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A Gender Study of Food Stress and Implications for International Students Acculturation

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Abstract: Acculturative stress can be a big problem for international students. Among the adaptation difficulties they may face, adjusting to new foods in a new environment is crucial to their well-being. Existing studies related to dietary acculturation point to gender differences, mostly on objective health impacts. Using the information processing approach, this study aims to examine the subjective perception of dietary acculturation difficulties, with a focus on the influence of social connectedness. Using the Bayesian inference approach with the Hamiltonian Markov Chain Monte Carlo (MCMC) technique on a sample of 268 students from a Japanese international university, we found that female students are more likely to have perceived difficulties in the process of adjusting to new foods, but social connectedness lessens this effect. We also found no significant differences between domestic and international students regarding perceived difficulties of food adjustment in this study site, likely due to its highly multicultural environment. We suggest international universities provide better information about the food situations on campuses, especially for female students, and organize more cultural exchange events and food-related social activities to help students overcome barriers of food stress.

Keywords: dietary acculturation; gender difference; acculturative stress; international student; multicultural environment

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1. Introduction

Our world is becoming increasingly interconnected. With the rapid advancement in transportation and information technology, globalization now affects various aspects of human society, such as the economy, education, and culture. People coming to a new environment will need to go through psychological adjustments related to their perceptions of new cultural values, which is the process of acculturation [1]. During the acculturative process, one receives and evaluates new values (as well as re-evaluates priorly integrated old values) to decide what to accept and what to reject as a natural mechanism to update one's mindset [2]. This process is often not easy and may cause acculturative stress to certain degrees [3–5]. Acculturative stress was found to be positively associated with depression [6–8], notably among international students [9,10]. Understanding the

difficulties people may face during the acculturative process can help create better support strategies to minimize negative effects.

Among the obstacles in the adaptation process, food stress is a serious issue. Food is an essential part of life, not only from the standpoint of nutrition and physical well-being but also from the perspective that cuisine is a major aspect of human culture. Each culture has different perceptions of the social, spiritual, and emotional values of food [11]. Coming to a new environment, people need to adjust to new food items and set up their nutrition plans accordingly. Sufficient helpful information is required in making such adjustments. In cases of international students, this can be provided through social channels such as digital social media platforms, which serve as important sources of information and psychological support during the acculturation process [12,13]. Without proper social support and good information, young adults can develop bad eating habits from dietary acculturation that negatively affect their health [14,15]. Overall, dietary acculturation is dynamic and complex, depending on various personal, cultural, and environmental factors [16].

The process of dietary acculturation can be difficult due to the influence of many different internal and external obstacles. These can include nutrition health awareness, personal preferences, the availability of traditional foods, as well as changes in methods of food preparation [17,18]. This points to the importance of social support to help people familiarize themselves with foreign cuisine cultures [19]. It is suggested that over time, dietary acculturation may lead to a shift in new eating habits different from one's original diet, which, in some studied cases, is influenced by the host country's dominant diet characteristics [20,21]. For international students, incorporating new foods without completely discarding the original diet creates a hybrid diet, with eating habits oscillating between the new and traditional dietary cultures [22]. Regardless of adaptation strategies, the changes in perceptions and behaviors toward cultural values within a multicultural environment are under the phenomenon of cultural additivity on both individual and social levels [23]. Thus, examining the social factors affecting dietary acculturation using an information processing framework for mindset shifting can provide helpful insights.

Regarding gender differences in food perception, studies have found that women are often more concerned about the health impacts and weight control aspects of food choice [24]. Additionally, women also tend to care more about the "virtuous" qualities of their food across different dimensions such as health, ethical issues, and body image [25]. Upon migration, women may worry about unfamiliarity with new food items, uncertainty about meal formats and food preparation, or religious food prohibitions, and thus tend to stick to those perceived as familiar or safe [26]. Such dietary concerns put a lot of pressure on women. Studies on international students in Japan found that females are at higher risk of depression [10,27]. However, having a higher level of consideration for food choices may help women achieve better health conditions. A study on food patterns of Korean immigrants in the United States found that women are less likely to be acculturated and less likely to be overweight than men [28]. Among Latinos coming to the United States, women also develop better diets compared to men [29]. In Filipino Americans adapting to Western diets, females were consistently found to have a lower body mass index (BMI) and waist–hip ratio [30]. For Chinese, Korean, and Vietnamese living in the United States, it was found that the association between acculturation and increased BMI is stronger among men compared to women [31].

While existing studies on dietary acculturation tend to focus on objective health impacts, the aspect of subjective perceptions in relation to social information exchange has not been well explored. In this present investigation, we examine possible gender differences in the perceived difficulties of dietary acculturation. As social connectedness is a predictor of the acculturative stress level [32], its influence in terms of information processing can help better explain the adjustment process. Thus, we conducted the present study on students from an international university with a highly multicultural campus environment (see the Study Site and Participants subsection for more details). This also helped investigate the food adjustment issues among both domestic and international students. To examine

the possible psychological mechanism underlying food stress perception in terms of information processing, the Bayesian Mindsponge Framework was employed (see the Model Construction and Statistical Analysis subsections for detailed rationale). Additionally, it is important to note that the data used in this current study were collected in 2018—before the COVID-19 pandemic—and all activities on the campus were normal at the time.

The study has the following research questions (RQs):

RQ1: Do international students experience more food stress compared to domestic students in a highly multicultural campus?

RQ2: Do female students experience more food stress due to dietary acculturation compared to male students?

RQ3: Does social connectedness influence the above relationship between gender and food stress?

In the Material and Methods section, we present the information-processing-based rationale for model construction, information about the study site and participants, and descriptions of the variables to be used in the statistical analysis. Technical validation and the results of the analysis are presented in the Results section. In the Discussion section, we present our arguments on the psychosocial factors and information processes related to food stress due to acculturation, as well as implications for policymaking.

