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1 Brazilian Cooking Skills Questionnaire Evaluation on the Using/Cooking 2 and Consumption of Fruits and Vegetables

3

4 INTRODUCTION

5

6 Cooking skills have been widely debated in the academic literature, with the main focus
7 on the relationship between cooking attitudes and skills to healthy eating habits [1-5]. The
8 studies that aimed to show this relationship are not homogeneous and there is still a lack of
9 consensus in the literature to evidence it. Even that, most of them has showed people who has
10 more confidence to cook, shows better diet's quality than ones who do not.

Commented [MMJ1]: Answer 1

11 Studies show that the use of cooking skills have been in decline among young adults,
12 especially among those entering college level education [3,6,7]. Whether this is due to lack of
13 basic skills or issues such as time and convenience of processed foods and take-away is not
14 clear. Students face barriers to preparing their own meals, ranging from a low confidence in
15 choosing and preparing foods, limited knowledge of cooking [7,8], easy availability and
16 accessibility to convenience food [3,6,7], high frequency of eating away from home [3,7,9,10],
17 time pressures and a shortage of money [3,7,11]. So, the general decrease in cooking practices
18 may lead these individuals to unhealthy eating habits and an over-reliance on processed and
19 ultra-processed foods, decreasing the consumption of fruits and vegetables, mainly [3,6,7,9,10].
20 Once you leave food preparation to others then you are less likely to be in control of your food
21 intake.

Commented [MMJ2]: Answer 3

Commented [MMJ3]: Answer 2

22 Cooking skills can be defined as individual's attitudes, knowledge and confidence with
23 respect to the purchasing, planning and preparing of food from scratch (fresh or raw or
24 unprocessed), as well as the use of processed and ultra-processed foods either on their own or
25 as components of a meal. Using the first category of foods requires pre-preparation culinary

26 techniques (such as washing, peeling, cutting) and it is healthier than the using of processed
27 and ultra-processed foods [1,12,13], as well as than eating away from home, because this
28 practice is related to low cooking skills and poor diets [3,7,9,10].

29 There is a lack of consensus on how to best evaluate cooking skills and healthy eating
30 outcomes in young adults and whether to attribute limited cooking to a lack of skills or to other
31 social factors [4,5,14,15]. Validated questionnaires that measure the use of cooking skills were
32 identified [2,15-24]. Factor analysis of cooking skills questionnaires was applied to explore the
33 constructs or emerging hypothesis that underpin the construct to be measured or reduce the
34 number of items [16,18-22,25]. This analysis is an interdependent technique that define the
35 fundamental structure among a set of variables [26]. Two of these questionnaires used
36 exclusively the exploratory factor analysis [16, 25] and three used the confirmatory factor
37 analysis to test how well the questionnaire items represented the theoretical constructs of the
38 current study [19,20,22]. Some of these cooking skills questionnaires contain references to the
39 underpinning theory which the traits, such as attitudes and behaviours are built on. The
40 theoretical basis of many of these measurements were grounded in the concept of 'Food
41 Agency' [20] or Self-Determination Theory [19,22] or Social Cognitive Theory [16,25]. It is
42 noteworthy, however that cooking from scratch was a key variable identified as common in
43 some articles [16, 20-22, 25].

44 Bailey et al. [22] developed a cooking skills evaluation questionnaire based on self-
45 determination theory and identified some health-related attitudes and motivations, but did not
46 identify what health measures or indicators for evaluating cooking skills could be used, such
47 as, the use of vegetables in recipes and meal planning. The cooking and food skills measurement
48 developed by Lavelle et al. [21] did not include a measure of healthy outcomes thus they had
49 to apply another complementary questionnaire to assess diet quality.

Commented [MMJ4]: Answer 1

50 Among these cooking skills questionnaires, one was judged to be more appropriate for
51 use with diverse adult populations in evaluating cooking skills related to healthy eating
52 [15,16,25]. This questionnaire was originally developed to evaluate the cooking intervention
53 program ‘Cooking with a Chef’ (CWC) designed by researchers from Clemson University in
54 South Carolina, United States of America. The CWC questionnaire was based on Social
55 Cognitive Theory and emphasizes increasing knowledge, positive attitude, and self-efficacy
56 related to cooking and healthful eating. The healthy eating aspects of this questionnaire is
57 related to the availability, accessibility, frequency, attitude and confidence to use and eat fruits
58 and vegetables [16,25]. This questionnaire was cross-adapted [27] and validated for use in
59 Brazil by the known-groups method. This method used a test that employed detecting the
60 differences in cooking skills between men and women as well as between high and low levels
61 of cooking knowledge of university students. This validation process clarified measures for
62 these different groups regarding attitude, confidence and behavior for cooking in a healthier
63 way. The instrument has adopted and subsequently renamed the Brazilian Cooking Skills and
64 Healthy Eating Questionnaire - BCSQ [15].

65 The BCSQ is based on the theoretical framework from CWC questionnaire related to an
66 individual’s self-efficacy, behaviors and attitudes toward cooking as well as employing
67 measures of diet quality. Examples of items from these measures include self-efficacy in using
68 fruits and vegetables to cook and eat, cooking from scratch, and frequency in using fewer
69 healthy convenience food items and leftovers, and the availability and accessibility of fruits and
70 vegetables ready to use and eat at home [10,15,16,25,28,29]. However, the definition of
71 cooking skills seems to appear unresolved in the literature regarding which attitudes and
72 behaviours are considered and if it involves only the confidence of cooking from scratch,
73 excluding the use of convenience foods or leftovers, for example [5,7,13]. This fact justifies the

74 diverse and big number of items belonging to the available questionnaires on the literature
75 [16,18-22,25].

76 Constructs usually emerge from theories or observations, which may further define
77 psychological attributes and can be culturally specific [30]. The constructs that compose the
78 cooking skills concept are the abilities related to food (use of unprocessed and
79 processed/ultraprocessed foods) and to the individual (cooking attitude, behavior, self-efficacy
80 and knowledge) [13, 15, 25, 27-29]. Cooking attitude is related to how interested the person is to
81 cook or prepare his/her meal (e.g. I like to try new recipes; I think cooking is tiring; etc).
82 Cooking behavior is the frequency of people in preparing their meals or cooking (e.g. using
83 fresh ingredients to cook once a week). Self-efficacy in cooking is related to the confidence to
84 plan and prepare meals or perform some culinary techniques (e.g. confident in boiling, or
85 cooking with fresh ingredients). Cooking knowledge is about food, nutrition, hygiene,
86 perceptual and conceptual abilities (e.g. predict the final result of a recipe, combine ingredients,
87 etc) [13, 25, 27-29]. Thus, some current literature denotes that confirmatory factor analysis tests
88 the extent to which a theoretical pattern of prespecified constructs represents the actual data
89 [26]. This analysis is able to refine an instrument such as the BCSQ to the lowest number of
90 items (questions) that can explain the constructs identified in the research questionnaire for
91 cooking attitude, behavior and self-efficacy, noted as a critical gap.

92 Until now, factor analysis has not been carried out on the BCSQ and it is supported by
93 the theoretical framework identified by this healthy eating construct [15]. The fact that there is
94 no commonly agreed measure for evaluating cooking skills and healthy eating as a construct,
95 makes such an evaluation of the BCSQ with the factor analysis opportune. The study explored
96 the factor structure of the Brazilian Cooking Skills and Healthy Eating questionnaire (BCSQ)
97 to identify the barriers to cook, use and consumption of fruits and vegetables by young adults.

98

Commented [MMJ5]: Answer 4

99 **METHODS**

100

101 **Measures**

102 The questionnaire was originally developed and validated in by Michaud [16] and
103 Condasky *et al.* [25] at Clemson University to evaluated the Cooking with a Chef (CWC)
104 intervention program in South Carolina, U.S. The CWC questionnaire consisted of six scales,
105 one knowledge evaluation section, and a short index, with a total of 64 items. The online format
106 of the questionnaire was tested with university students [10,29,31], in written form with parents,
107 child’s caregivers [16,25,32], and cooks [28]. The CWC questionnaire presented predictive and
108 construct validity and demonstrated correlations among the scales and between people with low
109 and high cooking knowledge levels [16]. All the scales showed high correlations, test-retest
110 levels, internal consistency as well as factor loadings, except for the Cooking Behavior measure
111 [16,25].

