



Analyse des déterminants de l'adhésion à la saine alimentation chez les Québécois

Thèse

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Analyse des déterminants de l'adhésion à la saine alimentation chez les Québécois

Thèse

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Résumé

Les évidences au sujet du rôle de la saine alimentation dans la prévention des maladies chroniques sont sans équivoque. Cependant, les Québécois peinent à atteindre les recommandations nationales en matière de saine alimentation. De nombreux facteurs relatifs à l'individu, à l'environnement social et à l'environnement alimentaire physique peuvent influencer les choix alimentaires. Jusqu'à présent, les déterminants de la saine alimentation ont été très peu étudiés au Canada. De plus, les études ayant identifié des déterminants de la saine alimentation ont souvent utilisé des outils de mesure non validés.

Le premier objectif général de mes travaux de doctorat était de développer des questionnaires spécifiquement conçus pour les adultes québécois et de procéder à leur validation. Pour ce faire, des questionnaires portant sur l'appréciation des aliments « camelote », le soutien des proches pour manger sainement et la perception de l'environnement alimentaire ont été développés. Dans le cadre d'une étude de validation, 75 femmes et 75 hommes ont rempli les questionnaires à deux reprises sur une plateforme web. Les questionnaires développés ont démontré leur validité et fiabilité à la suite d'un processus de validation en plusieurs étapes.

Le deuxième objectif général de cette thèse était d'identifier des déterminants, relatifs à l'individu, à l'environnement social et à l'environnement physique, associés à l'adhésion aux recommandations du guide alimentaire canadien (GAC) 2007, en vigueur au moment de l'étude, chez les adultes québécois et d'investiguer des interactions possibles entre les différents déterminants. Cet objectif a été atteint dans le contexte de l'étude PREDISE (PREDicteurs Individuels, Sociaux et Environnementaux de la saine alimentation), pour laquelle un échantillon composé de 1200 Québécois francophones âgés de 18 à 65 ans a été recruté. Les participants provenaient de cinq régions du Québec (Capitale-Nationale/Chaudière-Appalaches, Saguenay-Lac-St-Jean, Montréal, Mauricie et Estrie) et ont été recrutés par strates démographiques basées sur le sexe et l'âge dans le but de constituer un échantillon représentatif de la population francophone de ces régions. Les participants ont eu accès à la plateforme web de l'étude d'où ils ont rempli un ensemble de questionnaires, dont des rappels alimentaires de 24h.

Les travaux de cette thèse ont premièrement permis de documenter que l'autoévaluation de la qualité de l'alimentation ne reflète pas adéquatement l'adhésion mesurée aux recommandations du GAC 2007. Nous avons également observé que la connaissance des recommandations du GAC 2007 était associée positivement à l'adhésion à celles-ci, plus particulièrement chez les individus ayant un niveau de scolarité plus faible et chez ceux vivant sans enfant. L'appréciation des aliments riches en sel et en gras a été associée négativement à l'adhésion au GAC 2007, plus particulièrement chez les hommes ainsi que chez les femmes ayant un niveau de scolarité plus faible. L'appréciation des aliments riches en sucre, quant à elle, n'était pas associée significativement à l'adhésion aux recommandations du GAC 2007. Le soutien des proches à domicile pour

manger sainement a été associé à l'adhésion au GAC 2007, alors que la perception de l'environnement alimentaire physique n'y était pas associée. La motivation autodéterminée à l'égard de l'alimentation a été positivement associée à l'adhésion au GAC 2007 et la motivation non-autodéterminée y était négativement associée. Finalement, nous avons observé que la motivation autodéterminée explique en partie l'association entre certaines variables (c.-à-d., le sexe, l'éducation, le tabagisme, les connaissances en nutrition et le soutien social) et l'adhésion au GAC 2007.

En somme, les travaux présentés dans cette thèse sont le résultat de la première étude visant spécifiquement l'analyse de déterminants de l'adhésion aux recommandations canadiennes en matière de saine alimentation chez les adultes québécois. Ils ont permis d'identifier des déterminants importants, tels que les connaissances en nutrition, le soutien des proches à domicile et la motivation autodéterminée qui pourront dorénavant être des cibles de choix dans le but de guider les Québécois vers des choix alimentaires plus sains.

Abstract

The evidence about the role of healthy eating in the prevention of chronic disease is unequivocal. However, Quebecers are struggling to meet national guidelines for healthy eating. Many factors related to the individual, the social environment and the physical food environment can influence food choices. To date, determinants of healthy eating have been scarcely studied in Canada. In addition, studies on determinants of healthy eating have often used non-validated questionnaires.

The first general objective of this thesis was to develop and validate questionnaires specifically designed for French-speaking adults from the Province of Québec. Questionnaires on food liking, social support for healthy eating and the perception of the food environment were developed. As part of a validation study, 75 women and 75 men were recruited and completed the questionnaires twice on a web platform. The newly developed questionnaires have demonstrated their validity and reliability through a multistage validation process.

The second general objective was to identify individual, social, and environmental determinants of the adherence to 2007 Canada's Food Guide (CFG), in adults from the Province of Québec, and to investigate possible interactions between determinants. The 2007 CFG constituted the guidelines in force when the study was initiated. This objective was achieved in the context of the PREDISE study, for which a sample of 1,200 French-speaking adults from the Province of Quebec aged 18 to 65 was recruited. Recruitment was performed in five different regions of the province (i.e., Capitale-Nationale/Chaudière-Appalaches, Saguenay-Lac-St-Jean, Montreal, Mauricie, and Estrie) and was designed so that participants represent the French-speaking adult population of each region based on sex and age. Participants completed a series of questionnaires on an internet platform, including 24-hour food recalls.

In this thesis, we observed that self-rated diet quality has a poor ability to predict adherence to healthy eating guidelines. It was also found that nutrition knowledge is positively associated with adherence to 2007 CFG, and that the association is stronger among participants with a lower education level. We also observed that liking for sweet foods is not associated with diet quality, but that a stronger liking for foods high in salt and fat is associated with a lower adherence to 2007 CFG, especially among men and among women with a lower education level. Moreover, our results suggest that the social environment, more precisely social support from close others at home, may have a stronger influence on healthy eating than perceived physical environmental factors. Finally, self-determined motivation was positively associated with diet quality whereas non-self-determined motivation was negatively associated with diet quality. Self-determined motivation partly accounted for the associations of various factors (i.e., sex, education, smoking status, nutrition knowledge, and social support) with adherence to 2007 CFG.

In conclusion, this thesis is the result of the first study specifically aimed at analyzing the determinants of adherence to Canadian healthy eating guidelines in the adult population of the Province of Quebec. We have identified important determinants, such as nutrition knowledge, social support for healthy eating and self-determined motivation, which can henceforth be targeted in interventions and healthy eating campaigns to guide Quebecers towards healthier food choices.

Table des matières

| | |
|---|------|
| Résumé | ii |
| Abstract..... | iv |
| Table des matières | vi |
| Liste des tableaux..... | ix |
| Liste des figures..... | xi |
| Liste des abréviations, sigles et acronymes..... | xii |
| Remerciements..... | xv |
| Avant-propos | xvii |
| Introduction | 1 |
| Chapitre 1 : Revue de littérature | 3 |
| 1.1 Alimentation et santé | 3 |
| 1.1.1 Santé et facteurs modifiables | 3 |
| 1.1.2 Rôles des nutriments pour la santé..... | 3 |
| 1.1.3 Recommandations canadiennes en matière de saine alimentation | 4 |
| 1.1.4 Qualité de l'alimentation au Québec | 6 |
| 1.1.5 Mesures de la qualité alimentaire..... | 8 |
| 1.2 Déterminants de la qualité alimentaire | 11 |
| 1.2.1 Facteurs individuels | 12 |
| 1.2.2 Facteurs reliés à l'environnement social | 17 |
| 1.2.3 Facteurs reliés à l'environnement physique | 19 |
| 1.2.4 Interrelations entre différents facteurs..... | 21 |
| 1.3 Validation des outils de mesure..... | 22 |
| 1.3.1 Validité | 23 |
| 1.3.2 Fiabilité..... | 25 |
| 1.3.3 Interprétabilité | 26 |
| Chapitre 2 : Problématique, objectifs et hypothèses..... | 27 |
| Objectifs généraux..... | 27 |
| Objectifs spécifiques..... | 28 |
| Étude de validation..... | 28 |
| Étude PREDISE | 28 |
| Chapitre 3 : Comparaison entre l'autoévaluation de la qualité alimentaire et l'adhésion au GAC 2007 | 30 |
| Résumé | 31 |
| Abstract | 32 |
| Title page..... | 33 |
| Introduction..... | 34 |
| Materials and methods | 35 |
| Results | 38 |
| Discussion | 40 |
| References | 43 |
| Tables..... | 45 |
| Figures | 49 |
| Supplemental material..... | 52 |

