



Prevalence and predictors of food insecurity among university students – Results from the Justus Liebig University Giessen, Germany

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ABSTRACT

This study aimed to assess the prevalence and associated factors of food insecurity (FI) among university students in Germany during the COVID-19 pandemic. We conducted a cross-sectional study ($n = 626$) between November and December 2021 at the Justus Liebig University in Giessen, Germany, using an online questionnaire. The analysis of FI was based on the Food Insecurity Experience Scale (FIES) by the Food and Agriculture Organization (FAO). We statistically validated our data using the Rasch model. Moreover, demographic, socio-economic and educational variables were collected using a questionnaire developed by the Food Insecurity among European University Students during the COVID-19 Pandemic (FINESCOPE) consortium. Overall, 27.5 % of the university students are food insecure. The proportion of university students experiencing moderate or severe food insecurity ($FI_{mod+sev}$) is 10.4 % and the proportion experiencing severe food insecurity (FI_{sev}) 0.9 %. Results from a logistic regression showed that students have a higher chance to be food insecure if they were not born in Europe and if their parents have a secondary or lower educational level. We further found an association between age and FI. Also receiving a student loan during the pandemic and getting food assistance increased the likelihood of being food insecure. Our results show that FI is prevalent among this particularly vulnerable population group. Thus, public health, as well as policy efforts may need to become more target group-specific in accordance with the identified circumstances and specific characteristics to avoid that university students suffer from FI.

1. Introduction

Food security exists “when all people, at all times, have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO, 2009). In contrast, “a person is food insecure when they lack regular access to enough safe and nutritious food for normal growth and development and an active and healthy life” (FAO, 2023a). Worldwide the number of people suffering from food insecurity (FI) had already been on the rise before 2020 and has been pushed even further by succeeding crises in the past years (FAO, IFAD, UNICEF, WFP, WHO,

2023). In Germany, the estimated prevalence of moderate or severe FI in the total population for example increased from 3.4 % in 2019, to 3.5 % in 2020 and to 3.8 % in 2021 (FAO, 2023b; FAO, IFAD, UNICEF, WFP, WHO, 2023). FI is a serious public health issue that particularly affects vulnerable groups or persons in precarious life situations, also in high-income countries as shown for example for food bank users in Germany (Depa et al., 2018). In order to take data-driven action, indications are required about which population groups are in need for supporting policies. Previous research has underlined that university students have higher FI prevalence rates than the overall population and emerge to an at-risk population group (Abbey et al., 2022; Hagedorn-Hatfield et al.,

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2022; Whatnall et al., 2020). Even before the COVID-19 pandemic about one in three university students in the USA has been confronted with some form of FI (Nikolaus et al., 2020). Evidence from the USA showed that the level of FI has risen above pre-pandemic level (DeBate et al., 2021; Glantsman et al., 2022; Schuler et al., 2020; Soldavini et al., 2021; Wolfson and Leung, 2020). Suffering from FI leaves university students struggling in many areas of their life. FI is reported to have a negative effect on academic performance as well as health outcomes (Moore et al., 2021; Pourmotabbed et al., 2020; Smith et al., 2020). Even if only experienced temporarily, FI can induce detrimental health behaviors and increased risk of chronic disease (El Zein et al., 2019). So far for Europe - and Germany in particular - there is only limited data available with focus on FI among university students. There is even less data with regard to recent events such as the COVID-19 pandemic and there are no studies covering FI prevalence rates among university students in Germany yet. Therefore, to address this research gap, we aimed to (i) assess the prevalence of FI among university students in Germany during the COVID-19 pandemic and (ii) determine demographic, socio-economic and educational predictors of FI to better understand the complexity of FI.

2. Methods

The underlying cross-sectional study is part of the research project “Food Insecurity among European University Students during the COVID-19 Pandemic” (FINESCOPE). The study targets university students in different universities across Europe who were invited to respond to an online questionnaire at the beginning of the lecture period of the individual university. In this study we focus on students from the Justus Liebig University (JLU), a public university in Giessen Germany. The study was approved by the institutional review board of the JLU (JLU Giessen, Faculty Medicine, AZ 172/21).

