

Kansas State University Libraries

**New Prairie Press**

---

Adult Education Research Conference

---

## PIAAC's role in global food security: Evidence from machine learning-based feature selection across three major food security indicators

Sneha Roy

Jeffrey Zacharakis

Follow this and additional works at: <https://newprairiepress.org/aerc>



Part of the [Adult and Continuing Education Commons](#), [Adult and Continuing Education Administration Commons](#), [Educational Leadership Commons](#), and the [Social and Behavioral Sciences Commons](#)



This work is licensed under a [Creative Commons Attribution-Noncommercial 4.0 License](#)

---

This Event is brought to you for free and open access by the Conferences at New Prairie Press. It has been accepted for inclusion in Adult Education Research Conference by an authorized administrator of New Prairie Press. For more information, please contact [cads@k-state.edu](mailto:cads@k-state.edu).

# PIAAC's Role in Global Food Security: Evidence from machine learning-based feature selection across three major food security indicators

Sneha Roy<sup>1</sup> and Jeff Zacharakis<sup>2</sup>

<sup>1</sup>North Carolina Agricultural and Technical State University

<sup>2</sup>Kansas State University

## Abstract

The PIAAC country dataset for 36 countries is explored to understand its role in global food security, adding to its significance in sustainable development goal four, zero hunger.

*Keywords:* PIAAC, food security, adult, skills, sustainable development

## Purpose of the study

Since the conceptualization, implementation, and procurement of adult skills and competency (PIAAC) data from 32 OECD and 4 non-OECD countries, research on PIAAC has been in the literature database since 2008. Several dimensions of adult skills and competencies have been discussed until now including the link between adult skills, and health and well-being. Better self-reporting of health information and understanding of health practices are shown to be vital outcomes of adult skills and competencies (Feinberg et al., 2016; Marius & Strøm, 2020; Heilmann, 2020) in different countries where PIAAC was conducted. Other research domains of investigation include cross-national analyses of literacy, numeracy, and problem-solving skills, their trends, and patterns (Evans et al., 2017), methodological, and design improvements in the PIAAC assessments (Rammstedt et al., 2017; Goldhammer et al., 2017), policy interventions (Volante et al., 2017), and vocational training (Hämäläinen et al., 2017; Lee et al., 2019). However, food and food security dimensions have not been studied in the context of adult skills and competencies. When specifically looking into the literature database on PIAAC data analysis, it resulted in 170 scholarly research papers, reports, and book chapters. Multifarious topics have been explored since 2010 and the present, however, there is no evidence of PIAAC scores being related to food security dimensions. The closest literature found was the publications (n=12) highlighting the association of PIAAC literacy, numeracy, and problem-solving skills and health dimension among people, and the paper (n=1) describing the association between PIAAC numeracy skill levels and home use skills of individuals.

## Perspective or theoretical framework

There are two dimensions to studying food security: adult skills and competency nexus. The first one pertains to a society where adult skills and competencies are relatively scarce, and the second dimension is where the adults in the society are skilled, competent, and prosperous. In the first dimension, improving adult learning, skills, and competencies will improve better comprehension of food information leading to improvement in all four aspects (food availability, food affordability, quality and health, and natural resources and sustainability) of household food security levels. Whereas, in the second dimension, where society is already educated, skilled and prosperous, the demand for food is ever-increasing and varies greatly by composition. Therefore, providing the right type of information on food will improve food wastage issues and the overall thought process of people regarding food choices on a daily basis, which will eventually improve

food security levels in urban, and semi-urban areas. However, in both dimensions, establishing an empirical link between food security, and adult skills and competency is indispensable. With this motivation, our study aims to identify a relevant set of variables that can be used to empirically establish a causal link between food security, and adult skills and competency. Machine learning (ML) tools have a diverse range of feature selection methods that uses simpler models that shorter training time and helps reduce overfitting issues.

### Research design

For our study, we employed ML-based supervised feature selection using a wrapper tool called the random forest feature selection to obtain relevant variables that could throw light on empirical relations between adult skills and competencies and food security. Additionally, for validation of the results, we performed ML-based feature selection using other different wrappers, embedded, and filter tools, like Boruta (Kursa & Rudnicki, 2010), Recursive feature selection (Yan & Zhang, 2015), XgBoost without SHAP and XgBoost with SHAP (Dunn et al., 2021), Linear regressor (Şahin et al., 2021), and Stepwise regression (Zhang, 2016), information theory-based metrics like varrank analysis (Kratzer, 2022; Battiti, 1994), Genetic algorithm (Yan & Zhang, 2015).

