1. Introduction

Cooking skills are defined as a combination of the confidence, attitude, and knowledge of individuals in performing cooking tasks. These tasks involve planning menus, shopping, and preparing unprocessed (fresh foods), minimally processed (e.g., polish in rice, fermentation in cheese and yogurt), processed (e.g., canned foods with added salt or sugar, industrialized bread), or ultra-processed foods (Jomori et al., 2018). Ultra-processing is related to techniques which transform the original food, adding a lot of preservatives, salt, sugar and fat, to help with preservation, storage and distribution, generally, making the food ready to eat (Brazil, 2014). High levels of the use cooking skills are associated with an increase in the consumption of fresh fruits and vegetables, which may be related to healthy eating habits among adults and adolescents (Caraher et al., 1999; Laska et al., 2012; Utter et al., 2018; Wolfson & Bleich, 2015).

Processes involved in individual meal preparation (planning, transportation, shopping, preparing, and cleanup) were described as being an 'overwhelming responsibility' (Murray et al., 2016) aside from other barriers to cook among university students, leading them to have low cooking skills and low meal preparation frequency (Bernardo et al., 2017; Murray et al., 2016; Wilson et al., 2017; Sprake et al., 2018; de Borba et al., 2021), low consumption of fruits and vegetables, and high intake of fast foods, snacks, deep-fried foods, refined grains, sweets, carbonated, and other sugar-sweetened beverages (Bernardo et al., 2017).

Low cooking skills and low frequency of meal preparation or behaviors are related to poor diets, with low consumption of fruits and vegetables, high consumption of ultra-processed foods, meals away from home, take-way and fast food, related to high energy-dense food intake in these population (Bernardo et al., 2017; Bezerra et al., 2020; de Borba et al., 2021; Graham et al., 2013; Knol et al., 2019; Lavelle et al., 2016; Santos et al., 2015; Sprake et al., 2018; Utter et al., 2018; Vilela et al., 2014; Wilson et al., 2017). Additionally, factors related to greater access, convenience and consumption of ready-to-eat foods (ultra-processed foods) can be identified, such as difficulties in accessing healthy foods and fresh fruits and vegetables, lack of time, money, kitchen facilities, knowledge, and confidence to cook, and their living arrangements (Graham et al., 2013; Jones et al., 2014; Knol et al., 2019; Murray et al., 2016; Pulz et al., 2017; Sprake et al., 2018; Utter et al., 2018; Wilson et al., 2017).

Recommendations to promote healthy eating practices, encouraging meal preparation and the development of cooking skills are found in the United Kingdom (Tsouros et al., 1998; Dooris & Doherty, 2010; Community Food and Health Scotland, 2013), Northern Ireland (Food Standards Agency, 2012), Canada (Chenhall, 2010), in the United States of America (USDA, 2013) and in Brazil (Brasil, 2014). The Health Promotion Universities Network (REDUPS) that operate in collaboration with the Pan American Health Organization (OPAS/OMS) (REDUPS, 2013) has a commitment to health promotion in the university environment (Dooris & Doherty, 2010; Oliveira, 2017; REDUPS, 2013; Soares et al., 2015; Tsouros et al., 1998; WHO, 2015). In Brazil, the accreditation of universities at RIUPS is being implemented (Oliveira, 2017). One of the strategies to promote healthy eating practices among university students to achieve the recommendation of these documents could be to develop or improve their cooking skills and encourage them to prepare their own meals frequently (Bernardo et al., 2017; Wilson et al., 2017) or offer healthy foods at canteens and cafeterias (Pulz et al., 2017).

One of the concerns in promoting these policies is based on the barriers to cooking that students face ranging from access to food to the application of skills, as mentioned before (Jones et al., 2014; Wilson et al., 2017). Due to the COVID-19 pandemic, a suspension of presential classes and academic activities at universities have been put in place. As a result, university students have been affected by food insecurity, probably because many of them have lost their part-time jobs and have not been registered by student assistance programs, as well as the inaccessibility to university cafeterias that were closed during the pandemic. This requires the planning, purchasing, and preparation of their own food (Owens et al., 2020).

In this context, long periods at home require knowledge and skills to plan and prepare meals or any culinary involvement. Young people tended to increase their consumption of ultra-processed foods and reduce their consumption of fresh foods during the pandemic (Jribi et al., 2020; Owens et al., 2020; Ruiz-Roso et al., 2020). On the other hand, purchases of ready-made meals, such as instant ‘TV dinner’, were reduced during the pandemic by Italian individuals, although ultra-processed food’s consumption (e.g., chocolate, ice-cream, desserts, and salty snacks) has been increased (Scarmozzino & Visioli, 2020). Moreover, studies have shown that working and studying from home can increase the frequency of home cooking and homemade-

recipes, reduce the food waste, and encourage attention to food behaviors (Deschasaux-Tanguy et al., 2020; Di Renzo et al., 2020; Gerritsen et al., 2020; Restrepo & Zeballos, 2020; Reyes-Olavarría et al., 2020; United Nations, 2015).

It is important to consider social and individual characteristics that influence the cooking skills and meal preparation. A systematic review involving 38 papers about the relationship of social determinants and home cooking showed that the main determinants included gender (women and girls are more likely to be involved in cooking than men and boys), greater available time to cook and employment (those who have restrictions in time or working more tend to cook less than who have greater available time), close personal relationships (those who live with a partner or children were more likely to cook) and culture and ethnic background (Mills et al. 2017).Short and Gatley make the point that wider structural and economic determinants in the food environment influence both the acquisition and use of cooking skills (Gatley, Caraher and Lang 2014; Short 2006)

To improve university students' diets, it is necessary to increase their consumption of fresh foods, such as fruits and vegetables, rather than ultra-processed foods (Graham et al., 2013; Knol et al., 2019; Larson et al., 2006; Laska et al., 2012; Sprake et al., 2018; Utter et al., 2018; Wilson et al., 2017). However, it is important to consider the difficulty in preparing fresh foods, as they require the use of basic pre-preparation cooking techniques to scratch cook, as well as individual factors (i.g. attitude, confidence and knowledge to cook) (Jomori et al., 2018).

Researchers have identified the need for increases culinary skills and their usage among young people to improve their diet during this period when they are at home for long periods of time (Jribi et al., 2020; Owens et al., 2020; Ribeiro et al., 2020; Ruiz-Roso et al., 2020). However, to our knowledge, none of these studies have evaluated meal consumption and preparation related to their level of culinary skills and healthy eating practices during the pandemic. Therefore, it is an opportunity to identify the students' level of culinary skills and relate them to their characteristics and the food environment during the COVID-19 pandemic (Fulkerson et al., 2019; Owens et al., 2020; Rathi et al., 2018; Ribeiro et al., 2020; Ruiz-Roso et al., 2020).