2.1. Questionnaire

The questionnaire was developed in English through collaboration with all the partners in the FINESCOPE consortium - who participated in the selection and consensus of the measurement variables and tools. Food security can be distinguished in four pillars: Availability, access, utilization, and stability (Leroy et al., 2015). This work focuses on the access dimension of food security as it accounts for the acquisition of appropriate food on the individual level. For the evaluation of FI, in the present study, the Food Insecurity Experience Scale (FIES) (Ballard et al., 2013) was used, which consists of eight questions that provide information about limited access to food due to lack of money or other resources and allows to assess participants' severity of FI. Each participant was asked directly about his or her experience, i.e., whether at any time during the last twelve months they have had experienced what is being described in the question in terms of constrained access to food. We positioned the FIES items according to the standard administrative order, where questions are arranged according to severity of FI, from less severe to more severe (Ballard et al., 2013).

In addition, the questionnaire included demographic, socio-economic and educational variables. The origin of these questions was described in detail in an article by González-Pérez et al. (2023). In particular, the present study shows results on the following demographic variables: participants' age, gender, and birthplace; socio-economic variables: participation in food assistance programs or other types of food assistance during the COVID-19 pandemic, receiving student loans during the pandemic, and parents' educational level; educational variables: study level and international students (if applicable). The tools that had not been previously validated in languages other than English were translated into the local languages using the parallel translation/double translation method (Tsang et al., 2017). In the case of the JLU Giessen, the questionnaire was provided in German and English to also reach international students.

2.2. Data collection and sample

The online questionnaire was made available for university students from the JLU Giessen, Germany, via SoSci Survey from 1st of November until 12th of December 2021. All undergraduate and postgraduate students at the JLU Giessen with access to the internet could participate in the study. The survey link was shared on several platforms (e.g., email services of the JLU Giessen and Facebook groups) and further spread via snowball effect. The participants were informed about the purpose of the project, usage and storage of the collected data and were asked to give consent before starting the questionnaire. In total 938 people started the survey. After excluding 27 cases that did not answer the first question and 86 cases that were neither under- nor postgraduate and one implausible case, 824 cases remained in the data set. The focus is on the FIES items and thus 149 cases that did not finish these questions were excluded. Additionally, 49 cases were excluded due to missing responses (“Don't know” or “Refused”) for any of the FIES questions, reducing the sample size for analysis to 626 students.

2.3. Statistical analysis

We used the open-source software RStudio Version 2021.09.0 for data analysis. For analyzing the FIES data we applied the Rasch model with the RM.weights package by the Statistics Division at the Food and Agriculture Organization (FAO). We considered infit and outfit statistics and Rasch reliability to assess the quality of the data. To obtain internationally comparable estimates of the prevalence of FI ($FI_{mod+sev}$ and FI_{sev}) we performed an equating method as suggested by the FAO and by utilizing an official FAO Excel template (available under: https://www.fao.org/fileadmin/user_upload/voices_of_the_hungry/docs/EPE_Example_05.xlsx, last checked: 06.04.2023). A logistic regression model was estimated to examine the association between demographic, socio-economic and educational characteristics and FI. The reference categories were those reported in the literature to have a lower FI risk. Since all forms of FI should be taken into consideration from a policy point of view, i.e., not only severe FI, any form of FI was coded as FI, i.e., coded as 1 if raw score > 0 and 0 otherwise. The results are presented in terms of odds ratios (OR), with a 95 % confidence interval (CI). All tests were 2-sided, and *p* values less than 0.05 were considered statistically significant. The model fit was assessed using the Omnibus Test of Model Coefficients.

3. Results

3.1. Participant characteristics

Demographic, socio-economic and educational characteristics of the respondents are presented in Table 1. Around three quarters of the participants were female (75.7 %) and most were born in Europe (95.2 %). The mean age was 23.6 ± 3.9 years (17–53 years). Over two thirds of the participants were undergraduates (63.6 %). Over half of the participants had at least one parent with the highest education 1st stage (Bachelor, Master, or equivalent level) or 2nd stage of tertiary education (doctoral or equivalent level) (55.0 %). Only a small percentage were international students (2.9 %). 9.1 % had a student loan and 12.9 % received food assistance or used a strategy to improve their food access. From the 23 students who stated to have used “other strategies” to improve food access than the one listed in the questionnaire (“searching for edible food in waste containers”), named mainly *Foodsharing* ($n = 12$) and *Too Good To Go* ($n = 6$).