| | |
|---|-----|
| Chapitre 4 : Associations entre les connaissances en nutrition et l'adhésion au GAC 2007 | 54 |
| Résumé | 55 |
| Abstract | 56 |
| Title page..... | 57 |
| Purpose | 58 |
| Methods..... | 59 |
| Results | 63 |
| Discussion | 64 |
| References | 68 |
| Tables..... | 71 |
| Supplementary Material..... | 76 |
| Chapitre 5 : Développement et validation d'un questionnaire sur l'appréciation d'aliments salés et d'aliments sucrés | 80 |
| Résumé | 81 |
| Abstract | 82 |
| Title page..... | 83 |
| Introduction..... | 84 |
| Materials and Methods | 85 |
| Results and Discussion | 88 |
| Conclusions | 92 |
| References | 93 |
| Tables..... | 95 |
| Chapitre 6 : Associations entre l'appréciation d'aliments salés et d'aliments sucrés et l'adhésion au GAC 2007 | 98 |
| Résumé | 99 |
| Abstract | 100 |
| Titre page | 101 |
| Introduction..... | 102 |
| Methods..... | 103 |
| Results | 107 |
| Discussion | 109 |
| Conclusion..... | 113 |
| Tables..... | 118 |
| Supplemental material..... | 124 |
| Chapitre 7 : Développement et validation d'un questionnaire sur le soutien des proches pour manger sainement | 127 |
| Résumé | 128 |
| Abstract | 129 |
| Title page..... | 130 |
| Introduction..... | 132 |
| Methods..... | 133 |
| Results | 136 |
| Discussion | 138 |
| Conclusions | 141 |

| | |
|--|-----|
| References | 142 |
| Tables..... | 144 |
| Chapitre 8 : Développement et validation d'un questionnaire sur la perception de l'environnement alimentaire | |
| | 147 |
| Résumé | 148 |
| Abstract | 149 |
| Title page..... | 150 |
| Introduction..... | 151 |
| Material and methods | 152 |
| Results | 155 |
| Discussion | 157 |
| Conclusion..... | 160 |
| References | 161 |
| Tables..... | 163 |
| Chapitre 9 : Associations entre l'environnement social et l'environnement physique et l'adhésion au GAC 2007 | |
| | 166 |
| Résumé | 167 |
| Abstract | 168 |
| Title page..... | 169 |
| Introduction..... | 170 |
| Materials and Methods | 172 |
| Results | 176 |
| Discussion | 178 |
| Conclusions | 181 |
| References | 182 |
| Tables..... | 186 |
| Figure | 192 |
| Supplemental material..... | 193 |
| Chapitre 10 : Associations entre les types de motivation à l'égard de l'alimentation et l'adhésion au GAC 2007 | |
| | 196 |
| Résumé | 197 |
| Abstract | 198 |
| Title page..... | 199 |
| Introduction..... | 200 |
| Methods..... | 203 |
| Results | 208 |
| Discussion | 209 |
| Conclusion..... | 213 |
| References | 214 |
| Tables..... | 218 |
| Supplemental material..... | 223 |
| Discussion et conclusion..... | 224 |
| Conclusion générale..... | 236 |
| Bibliographie | 239 |

Liste des tableaux

Chapitre 1

| | |
|---|---|
| Tableau 1-1. Score Healthy Eating Index adapté aux recommandations canadiennes (C-HEI) | 9 |
|---|---|

Chapitre 3

| | |
|--|----|
| Table 3-1. Sample characteristics (n=1045)..... | 45 |
| Table 3-2. Participants' characteristics according to self-rated diet quality. | 46 |
| Table 3-3. C-HEI scores according to self-rated diet quality. | 47 |
| Table 3-4. Percent agreement between categories of self-rated diet quality and categorized C-HEI..... | 48 |
| Supplemental Table S3-5. List of questionnaires completed in the PREDISE study | 52 |
| Supplemental Table S3-6. Description of the C-HEI scoring for adults..... | 53 |

Chapitre 4

| | |
|--|----|
| Table 4-1. Sample characteristics (n=1092)..... | 71 |
| Table 4-2. Characteristics of participants with complete data and participants with incomplete data before imputation* | 72 |
| Table 4-3. Regression analyses of the C-HEI score on nutrition knowledge..... | 73 |
| Table 4-4. Regression analyses of the C-HEI score on nutrition knowledge stratified by education level..... | 74 |
| Table 4-5. Regression analyses of the C-HEI score on nutrition knowledge stratified by living or not with children. | 75 |
| Supplemental Table S4-6. Description of the C-HEI scoring for adults..... | 76 |
| Supplemental Table S4-7. Mean nutrition knowledge scores according to sociodemographic characteristics, smoking status and reporting status. | 79 |

Chapitre 5

| | |
|--|----|
| Table 5-1. Sample characteristics of the validation study (n = 143). | 95 |
| Table 5-2. Subscales' items, factor loadings, and results from the concurrent validity, internal consistency reliability, and test-retest reliability. | 96 |
| Table 5-3. Mean liking scores for the total sample, and according to gender, age, and body mass index (BMI). | 97 |

Chapitre 6

| | |
|---|-----|
| Table 6-1. Sample characteristics of participants in the PREDISE study (n=1096)..... | 118 |
| Table 6-2. Mean scores for liking for salty foods and for sweet foods according to individual characteristics. | 119 |
| Table 6-3. Mean Canadian Healthy Eating Index (C-HEI) total and components scores and correlations with liking scores. | 120 |
| Table 6-4. Regression analyses of Canadian Healthy Eating Index (C-HEI) on liking for salty foods and liking for sweet foods. | 121 |
| Table 6-5. Regression analyses of Canadian Healthy Eating Index (C-HEI) score on liking for salty foods and liking for sweet foods, stratified by sex. | 122 |
| Table 6-6. Regression analyses of Canadian Healthy Eating Index C-HEI score on liking for salty foods and liking for sweet foods among women, stratified by education level..... | 123 |
| Supplementary Table S6-7. Description of the C-HEI scoring for adults | 124 |

| | |
|--|-----|
| Supplementary Table S6-8. Food Liking Questionnaire | 125 |
| Supplementary Table S6-9. Characteristics of participants with complete vs. incomplete data. | 126 |

Chapitre 7

| | |
|---|-----|
| Table 7-1. Sample characteristics of the validation study (n=148) | 144 |
| Table 7-2. Questionnaire's items and factor loadings..... | 145 |
| Table 7-3. Scores obtained by participants for the four subscales, Cronbach Alpha, and intra-class correlation coefficients..... | 146 |

Chapitre 8

| | |
|---|-----|
| Table 8-1. Questionnaire items | 163 |
| Table 8-2. Validation study sample characteristics (n=147) | 164 |
| Table 8-3. Weighted Cohen's Kappa..... | 165 |

Chapitre 9

| | |
|--|-----|
| Table 9-1. Sample characteristics. | 186 |
| Table 9-2. Scores for the four subscales of the Social Support for Healthy Eating questionnaire for the whole sample and according to sociodemographic characteristics..... | 187 |
| Table 9-3. Regression analyses of Canadian Healthy Eating Index (C-HEI) score on social support variables. | 188 |
| Table 9-4. Regression analyses of Canadian Healthy Eating Index (C-HEI) score on social support variables, stratified by education levels..... | 189 |
| Table 9-5. Accessibility to healthy foods scores for the whole sample and according to sociodemographic characteristics..... | 190 |
| Table 9-6. Regression analyses of Canadian Healthy Eating Index (C-HEI) score on perceived food environment variables..... | 191 |
| Supplemental Table S9-7. Description of the C-HEI scoring for adults..... | 193 |
| Supplemental Table S9-8. Unadjusted Pearson's correlations between C-HEI and subscales of the Social Support for Healthy Eating..... | 194 |
| Supplemental Table S9-9. Sample characteristics | 195 |