In this context, this study aimed to estimate the probabilities of meal preparation and the place of consumption by university students before and during the COVID-19 pandemic, according to their individual characteristics and cooking skills.

1. Methods

1.1. Study design and participants

This descriptive cross-sectional study was conducted from June to August 2020, with undergraduate students from the Federal University of Rio Grande do Sul (UFRGS) and Federal University of Santa Catarina (UFSC), Brazil. Based on the total number of students enrolled at UFSC (n = 30,000) and UFRGS (n = 31,000), a minimum of 830 and 731 students, respectively, were calculated to be required bearing in mind a possible 10% loss, 2.0 effect, and 5% random error (Jomori et al., 2017).

The eligibility criteria were the enrollment in any undergraduate course at this institution. Those enrolled in postgraduate courses or those who did not answer all the questions provided in the questionnaire were excluded from analysis.

This study was approved by the Human Research Ethics Committee of the Federal University of Santa Catarina (UFSC) and Federal University of Rio Grande do Sul (UFRGS) under the approval number 09427219.5.3001.0121. Participants provided online informed consent prior to all analyses and were assured that all data would be used only for research purposes.

1.2. Measurements

The Brazilian Cooking Skills and Healthy Eating Questionnaire (BCSQ) was used to assess cooking skill levels. The BCSQ is an adapted and validated questionnaire for the Brazilian population (Jomori et al., 2017; Jomori et al., 2022). The questionnaire was shortened to 36 items and was distributed across seven factors, incorporating all items and structure from the U.S. version, as shown in supplementary material. Higher value of measures indicated higher cooking skills practiced or used.

1.3. Recruitment and data collection

The participants were recruited between June and July 2020 through university e-mail distribution lists and social media related to undergraduate courses, containing messages with a link and a quick response code (QRcode) to easily access an online questionnaire.

The participants voluntarily completed the online questionnaire. The total number of answers and distribution per course was observed and controlled until the established sample size was achieved. *For those courses that had no or few answers, the questionnaire was resent through e-mail asking to the course coordinators asking them to send the the study details to their students in order to have a heterogeneous sample between the different study areas. When sufficient numbers of participants from these courses were achieved, data collection was stopped*. The data collected included the following variables: gender (male or female); living arrangement (alone, colleagues, parents, or partner); frequency (never, 1 to 2 times a month, once a week, several times a week, or daily) of meal preparation (homemade meals prepared with fresh ingredients, homemade meals prepared with ultra-processed food, homemade meals prepared with fresh ingredients combined with ultra-processed food); consumption (fast food or delivery); self-reported cooking knowledge (yes or no); availability and accessibility of fruits and vegetables (low, medium, or high), cooking skills (low, medium, or high); and cooking knowledge (low or high).

1.4. Data analysis

Bayesian multilevel ordinal regression models were used to estimate the probabilities of meal preparation and local consumption by Brazilian university students before and during the COVID-19 pandemic, according to their individual characteristics and cooking skills. *A Bayesian approach considers parameters as random variables. It estimates the probability distribution based on the data available and the prior distribution information that measures the uncertainty about parameters (McElreath, 2015). Taking into account the different sources of inferential uncertainty, Bayesian methods allow for combining the known information before seeing the data (i.e., the prior uncertainty concerning a parameter or hypothesis expressed as a probability distribution). Then this is identified from the observed data (i.e., the likelihood of the*

data conditioned on the parameter or hypothesis) to update knowledge expressed as the posterior distribution (Lee; Wagenmakers, 2013; Kennedy; Gelman, 2020).

Bayesian data analysis reallocates credibility across the possibilities. It allows the combination of prior knowledge with the observed data, resulting in what is called posterior distribution (Kruschke & Liddell, 2018), as well as reducing bias and variance for posterior estimates (Gao, Kennedy, Simpson, & Gelman, 2020). Additionally, the use of multilevel regression models advances over traditional regressions (i.e., considers data structure at just one level) by considering the nested data structure and the different sources of variation (i.e., within and between groups) (Gelman & Hill, 2007).

The use of ordinal models also lies on the structure of the questionnaire, which our dependent variables are peoples' responses on ordinal categories. Although these variables are not metric, researchers commonly analyze them as metric responses, which can cause misinterpretation of the results (Liddell & Kruschke, 2017). Additionally, Bayesian multilevel ordinal models has been recommended as a better option for analyzing rating, which allow for unequal distances between responses (Verissimo, 2021).

The responses about university students' food consumption and place of consumption of the main meal were estimated across time by gender (female and male), age group (< 24 years old and > 25 years old), self-reported cooking knowledge (yes or no), living arrangements (alone, colleagues, parents, or partner), cooking ability (low, medium, or high), and cooking knowledge (low or high). Models were fitted using "time" (before and during COVID-19) as a fixed effect (population-level effect). To regularize the estimations, weakly informative prior distributions, normal prior (0, 10) for population-level effects, and normal priors (0, 1) for group-level effects were used. Additionally, to guarantee the Markov's convergence, two chains were run for 4000 iterations with a warm-up length of 1000 iterations. The analysis was performed using the BRMS package (Burkner, 2017) in R (R Core Team, 2018).

Cooking ability was derived from the Likert's measures CA, CB, SEPC, SEC, and SEFVS scored between 1 and 5 points. One question on the CA scale had a reversed score. Total scores were calculated and ranged from 20 to 100 points. Based on the sum, the classification of individuals was high cooking skill level (> 73 points), medium (44 – 73 points), and low (< 44 points). Cooking knowledge was calculated

188 based on responses where the correct answer was scored 1 point. A total score of six or
189 higher was characterized as having high cooking knowledge (Jomori et al., 2022).

190 It is important to note, when interpreting the results, that estimates are expressed
191 in standard deviation and can be interpreted as a standardized effects size. Additionally,
192 reference categories are fixed as one and interpretations of standardized effect sizes are
193 based on these categories. The literature recognizes that the interpretation of such
194 effects is not immediately obvious. Thus, results are plotted to have a natural metric
195 interpretation (Burkner & Vuerre, 2019).

196 **Results**

197 A total of 1919 students were eligible for the present study out of the 2061 total
198 students who responded to the online survey. Participants were aged 23.9 (± 6.8) years
199 on average, and the majority were female (73.48%), living with parents (48.93%), and
200 believed that they knew how to cook (92.03%). The demographic and cooking
201 characteristics are presented in Table 2.