3.2. Prevalence of food insecurity

When looking at the distribution of affirmative answers to each FIES question (Table 2), the item FEWFOOD was reported most often in our sample (21.4 %), followed by the item HEALTHY (15.2 %) and

Table 1
Participants' demographic, socio-economic and educational characteristics (n = 626).

Variable	Participants
Gender, n (%)	
Male	141 (22.5)
Female	474 (75.7)
Non-binary or other	7 (1.1)
Prefer not to say	4 (0.6)
Age Mean ± SD, years	23.6 ± 3.9
Place of birth, n (%)	
Europe	596 (95.2)
Asia	16 (2.6)
Africa	9 (1.4)
North and South America	5 (0.8)
Level of studies, n (%)	
Undergraduate	398 (63.6)
Postgraduate	228 (36.4)
Highest educational level of parent, n (%)	
Pre-primary education or no education	0 (0.0)
Primary education	7 (1.1)
Lower secondary education	76 (12.1)
(Upper) secondary education	104 (16.6)
Post-secondary non-tertiary education	82 (13.1)
First stage of tertiary education	284 (45.4)
Second stage of tertiary education	60 (9.6)
Do not know or prefer not to say	13 (2.1)
International student, n (%)	18 (2.9)
Student loan, n (%)	57 (9.1)
Food assistance/strategies to improve food access, n (%)	
Yes	81 (12.9)
Applied to a food assistance program	3 (0.5)
Food assistance from parents/family/friends (including financial aid for eating)	59 (9.4)
Searching for edible food in waste containers	10 (1.6)
Other strategies to improve food access	23 (3.7)
No	543 (86.7)
Don't want to answer	2 (0.3)

Survey conducted between November and December of 2021 among university students of the JLU Giessen, Germany, as part of the FINESCOP project.

Table 2
FIES questions (item) and affirmative answers (n = 626).

Item	Standard label	Question wording	n	%
		Now I would like to ask you some questions about food. During the last 12 months , was there a time when...		
1	WORRIED	You were worried you would not have enough food to eat because of a lack of money or other resources?	67	10.7
2	HEALTHY	You were unable to eat healthy and nutritious food because of a lack of money or other resources?	95	15.2
3	FEWFOOD	You ate only a few kinds of foods because of a lack of money or other resources?	134	21.4
4	SKIPPED	You had to skip a meal because there was not enough money or other resources to get food?	32	5.1
5	ATELESS	You ate less than you thought you should because of a lack of money or other resources?	42	6.7
6	RANOUT	Your household ran out of food because of a lack of money or other resources?	38	6.1
7	HUNGRY	You were hungry but did not eat because there was not enough money or other resources for food?	29	4.6
8	WHLDAY	You went without eating for a whole day because of a lack of money or other resources?	8	1.3

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WORRIED (10.7 %). Not eating for a whole day, assessed with the item WHLDAY, was chosen the least (1.3 %).

By adding the number of affirmatively answered FIES questions for each participant, we get the raw scores, which can take a value between zero and eight. Fig. 1 shows the distribution of the raw scores in our sample. Most respondents (72.5 %) had a raw score of 0. They did not report any of the assessed experiences of FI. Thus, in the framework of the FIES they are considered food secure. FI is defined by a raw score higher than 0, meaning that at least one of the eight FIES questions had been answered with YES, which was the case for 27.5 % of the participants.

Before calculating prevalence rates of FI, statistical validation is needed to ensure that the collected data is conform to the model's assumptions. For statistical validation, cases with extreme raw scores (0 or 8) were excluded. 168 complete, non-extreme cases remained for statistical validation. Item severity parameters (Table 3) show that having to eat only few kinds of food (FEWFOOD) has the lowest severity, followed by being unable to eat healthy and nutritious food (HEALTHY) and being worried that one would not have enough food to eat (WORRIED). The higher the severity of an item, the more severe the experience is.

In our sample the item WHLDAY has the highest item severity, representing therefore the most severe experience assessed as not eating anything for a whole day because of a lack of money or other resources. As the item parameter is estimated based on the overall pattern of responses given by all respondents, the severity order is in line with the percentage of affirmative responses and WHLDAY for example with the highest parameter value received the fewest number of "YES" responses in our sample. Infit statistics (Table 3) shows that all items have infits within the acceptable range of 0.7 – 1.3, meaning that all items are associated to the latent trait (FI) and discriminate equally well among respondents. Outfit statistics are useful to flag the presence of outliers. An outfit of > 2 is considered "high". In our sample all outfits are lower than 2 (Table 3). The Rasch reliability value of 0.75 confirms a good discriminatory power of the overall scale.