2. Materials and Methods

2.1. Model Construction

We used the Bayesian Mindsponge Framework (BMF) to construct conceptual models and conduct statistical analysis on the acculturative process of adjusting to new food [33]. In detail, the Mindsponge mechanism [2] was used as the theoretical foundation for model construction, while Bayesian inference was utilized to fit the model.

The Mindsponge mechanism is an information processing framework of how the human mind receives, filters, and accepts (or rejects) new values [34], which can be used to explain acculturative processes effectively. In a new (and multicultural) environment, students need to absorb and evaluate new values to adjust their mindset accordingly, which is necessary for them to adapt, regardless of chosen strategies [35]. This framework was used to provide insights into how acculturative stress and social connectedness may affect university students' depression levels [10]. In the Mindsponge mechanism, there are two basic conditions for the mind to incorporate a new value: information accessibility (the mind can receive the information that carries values) and favorable evaluation (subjective cost–benefit judgments based on existing trusted values in the mindset resulting in a positive assessment of that value) [36,37]. The mindset updated with the newly trusted (accepted) values will affect the subsequent evaluation of similar values in the respective direction. This updating manner is what creates adaptation over time.

In the current investigation, the new values being examined are new foods, and the adjustment to them in this context is an acculturative process. Many factors with complex interactions affect how a student adjusts to new food during their university years in the new environment. Such factors can be personal preferences, food price, food availability, preparation methods, and health concerns, as well as many other social factors such as curiosity, eating with friends, cultural exchange, etc. In this study, we want to know if there is a difference between domestic and international students regarding perceived food adjustment difficulties. It should be noted that the study site is a highly multicultural environment (see the Study Site subsection below). Next, we focus on examining the gender-based difference, but we also want to see the moderating effect of social connectedness in terms of information processing. As presented in the literature review above, women tend to have a higher level of consideration regarding food choices, which may increase the perceived cost of adapting to new foods. Social connectedness has been shown to function as a "priority pass" that facilitates the processes of receiving and filtering new information in the Mindsponge mechanism [36,38]. Having access to a lot of helpful and trusted information can help ease the perceived difficulties during the process of the food

adjustment process in a new environment. On the basis of the reasoning above, we derive the following model:

$$FoodProblem \sim \alpha + Inter\_Dom + Gender + Gender * SocialConnectedness$$

2.2. Study Site and Participants

This study employed a dataset from the survey on students' mental health and social connectedness conducted at a multicultural international university. The data collection was conducted at Ritsumeikan Asia Pacific University (APU), an international university in Oita Prefecture, Japan, from October to December 2018. Regarding the campus environment, the students were from 86 countries and regions, and faculty members were from 22 countries and regions at the time of survey collection. International students accounted for around 50.1% of the whole university's students on campus during the survey period. The data have been employed and validated in several research papers [10,36,39,40].

The survey procedure strictly conformed to the World Medical Association (WMA) Declaration of Helsinki and was permitted by APU & Ethical Committee Board Approval Number 2018-03. The questionnaire was created and distributed using the web-based platform Google Forms. The questionnaire was available in both English and Japanese. The Japanese version was validated by an APU senior researcher in public health who was fluent in both languages. All international students studying at APU were required to be fluent in either language (the majority of them used English). Two of the authors gave presentations in the classrooms where the survey was distributed online. Before participants filled in the questionnaire, the survey's purpose, content, confidentiality, and the right to refuse to participate in the survey were clearly explained. Participants could quit the survey at any time by either choosing "Not agree" to the informed consent or not submitting the survey. The data were anonymized and processed using Microsoft Excel and later stored as a comma-separated values (CSV) file.

There were 201 international students (75%) and 67 domestic ones (25%) in the total sample of 268 students. The mean age of participants was 20.9. The percentages of female and male students were 63% (n = 170) and 37% (n = 98), respectively. A total of 92% were undergraduate students and 8% were graduate students. A total of 43% were first-year students, 45% had been staying in Japan for 2 or 3 years, and 12% had been staying for 4 years or more. The origins of international students were diverse, including East Asia, South Asia, Southeast Asia, America, and others. Among all regions, the majority of students were from Southeast Asian countries (including Indonesia, Vietnam, Thailand, etc.), accounting for 45.5% of the total participants (n = 122). International students from East Asian countries (e.g., China, South Korea, etc.) accounted for 17.9% of all participants (n = 48), whereas the percentage for South Asian countries (e.g., India, Bangladesh, etc.) was 6.7% (n = 18). A complete description and validation of the dataset can be viewed in the article "A Dataset of Students' Mental Health and Help-Seeking Behaviors in a Multicultural Environment" [39]. The dataset is openly accessible online, which helps with transparent and cost-effective scientific cross-checking or reproduction [41].

2.3. Variable Description

Within the dataset, we purposely chose variables that could help explain the acculturative process regarding adjusting to new food among international and domestic students. In total, we employed four variables. A description of each variable is presented in Table 1.

Table 1. Variable description.

Name	Variable	Type of Variable	Description
Feeling uncomfortable in adjusting to new foods	*FoodProblem*	Continuous	The score of having stress when encountering new foods. The data range from 1 (low) to 5 (high).
Social connectedness	*SocialConnectedness*	Continuous	The total score of social connectedness (8 items) was measured by the Social Connectedness Scale developed by Lee and Robins [42]. The original values range from 8 to 48, which were then divided by the total item number to better fit the model.
Gender of student	*Gender*	Binominal	Gender of students: Male or female. "Female student" is coded as 1, and "Male student" is coded as 0.
Type of student	*Inter_Dom*	Binominal	Type of student: International student (Inter) or domestic one (Dom). "International student" is coded as 1, and "Domestic student" is coded as 0.

We generated an additional variable *Gender_SocialConnectedness* besides the above variables (Table 1) from the dataset. The variable *Gender_SocialConnectedness* is the interaction between two variables *Gender* and *SocialConnectedness*, which is used to examine their influence on *FoodProblem*. The outcome variable *FoodProblem* was based on the answers to the single question "I feel uncomfortable to adjust to new foods". Respondents chose one of five response options: "Strongly disagree", "Disagree", "Not sure", "Agree", and "Strongly agree". These responses were coded as 1, 2, 3, 4, and 5, respectively. The question was based on the Acculturative Stress Scale for International Students proposed by Sandhu and Asrabadi [43].