112 This questionnaire was cross-adaptated to Brazil, maintaining all original scales and
113 items with some ammendments and being renamed as Brazilian Cooking Skills and Healthy
114 Eating Questionnaire – BCSQ [27]. The BCSQ’s items are distributed across 8 measures [15],
115 incorporating all items and structure from U.S. version, as seen in **Chart 1** and in **Table 1**.

116 The Availability and Accessibility of Fruits and Vegetables (AAFV) index measured
117 the availability of fruits and vegetable over the past week. The Cooking Attitude (CA) measured
118 how respondents felt about cooking. The Cooking Behavior (CB) measured the frequency of
119 common cooking activities based on the Food and Cooking Skills Questionnaire. Four self-
120 efficacy scales (Produce Consumption Self-Efficacy - SEPC, Cooking SelfEfficacy - SEC,
121 Using Basic Cooking Techniques - SETC, Self-Efficacy for Using Fruits, Vegetables, and
122 Seasonings - SEFVS) were developed to evaluate cooking and nutrition related selfefficacy.
123 They measured the degree of confidence in meeting the government’s three recommendations

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124 for the consumption of fruits and vegetables (SEPC), performing 6 basic cooking activities
125 (SEC), 12 specific cooking techniques (SECT), and using fruits and vegetables when cooking.
126 The last measure evaluated the level of cooking knowledge by the Knowledge of Cooking
127 Terms and Techniques (CTT) [15,25,27-29] (supplementary data; Chart 1; Table 1).

128 The BSCQ was then validated by the known-groups method, which showed differences
129 in cooking skills between men and women as well as between high and low levels of cooking
130 knowledge of university students. Cooking Attitude (CA) and Behaviour (CB) scales showed
131 low internal consistency and Self-Efficacy in Using Basic Cooking Techniques (SECT) was
132 not able to detect differences between man and woman. This validation process clarified
133 measures for these different groups regarding attitude, confidence and behavior for cooking in
134 a healthier way. [15]. The BCSQ was applied in a randomized controlled intervention designed
135 to Brazilian university students with a six-month follow-up study. The BCSQ was self-
136 administered on-line by intervention and control group before, immediately after and six months
137 after intervention was delivered. This evaluation showed changes in the intervention group
138 before, after and six months after intervention as well as between intervention and control
139 groups, except for answers from Cooking Behaviour scale [31].

140 The higher the value of the measures, the higher the cooking skills practiced/used.

141

142 **Participants**

143 A baseline was developed from a larger study (4,112 freshmen) with university students
144 from the Federal University of Sana Catarina - UFSC, Brazil, in 2015 (n=767) [15]. A sample
145 size (power calculation) was calculated for the validation process, based on ten people
146 responding to each item (10:1) in the questionnaire [26], considering the sample size effect,
147 representativeness, and losses, the final sample size was 730 participants [15].

148 The inclusion criteria were students (16 years or over) enrolled in undergraduate
149 programs at UFSC, as freshmen in 2015. Those enrolled in postgraduate or online
150 undergraduate courses were excluded [15].

151

152 **Procedures**

153 Students were invited to participate through e-mail and leaflets distributed throughout
154 campus. The questionnaire was available on the university's website during the period of the
155 online survey (August to December 2015). Leaflets were distributed in the classrooms and in
156 queues in the university cafeteria (dining hall), which contained a quick response code
157 (*QRcode*) for participants to easily access the online questionnaire on their smartphones, if they
158 chose to do so. Participants accessed the online questionnaire until the established sample size
159 was achieved. Sociodemographic data related to age, gender, ethnicity, income classification,
160 if they had children, self-reported cooking knowledge, living arrangements, and lunch or dinner
161 location were also collected to characterize the population of the study [15].

162 The UFSC Ethics Committee approved the study and informed consent was obtained
163 from all participants.

164

165 **Data analysis**

166 Mean and standard deviations for sociodemographic data and for each item of scales
167 were calculated. The 48 items (items 9 to 56 from **Cooking Attitude - CA**, **Cooking Behavior**
168 **- CB**, **Self-Efficacy in Cooking – SEPC**, **Self-Efficacy in Cooking - SEC**, **Self-Efficacy in Using**
169 **Cooking Techniques - SECT**, and **Self-Efficacy in Using Fruits, Vegetables and Seasonings -**
170 **SEFVS** scales) were submitted to factor analysis to determine the factor structure of BCSQ
171 [15]. Dichotomous (AAFV) and multiple-choice (CTT) measures were not based on a five-

Commented [MMJ7]: Answer 5

172 point Likert scales as the other ones, so that they were not submitted to factor analysis, as
173 recommended by Streiner, Norman and Cairney [30].

174 Corrected item-total correlations for each item were calculated and values greater than
175 0.3 were accepted. The internal consistency reliability for each scale was examined using
176 Cronbach's coefficients, where alpha greater than 0.7 was considered acceptable [26].

177

178 *Exploratory Factor Analysis*

179 The Exploratory Factor Analysis (EFA) was run using the extraction method of
180 Principal Axis Factoring (PAF) onto data from the BCSQ's validation [15]. These data points
181 were submitted to oblique (promax) rotation [30,33]. *Eigenvalues* >1.0 and scree plot were used
182 to identify the number of dimensions to retain. The Kaiser-Mwyer-Olkin (KMO) test was
183 conducted, adopting >0.7 value. The Barlett's esfericity was also tested. Factor loading ≥ 0.3
184 was considered acceptable, by observing pattern matrix, and more than three items per factor.
185 Communalities of >0.3 was considered acceptable [26]. Analysis was run with the Statistical
186 Package for the Social Sciences SPSS® version 18.0 [34].

187 Items with low factor loadings, cross-loadings, low communalities, and higher alpha
188 coefficients if they were excluded. Factors with less than three items were reviewed, rearranged,
189 or excluded [26].

190

191 *Confirmatory factor analysis*

192 The Confirmatory Factor Analysis (CFA) was run to examine the factorial structure of
193 the model. Since this is the first empirical evaluation for the Brazilian questionnaire, the
194 research team opted to set loadings above 0.50 as acceptable in accordance with the literature
195 [35]. Items with high covariance among measure errors ($r>0.7$) were excluded. The final model
196 was tested through the most recommended for fit indices in the literature. These fit indices

197 include: Chi-square (X^2), Degrees of freedom (DF), Chi square ratio (X^2/df), Turcker Lewis
198 Index (TLI), Normed Fit Index (NFI), Root Mean Square Error of Approximation (RMSEA),
199 Comparative Fit Index (CFI), Standardized Root Mean Square (SRMS), Goodness of Fit Index
200 (GFI), and Expected Cross-validation Index (ECVI) [36]. CFA was estimated using the
201 “lavaan” package [37], available as a package in the R statistical language [38].

202

203 ***Convergent Validity, Discriminant Validity, and Internal Consistency***

204 Convergent validity assessed the correlation concept of two measures. To do so, we
205 used the Average Variance Extracted (AVE) to analyse the convergent validity, with a cut of
206 point of 0.5. On the other hand, discriminant validity is the extent to which a construct is truly
207 distinct from other constructs. Discriminant validity was assessed by comparing the AVE with
208 the average shared squared variance (ASV) and maximum shared variance (MSV), considered
209 adequate if $AVE > ASV$ and $AVE > MSV$. Composite reliability was also calculated using
210 reliability measures derived from the CFA, with values greater than 0.7 considered satisfactory
211 [26].