To receive comparable estimates of the prevalence of FI, we inserted the relevant output from RM.weights into the Excel Template from FAO. We examined the graphical representation of the item parameters. The item WORRIED was the furthest away from the diagonal line, with the highest absolute difference compared to all other items (Fig. 2). The correlation between item parameters of the two scales was 93.2 %. After excluding the item WORRIED the correlation between item parameters increased to 96.9 %. Due to a high absolute difference between the country and global standard items of ATELESS (Fig. 3), we decided to omit ATELESS which led to an increase in the correlation between the common items to 99.1 %. We choose this as best equating scenario (Fig. 4). The resulting proportion of the sample population experiencing

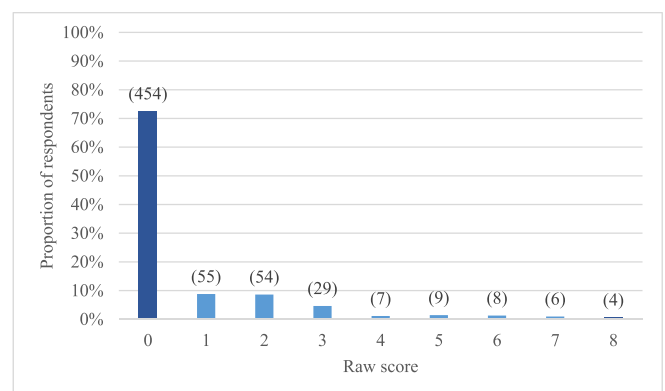


Fig. 1. Distribution of raw scores (n = 626) (FINESCOP project, university students of the JLU Giessen, Germany, data collected between November and December 2021).

Table 3
FIES item statistics.

Item	Item severity	Standard error	Infit	Outfit
WORRIED	-0.822	0.195	1.046	1.083
HEALTHY	-1.588	0.183	1.047	1.319
FEWFOOD	-2.582	0.198	1.035	1.533
SKIPPED	0.638	0.262	0.785	0.916
ATELESS	0.109	0.232	0.814	0.740
RANOUT	0.305	0.242	1.103	1.075
HUNGRY	0.826	0.274	0.993	1.158
WHLDAY	3.114	0.535	0.882	0.152

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moderate or severe FI ($FI_{mod+sev}$) is 10.4 %. The proportion of the population experiencing severe FI (FI_{sev}) is 0.9 %.

3.3. Factors associated to food insecurity

The logistic regression model is statistically significant, $\chi^2(9) = 46.7$, $p < 0.001$. The model explains 10.6 % (Nagelkerke R^2) of the variance in FI and correctly classifies 73.9 % of cases. Sensitivity is 12.7 %, specificity is 96.6 %, positive predictive value is 58.3 % and negative predictive value is 74.9 %. The results of the logistic regression (Table 4) show associations between FI and age, place of birth being outside of Europe (reference: Europe), parents' highest educational level being lower than tertiary education (reference: 1st and 2nd stage of tertiary education), student loan (reference: no student loan) and food assistance (reference: no food assistance) that are statistically significant ($p < 0.05$). There is an increase in the odds of FI with each one-year increase in age. The odds of FI among participants born outside of Europe are higher than the odds of participants born in Europe. The odds of FI