Students' social connectedness is measured by asking eight questions about feelings of connection to others in their social environment, which is demonstrated by the Social-Connectedness variable. The social connectedness level was rated based on a 6-point Social Connectedness Scale ranging from 1 ("Strongly disagree") to 6 ("Strongly agree"), developed by Lee and Robins [42]. Examples of the questions in the Social Connectedness Scale are "I feel so distant from people", "I have no sense of togetherness with my peers", "I don't feel related to anyone", etc. [42]. Regarding internal consistency, Cronbach's alpha for this scale in this dataset is 0.95 [10]. The two demographic variables Gender and Inter_Dom are determined by asking respondents, "What is your gender?" and "Are you a domestic student or an international student?", respectively.

2.4. Statistical Analysis

For assessing the food acculturative issue in students, the data were analyzed using the Bayesian analysis method with the Hamiltonian MCMC (Markov Chain Monte Carlo) technique. There are three main reasons for employing the Bayesian method in this study. First, since the evidence in the current study is novel, the Bayesian's updating capability can benefit future similar studies [44,45]. Second, since the Bayesian inference approach treats all the properties probabilistically, including unknown parameters, it aids the construction of parsimonious models [44]. By incorporating the power of the MCMC technique, Bayesian methods can fit a wide variety of models, such as multi-level correlation structures and non-linear regression frameworks, making flexibility a major advantage [46]. Finally, since the sample size in the dataset was small, the Bayesian MCMC simulation technique also helped enhance the estimation's precision [47]. Given these features, the Bayesian MCMC approach is highly compatible with the Mindsponge framework, and thus, the BMF was employed.

The data were analyzed using R software (version 4.0.2) with the *bayesvl* package [48,49]. The package was chosen due to its good visualization power and user-friendly, transparent

operation. The analysis was run using 5000 iterations (including 2000 warm-up iterations), four Markov chains, and four cores. To check the model's goodness-of-fit, we employed the Pareto smoothed importance-sampling leave-one-out cross-validation (PSIS-LOO-CV) approach [50]. We checked the Markov property with effective sample sizes, Gelman factors, and several visualized plots (see Results section). Because this is the first exploratory study of its scope and method, all estimations' priors were set as uninformative [45], which is equivalent to a normal distribution with mean = 0 and standard deviation = 10. We also performed the "prior-tweaking" technique to check the model's robustness. To do this, we reran the analysis using prior distributions demonstrating two cases of belief and disbelief toward the acquired results of a parameter. If the differences in the simulated results are small and negligible, the posterior results can be considered robust.

3. Results

To test the hypothesis, we examined the model as presented in the Model Construction subsection. The model examined the effects of students' gender and its interaction with social connectedness, and the type of student (international or domestic student) on the perceived difficulty of adjusting to new food. The model's logical network is shown in Figure 1.

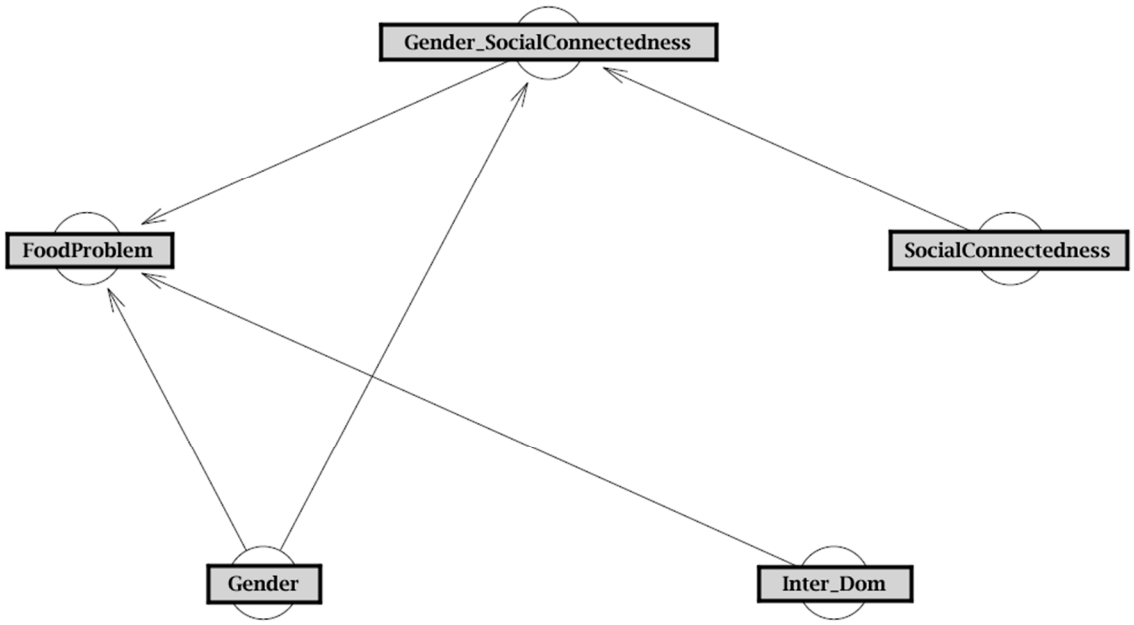

Figure 1. The model's logical network.

The PSIS diagnostic plot shows that all k values are below 0.5, implying that the model has a high goodness-of-fit with the data (see Figure 2).

All parameters show a good convergence since the effective sample sizes (n_eff) are greater than 1000, and Gelman shrink factors (Rhat) all equal one (see Table 2). Furthermore, the convergence was also confirmed visually using trace plots, Gelman plots, and autocorrelation plots (see Figures 3–5).