212

213 ***Multilevel linear regression***

214 Multilevel linear regression models were used to analyse variations on the BCSQ
215 dimension among the university students' sample when grouped by gender (female and male),
216 living arrangements (alone, with parents, with partner, with colleagues and alone), knowing
217 how to cook (yes and no), place of main meal (home and outside home) and time to cook at
218 home (< 1 hours, 1 hours to 3 hours and ≥ 3 hours). Multilevel analysis provides a more robust,
219 trustable, and flexible alternative by considering the hierarchy structure of the data as well as
220 the available information between-groups. This analysis estimates the participants' scores based
221 on the information derived from the individual and groups characteristics [39]. Thus, varying-

222 intercepts models [40] were employed allowing the intercept to vary between participants
223 responses (Level 1) nested by groups (Level 2; gender, living arrangements, knowing how to
224 cook, location of main meal and the time spent in cooking at home), which provide a more
225 precise estimate. Estimates were derived using Maximum Likelihood with the "lme4" package
226 [40], in the R statistical language [38].

227

228

229 **RESULTS**

230

231 **Sample characteristics**

232 Based on the 850 students who responded to the online Brazilian cooking skills and
233 healthy eating questionnaire (BCSQ), 767 were eligible for the present study, and their
234 sociodemographic characteristics can be found in **Table 2**.

235

236 **Exploratory Factor Analysis (EFA)**

237 The EFA indicated the sample size ($KMO=0.922$) was adequate and significant
238 sphericity (Bartlett's test <0.000). A total of eleven factors (11) explained 60,39% of the
239 variance. Four items were excluded because they showed low factor loadings (items 10, 44, 45,
240 47), another four with low communalities (items 14, 19, 26, 39), and two because they were
241 alone in an only factor (items 25 and 26) (**Chart 1; Table 3**). Thus, EFA was run again without
242 these items. This second test suggested eight factors, however items with low factor loadings
243 (item 23), low communality (item 21), or loading onto a different factor from its original one
244 (item 34), were excluded (**Chart 1; Table 3**). Thus, a seven-factor solution was decided on.

245 Low internal consistency was found for one factor with three important items (items 16,
246 17, and 24) (**Chart 1; Table 3**). These items evaluate the frequency of cooking from scratch

247 as well as cooking with convenience food. The authors decided to retain this factor and to run
248 a new factor analysis. The resulting scree plot (**Figure 1**) with *eigenvalues* (>1.0) suggested 6
249 factors to retain, with a total of 30 items (**Table 3**).

250 Six extracted factors explained 59,62% of the variance, showing good sample size
251 (KMO=0.903) and indicating significant sphericity (Bartlett's test <0.000) and commonalities
252 ranging from 0.30 to 0.082 (0.56±0.37DP). Item 49 showed low factor loadings (<0.3) and was
253 excluded (**Chart 1; Table 3**).

254 A total of 18 items were excluded. Most of the items behaved like the original
255 questionnaire, with the exception of items belonging to the CB, SECT and SEFVS scales. Items
256 on specific cooking techniques – item 36 (sef-efficacy in using boiling water to cook) and item
257 37 (self-efficacy in simmering) - that originally belonged to the factor from the SECT scale
258 (**Chart 1**), loaded onto factor 1, which is related to self-efficacy of cooking (**Table 3**). Item 48
259 (self-efficacy of using vegetables to cook), which originally belonged to factor 2 (SEFVS - self-
260 efficacy of using fruits, vegetables and seasonings) (**Chart 1**), loaded onto factor 3 (SEPC -
261 produce consumption self-efficacy) (**Table 3**). Items 16 (frequency of cooking from scratch),
262 and 50 (self-efficacy in using fruits to cook) (**Chart 1**) were cross-loaded onto different factors,
263 such as factor 1 (SEC scale) and factor 6 (CB2 scale), and factor 2 (SEFVS scale) and factor 3
264 (SEPC scale), respectively (**Table 3**). However, the researchers decided to keep these items as
265 per the original version of BCSQ. All the factors showed good internal consistency, except
266 factor 6 with items 16, 17, and 24 ($\alpha=0.616$) (**Table 3**).

267

268 **Confirmatory factor analysis**

269 The 6-factor structure with 29 items (M1) was tested, resulting from the EFA. Several
270 weaknesses were identified in M1 as noted in **Table 4**. Item 17 was then excluded due to low
271 factorial value (<0.3) (**Table 3**) and modification of the indexes suggested covariance between

272 measure error items. Since the covariances between the errors were high ($r > 0.8$), a decision to
273 exclude items 16, 37 and 56 was made (**Table 3; Table 4**). Additionally, item CB24 was
274 grouped within the factor “CB2”, in which it was originally grouped (Jomori et al., 2017), and
275 factor “CB” was eliminated. In testing a new model (M2), we found a better fit, but not
276 satisfactory. M2 also presented items with high covariance ($r > 0.7$) between the errors (24 and
277 55 items) Thus, both items were excluded from M2 and a new model was tested without these
278 items (M3). An increase of model’s fit was found, but it is not still well adequate to indicate
279 high covariances ($r > 0.7$) between errors (**Table 4**). In order to have a best model fit, items 13,
280 52 and 54 (**Chart 1**) were exclude due to high covariances between errors (**Table 4**). M4 was
281 tested and presented as well fitted and adequate with 20 items and 5 factors (Table 3).

282 Five-factor structure with 20 items in the Model 4 (M4: 5-factors) seemed to hold the
283 best solution for BCSQ. In this model, Cronbach- α showed adequate for all scales (CA = 0.74;
284 CB = 0.76; SEPC = 0.81; SEC = 0.84; SEFVS = 0.76). **Figure 2** shows the model and
285 covariances and factor loadings values.

286 Some items showed high-standardized residuals correlations (**Table 5**). However, this
287 did not disturb the final model as proved by adequate fit indexes (Table 4).

288 These results make sense when the content of items was verified, for example, the item
289 related to the frequency of using leftovers from a home-prepared meal to make a new dish (22)
290 showed high standardized residual correlation with items related to not liking to cook because
291 it takes too much time (9), liking to try a new recipe (12) and with self-efficacy in “preparing
292 meals with what you have at home” (32). In addition, the item “I like to try new recipes” (12)
293 was also highly correlated to the item about the self-efficacy in following a written recipe (31)
294 (**Chart 1; Table 5**).

295 **The final BCSQ is showed in the suplementary data (supplementary material).**

296 **Convergent Validity, Discriminant Validity, and Internal Consistency**
297

Commented [MMJ8]: Answer 6

298 CB and SECP presented evidence of convergent validity (>0.5) and CA, SEC and
299 SEFVS did not (**Table 6**). These two last factors presented an AVE remarkably close to the cut-
300 off point. We found evidence of convergent validity comparing AVE to ASV ($AVE > ASV$) in
301 all factors, but when comparing AVE to MSV, factors SEC and SEFVS did not presented
302 evidence of convergent validity. Lastly, all factors presented evidence of composite reliability
303 ($CR > 0.7$).

304

305 **Multilevel linear regression**

306 From **Table 7**, a series of multilevel linear regression modelling showed the estimates
307 of BCSQ in relation to gender, living arrangements, know how to cook, place of main meal and
308 time to cook at home.

309 The most important differences noted within cooking behaviors were between females
310 and males; people who lived with parents and those who lived alone; as well as between those
311 who eat their main meal at home compared to those that ate away from home. Self-efficacy in
312 cooking had less influence among those who lived with parents compared to those who lived
313 alone, with partner and/or with children, and with roommates. When comparing students that
314 reported knowing how to cook to those who reported that they do not know how to cook, those
315 who know how to cook showed the highest means for cooking attitude (4.05; IC 3.90- 4.19),
316 self-efficacy in cooking (4.17; IC 3.96-4.38), and using fruits and vegetable to cook (3.74; IC
317 3.50- 3.97). Students who reported knowing how to cook also showed higher mean scores for
318 self-efficacy in fruits and vegetables consumption, but not higher than with the scales
319 mentioned earlier (3.22; IC 3.04-3.41). It seems that time to prepare food at home and eating
320 outside of the home did not influence cooking skill dimensions.