202 **Table 1.** Demographic and cooking characteristics of the students from two
203 Brazilian universities (n=1919).

Variables	N	SD or %
Age (years)	23.9	6.8
Gender		
-Female	1410	73.48
-Male	509	26.52
Living Arrangement		
-Alone	348	18.13
-With Parents	939	48.93
-With Partner	248	12.92
-With Colleagues	384	20.01
Do you believe that you know how to cook?		
- Yes	1766	92.03
- No	153	7.97

204 SD: standard deviation

205 Table 3 shows the cooking skills and healthy eating characteristics, such as the
206 level of availability of fruits and vegetables, cooking skills, and cooking knowledge.

Most participants reported high availability of fruits and vegetables (73.01%), high levels of cooking skills (70.71%), and approximately half of them had high scores for cooking knowledge (50.65%).

Table 2. Level of availability of fruits and vegetables, cooking skills, and cooking knowledge of Brazilian university students (2020).

Measures	N	%
Availability and Accessibility of Fruits and Vegetables (AAFV)		
-Low	110	5.73
-Medium	408	21.26
-High	1401	73.01
Cooking skills		
-Low	14	0.73
-Medium	548	28.56
-High	1357	70.71
Cooking knowledge		
-Low	947	49.35
-High	972	50.65

Multilevel ordinal regression models were plotted (Figures 1-5), and the estimates and confidence intervals are presented in Supplementary Table 1. The response categories are presented as 1 (never), 2 (1 to 2 times a month), 3 (once a week), 4 (several times a week), and 5 (daily). In relation to the consumption of fast food (Figure 1), university students decreased their probability of consumption during the pandemic (standard deviation [*SD*] = −1.13, 95% confidence interval [CI] = [−1.21, –1.06]) compared to consumption before the pandemic, with a high probability of responding "never" during the pandemic. We did not find substantial variation between groups for each variable at each time point for consumption of fast food. In Figure 2 (delivery order), university students did not show substantial variation in their responses between time points (*SD* = 0.11, 95% CI = [0.04, 0.18]) or between groups, although there was a small increase during the pandemic.

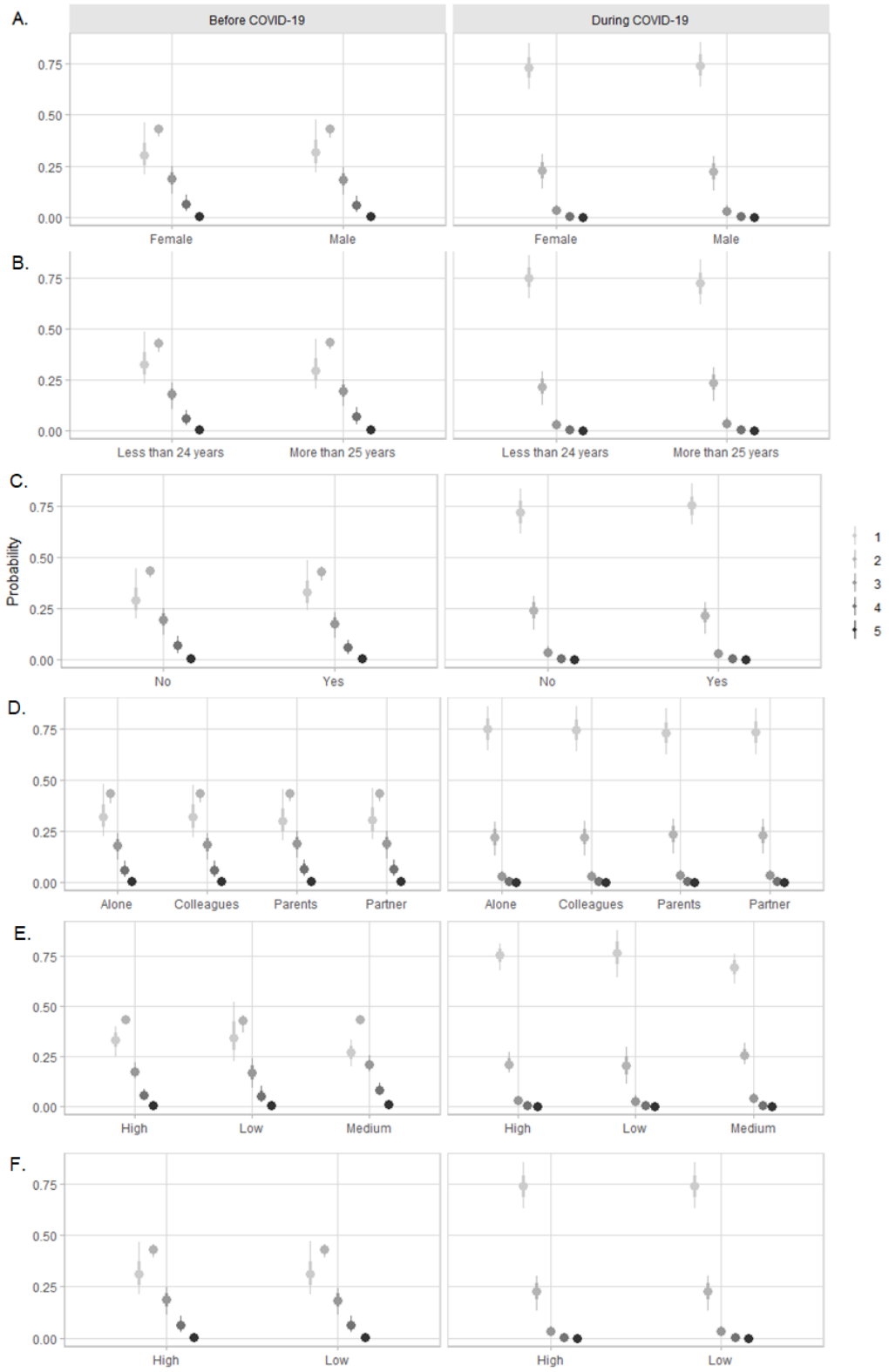

Figure 1. Consumption of fast food before and during COVID-19 according to gender (A), age (B), whether they know how to cook (C), living arrangements (D), cooking ability (E), and cooking knowledge (F). Response categories are presented as 1 (never),

2 (1 to 2 times a month), 3 (once a week), 4 (several times a week), and 5 (daily). Error bars indicate 95% of credible intervals.