Chapitre 10

| | |
|---|-----|
| Table 10-1. Sample characteristics (n=1097)..... | 218 |
| Table 10-2. Regulation styles for eating behaviors: mean scores according to individual characteristics. | 219 |
| Table 10-3. Regulation styles for eating behaviors: correlations coefficients with the Canadian Healthy Eating Index (C-HEI) score and its components | 220 |
| Table 10-4. Regression analyses of Canadian Healthy Eating Index (C-HEI) on regulation styles for eating behaviors | 221 |
| Table 10-5. Regression coefficients for the association between individual and contextual correlates and Canadian Healthy Eating Index (C-HEI) as mediated by self-determined motivation | 222 |
| Supplemental Table S10-6. Description of the C-HEI scoring for adults..... | 223 |

Liste des figures

Chapitre 1

| | |
|--|----|
| Figure 1-1. Guide alimentaire canadien 2019 | 5 |
| Figure 1-2. Recommandations du Guide alimentaire canadien 2007 | 6 |
| Figure 1-3. Facteurs individuels, sociaux et environnementaux influençant les choix et comportements alimentaires, proposé par Contento (2008)..... | 12 |
| Figure 1-4. Propriétés d'un bon instrument de mesure | 23 |

Chapitre 3

| | |
|--|----|
| Figure 3-1. Flowchart of the PREDISE study | 49 |
| Figure 3-2. Scores for C-HEI components according to self-rated diet quality..... | 50 |
| Figure 3-3. C-HEI score according to self-rated diet quality and gender..... | 51 |

Chapitre 9

| | |
|---|-----|
| Figure 9-1. Flowchart of the PREDISE study | 192 |
|---|-----|

Liste des abréviations, sigles et acronymes

BMI : *body mass index*

CFG : *Canada's food guide*

CI : *confidence interval*

CIHR : *Canadian Institutes of Health Research*

COSMIN : *COnsensus based Standards for the selection of health Measurement Instruments*

C-HEI : *healthy eating index canadien / canadian healthy eating index*

EFA: *exploratory factor analysis*

FCS : *fully conditional specification*

FFQ : *food frequency questionnaire*

GAC : *guide alimentaire canadien*

GBD : *Global Burden of Diseases, Injuries, and Risk Factors Study*

HEI : *healthy eating index*

INSPQ : *Institut national de la santé publique du Québec (INSPQ)*

OMS : *Organisation mondiale de la Santé*

PREDISE : *Prédicteurs individuels, sociaux et environnementaux*

R24W : *rappel de 24h Web*

ROC : *receiver operating characteristic*

SAS : *Statistical Analysis Software*

SDT : *Self-determination Theory*

À Ophélie et Adèle

*"If you know you are on the right track, if you
have this inner knowledge, then nobody can
turn you off... no matter what they say."
- Barbara McClintock*

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Entreprendre un doctorat, c'est se lancer dans une grande aventure scientifique parsemée d'embuches, mais également de grandes réussites et de moments de fierté. Au-delà de la production scientifique et de l'accumulation d'un bagage de connaissances, un doctorat est aussi une aventure humaine, de collaboration, de partage, de soutien et d'entraide. Plusieurs personnes ont contribué de près ou de loin à mon développement scientifique et humain durant les six dernières années, et je tiens à en remercier quelques-unes ici.

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Avant-propos

Cette thèse est composée de huit articles scientifiques originaux que j'ai rédigés à titre de première auteure. Trois d'entre eux ont été écrits dans le cadre d'une étude de validation de questionnaires alors que les cinq autres sont issus des données récoltées dans le cadre de l'étude PREDISE. Les articles sont présentés aux chapitres 3 à 10 dans un ordre visant à regrouper les thèmes. Ainsi, les trois articles de validation de questionnaires précèdent respectivement les articles de l'étude PREDISE utilisant spécifiquement ces questionnaires.

Ma directrice de thèse, Simone Lemieux, est la chercheuse principale de la programmation de recherche dans laquelle prennent place ces travaux et est donc à l'origine de l'élaboration des objectifs poursuivis dans le cadre de mon doctorat. Elle a supervisé l'ensemble des travaux, du recrutement des participants jusqu'à la révision des articles scientifiques. Elle a supervisé l'analyse des données et la rédaction des articles et a participé à l'interprétation des résultats. Mon codirecteur, Benoît Lamarche, a aussi contribué à l'élaboration du projet PREDISE ainsi qu'à l'analyse et à l'interprétation des données ainsi qu'à la révision des articles.

Dans le cadre de l'étude de validation de questionnaires, j'ai participé au développement des items inclus dans les questionnaires et au suivi des participants. Puis, j'ai réalisé les différentes étapes de validation, effectué les analyses statistiques, interprété les résultats et rédigé les manuscrits. Louise Corneau, professionnelle de recherche, a été la principale personne chargée du recrutement et du suivi des participants. Elle était également membre du panel d'experts qui ont contribué à évaluer la validation de contenu des questionnaires, en compagnie de Catherine Bégin, Sophie Desroches, Véronique Provencher, Julie Robitaille et Marie-Claude Vohl. Maude Bradette-Laplante, qui était étudiante à la maîtrise au moment de ces travaux, a également été impliquée dans le développement d'un questionnaire et les premières étapes de validation. Tous les coauteurs ont lu et révisé les articles. Ces travaux sont présentés aux chapitres 5, 7 et 8 de cette thèse.

Chapitre 5 : Elise Carbonneau, Maude Bradette-Laplante, Benoît Lamarche, Véronique Provencher, Catherine Bégin, Julie Robitaille, Sophie Desroches, Marie-Claude Vohl, Louise Corneau et Simone Lemieux. Development and Validation of the Food Liking Questionnaire in a French-Canadian Population, *Nutrients*, 2017, 9, 1337.

Chapitre 7 : Elise Carbonneau, Maude Bradette-Laplante, Benoît Lamarche, Véronique Provencher, Catherine Bégin, Julie Robitaille, Sophie Desroches, Marie-Claude Vohl, Louise Corneau et Simone Lemieux. Social Support for Healthy Eating: Development and Validation of a Questionnaire for the French-Canadian Population, *Public Health Nutrition*, 2018;21(13):2360-6.

Chapitre 8 : Elise Carbonneau, Julie Robitaille, Benoît Lamarche, Louise Corneau et Simone Lemieux. Development and Validation of the Perceived Food Environment Questionnaire in a French-Canadian Population. *Public Health Nutrition*. 2017;20(11):1914-20.

Dans le cadre de l'étude PREDISE, des participants provenant de cinq régions du Québec ont été recrutés par une firme de sondage. J'ai participé à la formation des recruteurs ainsi qu'au suivi et aux rencontres avec les participants de la région Capitale-Nationale/Chaudière-Appalaches. J'ai réalisé les analyses statistiques, interprété les résultats et rédigé les manuscrits. Louise Corneau a assuré la gestion des participants de la région Capitale-Nationale/Chaudière-Appalaches et a coordonné le projet en entier en effectuant des suivis avec les professionnels de recherche des autres régions. En plus d'avoir participé à l'élaboration du projet PREDISE, Julie Houle, Marie-France Langlois, Luigi Bouchard et Rémi Rabasa-Lhoret ont rendu possible le suivi des participants des régions de la Mauricie, l'Estrie, le Saguenay et Montréal, respectivement. Les autres collaborateurs au projet PREDISE, soit Julie Robitaille, Véronique Provencher, Sophie Desroches, Marie-Claude Vohl, Catherine Bégin, Mathieu Bélanger, Charles Couillard et Luc Pelletier ont tous participé à l'élaboration du projet de recherche et leurs expertises diverses ont été mises à profit pour l'interprétation des résultats obtenus. Tous les collaborateurs ont lu et révisé les articles pour lesquels leur nom apparaît à titre de coauteurs. Ces articles sont présentés aux chapitres 3, 4, 6, 9 et 10.

Chapitre 3 : Elise Carbonneau, Benoît Lamarche, Jacynthe Lafrenière, Julie Robitaille, Véronique Provencher, Sophie Desroches, Louise Corneau et Simone Lemieux, Are French Canadians able to accurately self-rate the quality of their diet? Insights from the PREDISE study, *Applied, Physiology, Nutrition, and Metabolism*, 2019, 44: 293–300.