321

322

323 **DISCUSSION**

324

325 The analytical framework was important to help sustain the structure of the Brazilian
326 Cooking Skills Questionnaire - BCSQ, thus making it shorter, easier to administer and
327 complete. It also showed adequate psychometric proprieties. Based on the validity of the
328 BCSQ, factor analysis suggested a five-factor structure. The number of extracted factors by
329 EFA was explained with consideration to the theoretical constructs adopted by this research
330 reasons rather than the explained total variance, as discussed way forward [26].

331 Some aspects were highlighted related to the factor on cooking behaviours (CB), also
332 seen by Jomori et al. [15]. It is important to note that most of the items related to the original
333 CB scale have not yet been fully validated [15,16,25]. In the CWC version of the questionnaire,
334 only three of these items (behaviors of cooking from basic ingredients, using convenience
335 foods, and reheating or using leftovers in another meal) were deemed suitable for analysis. Two
336 of them (cooking from basic ingredients and reheating/ or using leftovers in another meal)
337 demonstrated adequate factor loadings (0.30 and 0.38). The item regarding the use of
338 convenience food resulted in a low factor loading (0.23). At the time of the original pilot work,
339 it was noted that the internal consistency of this measure was low ($\alpha=0.29$) [16].

340 In the present study, factor 6 with items related to the frequency of cooking from basic
341 ingredients - one about the use of convenience foods, and one regarding the use of convenience
342 combined with basic foods - showed satisfactory factor loadings (Table 3) but low internal
343 consistency ($\alpha=0.616$). Jomori et al. [15] has previously discussed this, pointing out the low
344 internal consistency found in their study regarding the cooking behavior scale of the BCSQ. It
345 was noted this was probably due to the low correlation among the items of this construct,
346 showing the divergent concepts. It can be explained, on one-hand, by the presence of items that
347 were related to the frequency of cooking from scratch but on-the-other-hand, items that were

348 focused on the use of leftovers, and eating away from home in the BCSQ, seemed opposite
349 behaviours.

350 Michaud [16] applied Principal Component Analysis and Promax rotation while the
351 present study used the Principal Axis Factoring Analysis (PAF) and Promax rotation for EFA.
352 In the PAF the communality estimates on the diagonal of the correlation matrix are iteratively
353 estimated until the iterations converge. Thus, it provides a more robust data extraction and it is
354 widely used in the behavioural and social sciences [33].

355 When the CFA was run, all these items were excluded and item 24 (frequency of using
356 convenience food combined with basic ingredients) (Chart 1) transferred to factor 5 – Cooking
357 Behavior 1 (Figure 2). This change can be explained by the fact that the item referred
358 specifically to cooking from basic ingredients and this item differs from the other behaviors
359 that related to using convenience foods or even, leftovers. Condrasky et al. [25] indicated that
360 one question relating to self-efficacy of cooking with basic ingredients was loaded onto a factor
361 related to the self-efficacy in consumption of fruits and vegetables (0.48).

362 The clarity of this classification is important as it relates to the definition of cooking
363 skills. Cooking basic/fresh ingredients is different from using convenience or ultra-processed
364 foods, the former requires more hands-on, with the latter only requires heating. A distinction
365 made by the current study defines the nature of processed or ultra-processed foods as foods that
366 are less nutrient dense [13].

367 The concept of cooking from scratch and preparing meals from basic or fresh ingredients
368 is one that is prominent in the literature but rarely tackles the issue of people combining
369 processes and ingredients or indeed cooking extra food and using leftovers because they dislike
370 cooking and want to save time [13, 41] or lack food skills [21,42]. The issue of convenience is
371 one that is often overlooked in the existing literature. Given the pressures of studying and being
372 away from home, it is noted that some young adults, such as university students, may fall into

373 less than healthy eating and that they for various reasons do not cook for themselves [8,9,10,43].
374 Therefore, it is helpful for this population to be able to cook from scratch and identify recipes
375 using basic or fresh ingredients. [13,41], increase cooking skills [21,42] and to distinguish
376 benefits from using fewer processed or ultra-processed foods overall.

377 Regarding the behavior of reheating or using leftovers for another meal, a 3-items factor
378 showed good factor loadings and internal consistency (Table 3) and demonstrated good fit
379 indexes (Table 4). It is a possibility that Brazilian university students frequently apply these
380 behaviors when they reheat or use leftovers in a meal. This task differs from that involved in
381 using fresh foods to cook [3,8,9,10].

382 Additionally, loading was consistent when the item related to the use of convenience
383 combined with basic foods (item 24) was excluded (Chart 1; Figure 2; Table 3). It is suggested
384 that cooking from scratch (with fresh and raw ingredients) is being substituted or combined
385 with the use of technology such as with the microwave, for more convenience, mainly by young
386 people. In this sense, the term ‘culinary transition’, which is a transition in cooking from scratch
387 cooking to using convenience food alone or in combination can be applied. It is noted that
388 convenience food may also employ the need for some cooking skills, even when one is simply
389 heating food to a desired level [1,42].

390 Moreover, people may be preparing meals at home by using leftovers from ready-to-eat
391 meals or convenience foods as well as takeout foods. In terms of the wider issue of domestic
392 economy, it can be argued that people are food combining to save time and energy to devote to
393 other household activities [42]. The use of convenience foods offers freedom from the kitchen
394 for many and particularly for women who disproportionately have a higher burden of work in
395 the home [43, 44]. Short [12] called for a re-evolution of cooking skills to include meal
396 combining and preparation not just cooking from basics, which she saw as antiquated and based
397 on a model which enslaved women to the home and the kitchen.

398 Leftovers may include food from meals, which were eaten away from home, or from
399 meals cooked previously at home. If cooking is defined as submitting food to heat [12,45];
400 heating leftovers supports this definition which remains unclear in the literature [5,13,7,46].
401 Short noted that there is a new category of skills, which is food combining and food planning
402 which involves a different set of skills and knowledge than that involved in cooking from
403 scratch [12].

404 The high standardized residual correlations found (Table 5) may indicate that tasks
405 related to using leftovers to make a new dish, or trying new recipes or following a recipe, as
406 well as making a meal with items available at home require cooking knowledge. The highest
407 values (>0.1) of standardized residual correlations can show a sense of misfit [47]. However,
408 data showed a good fit index, and these correlations did not influence the final model (Table
409 4).

410 Garcia et al. [46] evaluated the impact of a 6-week community-based cooking program
411 with socioeconomically disadvantaged people ($n=112$) in Glasgow, UK. They found significant
412 increases in confidence for using leftovers (4 vs. 5, $p = 0.002$) between baseline and post-
413 intervention. Participants also reported eating more leftover foods from “never” to “once a
414 week” at baseline (88%) to “2–4 times a week” to “once a day” at post-intervention (97%).
415 Authors measured the frequency (never to always) in using leftovers which is similar to measure
416 used in this current study in measuring cooking confidence. The participants identified the
417 usage of leftovers as an alternative to save money and reduce food waste and allow them, to
418 plan and prepare more meals. They also claimed that they could freeze or store leftovers as well
419 as make new recipes. Thus, using leftovers may be a reliable indicator of cooking skills
420 (planning and preparing more meals, save time and wasting, making new dishes, etc), because
421 it reflects the ability to procure and prepare food within the social, physical, and economic
422 environment contexts, named as food agency [20].

423 In the present study, the means of the items related to the frequency of using or re-
424 heating leftovers in another meal were higher among students that lived with their parents
425 compared to those that lived alone or with roommates. It appears that when parents are
426 responsible for purchasing the food and preparing home meals students can simply re-heat or
427 use the leftovers in another meal, rather than prepare meals from scratch (Table 7). In a study
428 evaluating self-reported food skills of 6638 students from a Canadian university, those who
429 lived away from home for longer than one year reported greater food skills than those who lived
430 away for less than a year [9].

