household diet in Malawi. *Food Secur* **7**, 83–96.
6. Sibhatu KT, Krishna VV & Qaim M (2015) Production diversity and dietary diversity in smallholder farm households. *Proc Natl Acad Sci U S A* **112**, 10657–10662.
7. Ruel MT, Harris J & Cunningham K (2012) Measuring dietary quality in developing countries: a review of the usefulness of individual dietary diversity indicators. In *Diet Quality: An Evidence-Based Approach*, pp. 239–261 [VR Preedy, editor]. New York: Springer.
8. Keding GB, Msuya JM, Maass BL *et al.* (2012) Relating dietary diversity and food variety scores to vegetable production and socio-economic status of women in rural Tanzania. *Food Secur* **4**, 129–140.
9. Working Group on Infant and Young Child Feeding Indicators (2006) *Developing and Validating Simple Indicators of Dietary Quality and Energy Intake of Infants and Young Children in Developing Countries: Summary of Findings from Analysis of 10 Data Sets*. Washington, DC: Food and Nutrition Technical Assistance (FANTA) Project, Academy for Educational Development (AED).