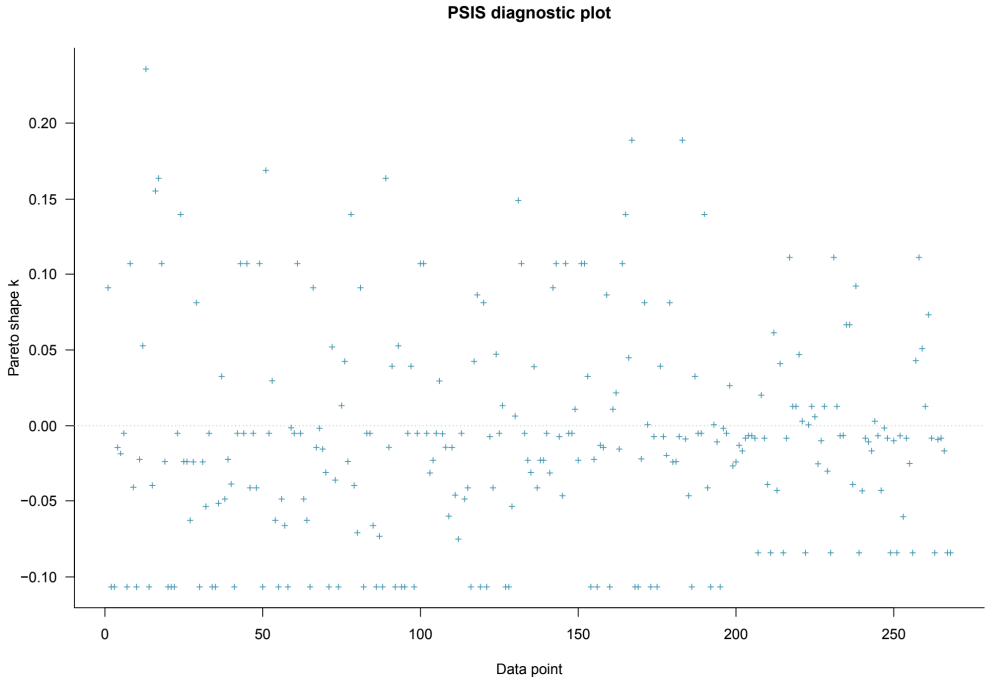

Figure 2. The model's PSIS diagnostic plot.

Table 2. The model's simulated posteriors.

Parameters	Uninformative Prior		Prior-Tweaking (Belief on Effect)		Prior-Tweaking (Disbelief on Effect)		N_eff *	Rhat *
	Mean	SD	Mean	SD	Mean	SD		
FoodProblem	1.75	0.14	1.76	0.14	1.75	0.14	5959	1
Inter_Dom	−0.04	0.13	−0.04	0.13	−0.04	0.13	6347	1
Gender	1.03	0.30	1.07	0.30	0.99	0.30	5730	1
Gender_SocialConnectedness	−0.19	0.06	−0.20	0.06	−0.18	0.06	5793	1

* n_eff and Rhat values presented in the tables are the effective sample sizes and Gelman values taken from the simulated results using uninformative prior.

The trace plots in Figure 3 show the Markov chains fluctuating around a central equilibrium (posterior values on the *y*-axis over iterations on the *x*-axis), indicating that the chains converge well.

As shown in Figure 4, the shrink factors rapidly drop to one during the warm-up phase, meaning that the average variance between chains and the average variance within chains are similar, which indicates good convergence [51]. Additionally, we can observe in Figure 5 that the autocorrelation for each parameter is quickly eliminated, which again confirms the healthy Markov property of the chains.

Regarding gender, females were found to be positively associated with a higher level of perceived difficulties in adjusting to new food (μ_{Gender} = 1.03 and σ_{Gender} = 0.30). However, the interaction with social connectedness produced a negative value, suggesting social connectedness lessens the effect of gender on food problems ($\mu_{Gender\_SocialConnectedness}$ = −0.19 and $\sigma_{Gender\_SocialConnectedness}$ = 0.06). The impact of the type of student (domestic or international student) was found to be not significant toward food acculturative problems (μ_{Inter_Dom} = −0.04 and σ_{Inter_Dom} = 0.13). The posterior distributions of *Gender* and *Gender_SocialConnectedness* fell entirely on the positive and negative, respectively, indicating the high reliability of the results (see Figure 6). We can also see that the majority of simulated samples are located on the positive side for *Gender* (*x*-axis) and the negative side for *Gender_SocialConnectedness* (*y*-axis) in the pairwise distribution graph (see Figure 7). We can also confirm the result's reliability

through the demonstration of the 95% highest posterior density intervals (HPDIs), as shown in Figure 8.