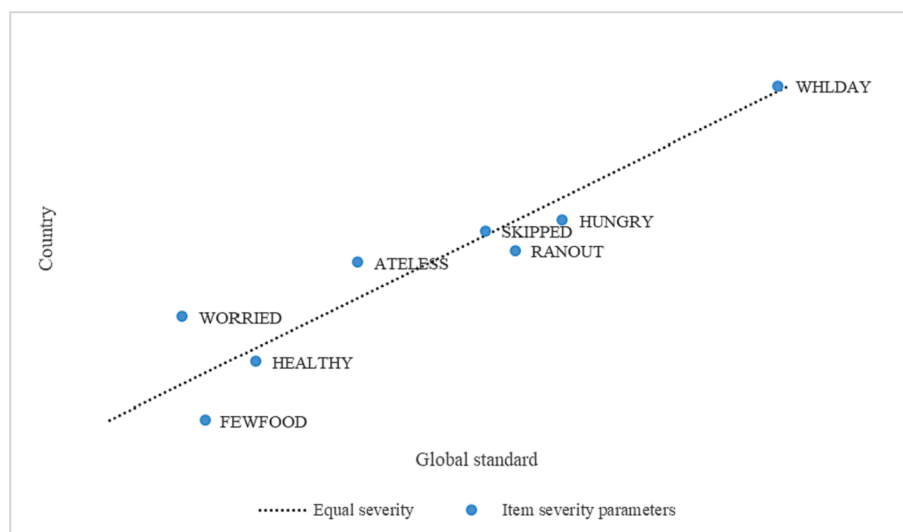


Fig. 2. First equating scenario (all FIES items determined to be common); created using the FIES Excel template (FINESCOP project, university students of the JLU Giessen, Germany, data collected between November and December 2021).

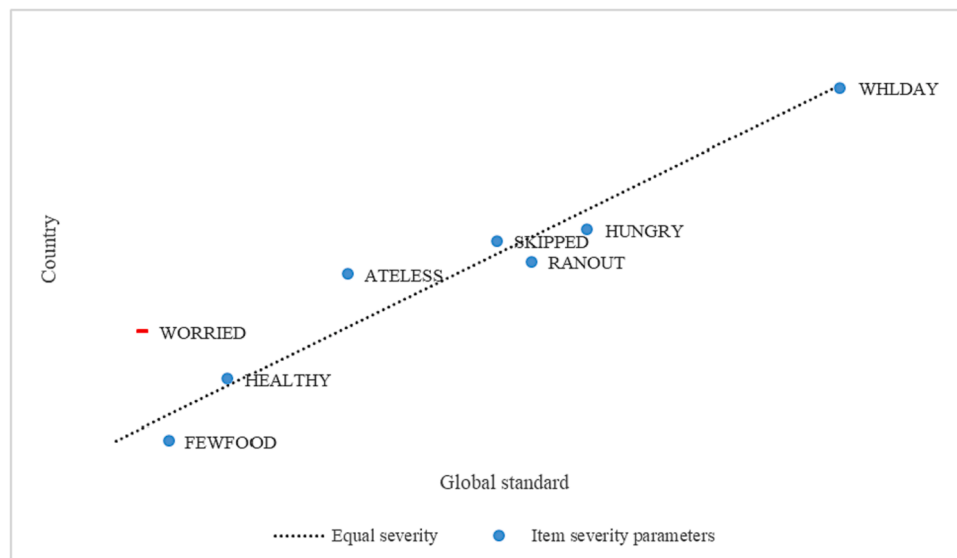


Fig. 3. Second equating scenario (FIES item WORRIED determined to be unique); created using the FIES Excel template (FINESCOP project, university students of the JLU Giessen, Germany, data collected between November and December 2021).

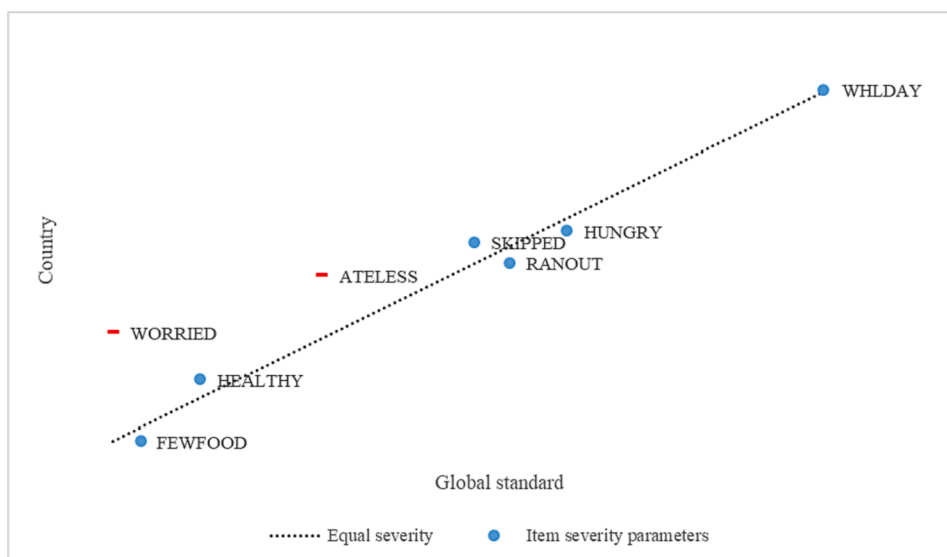


Fig. 4. Final equating scenario (FIES items WORRIED and ATELESS determined to be unique); created using the FIES Excel template (FINESCOP project, university students of the JLU Giessen, Germany, data collected between November and December 2021).