431 On the other hand, one item related to self-efficacy in cooking from scratch showed
432 strong values in the present study. Self-efficacy in cooking may predict cooking behaviors
433 [5,16]. However, there is lack of evidence that self-efficacy or confidence in cooking may be
434 sufficient to determine the cooking behavior [48]. Despite this, culinary confidence is still
435 considered a good indicator for cooking practices, demonstrating a close relationship with the
436 frequency in preparing meals at home [2,9,16,31,42]. Thus, the item about behavior of cooking
437 from scratch (item 16) could be excluded and thus shorten the BCSQ. It is represented by the
438 item about self-efficacy in cooking from scratch (item 30) (**Chart 1**) as such these items seemed
439 repetitive.

440 The current study also found evidence of convergent and discriminant validity and
441 composite reliability. Although some factors did not present high values of convergent validity,
442 most of them were higher or closer to our cut-off point (>0.5). Factor CA did not meet our cut-
443 off point, but this was the first time this analysis was conducted for this construct [15], and we
444 could find no previous discussion in other similar questionnaires of verification of a similar
445 factor [2,16-24]. Additionally, cooking attitudes showed low validity compared to other scales
446 from the BCSQ because it refers to barriers to cook, such as negative attitudes (e.g. individuals
447 who think cooking is tiring) [15].

448 Based on the comparison between AVE and ASV, all factors presented evidence of
449 discriminant validity ($AVE > ASV$), but when AVE is compared to MSV some factors did not
450 present such strong evidence (e.g., SEC and SEFVS). A single factor, named *Cooking*
451 *Techniques and Meal Preparation Self-Efficacy*, was extracted by Condrasky et al. [25]. This
452 factor was loaded by items from SEC and SECT scales, but not from SEFVS as seen by
453 Michaud [16] and Jomori et al. [15]. This may be due to the fact that they were theoretically
454 different. The SEC scale relates to the self-efficacy to plan and prepare meals from scratch,
455 follow recipes, etc [15,16, 25]. It is related to food skills, which involve a different set of tasks
456 to be completed before cooking takes place [16,42]. The SEFVS scale is a measure for the use
457 of fruits, vegetables, and seasonings to cook [15,16]. Thus, although the SEC and SEFVS
458 factors did not present $AVE > MSV$, they did show $AVE > ASV$ (Table 6) and theoretical
459 differences, as previously presented [15,16,25,41], which may support the reasons why both
460 factors can be considered discriminant from the others. Lastly, composite reliability confirmed
461 the evidence of good internal consistency of all of the factors, which indicates that the items are
462 measuring the same construct in each factor [30].

463 In the present study, there was no evidence of the influence of amount of time available to
464 cook for the individuals participating on cooking behavior and self-efficacy scales (Table 7).
465 Studies have noted that having to spend time in cooking at home may be considered a barrier
466 to cooking. This notion may lead university students to prefer to consume their meals in the
467 cafeteria setting thus avoiding spending the time necessary to cook for themselves [8,49].
468 Young adults who spent the least amount of time on food preparation tend to prefer to use
469 convenience foods and spent more money on food away from their homes [3,8,11,49]. As
470 mentioned previously, items on the BCSQ related to behaviors about using and re-heating
471 leftovers in another meal, as well as using convenience foods combined with basic ingredients,
472 may further explain why the amount of time available was not an influence.

473 Conversely, available time is an important influence on tasks about cooking from
474 scratch on the SEC scale. [8,9,49]. A study carried out with the BCSQ analysed the relationship
475 between scores from all BCSQ scales and sociodemographic variables of university students.
476 University students with low SECT, SEFVS and SEPC scores were associated with having less
477 than one hour a day to cook ($p=0.23, 0.01, \text{ and } 0.002$, respectively). The authors analysed data
478 obtained from SEC and SECT scales bracketed, named the last scale (SECT). This SECT scale
479 was composed by items that evaluated the confidence in cooking from basic ingredients,
480 planning nutritious meals, using knife skills, peeling and chopping foods, for example, as well
481 as some cooking techniques, such as, boiling, stir-frying, baking, etc. Higher SECT and SEFVS
482 scores were observed for students who had more than 3 h available per day to cook whereas
483 SEPC scores were higher for students who had 1–3 h to cook [49].

484 In the present study, time spent on cooking had no substantial influence on cooking
485 confidence for students (Table 7) thus it is likely that this dimension does not depend on the
486 barrier so noted as a lack of time or of time pressures. It is possible that within time constraints,
487 there are additional aspects such as the amount of cooking parents do at home and of teaching
488 their children to cook. This seems like a negative influence on cooking confidence of university
489 students [48].

490 Factors 3 (SEPC) and 4 (CA) mimicked the original measure [16,25], but the current
491 study excluded 3 items from factor 4 (Figure 2; Table 3), due to the low factor loadings (<0.5)
492 and the high correlations ($r>0.7$).

493 The positive cooking attitudes items were primarily validated in the original
494 questionnaire (factor loading >0.40) [16]. This measure in the Brazilian version had indicated
495 low internal consistency [15], and now displaying good values when items on the preparation
496 of healthy meals and affordability of cooking were excluded (Figure 2; Table 3).

497 Negative cooking attitudes, which represented most of the items within this factor, were
498 about time-spent to cook (Figures 2; Table 3). One explanation could be that there was no
499 influence on the CA scale by the amount of time available to cook (Table 7). The willingness
500 to cook for university students within the present study seemed to depend more on their
501 reporting of knowing how to cook and if they live with parents than the time available to cook
502 rather than the time available itself, as reported in other studies [9,48]. Other aspects such as
503 resources (easy access to food), as well as family schedule and engagement are related to
504 negative perceptions about the time, which can play a role on the students' cooking motivation
505 [48].

506 The items about self-efficacy for using unprocessed fruits, vegetables (green), and root
507 vegetables (i.e. potatoes) (**Chart 1**) are difficult to interpret. For those individuals that cook in
508 Brazil they generally prepare potatoes and green vegetables from scratch. Food guidelines in
509 Brazil consider raw or fresh vegetables to be healthier than ultra processed foods [13,50].

510 The results of the validation research on the CWC questionnaire in South Carolina for
511 the CWC program demonstrated good loadings for items about self-efficacy in using
512 vegetables, fruits, and herbs [13,25]. Condrasky et al. [25] extracted 3 factors, where these items
513 were loaded onto the factor about *Cooking Techniques and Meal Preparation Self-Efficacy*.
514 However, items about self-efficacy for using spices, vinegars and hot sauces items were not
515 validated in this study [16,25].

516 In the present study, the item related to self-efficacy when cooking green vegetables
517 (items 49 – **Chart 1**; Figure 2) was excluded as it showed low factor loading (Table 2), as did
518 the items about spices and hot sauces with high correlation ($r > 0.8$). These specific seasonings
519 require little or no handling and may be associated with specific cooking techniques related to
520 cooking (heating food) and not to scratch cooking [13].

521 The current study excluded an entire factor (with 6 items) on self-efficacy that was
522 concerned with the use of specific cooking techniques (**Chart 1**). Even though these items
523 demonstrated good factor loadings for items and internal consistency after EFA was run, it was
524 not used. The rationale for the exclusion was that the SECT measure could detect differences
525 between high and low levels of cooking knowledge (≥ 6 points and < 6 points, respectively) but
526 not between genders in the process of construct validity by the known-groups method within
527 Brazilian university students [15]. No differences between genders in confidence of using
528 cooking techniques were found by Caraher et al. [1] and Hartmann et al. [2]. It appears that
529 specific cooking techniques are influenced by cooking knowledge among university students
530 but are not by gender specific. Cooking techniques' knowledge has already been evaluated by
531 BCSQ [15], therefore it was judged unnecessary to evaluate the self-efficacy in using specific
532 cooking techniques in young adults, but to focus on knowledge of how to use them and to
533 exclude the SECT scale. However, for specific population, the SECT can be used, for example,
534 cooks and chefs, when it is necessary to evaluate the confidence in using these techniques, in
535 addition to their cooking knowledge [28].