Chapitre 4 : Elise Carbonneau, Benoît Lamarche, Véronique Provencher, Sophie Desroches, Julie Robitaille, Marie-Claude Vohl, Catherine Bégin, Mathieu Bélanger, Charles Couillard, Luc Pelletier, Luigi Bouchard, Julie Houle, Marie-France Langlois, Louise Corneau et Simone Lemieux, Associations between nutrition knowledge and overall diet quality: the moderating role of sociodemographic characteristics – Results from the PREDISE study, *American Journal of Health Promotion*, 2020.

Chapitre 6 : Elise Carbonneau, Benoît Lamarche, Véronique Provencher, Sophie Desroches, Julie Robitaille, Marie-Claude Vohl, Catherine Bégin, Mathieu Bélanger, Charles Couillard, Luc Pelletier, Julie Houle, Marie-France Langlois, Rémi Rabasa-Lhoret, Louise Corneau et Simone Lemieux, Liking for foods high in salt and fat is associated with a lower diet quality but liking for foods high in sugar is not – Results from the PREDISE study, *Food Quality and Preference*, 2021.

Chapitre 9 : Elise Carbonneau, Benoît Lamarche, Julie Robitaille, Véronique Provencher, Sophie Desroches, Marie-Claude Vohl, Catherine Bégin, Mathieu Bélanger, Charles Couillard, Luc Pelletier, Luigi Bouchard, Julie Houle, Marie-France Langlois, Louise Corneau et Simone Lemieux, Social Support, but Not Perceived Food Environment, Is Associated with Diet Quality in French-Speaking Canadians from the PREDISE Study, *Nutrients*, 2019, 11(12).

Chapitre 10 : Elise Carbonneau, Luc Pelletier, Catherine Bégin, Benoît Lamarche, Mathieu Bélanger, Véronique Provencher, Sophie Desroches, Julie Robitaille, Marie-Claude Vohl, Charles Couillard, Luigi Bouchard, Julie Houle, Marie-France Langlois, Rémi Rabasa-Lhoret, Louise Corneau et Simone Lemieux, Individuals with self-determined motivation for eating have better overall diet quality: Results from the PREDISE Study. Cet article a été soumis au journal *Appetite* en août 2020.

Dans cet avant-propos, je désire aussi présenter une autre publication scientifique que j'ai écrite à titre de première auteure, mais qui n'est pas incluse dans cette thèse. Dans le cadre de l'étude de validation, nous avons procédé à la traduction, l'adaptation culturelle et la validation d'un questionnaire portant sur l'alimentation intuitive, originalement développé en anglais (1). Puisque dans le cadre de mon doctorat je n'ai pas utilisé les données de ce questionnaire pour l'analyse des déterminants de la saine alimentation dans l'étude PREDISE, cet article n'a pas été inclus dans cette thèse.

Elise Carbonneau, Noémie Carbonneau, Benoît Lamarche, Véronique Provencher, Catherine Bégin, Maude Bradette-Laplante, Catherine Laramée et Simone Lemieux, Validation of a French-Canadian adaptation of the intuitive eating scale-2 for the adult population, *Appetite*, 2016;105:37-45.

Introduction

Plusieurs organismes, dont l'Organisation mondiale de la Santé (OMS) et la commission EAT-Lancet, reconnaissent la saine alimentation comme une des avenues les plus efficaces afin de contrer le développement des maladies chroniques (2, 3). En 2017, les principaux facteurs de risque alimentaires, tels qu'un apport élevé en sodium, un apport faible en grains entiers et un apport faible en fruits, ont été responsables de 11 millions de décès à travers le monde, c'est-à-dire 22% de tous les décès dans la population adulte, principalement dus aux maladies cardiovasculaires, à différents types de cancer et au diabète de type 2 (4). Bien que la relation entre l'alimentation et la diminution du risque de maladies chroniques soit bien connue, les individus éprouvent des difficultés à adhérer aux principes de la saine alimentation, ce qui rend les interventions nutritionnelles globalement inefficaces (5). La faible amélioration de la qualité de l'alimentation de la population au fil des ans (6) suggère que les individus ont du mal à adhérer aux principes de la saine alimentation.

Au Québec, des données récemment publiées par l'Institut national de la santé publique du Québec (7) suggèrent que la population peine à adhérer aux recommandations nationales et que la majorité des Québécois n'atteignent pas les recommandations du GAC pour l'apport en légumes et fruits, produits céréaliers et lait et substituts. Cependant, il semble que, bien qu'ils ne réussissent pas à adhérer correctement aux recommandations nationales, les Québécois et Canadiens aient un intérêt envers la saine alimentation. En effet, selon les données d'une enquête périodique effectuée au Canada, 89% des Canadiens considèrent que l'aspect nutritionnel des aliments est important lors du choix des aliments et près des deux tiers des répondants rapportaient en 2015 avoir fait au moins un changement dans le but d'améliorer leur alimentation durant l'année précédente (8). Par ailleurs, 86% des Canadiens interrogés rapportent que le maintien d'une bonne santé est un facteur qui influence leurs choix alimentaires (8). Ces informations amènent à se questionner sur les raisons qui font en sorte que les Québécois n'atteignent globalement pas les recommandations du GAC.

Plusieurs facteurs peuvent influencer l'adhésion aux recommandations alimentaires (9, 10). La manière dont un individu s'alimente évolue tout au long de sa vie, sous les influences de la famille, l'entourage, la culture, les normes sociales, l'environnement alimentaire, ainsi que selon son développement physique et psychologique. Des facteurs individuels tels que des prédispositions d'ordre biologique, différentes expériences avec la nourriture, des facteurs psychosociaux et des caractéristiques sociodémographiques peuvent influencer la façon dont un individu s'alimente. En ce qui concerne les facteurs sociaux, il semble que la famille et les amis puissent influencer positivement ou négativement la qualité de l'alimentation. L'environnement alimentaire physique dans lequel évolue un individu peut également influencer la qualité de son alimentation.

Jusqu'à présent, les déterminants de la saine alimentation ont été très peu étudiés au Canada. De plus, de nombreuses études ayant identifié des déterminants de la saine alimentation ont utilisé des outils de mesure

non validés. Considérant l'écart entre l'alimentation souhaitable selon les évidences scientifiques et la qualité de l'alimentation des Québécois, il est primordial d'étudier les facteurs influençant l'adhésion aux recommandations de la saine alimentation, et ce, en utilisant des outils de mesure validés. Dans une perspective de santé publique, une meilleure compréhension des différents déterminants de la saine alimentation chez les Québécois a le potentiel d'aider à développer des interventions mieux ciblées visant à améliorer la qualité de l'alimentation de la population.

Dans le cadre de cette thèse, nous avons donc développé et validé des questionnaires qui nous ont permis d'analyser différents déterminants individuels, sociaux et environnementaux de l'adhésion aux recommandations visant la saine alimentation au sein d'un échantillon représentatif de la population adulte québécoise.

Cette thèse est divisée en 11 chapitres. Le premier chapitre constitue une revue de la littérature dont les grands thèmes sont le lien entre l'alimentation et la santé, la qualité de l'alimentation des Québécois, les déterminants de la saine alimentation relatifs à l'individu, à l'environnement social et à l'environnement physique, et finalement la validation des outils de mesure. Dans le deuxième chapitre, les objectifs du projet de recherche sont décrits ainsi que les hypothèses qui s'y rattachent. Puis, les chapitres 3 à 10 présentent huit articles scientifiques rédigés durant mes études doctorales et qui permettent d'atteindre les objectifs de recherche. Finalement, dans le dernier chapitre, les résultats obtenus dans les huit articles scientifiques sont discutés suivis des conclusions générales de cette thèse.

Chapitre 1 : Revue de littérature

1.1 Alimentation et santé

1.1.1 Santé et facteurs modifiables

Parmi les nombreuses influences possibles sur l'état de santé de la population, quelques facteurs majeurs contribuent à une proportion significative des décès et des maladies à travers de monde. L'OMS identifie que les principaux facteurs de risque des maladies chroniques sont l'hypertension artérielle, le tabagisme, l'hypercholestérolémie, la faible consommation de fruits et de légumes, le surpoids et l'inactivité physique (11). Ces facteurs sont considérés comme étant modifiables puisque les individus ont, dans certaines mesures, un pouvoir d'action afin de les modifier, contrairement à d'autres facteurs considérés non modifiables comme l'âge, le sexe et l'hérédité. En 2016, les mauvaises habitudes alimentaires étaient le deuxième principal facteur de risque de mortalité dans le monde, contribuant à près d'un décès sur cinq (12). Ainsi, l'adoption d'une saine alimentation est reconnue comme une des avenues les plus efficaces afin de contrer le développement de plusieurs maladies et d'optimiser la santé physique et mentale (2, 3).