Table 4
Results of a logistic regression analysis of experiencing FI by demographic, socio-economic and educational variables (n = 613).

Variable	OR	95 % CI	p value
(Intercept)	0.03	(0.01, 0.12)	< 0.001
Age	1.07	(1.02, 1.13)	0.008
Female (reference: male)	1.12	(0.72, 1.77)	0.614
Not born in Europe (reference: born in Europe)	2.70	(1.20, 6.07)	0.016
Parents' highest educational level (reference: 1st and 2nd stage of tertiary education)			
Lower than tertiary education	1.85	(1.26, 2.70)	0.002
Don't know	1.89	(0.45, 6.57)	0.337
Undergraduate (reference: postgraduate)	1.32	(0.87, 2.03)	0.199
International student (reference: no international student)	1.92	(0.67, 5.31)	0.211
Student loan (reference: no student loan)	2.17	(1.20, 3.88)	0.010
Food assistance (reference: no food assistance)	2.07	(1.22, 3.48)	0.007

Cox & Snell R²: 0.073; Nagelkerke R²: 0.106.
The logistic regression model satisfied the Omnibus Test of Model Coefficients (p < 0.001).
13 observations excluded due to missing answers; p values < 0.05 bolded.
Survey conducted between November and December of 2021 among university students of the JLU Giessen, Germany, as part of the FINESCOP project.

among university students whose parents' highest education is lower than tertiary education are higher compared to university students whose parents' highest degree is 1st or 2nd stage of tertiary education. We can see the same effect for student loan recipients: University students with a student loan have higher odds to suffer from FI than university students without student loans. Furthermore, the odds of FI among university students that receive food assistance are higher compared to university students that receive no food assistance. Other variables do not have a significant effect in our logistic regression model.

4. Discussion

This study sought to assess the prevalence and associated factors of FI among university students from a German university, during the COVID-19 pandemic. We found that more than one in four university students in our sample experienced FI during the pandemic.

Our results, with FI_{mod+sev} being 10.4 %, indicate that university students who participated in this study might be more likely to suffer from FI than the overall population. In Germany, 3.8 % of the total population are estimated to be moderately or severely food insecure according to the latest survey data from the FAO for 2020–2022 (FAO, IFAD, UNICEF, WFP, WHO, 2023). It has to be noted that a comparison of our results with the national survey should be treated carefully due to the nature of our sampling procedure. We can for example not rule out that the results are influenced by self-selection bias. Socio-demographic variables in the participant population (i.e. 75.7 % female participants and a mean age of 23.6) differ from student population in general (i.e. the percentage of female university students in Germany is 49.4 %, the mean age is 25.8 (Kroher et al., 2023)), and the total population in Germany (i.e. the percentage of females in Germany is 50.7 % (Statistisches Bundesamt, 2023), the mean age is 44.7 (Statistische Ämter des Bundes und der Länder, 2022)). However, our findings are in line with previous research from other countries that have shown that university students emerge as an at-risk group for FI and have higher prevalence rates compared to the total population (Abbey et al., 2022; Hagedorn-Hatfield et al., 2022; Whatnall et al., 2020). First results of the 2021 statistics on income and living conditions (EU-SILC) have shown that in Germany 37.9 % of university students were at risk of poverty (monetary poverty), which is much higher compared to the respective percentage of 15.8 % for the total population (Statistisches Bundesamt, 2022). Since a limited purchasing power is argued to be one of the main causes for FI (Martinez et al., 2020), it makes sense that this population group with limited financial resources might be more food insecure compared to the total population. This is aligned with findings from a study among food bank users in Germany who also showed higher prevalence of FI compared to the total population (Depa et al., 2018). Interestingly, the prevalence of severe FI in our sample (FI_{sev}: 0.9 %) is lower than the estimation for the total population in Germany (FI_{sev}: 1.4 %) (FAO, IFAD, UNICEF, WFP, WHO, 2023). One possible explanation is that university students in Germany have various options to receive financial support, e.g. parental support or state funding for students under the Federal Training Assistance Act (BAföG) (Kohls et al., 2021). Despite the

fact that these funding options can apparently not fully prevent the risk of poverty, they seem to provide at least a safety net to effectively reduce severe FI, which is described as running out of food, and in extreme cases as not eating for days. This line of thought may be addressed by future research. It might be of interest to further elaborate on the concrete impact of the access to specific state funding programs such as BAföG, parental support and student benefits (e.g. the possibility to eat at a subsidized canteen) on different levels of FI. Specifically, a comparison with other population groups having a similar income and risk of poverty might generate new insights on the effects of target-group specific funding and measures.