536 The second reason for excluding SECT scale refers to the choice of which cooking
537 techniques are essential to evaluate cooking skills in each demographic of young adults. The
538 item self-efficacy in using basic cooking techniques showed good factor loading (0.53) onto
539 the factor related to other cooking techniques in the study carried out by Condrasky et al. [25].
540 Within the BCSQ administration, researchers presented examples to the participants for specific
541 techniques (e.g. washing, peeling, chopping) These cooking technique examples were then
542 maintained in the SEC scale (**Chart 1**). Another cooking technique that was added to this scale
543 was 'boiling' which had been excluded from the SECT [15,16]. With these changes, the current
544 study prioritized its evaluation of self-efficacy in cooking from scratch as mentioned by others
545 [13,7,41,42], instead of maintaining all SECT items in the measure.

546 Finally, some cooking techniques presented in SECT scale were considered unhealthy,
547 such as deep-frying, but participants of previous studies have usually employed it to cook
548 [25,27]. However, these cooking techniques is not recommended to compose the health
549 practices, as a proposed construct for BCSQ. Raber et al. [14] have provided a conceptual model
550 for healthy cooking behaviors. The authors identified within their systematic review that some
551 studies, excluded cooking techniques or food processing which apply high temperatures, such
552 as roasting and barbecuing, mainly in meats from healthy cooking techniques listing. It is noted
553 that in some cooking processes these techniques have been implicated as potential contributors
554 to risk factors for certain diseases. Deep-frying, as it contributes to fat intake is not considered
555 a healthy cooking technique [14,28]. However, many cooking techniques can be useful to
556 prepare healthy meals, such as boiling, simmering, steaming, poaching, broiling, grilling
557 [14,28]. These techniques depend on the care taken in reducing reliance on using
558 certain ingredients (convenience /ultra-processed foods with low-nutrient and energy-density)
559 and on the addition or replacement of ingredients such as fresh fruits, vegetables and herbs to
560 related to them as part of healthy cooking methods [13,14,31]. The BCSQ intended to evaluate
561 cooking skills and healthy eating aspects, and that the use of various cooking techniques would
562 depend on the kind of food being used. Thus, the authors chose to exclude the SECT in this
563 evaluation, even with high factor loadings, to make the BCSQ shorter.

564

565 **Strengths and limitations**

566 To the best of the knowledge of the research team, this is the first cooking skills
567 questionnaire that has been validated in Brazil that provides an extensive psychometric
568 propriety analysis, supported by healthy eating constructs. The work within EFA and CFA
569 together provides evidence for an improved structure for the BCSQ, that could support the
570 evaluations and cooking skills linked to healthy eating practice constructs. The theoretical

571 constructs include confidence in cooking from scratch with unprocessed foods and in using and
572 eating fruits and vegetables [13,25] which were not seen in any other cooking skills
573 measurement tool.

574 The confirmatory factor analysis using the five-factor proposed by this study, the fit
575 models, and the analysis of the correlation were able to shorten the BCSQ and make it easier to
576 administer and reduce the cost in future use with young adults. High correlations showed that
577 some items appeared to the team as redundant. Thus, excluding them did not cause any effect
578 to the final model and its fit indexes, as well as the standard residual correlations have supported
579 the maintenance of many items that were controversial.

580 The results showed that items related to use of leftovers provides a basis for which to
581 evaluate cooking behaviors, not seen in other studies. Moreover, negative cooking attitude
582 seemed more appropriate for reaching at the cooking skills of this population. This shortened
583 version of BCSQ presents an evaluation of barriers to preparing meals by young adults.

584 It is important to notice that the BCSQ was validated with college aged young adults in
585 a single university in Brazil. The university studied has students from all regions of the country
586 which increases its diversity. From other research the researchers believe that most young adults
587 cooking skill that can be evaluated by this measurement may also fit to other age groups such
588 as adults. For this work there may need to be some modifications to account for various taste
589 profiles and by regional culture.

590 The exclusion of the SECT scale was a calculated decision by the authors. The
591 researchers relied on evidence on cooking skills from the recent literature rather than solely on
592 the factor loadings and internal consistency. This decision allowed the goal of shortening the
593 questionnaire to be accomplished. This decision does not mean that other studies can not use
594 this scale to complement the evaluation as long as it is used to test specifically the levels of
595 cooking knowledge.

596

597 **CONCLUSIONS**

598

599 This research has contributed to the development of an appropriate, robust, and
600 shortened version of a tool to be used to evaluate cooking skills and healthy eating practices of
601 young adults. Beside the healthy eating constructs, the shortened BCSQ identifies barriers to
602 preparing meals by young adults, such as negative attitudes as well as the frequency of using
603 leftovers to cook. This research will help support researchers and health professionals who work
604 to design future healthy eating tools and interventions.

605 It is recommended that the questionnaire presented in this study be tested with other
606 adult populations. It is also suggested that other studies that develop cooking skills construct
607 questionnaires could adopt the methodology used in the present study and aim to establish
608 homogenous measurements that can further compare and strengthen the results.

609

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618

619 **Author Contributions**

620 MMJ was responsible for designing the research, collecting, analysing, and interpreting the
621 data, and for writing the manuscript. RTQ contributed to the design of the study, data analysis,
622 interpretation of results and manuscript review. MDC contributed to the description of the
623 measurement, the discussion, and the manuscript review. MC contributed for the design of the
624 study, literature, and manuscript review, as well as for the choice of the journal. All the authors
625 approved this version for publication and accepted the conditions established by the *Nutrition*.

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752
753

754 **Chart 1.** Description of the items from the Brazilian Cooking Skills and Healthy Eating
 755 Questionnaire – BCSQ.

Brazilian Cooking Skills and Healthy Eating Questionnaire - BCSQ	
Scales	Items*
AAFV	Please mark YES or NO for EACH question
1.	Was there 100% natural fruit juice (READY OR homemade, including fruit pulp) in your home last week?
2.	Was there fresh fruit in your home last week?
3.	Were there raw or cooked vegetables and greens in your home last week?
4.	Was there leaf vegetables to salad in your home last week?
5.	In the last week, were fruit, vegetables and greens visible somewhere in the kitchen?
6.	In the last week, were there 100% natural fruit juice (READY OR homemade, including fruit pulp) or fresh fruits visible IN the refrigerator to be easily used as a snack?
7.	In the last week, were there PRE-PREPARED fresh vegetables and greens and visible IN the refrigerator to be easily used as snack?
8.	In the last week, were there ready vegetables and greens in the refrigerator to be used in a meal?
CA	Indicate the extent to which you agree or disagree with the following statements
9.	I do not like to cook because it takes too much my time.
10.	Meals made at home are affordable
11.	Cooking is frustrating
12.	I like testing new recipes
13.	Cooking is tricky
14.	Making meals at home helps me to eat in a healthier way
15.	Cooking is tiring
CB	How often did you do the following?
16.	Prepare meals with basic ingredients (e.g. whole lettuce, raw meat, etc)
17.	Prepare meals using pre-prepared/prepared foods (e.g. leaf vegetables ready to eat, canned corn, grated carrots, roast chicken)
18.	Reheat or use leftovers to eat in another meal
19.	Eat breakfast away from home
20.	Reheating leftovers from a home cooked lunch or dinner meal
21.	Reheating leftovers from a ready meal bought away from home to eat at lunch or dinner meal in home
22.	Using leftovers from a home cooked meal to make a new dish
23.	Using leftovers from a ready meal bought away from home to make a new dish
24.	Using fresh and pre-prepared/prepared items in combination to prepare a home meal (e.g. ready-to-eat leaf vegetables' salad with home cooked meat)
25.	Eat lunch away from home
26.	Eat dinner away from home
SEPC	Indicate the extent to which you feel confident about performing the following activities:
27.	Eat fruits, vegetables and greens every day at lunch and dinner