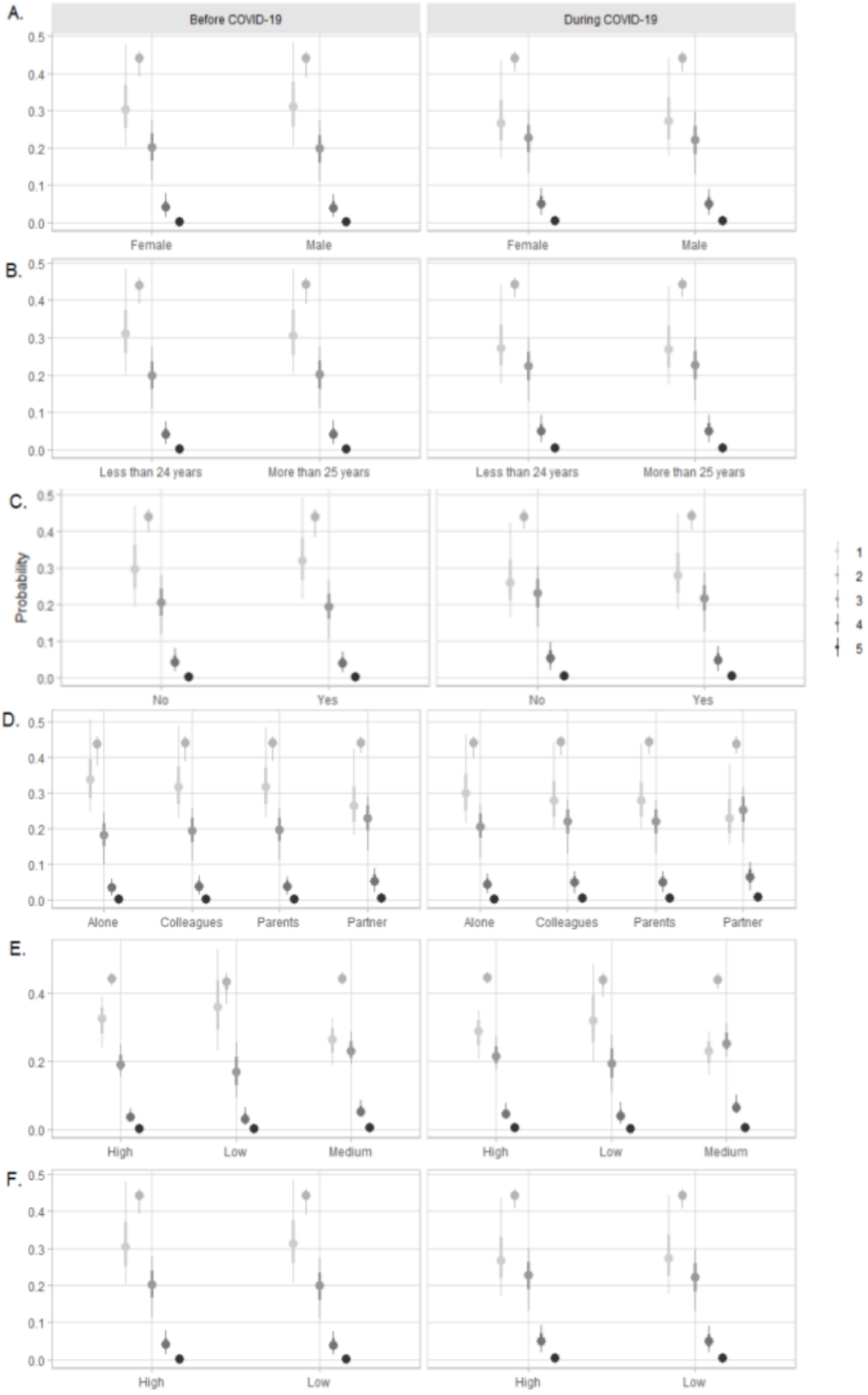

Figure 2. Consumption of delivery before and during COVID-19 in relation to gender (A), age (B), whether they know how to cook (C), living arrangements (D), cooking ability (E), and cooking knowledge (F). Response categories are presented as 1 (never), 2 (1 to 2 times a month), 3 (once a week), 4 (several times a week), and 5 (daily). Error bars indicate 95% of confidence intervals.

Figure 3 shows the use of fresh ingredients to cook before and during the pandemic. Overall, university students substantially increased the use of fresh ingredients during the pandemic (*SD* = 0.83, 95% CI = [0.75, 0.90]) compared to before the pandemic. Students with high cooking ability increased the probability of using fresh ingredients during the pandemic. The probability of answering "never" was almost zero among these participants whereas responding "daily" substantially increased (*SD* = 1.50, 95% CI = [–0.61, 3.62]). People with a medium level of cooking ability showed a substantial increase in the probability of using fresh ingredients "several times per week" and "daily" during the pandemic when compared with before the pandemic. Those with low cooking ability had a slightly increased probability of using fresh ingredients during the pandemic (1 to 2 times a month, once a week, several times a week, and daily), even though this increase was lower than in students with medium and high cooking abilities (Figure 3). The probability variation of the response of "daily" increased for both groups that responded that they knew or did not know how to cook.