The set of dependent variables (outcome) included three country-level food security indicators estimated for the most recent years (global food security indicator, the prevalence of undernourishment, and the prevalence of severe food insecurity). The predictors were PIAAC country-level data on mean literacy, numeracy, and problem-solving skill scores, mean literacy, numeracy, and problem-solving skill scores based on gender, parental literacy, and age group diversity, rate of adult literacy, level of adult education (secondary, and tertiary), and adult employment rate. The results were compared and ranked across all ML feature selection tools to finally get the set of key indicators of adult skills and competency that can be further used to explore its causal links with food security.

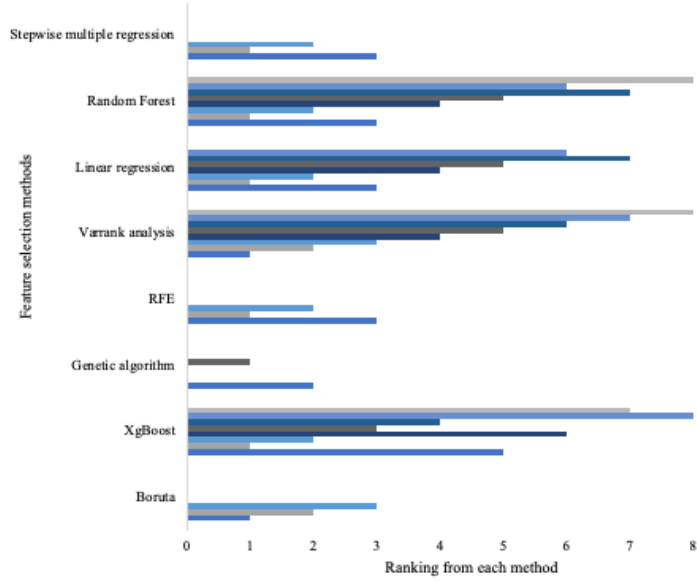
### Findings

The overall results for all three target variables show that variables PIAAC mean literacy and numeracy scores, and average years of total school for adults to be the three most important variables out of the other selected adult learning and education indicators. Other indicators, like secondary school enrollment, tertiary enrollment rates, PIAAC problem-solving skills, and male unemployment were also found to be relevant for food security (Table 1). The ranking obtained from each machine learning-based feature selection method is shown in Figure 1 below. The methods, random forest, varrank analysis, and XgBoost were able to rank most variables. Using multiple feature selection methods, we confirmed the importance of the variables for food security indicators.

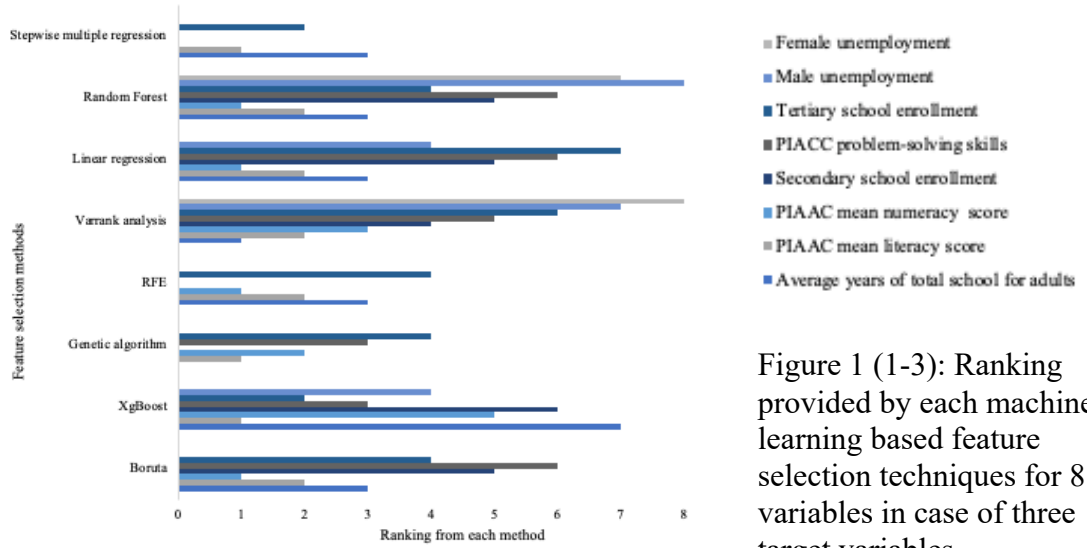
Target variable	Top variables
Severe food insecurity	<i>PIAAC mean literacy score</i> <sup>2</sup> <i>PIAAC mean numeracy score</i> <sup>2</sup> <i>Average years of total school for adults</i> <sup>3</sup> <i>Secondary school enrollment</i> <sup>4</sup> <i>Tertiary school enrollment</i> <sup>7</sup> <i>Male unemployment</i> <sup>6</sup>
Undernourishment	<i>PIAAC mean numeracy score</i> <sup>2</sup> <i>PIAAC mean literacy score</i> <sup>2</sup> <i>Average years of total school for adults</i> <sup>3</sup> <i>Tertiary school enrollment</i> <sup>7</sup>
Global food security indicator	<i>PIAAC mean literacy score</i> <sup>2</sup> <i>PIAAC mean numeracy score</i> <sup>2</sup> <i>Average years of total school for adults</i> <sup>3</sup> <i>PIAAC problem-solving skills</i> <sup>5</sup> <i>Tertiary school enrollment</i> <sup>7</sup> <i>Secondary school enrollment</i> <sup>4</sup> <i>Male unemployment</i> <sup>6</sup>