1.1.2 Rôles des nutriments pour la santé

L'OMS présente plusieurs recommandations en matière d'alimentation dans le but de prévenir ou de ralentir la progression de différents problèmes de santé (13). Elle recommande une alimentation riche en fruits et légumes et acides gras polyinsaturés, et faible en sodium et acides gras saturés et trans dans le but de réduire les risques de maladies cardiovasculaires. L'OMS suggère également qu'un apport adéquat en fruits et légumes aide à réduire les risques de cancers associés au système digestif (13). La consommation de calcium et de vitamine D est quant à elle encouragée pour la réduction du risque d'ostéoporose et de fractures. L'OMS suggère également de limiter la consommation de sucres pour prévenir l'apparition de caries dentaires. De plus, dans le but de prévenir un gain de poids non souhaitable, l'OMS recommande de réduire la consommation d'aliments riches en gras et les aliments et boissons riches en sucre. Le regroupement EAT Lancet abonde dans le même sens que l'OMS et caractérise les régimes alimentaires sains par un apport calorique optimal et se composant principalement d'une diversité d'aliments d'origine végétale, de faibles quantités d'aliments d'origine animale, de graisses insaturées plutôt que saturées et de quantités limitées de céréales raffinées, d'aliments hautement transformés et de sucres ajoutés (2).

Dans le but de documenter l'impact sur la santé de la consommation des différents nutriments et groupes d'aliments, la *Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2017* (4) a procédé à une analyse systématique de données provenant de 195 pays. Selon cette étude, les 15 principaux facteurs de risque alimentaires (p. ex., alimentation faible en légumes, alimentation faible en noix et graines, alimentation

riche en viande rouge) ont été responsables de 11 millions de décès à travers le monde en 2017, c'est-à-dire 22% de tous les décès dans la population adulte. Les principales causes de ces décès reliés aux facteurs de risque alimentaires sont, dans l'ordre, les maladies cardiovasculaires, les cancers et le diabète de type 2 (4). Toujours selon les données de la GBD 2017, les facteurs de risque alimentaires ayant eu le plus grand impact sur la santé sont un apport élevé en sodium, un apport faible en grains entiers et un apport faible en fruits (4). Ces résultats corroborent ceux de récentes méta-analyses ayant associé l'apport en légumes et fruits à un risque réduit de maladies cardiovasculaires (14, 15) et de mortalité toutes causes confondues (14, 16). Un apport plus élevé en grains entiers a également été associé à une réduction du risque de maladies cardiovasculaires et de mortalité toutes causes (14, 17, 18) ainsi qu'à un risque plus faible de diabète de type 2 (19).

Ainsi, la saine alimentation est caractérisée par des habitudes ou comportements alimentaires qui favorisent l'amélioration ou le maintien de la santé (20). Selon *La Vision de la saine alimentation: Pour la création d'environnements alimentaires favorables à la santé* du Ministère de la Santé et des Services Sociaux, une alimentation saine est constituée d'aliments diversifiés et donne priorité aux aliments de valeur nutritive élevée sur le plan de la fréquence et de la qualité (21).

1.1.3 Recommandations canadiennes en matière de saine alimentation

Les recommandations canadiennes sur la saine alimentation visent une amélioration ou un maintien de l'état de santé et une réduction des risques de maladies (22) et sont présentées dans le GAC. La plus récente version du GAC a été publiée en janvier 2019 (23), remplaçant le guide qui faisait office de référence officielle depuis 12 ans, soit le GAC 2007 (24).

1.1.3.1 *Guide alimentaire canadien 2019*

Le GAC 2019 a été élaboré à partir des trois grandes lignes directrices suivantes : 1) les aliments de haute valeur nutritive sont les fondements de la saine alimentation; 2) les aliments et boissons transformés ou préparés qui contribuent à une consommation excessive de sodium, de sucres libres ou de lipides saturés nuisent à la saine alimentation; 3) les compétences alimentaires sont nécessaires pour naviguer dans un environnement alimentaire complexe et favoriser une saine alimentation (25). Les principales recommandations du GAC 2019 sont présentées à la figure 1-1.



Figure 1-1. Guide alimentaire canadien 2019

La présentation visuelle du GAC 2019 est une assiette qui représente les proportions que les différents types d'aliments devraient occuper dans l'alimentation, soit la moitié en légumes et en fruits, un quart en aliments à grains entiers et un quart en aliments protéinés. Parmi les aliments protéinés, on observe que les protéines végétales, telles que le tofu, les légumineuses, les noix et les graines, sont mises de l'avant, bien que les viandes, les poissons, les œufs et le yogourt y soient également présentés. L'eau est suggérée comme boisson à privilégier. Une des nouveautés de ce guide alimentaire est la grande place donnée aux recommandations qui ne concernent pas spécifiquement le choix des aliments, mais plutôt la manière de consommer les aliments et les contextes entourant les repas. En effet, on recommande maintenant aux Canadiens et Canadiennes de prendre conscience de leurs habitudes alimentaires, de cuisiner plus souvent, de savourer les aliments, de prendre leurs repas en bonne compagnie, d'utiliser les étiquettes des aliments et de rester vigilants face au marketing alimentaire. Ainsi, ce nouveau guide alimentaire se veut plus qu'un outil pour éduquer sur « quoi manger », mais également pour aider à « comment manger ».

1.1.3.1 Guide alimentaire canadien 2007

Bien que le GAC 2007 ne soit plus la référence officielle au Canada en matière de saine alimentation depuis janvier 2019, les recommandations qu'on y trouvait sont décrites dans la présente section puisqu'elles étaient en vigueur lors du début des travaux présentés dans cette thèse. Il est donc à noter que ce sont à ces recommandations que réfèrent tous les articles qui seront présentés dans les prochains chapitres. Par ailleurs, malgré les nouvelles lignes directrices de 2019, il n'en demeure pas moins que le contenu du GAC 2007 a été fondé sur des données scientifiques probantes et est associé à un profil de santé favorable (22). La figure 1-2 présente les principales recommandations du GAC 2007. Ce guide est basé sur le concept de portions

d'aliments provenant de quatre groupes alimentaires, soit *légumes et fruits, produits céréaliers, lait et substituts* et *viandes et substituts*. Dans le but d'atteindre une alimentation équilibrée, le GAC 2007 recommande un nombre de portions pour chaque groupe alimentaire, selon l'âge et le sexe. De plus, des suggestions sur les types d'aliments à privilégier dans chaque groupe alimentaire sont présentées afin de favoriser des choix alimentaires optimaux pour la santé. Par exemple, il est recommandé de consommer quotidiennement des légumes vert foncé ou orangés, de manger au moins la moitié des produits céréaliers sous forme de grains entiers, de choisir des produits laitiers faibles en matière grasse et de remplacer régulièrement la viande par des protéines d'origine végétale.