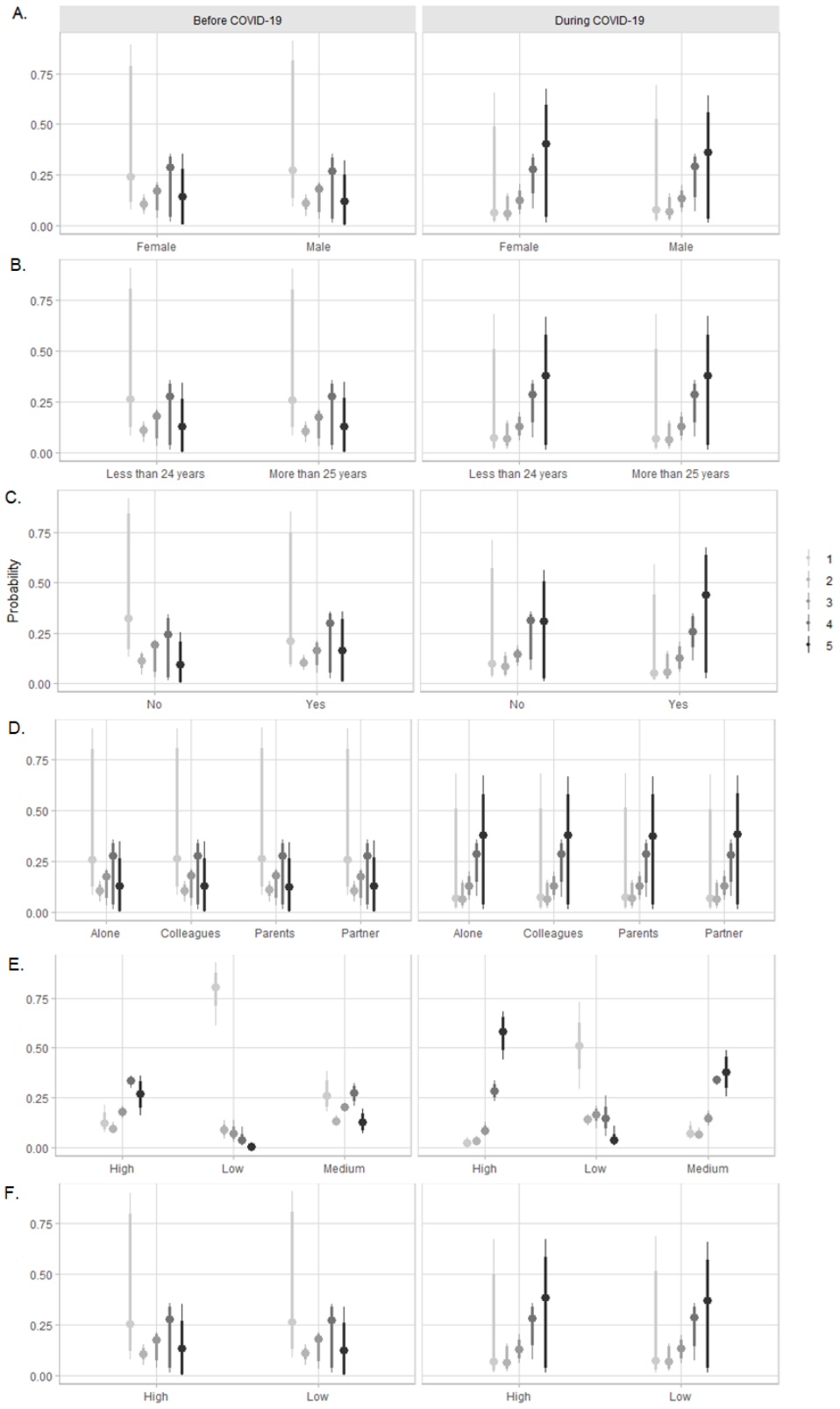

Figure 3. Use of fresh ingredients to cook before and during COVID-19 according to gender (A), age (B), whether they know how to cook (C), living arrangements (D), cooking ability (E), and cooking knowledge (F). Response categories

256 are presented as 1 (never), 2 (1 to 2 times a month), 3 (once a week), 4 (several times a
257 week), and 5 (daily). Error bars indicate 95% of confidence intervals.

258 Regarding the use of ultra-processed foods (Figure 4), university students
259 increased the probability of using this type of food during the pandemic (*SD* = 0.37,
260 95% CI = [0.30, 0.43]) when compared to before the pandemic. Students with low,
261 medium, and high cooking skills had a decreased probability of responding "never" and
262 an increased probability of responding "daily" (*SD* = 1.49, 95% CI = [–0.19, 3.11]). The
263 probability of using combined fresh ingredients with ultra-processed foods (Figure 5)
264 substantially increased during the pandemic (*SD* = 0.57, 95% CI = [0.50, 0.64])
265 compared to before the pandemic. University students with high cooking ability
266 presented a higher probability of responding "daily" (*SD* = 1.28, 95% CI = [–0.57,
267 3.07]) compared to the other groups. Additionally, the probability of answering "never"
268 to this behavior decreased for all groups (low, medium, and high cooking skills).
269 Participants who reported that they did or did not know how to cook had an increased
270 probability of responding "daily" and a decreased probability of responding "never"
271 although with no substantial variation between the two groups.