Table 1: Top variables selected for each target variable using 8 different feature selection techniques.

Target variable: Severe food insecurity



Target variable: Undernourishment



Target variable: Global food security indicator

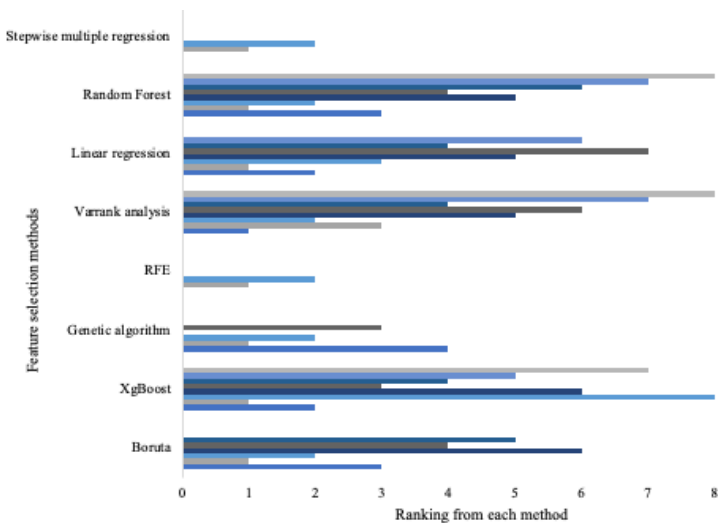


Figure 1 (1-3): Ranking provided by each machine learning based feature selection techniques for 8 variables in case of three target variables.

### **Implications for adult education theory and practice**

The findings are extremely important for furthering research on interdisciplinary dimensions of adult learning and leadership studies, and PIAAC data. Very little research work has been conducted on looking into the potential of adult learning in sustainable development goals. Our findings support the probable role of adult learning in the world's one of the most challenging issues of food insecurity. Moreover, it establishes the important role of PIAAC data globally, and the need to have similar large-scale data assessments for other parts of the world which have severe food insecurity-related problems. Our findings are extremely crucial for policymakers to combat crucial challenges that arise because of global food insecurity. The importance of adult learning variables from PIAAC data determines what suitable policies and initiatives from different organizations both governmental and non-governmental, incorporating adult education must be taken to combat global food insecurity.

Our working paper on the development of the concept of adult food security literacy (Roy & Zacharakis, 2022) is well aligned with our present work on understanding the role of PIAAC (adult learning, and competencies) on global food security. Based on the critical adult learning and competency features of food security indicators, and their causal links, we propose a food security literacy platform for adults which is fundamentally a development platform that will enable widespread education and awareness among adults about different dimensions of household food security at various levels.

In conclusion, in our current research on understanding the role of adult learning and competencies in combating global challenges arising due to food insecurity, we have used robust multiple machine learning-based feature selection techniques to isolate the most important and relevant variables for exploring the causal links between adult learning and food insecurity indicators further. Our initial results indicate that adult learning and competency variables do have strong importance in the context of global food insecurity indicators. This unlocks the further possibility of causal relationships between these variables. The findings will be extremely useful for the policymakers from different agencies, supporting sustainable development goals.