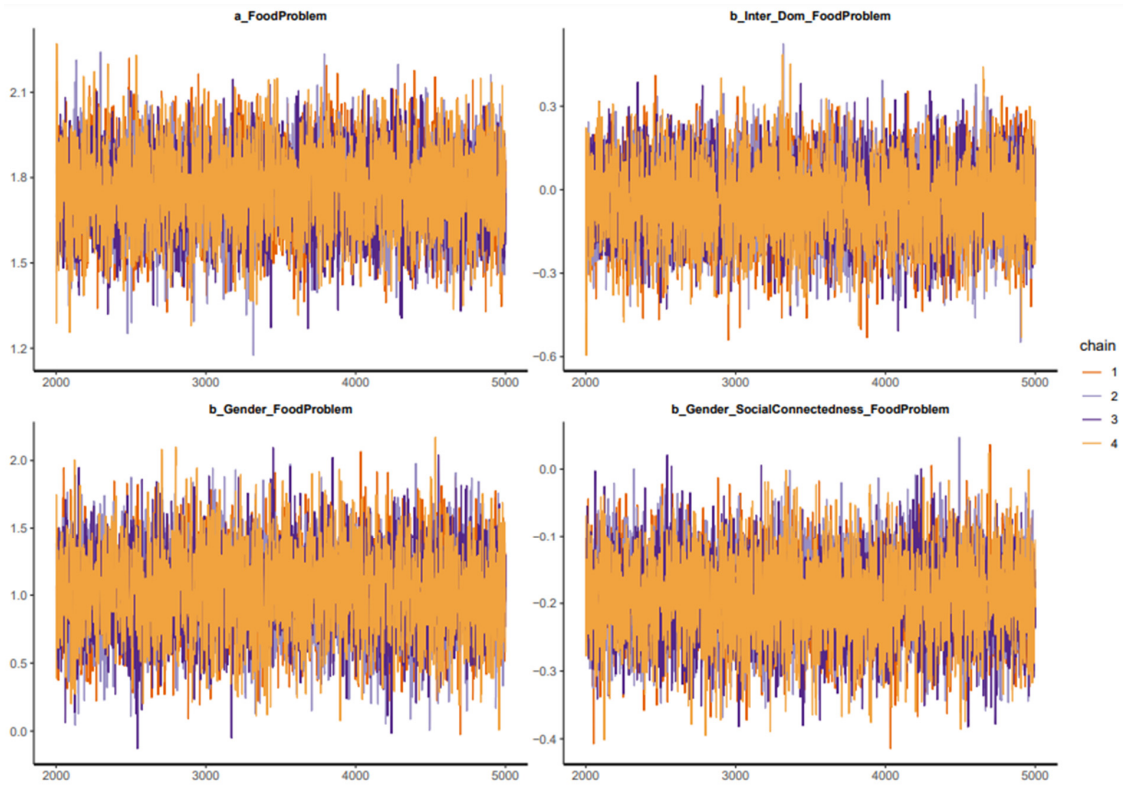

Figure 3. Trace plots for the model's posterior coefficients.

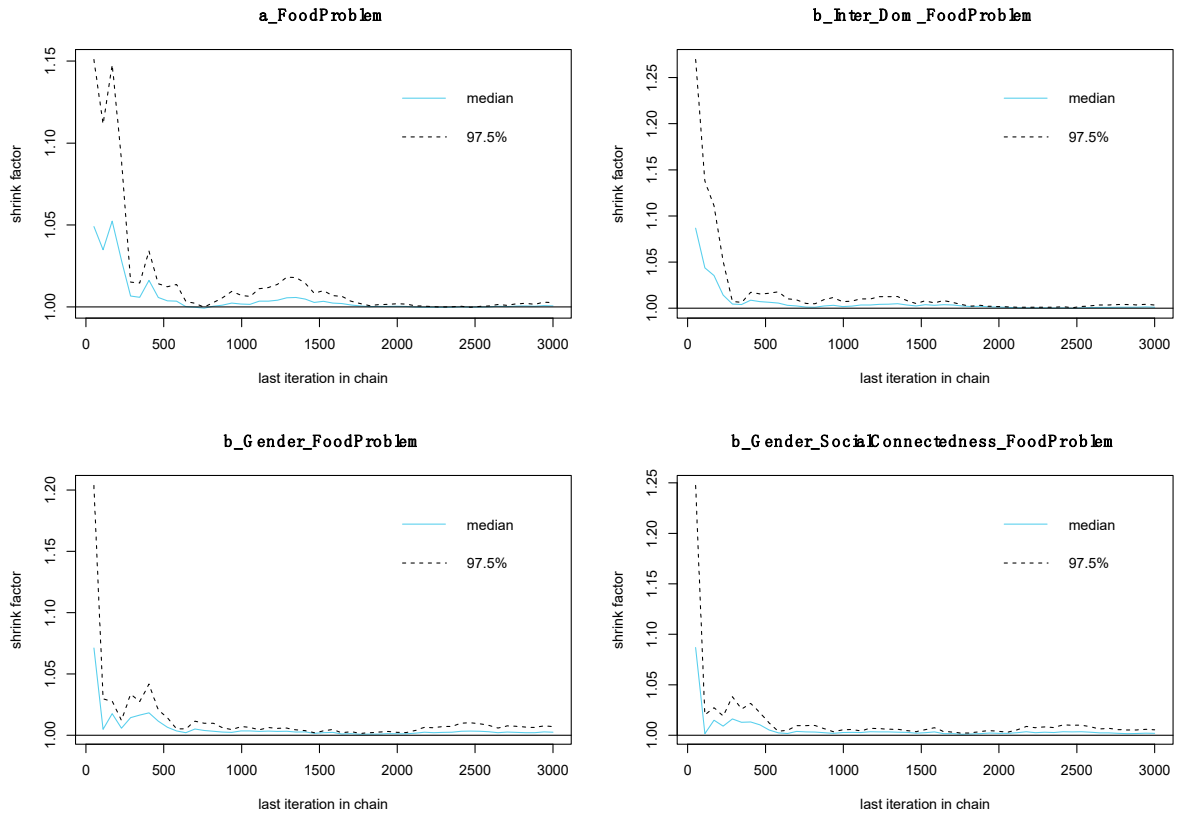

Figure 4. Gelman plots for the model's posterior coefficients.