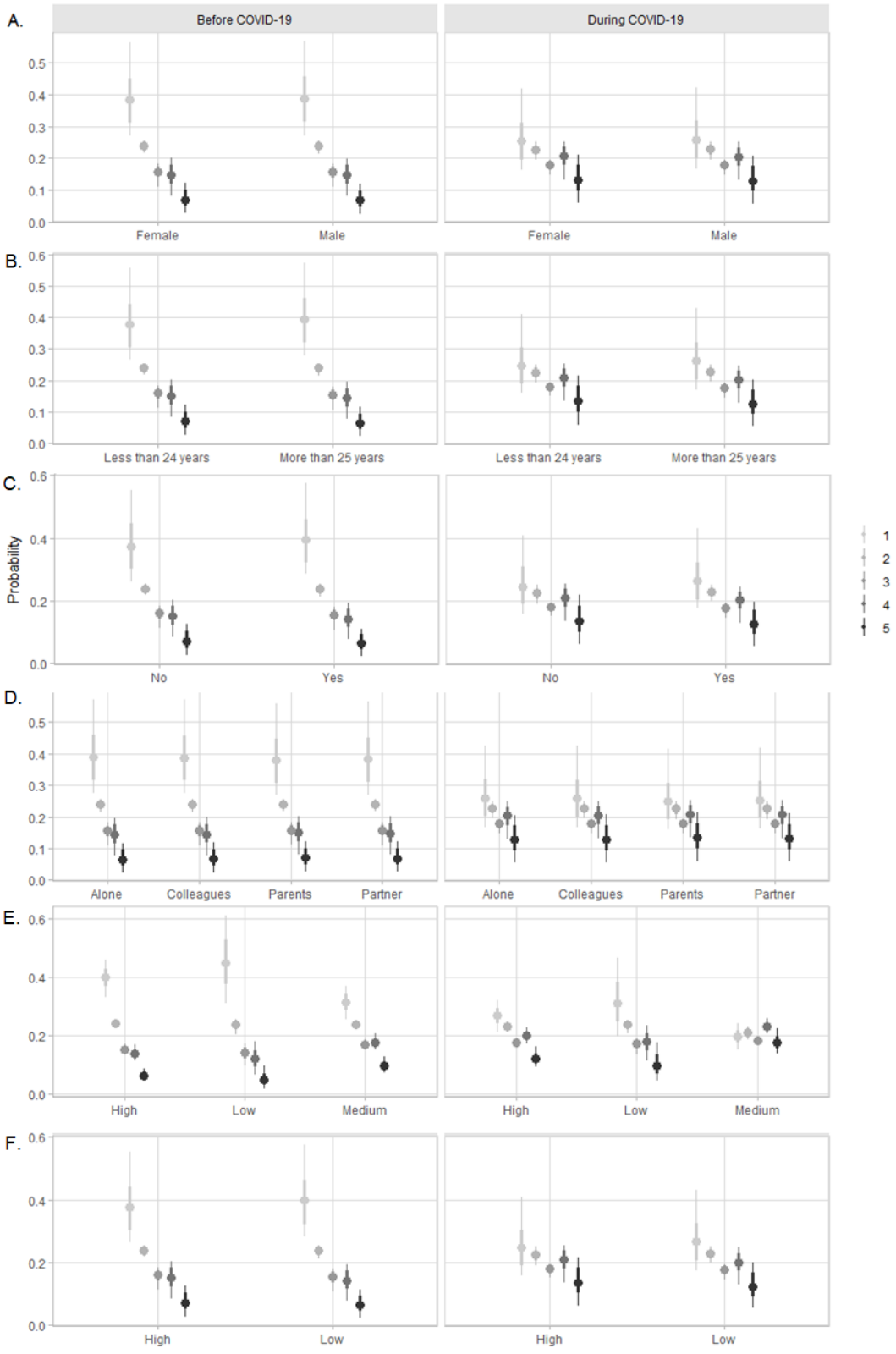

Figure 4. Use of ultra-processed food to cook before and during COVID-19 according to gender (A), age (B), whether they know how to cook (C), living arrangements (D), cooking ability (E), and cooking knowledge (F). Response categories are presented as 1

(never), 2 (1 to 2 times a month), 3 (once a week), 4 (several times a week), and 5 (daily). Error bars indicate 95% of confidence intervals.

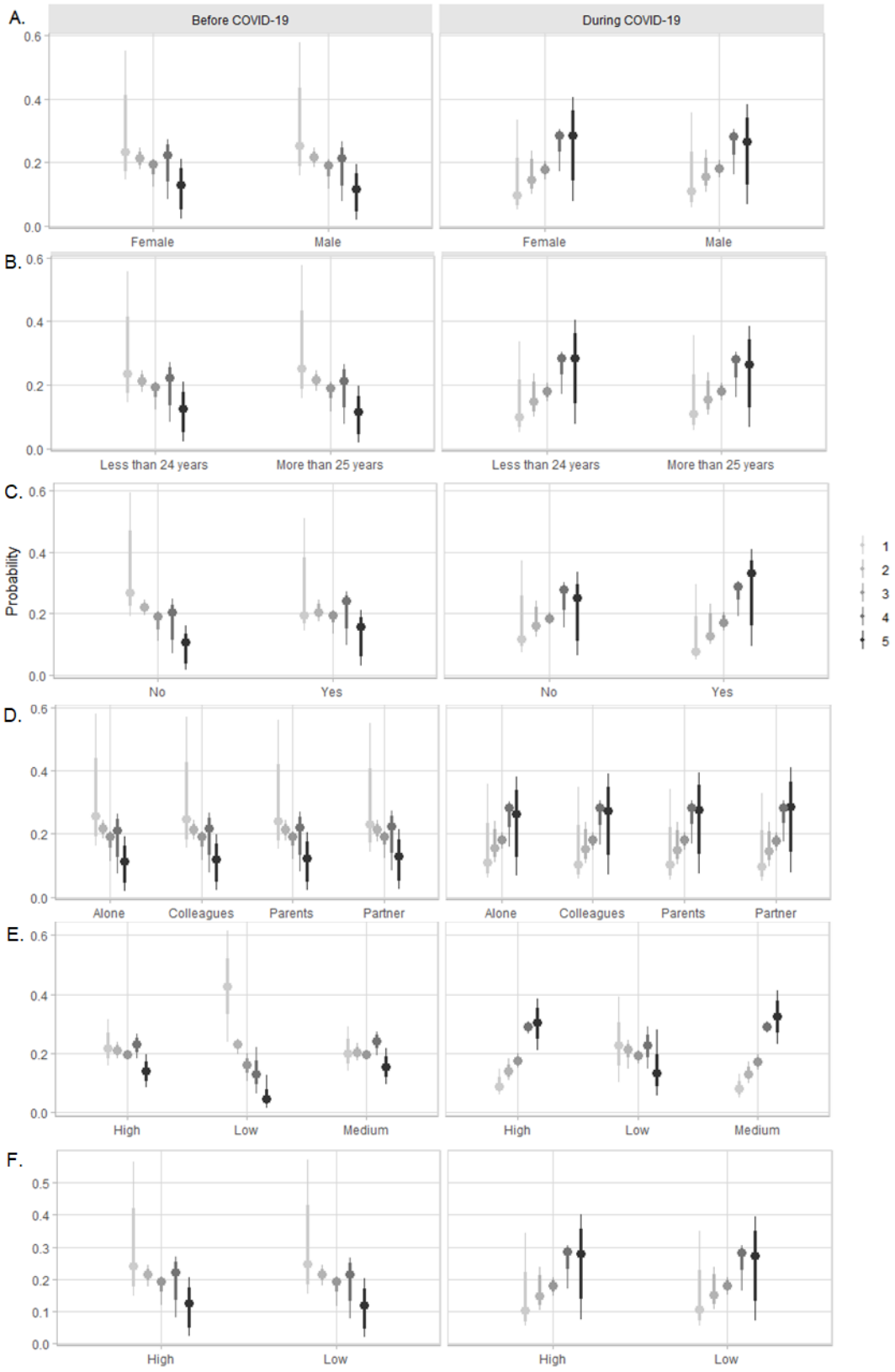

Figure 5. Use of fresh ingredients and ultra-processed food to cook before and during COVID-19 according to gender (A), age (B), whether they know how to cook (C), living arrangements (D), cooking ability (E), and cooking knowledge (F). Response categories are presented as 1 (never), 2 (1 to 2 times a month), 3 (once a week), 4 (several times a week), and 5 (daily). Error bars indicate 95% of confidence intervals.

2. Discussion

This study assessed the characteristics of meal preparation and consumption by Brazilian university students before and during the COVID-19 pandemic according to their cooking skill level and individual characteristics. Overall, the sample showed higher availability and accessibility of fruits and vegetables at home, higher scores in their cooking skills, a decrease in the consumption of fast food and an increase in homemade meals made with fresh ingredients, ultra-processed food, or both during the pandemic compared to the period before the pandemic.