28.	Eat fruits or vegetables and greens as a snack, even if everybody else were eating other snacks
29.	Eat the recommended 3 servings of fruits, and 3 of vegetables and greens every day
SEC	Indicate the extent to which you feel confident about performing the following activities:
30.	Cook from unprocessed ingredients (ex: lettuce head, fresh tomatoes, raw meat)
31.	Follow a written recipe (ex: preparing <i>vinagrete</i> sauce with tomatoes, onion, bell pepper, vinars, olive oil, salt peppers)
32.	Prepare dinner with items you have in the moment in your home
33.	Use knife with skills in the kitchen.
34.	Plan nutritious meals.
35.	Use pre-preparation culinary techniques (e.g. washing, peeling, chopping)
SECT	Indicate the extent to which you feel confident about performing the following activities:
36.	Cooking in boiling water
37.	Simmering
38.	Steaming (steam-cook)
39.	Frying with a large amount of oil
40.	Sautéing
41.	Braising
42.	Broiling
43.	Poaching/Scalding
44.	Baking/Roasting (is the same in Portuguese)
45.	Barbecuing/Grilling
46.	Stewing
47.	Using the micro-wave oven
SEFVS	Indicate the extent to which you feel confident about performing the following activities:
48.	Fresh or frozen vegetables and greens (ex: broccoli, pea)
49.	Root vegetables and tubers (ex: potatoes, beets, sweet potatoes)
50.	Fruits (ex: orange, watermelon)
51.	Herbs (ex: parsley, spring onion)
52.	Spices (e.g. pepper, cinnamon)
53.	Vinegars
54.	Juice of citrus fruits
55.	Zest of citrus fruits
56.	Hot sauces (e.g. pepper sauces, mustard sauce)
CTT	Select ONE answer for EACH question:
57.	Cooking potatoes briefly in boiling water and, following, put in cold water to preserve them for long time OR avoid their browning is an example of which culinary technique below?
58.	If a recipe asks you to sauté an onion, you should cook it:
59.	A diced potato should be cut into:
60.	Water is simmering when:
61.	Sweet potatoe is roasted when it is:
62.	What is the term used (designated) for washing, peeling and slicing foods before beginning to cook?
63.	To precisely measure 1 cup of milk for this recipe:

64. Which is best utensil for precisely measuring the honey in this recipe?

756 Notes: AAFV = Availability and Accessibility of Fruits and Vegetables Index / CA = Cooking Attitude / CB =
 757 Cooking Behavior / SEPC = Produce Consumption Self-Efficacy / SEC = Self-Efficacy in Cooking / SETC = Self-
 758 Efficacy in Using Basic Cooking Techniques –/ SEFVS = Self-Efficacy for Using Fruits, Vegetables, and
 759 Seasonings / CTT = Knowledge of Cooking Terms and Techniques Evaluation

760 *Answers-options (not showed) is described in Table 1

761

762 **Table 1.** Description of the Brazilian Cooking Skills and Healthy Eating Questionnaire –
 763 BCSQ.

Brazilian Cooking Skills and Healthy Eating Questionnaire - BCSQ				
Scales	What it measure?	Items	Answers / score	
1. Availability and Accessibility of Fruits and Vegetables Index - AAFV [15,16]	The availability of fruits and vegetable over the past week	8	Yes/no (1 or 2 points)	
2. Cooking Attitude - CA [10,15,16,25]	How respondents felt about cooking	7	5-point Likert scale (from “strongly disagree” to “strongly agree”)	
3. Cooking Behavior - CB [15,16, 28, 31, 32]*	The frequency of common cooking activities	11	11-items (from “not at all” to “about every day”)	
4. Produce Consumption Self-Efficacy - SEPC [15,16]	The degree of confidence in being able to meet the government’s three Brazilian recommendations for the consumption of fruits and vegetables	3		
5. Self-Efficacy in Cooking – SEC [15,16]	The degree of confidence in performing basic meal preparation activities	6	5-point Likert scale (from “not at all confident” to “extremely confident”)	
6. Self-Efficacy in Using Basic Cooking Techniques – SETC [15,16]	The degree of confidence in specific cooking techniques	12		
7. Self-Efficacy for Using Fruits, Vegetables, and Seasonings – SEFVS [15,16]	The degree of confidence in using fruits and vegetables when cooking	9		
8. Knowledge of Cooking Terms and Techniques Evaluation (CTT) [15,16, 27]	The level of cooking knowledge	8	Multiple-choice answers (1 point for the correct answer) Low CK - <6 points High CK - ≥6 points	
		Total	64	Lower to higher mean

*Items with low loading and internal consistency [15,16]

CK = Knowledge of Cooking

Table 2. Sociodemographic characteristics of Brazilian university students (n=767).

Characteristics	Values
Sex (%)	
Female	59.6
Male	40.4
Age (mean, SD)	20.7 (\pm 5.59)
Ethnicity (%)	
White	84.5
Black	9.2
Other	6.3
Income*(%)	
Low	15.4
Other	84.6
Living arrangements (%)	
With parents/grandparents	44.6
With friends or partner or other	35.5
Alone	19.9
Children (%)	
Yes	96.9
No	3.1
Courses (%)	
Full-time	52.9
Part-time	47.1
Location of the main meal	
Home	49.0
Outside	51.0
Reporting that know how to cook (%)	
Yes	72.0
No	28.0

Table 3. Exploratory Factor Analysis and Reliability Estimates of the BCSQ (n=767)^a.

Items and correspondent BCSQ scales	Factor loadings					
	1	2	3	4	5	6
Cronbach- α	0.86	0.89	0.81	0.77	0.77	0.62
SEC-Self-Efficacy in Cooking (7 items) - How confident do you feel in:						
30. Cook from basic ingredients (ex: whole head of lettuce, fresh tomatoes, raw meat)	0.72					
31. Follow a written recipe (ex: preparing <i>vinagrete</i> sauce with tomatoes, onion, bell pepper, vinars, olive oil, salt peppers)	0.56					
32. Prepare dinner with items you have in the moment in your home	0.66					
33. Use knife with skills in the kitchen.	0.71					
35. Use basic cooking techniques (e.g. washing, peeling, chopping)	0.71					
36. Cooking in boiling water	0.77					
37. Simmering	0.76					
SEFVS-Self-Efficacy in Using Fruits, Vegetables and Seasonings (9 items) - How confident do you feel in using:						
48. Fresh or frozen vegetables and greens (ex: broccoli, pea)			0.43			
50. Fruits (ex: orange, watermelon)		0.31	0.45			
51. Herbs (ex: parsley, spring onion)		0.52				
52. Spices (e.g. pepper, cinnamon)		0.77				
53. Vinars		0.70				
54. Juice of citrus fruits		0.68				
55. Zest of citrus fruits		0.70				
56. Hot sauces (e.g. pepper sauces, mustard sauce)		0.76				
SEPC- Produce Consumption Self-Efficacy (3 items) - How confident do you feel in:						
27. Eat fruits, vegetables and greens every day at lunch dinner			0.86			
28. Eat fruits or vegetables and greens as a snack, even if everybody else were eating other snacks			0.79			
29. Eat the recommended 3 servings of fruits, and 3 of vegetables and greens every day			0.80			
CA- Cooking Attitude (5 items) - How much do you agree or disagree with statements below:						
9. I do not like to cook because it takes too much my time.				0.63		
11. Cooking is frustrating.				0.57		
12. I like testing new recipes.				0.34		
13. Cooking is tricky.				0.66		
15. Cooking is tiring.				0.79		
CB 1 - Cooking Behavior related to use of leftovers (3 items) - How frequent do you:						
18. Reheat or use leftovers to eat in another meal					0.80	
20. Reheat leftovers from a home cooked lunch or dinner meal					0.93	

22. Use leftovers from a home cooked meal to make a new dish 0.42

CB 2 - Cooking Behavior related to cooking from scratch or convenience food (3 items) - How frequent do you:

16. Prepare meals with basic ingredients (e.g. whole lettuce, raw meat, etc)	0.32	0.40
17. Prepare meals using pre-prepared/prepared foods (e.g. leaf vegetables ready to eat, canned corn, grated carrots, roast chicken)		0.64
24. Use fresh and pre-prepared/prepared items in combination to prepare a home meal (e.g. ready-to-eat leaf vegetables' salad with home cooked meat)		0.75

Notes: BCSQ: Brazilian Cooking Skills and Health Eating Questionnaire.