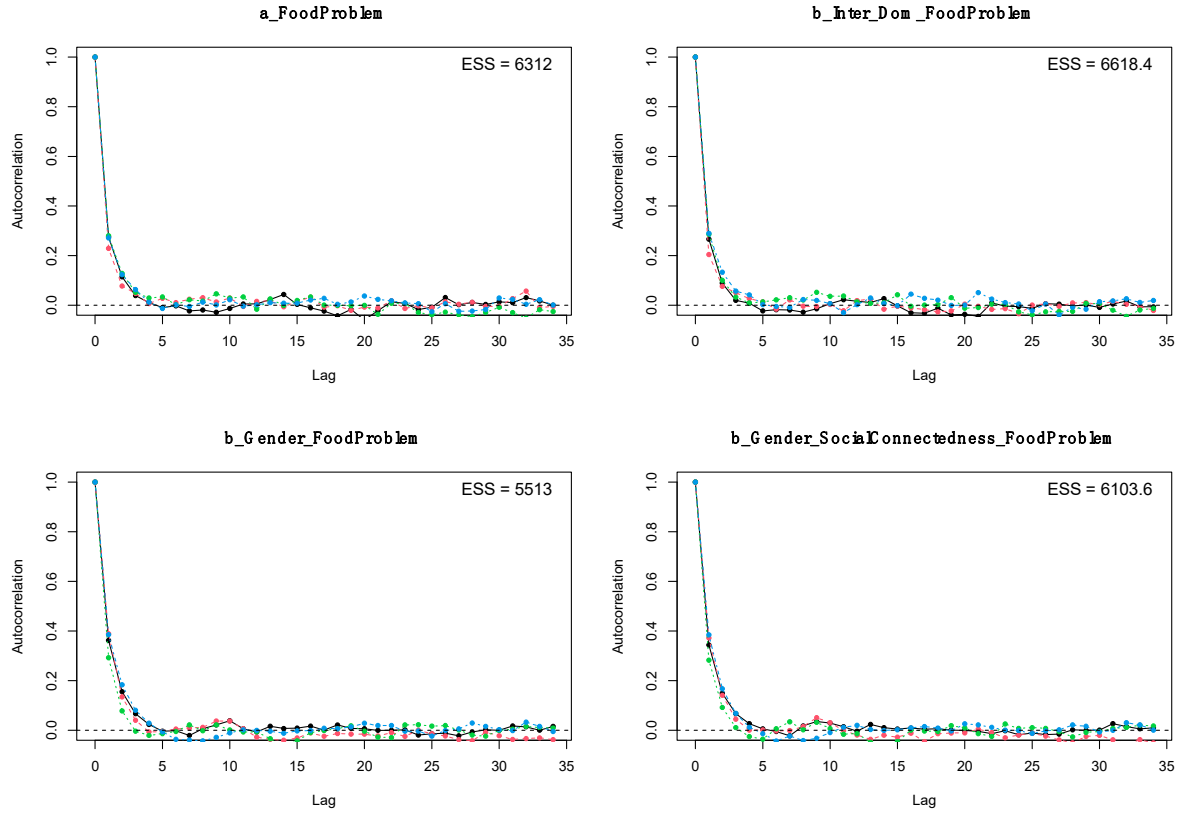

Figure 5. Autocorrelation plots for the model's posterior coefficients.

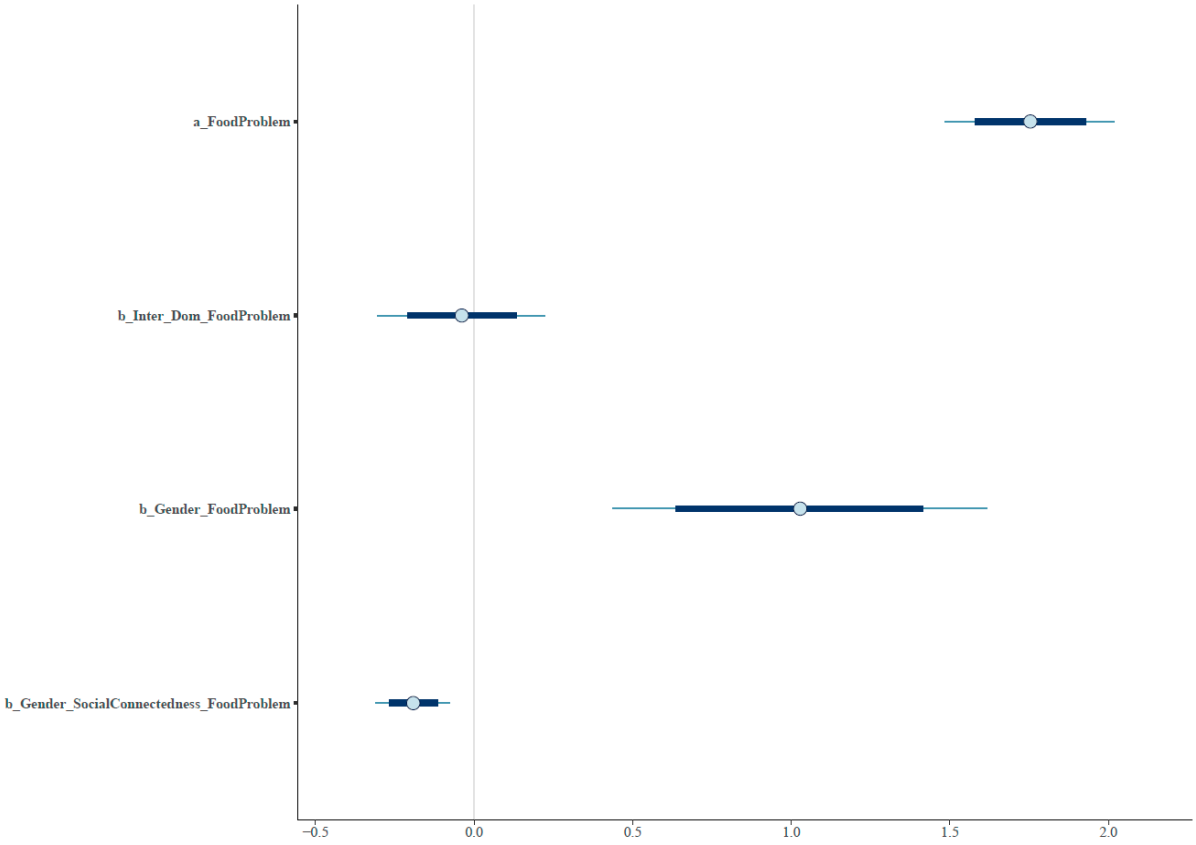

Figure 6. Interval distributions of the model's posterior coefficients.