Furthermore, referring to the number of affirmative answers for each FIES item, it appears that worrying about not having enough to eat (Item 1 – WORRIED) is not the primary experience of university students when facing FI. In agreement with other authors (Beam, 2020), it seems that a change in the quality of the diet is more common. Limiting the variety of foods consumed (Item 2 – FEWFOOD) and eating less healthy and nutritious food (Item 3 – ATELESS) were reported the most. Whereas items regarding the quantity of food occurred less often, especially item 8 (WHLDAY). Not eating all day seems to be the least common experience of FI, representing the most severe item of the FIES.

In contrast to the literature (Owens et al., 2020), we found that with increased age the odds of FI increased, which might be country-specific as e.g. financial support for students is limited for a certain time in Germany (i.e. BAföG). Regarding parents' highest education our results align with published literature, where FI was associated with a lower parental educational attainment, such as high-school degree or less (Bennett et al., 2022; El Zein et al., 2019; Laska et al., 2021; Leung et al., 2021). Also, we found the same association as previous literature between FI and students having student loans (Laska et al., 2021) and receiving food assistance (Bennett et al., 2022). We could find an association between birthplace and FI as suggested by literature from the USA (Joseph et al., 2022). Specifically, our results indicate that the odds of FI are higher among university students born outside of Europe. To explain differences in FI rates with regard to the birthplace recent literature has looked at the impact of socio-cultural aspects (Bauch et al., 2023). Bauch et al. (2023) point out that international students from Africa reported a lack of socializing while eating compared to the level of socialization that they perceive common in their home country. The authors underline that socialization can decrease the FI rate of students (Bauch et al., 2023). Future research might include socio-cultural aspects to further evaluate its impact on FI rates among university students born outside of Europe.

5. Limitations, strengths, and opportunities

This study has several limitations. First, a convenience sample from a university was used, which is not fully representative for university students at the institution where the study was conducted. Survey respondents could choose whether to participate in the survey, which may have introduced self-selection bias. Future research should collect data from more than one university in Germany and decrease the potential for selection bias via a representative sample. Second, since our study was cross-sectional, we cannot determine causal relationships. Future research could analyse FI over time by implementing a longitudinal approach. However, this study has also several strengths. To start with, the FIES is used to measure FI at the global level and recognized as an indicator to measure the SDG 2 - no hunger. One specific strength of the FIES is that it produces valid, reliable, and comparable FI prevalence estimates across countries and cultures, even in countries with a low rate of FI. Moreover, our study is the first to provide results for FI and its association with demographic, socio-economic and educational variables among university students in Germany and thus adds to the limited research of FI among university students in Europe. The results may support better understanding of needs and demands of university students and guide policy interventions. For example, we found an

association between FI and university students that received student loans. Authorities or policy making bodies may be able to specifically address student loan recipients, e.g., with information material or offer low threshold support to enhance food security.

6. Conclusions

To sum up, FI seems to be more prevalent among university students compared to the general population in Germany. These results add to the already existing studies from other countries that came to the same conclusion of university students being an emerging at-risk population group. We could identify increasing age, being born outside of Europe, parents' highest education being lower than tertiary education, having a student loan and receiving food assistance as factors associated with higher odds of FI. Since not all variables that had a significant effect in other countries were significant for our sample, differences in determinants of FI between countries should be further analyzed.

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CRedit authorship contribution statement

Maike Kötzsche: Conceptualization, Methodology, Software, Validation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Ramona Teuber:** Supervision, Writing – review & editing. **Irmgard Jordan:** Supervision, Writing – review & editing. **Eleonore Heil:** Writing – review & editing. **Liv E. Torheim:** Project administration, Writing – review & editing. **Marta Arroyo-Izaga:** Project administration, Writing – review & editing.

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 will be made available on request.

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