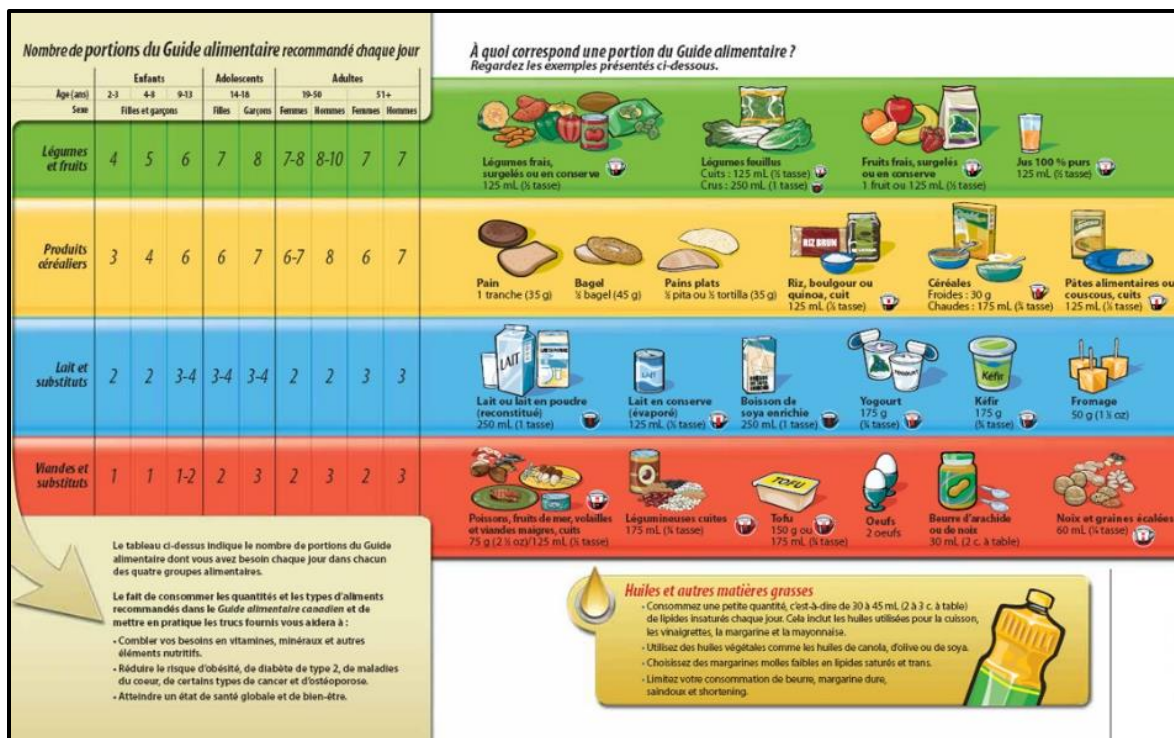


Figure 1-2. Recommandations du Guide alimentaire canadien 2007

1.1.4 Qualité de l'alimentation au Québec

Bien que l'association entre la saine alimentation et la diminution du risque de maladies chroniques soit bien connue dans la littérature scientifique (4), les individus éprouvent des difficultés à adhérer aux principes de la saine alimentation. (5). Au Québec, le rapport intitulé *La consommation des aliments chez les Québécois selon les recommandations du Guide alimentaire canadien* publié par l'Institut national de la santé publique du Québec (INSPQ) en 2019 (7) suggère en effet que les Québécois peinent à adhérer aux recommandations nationales. Les données présentées dans ce rapport ont été collectées dans le cadre de l'Enquête sur la santé dans les collectivités canadiennes de 2015, lors de laquelle près de 2500 adultes québécois ont été interrogés. Selon les

résultats de cette étude, les adultes québécois consommaient en général 5 portions de légumes et fruits par jour. Ainsi, un peu plus de 80% d'entre eux ne consommaient habituellement pas le minimum de portions recommandé par le GAC 2007 (c.-à-d., 7 à 10 selon le sexe et l'âge). Pour ce qui est des produits céréaliers, la consommation moyenne des adultes québécois était de 6 portions par jour, résultant à près de 75% d'entre eux qui n'atteignaient pas les recommandations. D'ailleurs, alors que le GAC 2007 recommande de consommer la moitié des portions de produits céréaliers sous forme de grains entiers, ceux-ci ne représentaient que 14% des portions consommées. Concernant la consommation de lait et substituts, la consommation moyenne des Québécois de 19 à 50 ans était de 2 portions, comme recommandé par le GAC 2007. Cependant, alors que la recommandation augmente à 3 portions pour les adultes de 51 ans et plus, la consommation moyenne, elle, diminue à 1,5 portion chez les individus de ce groupe d'âge. Il en résulte que près de trois adultes sur quatre ne consommaient pas quotidiennement le nombre minimal de portions recommandées. Finalement, pour ce qui est des viandes et substituts, les Québécois de 19 à 50 ans consommaient en moyenne le nombre de portions recommandées (c.-à-d., 2 portions pour les femmes et 3 portions pour les hommes). Les individus de 51 ans et plus avaient cependant plus de difficulté à atteindre la recommandation. Ainsi, 62% des Québécois de 51 ans et plus n'atteignaient pas le nombre minimum de portions recommandées. Les sources végétales de substituts de la viande représentaient 19 % des portions de viandes et substituts consommées.

Les données du rapport de l'INSPQ révèlent également que l'adhésion aux recommandations du GAC varie en fonction de certaines variables socioéconomiques. Les Québécois ayant des revenus plus élevés consommaient significativement plus de portions de légumes et fruits et de viandes et substituts, et avaient des apports moyens en sodium et en gras saturés plus élevés. Les Québécois provenant des ménages les plus scolarisés consommaient davantage de portions de légumes et fruits, de lait et substituts et de viandes et substituts.

Les données présentées dans le rapport de l'INSPQ corroborent celles issues de l'étude PREDISE, dans laquelle s'inscrivent les travaux qui sont présentés dans cette thèse et qui sera présentée avec plus de détails dans les prochains chapitres. Brièvement, les apports alimentaires de 1147 adultes francophones provenant de cinq régions administratives de la province de Québec ont été documentés par Brassard et al. (26). Les auteurs ont observé qu'une grande majorité d'individus n'atteignaient pas les recommandations pour les différents groupes alimentaires (76% pour les légumes de fruits, 87% pour les produits céréaliers et 61% pour le groupe lait et substituts). De plus, 80,5% des participants consommaient plus que l'apport maximal tolérable en sodium (c.-à-d., 2300mg par jour) et 74,2% dépassaient la recommandation d'un apport en gras saturé inférieur à 10% de l'apport énergétique total.

Les plus récentes données sur l'alimentation des Québécois dépeignent donc un portrait plutôt sombre de la qualité alimentaire au Québec et suggèrent une faible adhésion aux recommandations du GAC 2007.

1.1.5 Mesures de la qualité alimentaire

1.1.5.1 Outils d'évaluation alimentaires

Dans le but d'évaluer la qualité de l'alimentation, différents outils peuvent être utilisés pour récolter des données alimentaires tels que le questionnaire de fréquence alimentaire, de journal alimentaire et le rappel de 24h. Le questionnaire de fréquence permet d'obtenir des informations sur la fréquence et, dans certains cas, la taille des portions d'aliments et de boissons consommés sur une période donnée, généralement le dernier mois ou la dernière année. Le questionnaire de fréquence alimentaire a été utilisé dans de nombreuses études depuis des décennies (27) et constituait en 2017 l'outil le plus fréquemment utilisé dans les études passées ou en cours au Canada (28). Le rappel de 24h, quant à lui, a pour but d'obtenir des informations détaillées sur tous les aliments et boissons consommés un jour donné, soit la journée précédant celle de la complétion du questionnaire. L'utilisation de multiples rappels de 24h, comparativement au questionnaire de fréquence, semble permettre d'obtenir des valeurs plus valides en ce qui a trait à l'apport énergétique et l'apport en protéines (29, 30). Originellement, l'utilisation de multiples rappels de 24h était coûteuse et nécessitait beaucoup de temps, car les rappels devaient être administrés par un professionnel de recherche formé à cet effet. Le développement de technologies web automatisées permet maintenant la complétion de rappels de 24h sur Internet ce qui réduit le temps et les coûts associés, faisant du rappel de 24h un outil à privilégier pour plusieurs devis d'étude (31).

1.1.5.2 Indicateurs de la qualité de l'alimentation

Une fois les données alimentaires récoltées, différents indicateurs peuvent être mesurés pour évaluer la qualité de l'alimentation des individus ou des populations. Étant donné son association fortement documentée avec un risque réduit de maladies cardiovasculaires et de mortalité (14-16), la consommation de légumes et fruits est régulièrement utilisée comme indicateur de la qualité alimentaire. Des indices composés de plusieurs groupes d'aliments sont de plus en plus utilisés dans la littérature scientifique pour évaluer la qualité globale des apports alimentaires d'individus ou de populations. Ces indices sont généralement développés dans le but d'évaluer l'adhésion aux recommandations de la saine alimentation. Par exemple, le *Healthy Eating Index* (HEI) a été introduit pour la première fois en 1995 (32) pour évaluer l'adhésion aux recommandations américaines en matière de saine alimentation, puis a été modifié à quelques reprises (HEI-2005 (33), HEI-2010 (34), HEI-2015 (35)) pour suivre l'évolution des recommandations faites à la population.