The high availability and accessibility of fruit and vegetable scores showed during the pandemic (Table 2) is related to the fact that living at home may have resulted in others taking responsibility for shopping and purchasing of foods. Thus, an access barrier to food supply may have been averted and account for the reported high availability. Studies have shown that high availability and accessibility of fruits and vegetables are consistently positively correlated with fruit and vegetable intake. Neumark-Sztainer et al. (2003) carried out a study with 3957 teenagers and found that the availability of fruits and vegetables at home was one of the factors most related to the consumption of these foods. A study by Kratt et al. (2000) investigated the availability of fruits and vegetables as a moderating variable for fruit and vegetable consumption relationships and how these relationships might change with varying levels of fruit and vegetable availability. The authors found that homes with more fruits and vegetables had a larger and stronger set of motivating factors for the consumption of these foods by parents and children compared to those with low availability. This suggests that participants of the present study not only have a high availability of fruits and vegetables, but also may have a high intake of fruits and vegetables once they also showed an increase in the probability of using fresh ingredients to cook (Figure 3), independent of their cooking skill level.

311 Utter et al. showed in a longitudinal study carried out through a questionnaire
312 with young adults (18-23 years, n=1158), and with results from the same questionnaire
313 applied a decade later (30-35 years), that a quarter of their sample had very adequate
314 cooking skills as young adults (18-23 years). Utter and colleagues found found that
315 having cooking skills led these participants to better eating behaviors through greater
316 involvement in cooking and a lower consumption of fast food 10 years later in
317 adulthood (Utter et al., 2018). The present study sample reported high scores for
318 cooking skills during COVID-19 (Table 2), this suggests that they are more likely to
319 experience long-term benefits, such as healthy dietary behaviors, compared to the low
320 level of cooking skills' participants.

321 On the other hand, approximately half of our sample achieved a high level of
322 cooking knowledge (Table 2), and half of these recorded high frequency cooking
323 practices. Cooking knowledge involves perceptual skills (judging flavors, combining
324 and replacing ingredients with a minimum number of errors at the end of preparation,
325 and adjusting the time to perform culinary tasks), conceptual skills (predicting results,
326 knowing how to adapt ingredients, planning menus, knowledge of culinary terms and
327 techniques, and using appropriate equipment, utensils, and ingredients), and academic
328 knowledge (knowledge about nutrition, food hygiene, and food trends). This knowledge
329 is part of person-centered cooking skills; therefore, they can have an impact on
330 confidence, attitude, and individual cooking behavior (Jomori et al., 2018).

331 The lack of culinary knowledge may not necessarily influence the practice and
332 food choices of the participants, but the lack of culinary knowledge can impact on
333 confidence and culinary attitudes, leading to less healthy choices. Murray et al. (2016)
334 carried out a focus group with college students who did not live on campus, and thus
335 were not part of the campus meal system, but lived independently of their parents
336 (n=24) and found no evidence that culinary knowledge at different levels had a direct
337 impact on food choices and culinary practices of these students. Those living at home
338 with others may be less likely to be the sole food preparers and may in fact benefit from
339 the activities of others in the household.

340 Long stay-at-home time during the COVID-19 pandemic may lead to a decrease
341 in the probability of fast-food consumption by the participants of our study in all the
342 variables analyzed, showing that it was independent of their level of cooking skills and
343 knowledge. The closure of restaurants, social distancing by imposing safety standards,

and fear of the disease could be the factors that justify the decrease in the consumption of fast-food and food delivery orders (Figure 1 and 2), as a structural determinant. One study carried out in Brazil with people over 18 years old showed that people were more likely to go to restaurants where they could see safety standards were in place such as mask wearing, social distancing and eating in well ventilated places or outside during the pandemic (Piton Hakim et al., 2021). Likewise, Husain and Ashkanani (2020) carried out an online questionnaire with adults (18-73 years old) in Kuwait and found that 49% of their sample were likely to consume fast food 1–2 times per week before the pandemic, while up to 82% reported not consuming fast food during the pandemic. Błaszczyk-Bębenek et al. (2020) also found a reduction on the daily servings of fast-food consumption in Polish adults during lockdown, where during the pandemic the percentage of participants who do not consume fast food daily increased to 41,7% from 26% before the pandemic.

On the other hand, the present study showed that the long stay-at-home period increased the probability of cooking homemade meals, as observed in other studies worldwide during the pandemic (Deschasaux-Tanguy et al., 2020; Di Renzo et al., 2020; Gerritsen et al., 2020; Reyes-Olavarría et al., 2020). In Chile, Reyes-Olavarría et al. (2020) found that almost 60% of the adult participants in their study increased home cooking during the pandemic compared to before the pandemic. Di Renzo et al. (2020) showed that their Italian sample aged between 12-86 years had increased homemade recipes during the pandemic. In New Zealand, Gerritsen et al. (2020) showed that adult participants had increased home cooking and baking from scratch during quarantine. A study was conducted in France with 37,252 adults from a web-based cohort-filled lockdown-specific questionnaire in April-May 2020. They verified that 40% of the participants had increased home-made meals during the pandemic (Deschasaux-Tanguy et al., 2020). These studies concluded that even though the pandemic resulted in a small overall shift towards an unhealthy diet, they also created an opportunity for some people to improve their cooking and nutritional behaviors, beginning with home cooking practices, as also shown in the present study. Over a period of extended lockdown there are reports of changing culinary practices, so reports of increased cooking from scratch were verified in the early stages but as lockdown continues some of this initial impetus is lost (Cummins et al., 2020).

Some of this is also influenced by the fact that although eating out may have been difficult due to restrictions the catering industry adapted quickly to use online ordering and offer home delivery of fast food. A study by Scarmozzino and Visioli (2020) in Italy with 1932 participants assessed the effects of COVID-19-induced confinement policies on self-reported food consumption through an online questionnaire. They found a reduction of nearly 50% in the purchase of ready meals during the pandemic. Nevertheless, these data show that, even in the middle of a pandemic, people continued to have access to fresh ingredients, going out to purchase them frequently. These attitudes, such as prioritizing fresh products, preparing homemade meals, and limiting ultra-processed foods, are encouraged by the World Health Organization during the pandemic (WHO, 2020).

The results of the present study reflect some of the above with people with the highest level of cooking skills reporting that they had already used fresh ingredients more frequently than those with medium or low cooking skills before the pandemic and had a proportional increase during the pandemic among the high, medium, and low cooking skill groups. People who self-reported that they knew how to cook in our study also claimed they used to use more fresh ingredients than those who reported that they did not know how to cook before the pandemic, even though both groups increased the use of this kind of food during the pandemic. De Borba et al. (2021) analyzed self-efficacy in cooking and consuming fruits and vegetables among 766 first-year students from a university in southern Brazil. In their study, most participants reported that they knew how to cook (72%), and among them, the majority were confident or extremely confident in cooking from basic ingredients, including fresh vegetables.