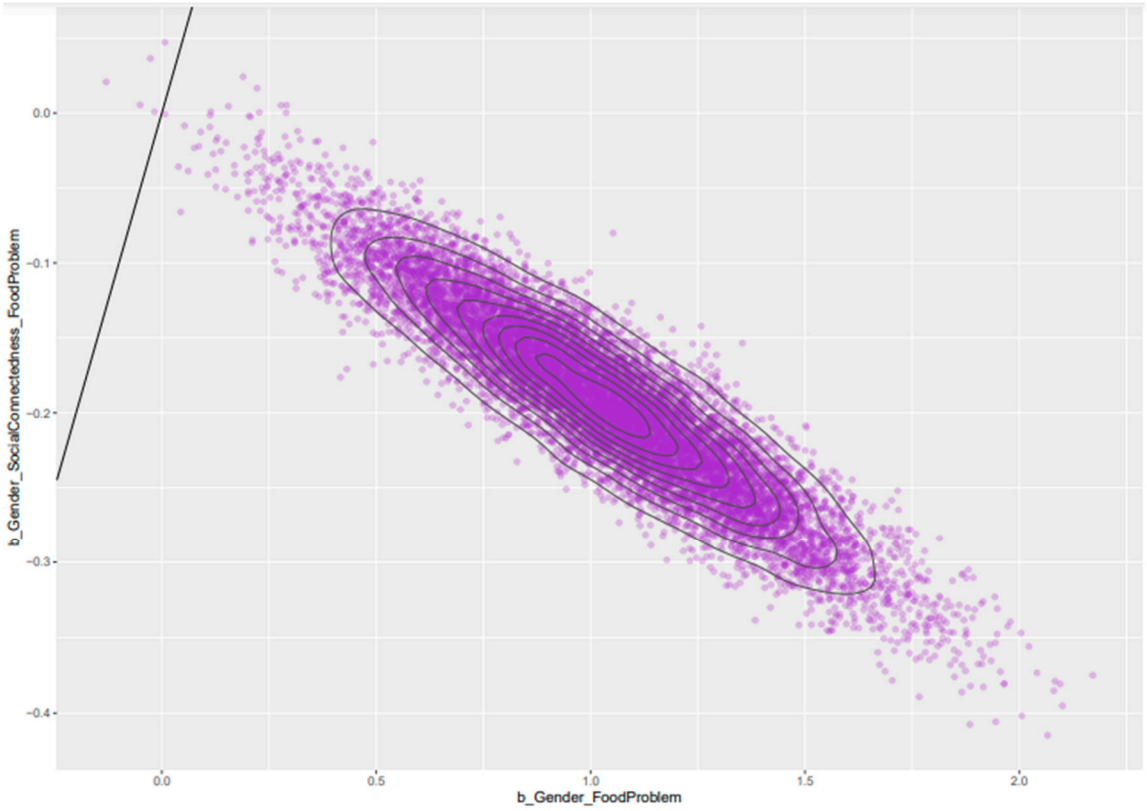

Figure 7. Pairwise distribution plot for *Gender* and *Gender_SocialConnectedness*.

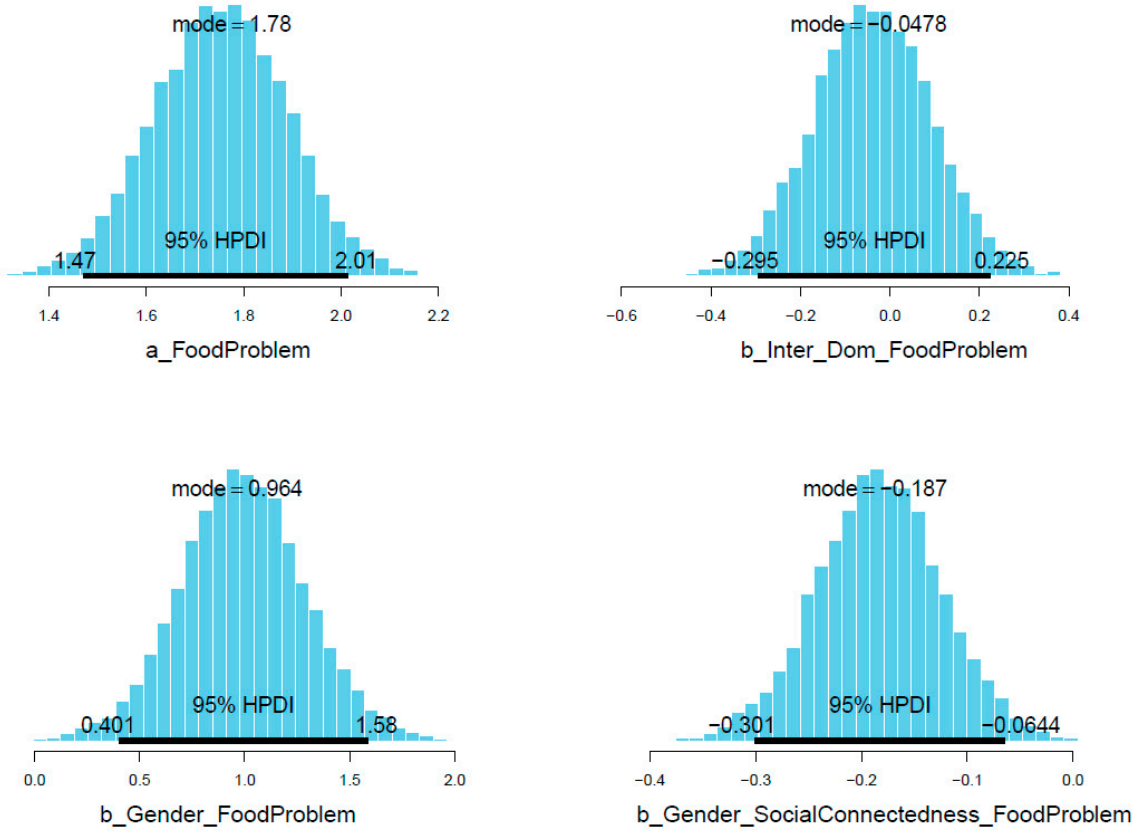

Figure 8. Distributions of the model's coefficients with HPDI 95%.

To check the robustness of the model, we performed the prior-tweaking technique on *Gender_SocialConnectedness* using two prior distributions: belief on effect and disbelief on effect. The prior demonstrating our belief that the moderation effect of *Gender_SocialConnectedness* is positive was set using a normal distribution with a mean of −0.5 and a standard deviation of 0.3. The prior demonstrating the disbelief about the moderation effect was set using a normal distribution with a mean of 0 and a standard deviation of 0.3. The simulated results using informative priors are almost similar to the generated results employing uninformative priors (see Table 2), which indicates the model's high resistance to initial changes in priors. In other words, the model can be deemed robust.