Au Canada, Dubois et al. (36) ont adapté trois indices existants (32, 37, 38) aux recommandations nationales de 1992 en matière de saine alimentation afin d'analyser des données alimentaires récoltées chez des Québécois en 1990. Puis, plus récemment, un score inspiré du HEI-2005 des États-Unis a été adapté aux recommandations canadiennes de 2007 et validé par Garriguet (39). Tel que détaillé dans le tableau 1-1, le HEI canadien (C-HEI) comprend 11 composantes, dont huit dites d'adéquation (c.-à-d., caractéristiques d'une alimentation saine à consommer en quantité suffisante pour une santé optimale) et trois dites de modération

(c.-à-d., caractéristiques d'une alimentation saine qui doivent être limitées pour une santé optimale). Ainsi, pour les huit composantes d'adéquation, un score plus élevé est attribué lorsque la consommation des aliments ou nutriments est plus grande (voir les portions « maximum » dans la colonne « critères »), pour un total maximal de 5 ou 10 points par composante. Pour les trois composantes de modération, un score maximum de 10 ou 20 points est attribué si la consommation minimale (voir les portions « minimum » dans la colonne « critères ») est respectée. Un score de 0 est attribué si la consommation dépasse le critère « maximum ». Les scores sont attribués proportionnellement à l'atteinte des critères établis pour chaque catégorie. Le pointage maximal est de 100 points.

Tableau 1-1. Score Healthy Eating Index adapté aux recommandations canadiennes (C-HEI)

| Composantes | Scores | Critères |
|-------------------------------|-------------------------------|--|
| Adéquation | 0 à 60 points | |
| Légumes et fruits totaux | 0 à 10 points | Minimum: 0 Maximum: 4 à 10 portions |
| Fruits entiers | 0 à 5 points | Minimum: 0 Maximum: 0,8 à 2,1 portions (21% de la recommandation en légumes et fruits totaux) |
| Légumes vert foncé ou orangés | 0 à 5 points | Minimum: 0 Maximum: 0,8 à 2,1 portions (21% de la recommandation en légumes et fruits totaux) |
| Produits céréaliers totaux | 0 à 5 points | Minimum: 0 Maximum: 3 à 8 portions |
| Grains entiers | 0 à 5 points | Minimum: 0 Maximum: 1,5 à 4 portions (50% de la recommandation produits céréaliers totaux) |
| Lait et substituts | 0 à 10 points | Minimum: 0 Maximum: 2 à 4 portions |
| Viandes et substituts | 0 à 10 points | Minimum: 0 Maximum: 1 à 3 portions (75 à 225 grammes) |
| Gras insaturés | 0 à 10 points | Minimum: 0 Maximum: 30 à 45 grammes |
| Modération | 0 à 40 points | |
| Gras saturés | 8 à 10 points 0 à 8 points | Minimum 7% à 10% de l'apport énergétique total 10% à maximum 15% de l'apport énergétique total |
| Sodium | 8 à 10 points 0 à 8 points | Apport suffisant à Apport maximal tolérable Apport maximal tolérable à deux fois l'Apport maximal tolérable |
| "Autres aliments" | 0 à 20 points | Minimum: ≤5% de l'apport énergétique total Maximum: ≥40% de l'apport énergétique total |

Note : Critères établis en fonction de l'atteinte des recommandations du Guide alimentaire canadien selon le sexe et l'âge.

À partir des données récoltées lors de l'Enquête dans les collectivités canadiennes de 2004 auprès des adultes de 19 à 70 ans, des scores moyens allant de 56,9 à 61,3 chez les femmes et de 54,0 à 57,7 chez les hommes ont été calculés (39). Plus récemment, un score moyen de 54,5 a été mesuré par Brassard et al. (26) chez des adultes québécois de 18 à 65 ans de l'étude PREDISE. Bien que non validées, des valeurs seuils ont été suggérées (39) pour définir une alimentation de faible qualité (<50/100), de qualité moyenne (50-80/100) et de bonne qualité (>80/100). Ainsi, les valeurs moyennes dans la population canadienne et québécoise suggèrent qu'une proportion importante d'adultes ont une alimentation qui peut être considérée comme étant de faible qualité.

Lors de l'utilisation de scores alimentaires tels que le C-HEI, il importe de considérer qu'ils sont des indicateurs de l'adhésion à des recommandations (celles du GAC 2007 dans le cas du C-HEI), et non pas des indicateurs absolus de qualité alimentaire. D'ailleurs, tel que rapporté par Waijers et al. (40), certaines composantes de l'alimentation prises seules (p. ex., consommation de fruits et légumes) semblent être autant, si non plus fortement associées à un risque diminué de maladies ou de mortalité. Contrairement aux indices décrits précédemment, qui sont élaborés dans le but d'évaluer l'adhésion à des recommandations, certains nouveaux scores sont élaborés à partir de données épidémiologiques dans le but d'identifier des composantes spécifiques de l'alimentation associées aux risques de maladies métaboliques (41). Les composantes incluses pour ces scores sont donc choisies en fonction de leur capacité à prédire le risque de maladies. Les deux types de scores ont donc des utilités pertinentes, mais distinctes. Dans le cadre des travaux présentés dans cette thèse, le score C-HEI a été choisi puisque le but est d'évaluer spécifiquement l'adhésion aux recommandations du GAC 2007.

1.1.5.3 Autoévaluation de l'alimentation

Une évaluation alimentaire valide et fiable est fondamentale dans les études en nutrition, car des erreurs de mesure peuvent avoir un impact sur les résultats observés (42, 43). Cependant, l'évaluation alimentaire peut être contraignante pour les participants et est considérée comme coûteuse et longue pour les chercheurs. Ainsi, dans certains sondages et études, plutôt que de demander aux participants de rapporter leurs apports alimentaires, les chercheurs utilisent des mesures alimentaires plus brèves, souvent composées d'une ou quelques questions seulement (28). Parmi ces mesures brèves se trouvent des mesures autorapportées de la qualité alimentaire. Par exemple, dans le sondage canadien *Tracking Nutrition Trends* (8), on demande aux participants « En général, comment considérez-vous vos habitudes alimentaires : excellentes, très bonnes, bonnes, passables ou mauvaises ? ». De telles mesures ne permettent pas d'obtenir autant de détails sur l'alimentation des individus à l'étude comparativement à des outils tels que des rappels alimentaires ou des questionnaires de fréquences, mais peuvent être utiles pour obtenir un portrait global d'une population (44) ou pour cibler des individus qui bénéficieraient davantage d'interventions en nutrition.

L'utilisation de ces mesures se base sur la présomption que les individus sont capables d'évaluer la qualité de leur alimentation. Pour ce faire, ils doivent donc être en mesure de prendre conscience de leurs apports alimentaires et doivent avoir certaines connaissances quant aux recommandations en vigueur en matière de saine alimentation. Les quelques études ayant évalué la validité de telles mesures d'autoévaluation de l'alimentation ont observé des associations significatives entre l'autoévaluation et des scores objectifs de qualité alimentaire globale (p. ex., score HEI ou *Diet Quality Index*) (44-46). Cependant, des perceptions individuelles erronées ont également été rapportées quant à la qualité alimentaire globale (45), la consommation de légumes et fruits (47) et la consommation de gras (48). Il est suggéré que les hommes, les individus ayant une scolarité plus élevée et les fumeurs ont une plus grande tendance à surestimer la qualité de leur alimentation (45).

De récentes données suggèrent une piètre adhésion des Québécois aux recommandations du GAC 2007 (7, 26). Pourtant, 81% des adultes québécois interrogés dans le cadre du sondage *Tracking Nutrition Trends* (8) rapportaient que la qualité nutritionnelle était un facteur important lors du choix des aliments. Ainsi, les résultats des récents sondages et études sur les habitudes alimentaires des Canadiens et Québécois portent à croire que les Québécois sont soit peu conscients de leurs mauvaises habitudes alimentaires, soit insuffisamment motivés ou outillés pour améliorer leur alimentation. À ce jour, aucune étude n'a évalué la capacité des adultes québécois à évaluer la qualité de leur alimentation.