The fact that the participants of the present study were in the period of quarantine, where social distancing was imposed and the participants were staying at home for longer periods of time, suggests that they looked for ways to increase their access and use of fresh ingredients to cook. This may lead to the belief that they are cooking healthier and more frequently during the pandemic when compared to before the imposition of social distancing.

At the same time, the frequency of using ultra-processed foods to cook was also increased by participants during the pandemic in all variables. However, this increase was not as significant as the increase in fresh ingredients (Figure 4). The group with low cooking skills was the group with the highest probability of never using ultra-processed

409 foods before and during the pandemic and the smallest probability of using several
410 times per week and daily when compared to the medium and high cooking skills groups.
411 The reason for this could be that they did not cook at all before or during the pandemic,
412 even though the consumption of ultra-processed food requires lower cooking skills than
413 fresh ingredients (Caraher & Lang, 1999; Chenhall, 2010). Conversely, Wolfson and
414 Bleich (2015) showed that individuals who had a high cooking frequency had a lower
415 frequency of meals taken from fast-food or frozen meals/pizzas per week in the past 30
416 days, when compared to people with low cooking frequency.

417 On the other hand, the use of a combination of fresh ingredients and ultra-
418 processed foods had the highest increase during the pandemic among people who had
419 high cooking skills, followed by the medium cooking skills group. Although the group
420 with low cooking skills also increased the consumption of this combination of foods,
421 the probability was lower than in the medium and high cooking skills groups, and they
422 maintained the highest probability of never using combined ingredients before and
423 during the pandemic. This can be justified by the fact that they might not have enough
424 confidence to use some techniques, plan meals, use a large variety of ingredients, and
425 cook from scratch, depending on the type of ultra-processed food (Jomori et al., 2018).
426 In addition, both students who self-reported knowing and not knowing how to cook
427 reported a higher probability of using combined ingredients during the pandemic when
428 compared to the period before, being higher in the group who reported knowing how to
429 cook.

430 In a study carried out by Murray et al. (2016) with 24 students through focus
431 groups, the participants remarked that they would eat more healthily if they had the
432 knowledge and information to prepare healthy foods. This shows that interventions can
433 be important to this group to develop cooking knowledge, especially regarding the use
434 of fresh ingredients and cooking skills, resulting in the improvement of their diet
435 behaviors. Seabrook et al. (2019) and Bernardo et al (2018) showed that students who
436 had taken a food and nutrition course, and culinary intervention had more cooking skills
437 than those who had not taken the course. Higher cooking skills acquisition is supported
438 when university students take a culinary intervention and remains in place for long time
439 (Bernanrdo et al., 2018).

440 Cooking knowledge can be related to cooking skills and practices, which are
441 linked to healthy diets. Study of Utter et al. (2018) found that having cooking skills led

442 the participants to better eating behaviors, greater involvement in cooking, and a lower
443 consumption of fast-food in adulthood. Wolfson and Bleich (2015) found a significant
444 association between the habit of making dinner at home with better diet quality and
445 lower consumption of energy, carbohydrates, fat, and sugar, fewer energy from meals
446 consumed outside home, or frozen or ready-to-eat meals. Similarly, Hartmann et al.
447 (2013) showed that cooking skills correlated positively with weekly vegetable
448 consumption, but negatively with weekly convenience food consumption frequency.
449 Thus, there might be a high probability that university students with high levels of
450 cooking skills are more likely to use fresh ingredients to improve their diet compared to
451 those with low levels of cooking skills.

452 The results of the present study indicate the demand for stimulating and
453 promoting the use of fresh ingredients, teaching how to prepare and cook from scratch,
454 in order to reduce the use of ultra-processed food and to increase the availability and
455 consumption of fruits and vegetables by university students, mainly those with medium
456 and lower cooking skills. The fact that students with low cooking skills have lower
457 probabilities of increasing their frequency of cooking any kind of food leads to the
458 belief that they are not encouraged to cook, faced by several barriers reported in the
459 literature (Graham et al., 2013; Jones et al., 2014; Murray et al., 2016; Wilson et al.,
460 2017; Pulz et al., 2017; Sprake et al., 2018; Utter et al., 2018; Knol et al., 2019). This
461 highlights the need for strategies focused on cooking skills and excluding these barriers,
462 especially because in Brazil, there are no public policies that promote healthy eating
463 among university students or guidelines for this group. Thus, policies and interventions
464 need to be focused on solving this aspect, independently of the pandemic situation.

465 ## 3. Conclusion

466 This study demonstrated that most of the students showed a high level of
467 cooking skill and high availability and accessibility of fruits and vegetables. However,
468 only half of the participants showed high cooking knowledge, even though most
469 believed that they knew how to cook. This suggests that more attention should be given
470 to those who have low cooking knowledge, because the lack of cooking knowledge may
471 affect their confidence in cooking, and in this way, affect their food choices. In addition,
472 the participants increased their cooking frequency during the pandemic, regardless of
473 their cooking skills. However, the group with low cooking skills had only a slight
474 increase in the use of fresh ingredients, possibly because lack sufficient knowledge and

confidence to cook from scratch using ingredients that require more cooking skills. Based on these results, interventions to disseminate information about cooking to university students are highly recommended to increase cooking knowledge and cooking skills, focusing on the preparation of fresh ingredients and offering options to increase positive cooking attitudes, such as easy and convenient cooking techniques or ways to use fresh foods. Further follow-up studies are required to assess whether these students will retain their cooking knowledge, high cooking skills, and great availability and accessibility of fruits and vegetables after college.

4. Limitations and strengths

The strengths of the study included the large sample size, multilevel analysis, and use of the validated BCSQ, which presents several variables related to healthy eating practices. Moreover, the relationship found between cooking skills and location of meal preparation and consumption before and during the pandemic was able to indicate which situations or university students' profiles need support to improve their cooking skills, cooking knowledge, and diet.

On the other hand, this study was conducted in only two Brazilian universities in southern Brazil. Even if they receive students from all over the country, this research does not represent all the countries and could be conducted in other Brazilian regions.

Furthermore, our sample included a higher percentage of females (73.48%). This can be justified by the fact that women are usually more concerned about health or diet issues. Recall bias may also be a limitation. However, it was important to analyze this scenario during the pandemic to plan interventions with this population that, in Brazil, does not have a specific public policy.

Moreover, the study did not evaluate measures before and during the pandemic, at different times, but is a cross-sectional study, depending on the record of students. Further analysis is recommended for the follow-up.

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Author Contributions

Talissa Dezanetti: Acquisition of data, Interpretation of data, Investigation, Writing as well as for the choice of the Journal.

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