4. Discussion

Our analysis result shows no significant difference between domestic and international students regarding the perceived difficulties in adjusting to new food. This result should be interpreted carefully since it is heavily dependent on context. While some former studies only focused on examining the acculturative effects on international students or immigrants coming to the host countries [19,20], our study investigates both domestic and international students in a highly multicultural environment. To elaborate, at the time of data collection, about half of the total student population on campus were international students (see the Methodology section). Asian dietary culture in general can be quite different from that of the West where high-calorie foods and dairy products have a relatively higher consumption frequency [52]. Even within the East Asia sphere, the dietary cultures of different countries vary to certain degrees [53]. Cultural values are reinforced collective values in specific infospheres (societies). As these values in one's mindset influence the evaluation of related information, higher degrees of value deviation will likely face a stricter filtering process [33]. Thus, students who are sensitive regarding dietary changes are likely more affected by differences in dietary cultures and food items.

APU regularly held social events (such as Multicultural Weeks) co-organized by students to introduce and exchange the cultural values in every country or region [54]. Foods from various cultures are accessible to all students not only during these events but also through the school cafeteria's diverse menu, as well as many independent food vendors on the campus. There are also usual informal shared cooking activities among domestic and international students in the university's dormitory, which follows the university's cultural exchange system, especially for first-year students. Additionally, the local government has been supporting cultural diversity, and a wide range of foreign food items are available in non-Japanese restaurants and supermarkets across the town. In this highly multicultural environment, all students, domestic and international, have access to food items that are unfamiliar to them. Here, not only international students can incorporate the host country's foods into their new diets [22] but domestic students can (and are socially encouraged to) incorporate foreign foods into their hybrid diets too. Thus, in this particular environment, the acculturative process regarding food can be applied to all students regardless of their origins.

Regarding gender differences, we found that female students are more likely to perceive difficulties in the process of dietary acculturation; however, a higher level of social connectedness helps lessen this effect. Several characteristics may help explain why female students may find it harder to adjust to new food. Women are relatively more selective regarding food choices due to a higher level of concern about nutrition, body image, and ethical implications [24,25]. As women may exhibit stronger reactions to stressors [55], their concerns about food choices can increase perceived difficulties in adapting to diet changes. Additionally, women may be more risk-averse compared to men [56], which can make them hesitant to try new foods and nutrition plans [26]. Another study suggested that this risk-aversion attitude is self-assessed [57], but subjective assessments would still affect the ideation of perceived risks. Humans decide their behaviors based on intentions [58,59], which in turn are determined by the trust-based subjective cost–benefit judgments of the action's perceived value [60]. Adjusting to new diets takes a lot of effort [17,18], and these

psychological characteristics may add more to the perceived cost of such decisions and will be expressed as uncomfortable feelings. In other words, their intentions and behaviors of adapting to new foods are more likely to cause cognitive dissonance.

How does social connectedness help female students better cope with food adjustment? Women may perceive a lower level of social support than men during the acculturative process [61]. However, they may rely more on collectivistic approaches in dealing with acculturative stress [62]. This suggests that a stronger feeling of being connected to other people can help female students find the adaptation process less stressful. In terms of the information processing mechanism, a sense of connectedness was shown to have the role of a "priority pass" that speeds up the process of receiving and filtering information, increasing the probability of external information absorption and the acceptance of values into one's mindset [36]. Adaptation requires a lot of information from many sources as well as rigorous processes of filtering such information [34]. In this case, they are food-related information such as taste, nutritional properties, availability, price, preparation methods, attached cultural, religious, and ethical values, etc. Adjusting to new diets in a new living environment is not as simple as trying the items to see if one likes them or not but rather is a complex assessment based on related perceived values in various aspects (a Mindsponge process of adaptation). Therefore, a higher level of social connectedness will make it easier to gather information from social groups or ask for advice from other people about food. The willingness to connect socially also increases trust toward the information sources [38], which helps students accept and integrate the values of new foods and dietary changes easier.

These results have several implications for policy on acculturation and international education. In a highly multicultural environment, everyone is exposed to new cultural values. As the world is becoming more globalized, managing international environments for education, business, or living requires careful consideration of the effects of acculturation on all population groups. For international university campuses, besides a sufficient supply of diverse food items from many cultures, more specific information about food situations (variety, availability, etc.) in the living environment (campus and local places) should be provided to students in advance. Additionally, because gender inequality issues are still a big concern in the globalization context [63], our study shows that there needs to be more support for female students regarding acculturation-related difficulties. Here, providing professional advice about the nutritional values, health impacts, diet structures, and ethical implications of new foods can help female students assess their related concerns in a faster and healthier manner. Social activities such as cultural exchange events or cooking and eating together can increase the level of social connectedness among students in the new environment, helping them provide each other with information as well as practical support.

The current study's limitations are presented here for transparency. The sample we use for analysis is small and has a higher female-to-male ratio. However, we employed the Bayesian MCMC approach to help increase the simulated results' precision. Additionally, the number of APU international students with Asian origins is higher than those from other regions; thus, this environment may not represent all cultures equally and sufficiently.

5. Conclusions

Dietary acculturation is an important issue in our increasingly globalized world. Many studies in this field focus on the objective health impacts of changes in eating habits. Our study provides a different perspective on the issue by employing the information processing approach to examine the psychological aspects. Our findings show that female students tend to have more perceived difficulties in adjusting to new foods, but the moderating effect of social connectedness helps lessen this association. Helpful, trusted information from social channels can support female students in overcoming food stress due to their relatively higher dietary concerns. Interestingly, we also found that in a highly multicultural environment where foreign foods are widely available, domestic students also find it equally

difficult to adjust to new foods. On the basis of the findings, we suggest that educational institutions and migration policymakers should pay more attention to the subjective aspects of dietary acculturation and provide more cultural exchange opportunities.

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