### **References**

- Battiti, R. (1994). Using mutual information for selecting features in supervised neural net learning. *IEEE Transactions on Neural Networks*, 5(4), 537–550.  
<https://doi.org/10.1109/72.298224>
- Evans, J., Yasukawa, K., Mallows, D., & Creese, B. (2017). Numeracy skills and the numerate environment: Affordances and demands. *Adults Learning Mathematics: An International Journal*, 12(1), 17-26.  
[https://eprints.mdx.ac.uk/23308/3/Pages%20from%20almij\\_121\\_october2017.pdf](https://eprints.mdx.ac.uk/23308/3/Pages%20from%20almij_121_october2017.pdf)
- Feinberg, I., Frijters, J., Johnson-Lawrence, V., Greenberg, D., Nightingale, E., & Moodie, C. (2016). Examining Associations between Health Information Seeking Behavior and Adult Education Status in the U.S.: An Analysis of the 2012 PIAAC Data. *PLOS ONE*, 11(2), e0148751. <https://doi.org/10.1371/journal.pone.0148751>
- Goldhammer, F., Martens, T., & Lüdtke, O. (2017). Conditioning factors of test-taking engagement in PIAAC: an exploratory IRT modeling approach considering person and item characteristics. *Large-Scale Assessments in Education*, 5(1), 18.  
<https://doi.org/10.1186/s40536-017-0051-9>

- Hämäläinen, R., De Wever, B., Nissinen, K., & Cincinnato, S. (2017). Understanding adults' strong problem-solving skills based on PIAAC. *Journal of Workplace Learning*, 29(7/8), 537–553. <https://doi.org/10.1108/JWL-05-2016-0032>
- Heilmann, L. (2020). Health and numeracy: the role of numeracy skills in health satisfaction and health-related behavior. *ZDM*, 52(3), 407–418. <https://doi.org/10.1007/s11858-019-01106-z>
- Dunn, J., Mingardi, L., & Zhuo, Y. D. (2021). Comparing interpretability and explainability for feature selection. *ArXiv*. <https://doi.org/10.48550/arXiv.2105.05328>
- Lee, J.-W., Han, J.-S., & Song, E. (2019). The effects and challenges of vocational training in Korea. *International Journal of Training Research*, 17(sup1), 96–111. <https://doi.org/10.1080/14480220.2019.1639272>
- Marius Vaag Iversen, J., & Strøm, B. (2020). Skills, Employment, and Labor Market Institutions: Evidence from PIAAC. *LABOUR*, 34(3), 277–304. <https://doi.org/10.1111/labr.12174>
- Kratzer G, Furrer R (2022). *varrank: Heuristics Tools Based on Mutual Information for Variable Ranking*. R package version 0.5, <https://CRAN.R-project.org/package=varrank>.
- Kursa, M. B., & Rudnicki, W. R. (2010). Feature Selection with the Boruta Package. *Journal of Statistical Software*, 36(11). <https://doi.org/10.18637/jss.v036.i11>
- Rammstedt, B., Martin, S., Zabal, A., Carstensen, C., & Schupp, J. (2017). The PIAAC longitudinal study in Germany: rationale and design. *Large-Scale Assessments in Education*, 5(1), 4. <https://doi.org/10.1186/s40536-017-0040-z>
- Roy, S., & Zacharakis, J. (2022). *Preliminary Analysis: Is there enough definitional clarity of food literacy for food security?* Adult Education Research Conference. <https://newprairiepress.org/aerc/2022/papers/3/>
- Şahin, D. Ö., Kural, O. E., Akleylek, S., & Kılıç, E. (2021). A novel permission-based Android malware detection system using feature selection based on linear regression. *Neural Computing and Applications*. <https://doi.org/10.1007/s00521-021-05875-1>
- Volante, L., and Xavier Fazio, Jo Ritzen, M. (2017). The OECD and Educational Policy Reform: International Surveys, Governance, and Policy Evidence. *Canadian Journal of Educational Administration and Policy*, 184, 34–48. <file:///Users/sneha/Downloads/dulude,+Volante.pdf>
- Yan, K., & Zhang, D. (2015). Feature selection and analysis on correlated gas sensor data with recursive feature elimination. *Sensors and Actuators B: Chemical*, 212, 353–363. <https://doi.org/10.1016/j.snb.2015.02.025>
- Zhang, Z. (2016). Variable selection with stepwise and best subset approaches. *Annals of Translational Medicine*, 4(7), 136–136. <https://doi.org/10.21037/atm.2016.03.35>