^aPrincipal Axis Factoring method with Promax rotation (extraction eigenvalues > 1 and scree test).

Table 4. Confirmatory factor analysis fit indexes.

	X ²	df	X ² /df	CFI	TLI	NFI	RMSEA	GFI	ECVI	SRMR
M1	1690.505	362	4.66	0.855	0.838	0.824	0.069	0.866	2.394	0.061
M2	1088.966	265	4.11	0.892	0.878	0.862	0.064	0.894	1.576	0.059
M3	825.076	220	3.75	0.913	0.900	0.885	0.060	0.911	1.222	0.052
M4	499.460	170	2.94	0.940	0.929	0.914	0.053	0.938	0.782	0.046

M1 = Model 1 / M2 = Model 2 / M3 = Model 3 / M4 = Model 4

X² = chi-square; df = degree of freedom; X²/df = adjusted chi-square; CFI = Comparative Fitness Index; TLI = Tucker–Lewis Index; NFI = Normed fit index; RMSEA = Root Mean Square of Error of Approximation; GFI = Goodness of Fit Index; ECVI = Expected Cross-validation Index; SRMS = Standardized Root-mean-square residual.

Table 5. Standardized residuals correlations matrix

	9	11	12	15	18	20	22	27	28	29	30	31	32	33	35	36	48	50	51	53
9	0.000																			
11	-0.013	0.000																		
12	-0.019	-0.004	0.000																	
15	0.052	0.014	-0.042	0.000																
18	0.006	-0.007	0.031	-0.048	0.000															
20	0.021	-0.014	0.020	0.047	0.001	0.000														
22	0.129	0.037	0.113	0.031	-0.006	-0.001	0.000													
27	-0.041	-0.021	-0.034	-0.018	-0.015	-0.034	0.049	0.000												
28	0.008	0.013	0.012	0.067	0.012	0.028	0.066	-0.017	0.000											
29	-0.046	0.019	0.002	0.040	0.000	-0.013	0.046	-0.002	0.019	0.000										
30	-0.022	0.013	0.063	-0.061	0.016	0.030	0.053	0.092	0.099	0.068	0.000									
31	0.036	0.003	0.173	-0.041	-0.015	0.026	0.030	-0.045	0.027	-0.019	0.066	0.000								
32	0.011	0.032	0.045	-0.022	0.040	0.050	0.103	-0.109	-0.020	-0.070	0.016	0.013	0.000							
33	-0.020	0.004	0.045	-0.049	-0.074	-0.075	0.043	-0.068	-0.030	-0.013	-0.062	-0.006	0.007	0.000						
35	-0.058	-0.025	0.033	-0.016	-0.034	-0.026	0.091	-0.030	0.029	0.023	-0.020	-0.070	-0.009	0.084	0.000					
36	0.001	-0.032	0.037	-0.018	-0.014	-0.025	0.032	0.023	-0.018	-0.014	-0.019	-0.020	-0.016	0.028	0.011	0.000				
48	-0.032	0.041	0.022	-0.038	0.014	0.004	0.063	0.124	0.051	0.014	0.063	-0.023	-0.081	-0.115	-0.043	-0.031	0.000			
50	-0.097	-0.065	-0.013	-0.072	-0.022	-0.052	0.067	0.089	0.091	0.050	-0.039	-0.090	-0.025	-0.088	-0.001	0.010	0.010	0.000		
51	0.023	0.031	0.092	-0.016	0.029	0.032	0.085	-0.049	-0.086	-0.085	0.063	0.053	0.014	-0.027	0.062	0.063	-0.026	0.004	0.000	
53	0.015	0.022	0.067	0.016	-0.043	-0.070	0.065	-0.050	-0.049	-0.067	0.026	0.029	-0.016	0.053	0.023	0.020	0.005	-0.048	0.053	0.000

*In bold = high correlation (>0.1)

Table 6. Convergent validity, discriminant Validity, and composite reliability of the BCSQ.

	AVE	ASV	MSV	CR
CA	0.42	0.14	0.40	0.74
CB	0.57	0.02	0.03	0.79
SECP	0.59	0.13	0.46	0.81
SEC	0.48	0.23	0.56	0.84
SEFVS	0.46	0.28	0.56	0.77

Notes: BCSQ = Brazilian Cooking Skills and Healthy Eating Questionnaire / AVE= average variance extracted; ASV= average shared squared variance; MSV = Maximum shared squared variance; CR = Composite reliability; SEC = Self-Efficacy in Cooking / SEFVS = Self-Efficacy in Using Fruits, Vegetables and Seasonings / SEPC = Produce Consumption Self-Efficacy / CA = Cooking Attitude / CB = Cooking Behaviour

Table 7. Estimates of the BCSQ scales related to sex, living arrangements, knowing how to cook, place of main meal and time to cook at home (n=767)^a.

	CA	CB	SEPC	SEC	SEFVS
Estimates (95% CI)					
Gender					
Female	3.58 (3.58 to 3.58)	3.29 (3.10 to 3.48)	3.04 (2.93 to 3.23)	3.74 (3.63 to 3.85)	3.30 (3.10 to 3.50)
Male	3.58 (3.58 to 3.58)	3.09 (2.90 to 3.28)	3.12 (3.01 to 3.24)	3.65 (3.54 to 3.76)	3.49 (3.29 to 3.69)
Living					
Alone	3.57 (3.51 to 3.63)	3.08 (2.90 to 3.27)	3.07 (3.01 to 3.14)	3.75 (3.63 to 3.88)	3.37 (3.27 to 3.47)
With parents	3.59 (3.55 to 3.65)	3.38 (3.21 to 3.55)	3.06 (3.00 to 3.13)	3.57 (3.45 to 3.69)	3.37 (3.28 to 3.46)
With partner	3.58 (3.53 to 3.64)	3.23 (3.02 to 3.44)	3.09 (3.02 to 3.16)	3.76 (3.62 to 3.91)	3.45 (3.35 to 3.56)
With colleagues	5.57 (3.52 to 3.63)	3.06 (2.88 to 3.24)	3.09 (3.03 to 3.16)	3.70 (3.58 to 3.83)	3.40 (3.30 to 3.49)
Cook					
Yes	4.05 (3.90 to 4.19)	3.22 (3.13 to 3.31)	3.22 (3.04 to 3.41)	4.17 (3.96 to 4.38)	3.74 (3.50 to 3.97)
No	3.11 (2.95 to 3.28)	3.16 (3.06 to 3.26)	2.94 (2.74 to 3.15)	3.22 (3.00 to 3.44)	3.06 (2.81 to 3.31)
Place					
Home	3.61 (3.52 to 3.70)	3.35 (3.33 to 3.37)	3.08 (3.08 to 3.08)	3.76 (3.61 to 3.91)	3.40 (3.40 to 3.40)
Outside	3.55 (3.47 to 3.64)	3.03 (2.82 to 3.25)	3.08 (3.08 to 3.08)	3.63 (3.48 to 3.78)	3.40 (3.40 to 3.40)
Time					
< 1h	3.60 (3.48 to 3.73)	3.19 (3.19 to 3.19)	2.98 (2.78 to 3.19)	3.70 (3.70 to 3.70)	3.37 (3.23 to 3.52)
1h to 3h	3.61 (3.51 to 3.73)	3.19 (3.19 to 3.19)	3.02 (2.83 to 3.21)	3.70 (3.70 to 3.70)	3.35 (3.21 to 3.48)
≥ 3h	3.52 (3.40 to 3.64)	3.19 (3.19 to 3.19)	3.06 (2.90 to 3.23)	3.70 (3.70 to 3.70)	3.47 (3.35 to 3.60)

Notes: BCSQ = Brazilian Cooking Skills and Healthy Eating Questionnaire/ CI = confidence interval / - = no difference / SEC= Self-Efficacy in Cooking / SEFVS = Self-Efficacy in Using Fruits, Vegetables and Seasonings / SEPC (Produce Consumption Self-Efficacy / CA = Cooking Attitude / CB = Cooking Behaviour

^ap<0.05