1.2 Déterminants de la qualité alimentaire

L'écart entre l'alimentation souhaitable selon les évidences scientifiques et les comportements alimentaires observés provient potentiellement du fait que les apports alimentaires résultent d'un processus décisionnel complexe influencé par plusieurs facteurs, notamment des facteurs individuels, sociaux et environnementaux (9). Bien que différents auteurs utilisent des taxonomies variées pour décrire les niveaux de facteurs influençant les choix alimentaires, il en demeure qu'une multitude de facteurs influencent les choix et comportements alimentaires tel que l'illustre la figure suivante (10). On retrouve ainsi des prédispositions d'ordre biologique et différentes expériences avec la nourriture qui regroupent des facteurs de type sensoriel et affectif. Puis, des facteurs intrapersonnels et interpersonnels peuvent influencer des choix alimentaires via les croyances, attitudes et normes sociales associées à l'alimentation. Finalement, des facteurs reliés à l'environnement, soit physique, social, économique ou informationnel, peuvent entre autres influencer la disponibilité des aliments, mais peuvent également faciliter ou entraver la capacité des individus à agir selon leurs croyances, leurs attitudes et leurs connaissances (10).

Figure 1: Influences on Food Choice

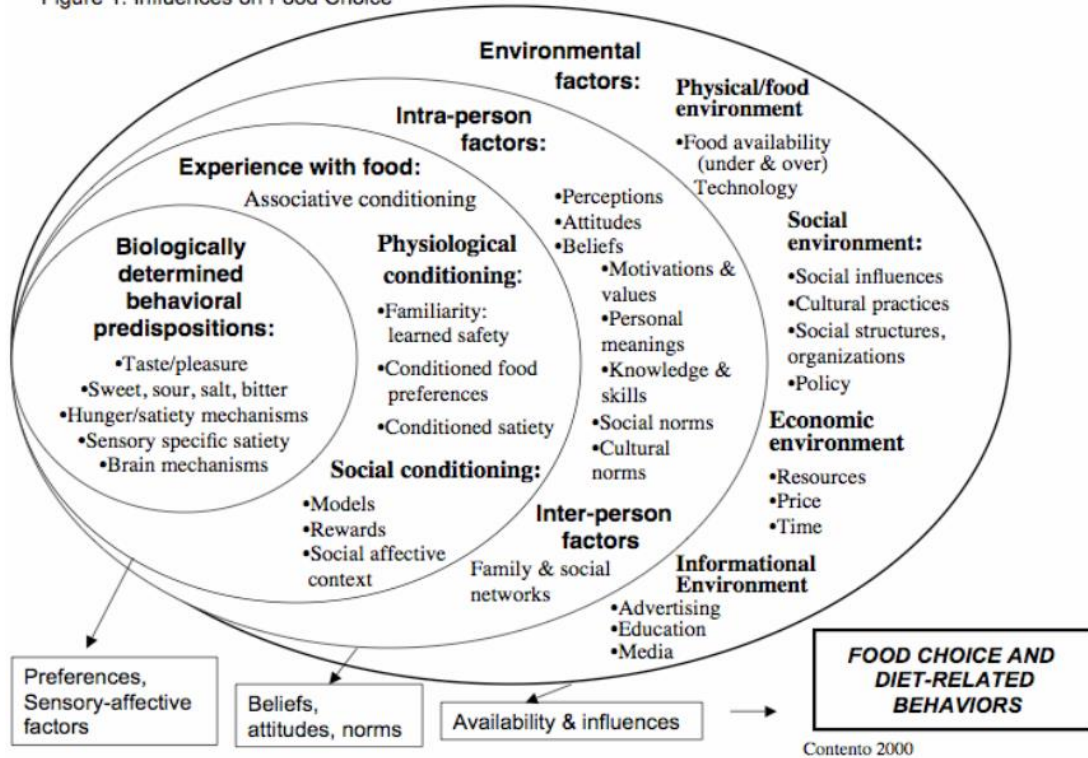


Figure 1-3. Facteurs individuels, sociaux et environnementaux influençant les choix et comportements alimentaires, proposé par Contento (2008)

Dans les sections qui suivent, plusieurs de ces facteurs seront décrits plus en détail et seront divisés en trois catégories, soit les facteurs individuels, les facteurs relatifs à l’environnement social et les facteurs relatifs à l’environnement physique. Puisque la consommation de légumes et fruits est reconnue comme un bon indicateur d’une saine alimentation, les études présentées dans cette section portent principalement sur les déterminants de la saine alimentation de manière générale et ceux de la consommation de légumes et fruits. Le rôle de différents déterminants évolue au cours de la vie d’un individu; ainsi les facteurs peuvent avoir un impact différent chez les enfants et chez les adultes. Dans la présente thèse, seules les études menées auprès de populations adultes seront présentées.

1.2.1 Facteurs individuels

1.2.1.1 Caractéristiques sociodémographiques et reliées au mode de vie

Différents facteurs individuels sont associés à l’adhésion à la saine alimentation, dont plusieurs caractéristiques sociodémographiques. Selon la littérature, les femmes semblent respecter davantage les recommandations de la saine alimentation. À titre d’exemples, il a été observé, que les femmes consomment plus de légumes et fruits (49-53), consomment moins d’aliments riches en gras (52) et ont une meilleure adhésion aux recommandations canadiennes (39) ou américaines (54) en matière de saine alimentation. Les études portant sur les déterminants

sociodémographiques de la saine alimentation s'entendent aussi généralement sur le fait que la qualité de l'alimentation s'améliore avec l'âge (39, 49, 51, 53-55). Bien que les tranches d'âges analysées soient différentes d'une étude à l'autre, une meilleure alimentation semble être observée à partir de 50 à 60 ans. Les individus plus âgés passent plus de temps à cuisiner (56), ont de meilleures compétences culinaires (57) et consomment moins de repas au restaurant (58) ce qui aide à expliquer la meilleure qualité de leur alimentation.

En ce qui a trait au niveau socioéconomique, de nombreuses études sont également unanimes sur l'impact d'un revenu plus élevé (39, 49, 50, 53, 54, 59) ainsi que d'un niveau de scolarité supérieur (39, 50, 51, 53-55, 60-62) sur une meilleure qualité de l'alimentation. Le revenu et la scolarité reflètent tous deux le niveau socioéconomique, toutefois des études suggèrent que les deux variables sont associées à des différences spécifiques pour ce qui est de l'apport en nutriments et de la consommation de groupes d'aliments (63-65), soulignant la pertinence d'utiliser les deux variables distinctement.

Le fait d'être marié ou de vivre avec un conjoint est associé à une meilleure alimentation dans la majorité des études sur le sujet (49, 50, 55, 59, 61, 66), quoique l'association inverse ait aussi été observée dans une étude canadienne où les adultes célibataires rapportaient une plus grande consommation de fruits et de légumes (51).

Deux autres facteurs reliés au mode de vie ont été régulièrement associés à l'alimentation. Le tabagisme a été associé à de moins bonnes habitudes alimentaires dans plusieurs études (39, 51, 55, 61, 67, 68). La pratique régulière d'activité physique serait également associée à une meilleure alimentation (39, 61, 69-71), alors que la sédentarité serait associée à des comportements alimentaires sous-optimaux (55, 72). Ces résultats suggèrent que l'adoption de différents comportements de santé semble interreliée.

1.2.1.2 Déterminants psychosociaux (ou intrapersonnels)

De nombreux déterminants psychosociaux sont également associés à la saine alimentation. Dans le cadre d'une revue systématique de 23 études, Guillaumie et al. (73) ont identifié les facteurs psychosociaux suivants comme étant les plus régulièrement associés à la consommation de légumes et fruits ou à l'intention d'en consommer : l'habitude, la motivation et les buts, les croyances en ses capacités (ou efficacité personnelle), les connaissances, les croyances sur les conséquences et l'influence sociale. Ces résultats sont similaires à ceux d'une précédente revue systématique dont les résultats suggèrent que les trois construits psychosociaux les plus fortement associés à la consommation de légumes et fruits sont l'efficacité personnelle, les connaissances et le soutien social (74). Les variables reliées à l'influence sociale, telles que le soutien social, seront abordées dans la section 1.2.2 touchant spécifiquement les facteurs relatifs à l'environnement social.

L'efficacité personnelle, définie dans le présent contexte comme étant la confiance des individus quant à leur capacité à faire des choix alimentaires sains, est un des facteurs psychosociaux les plus régulièrement associés

à la qualité de l'alimentation dans la littérature (49, 75, 76). Les individus qui présentent des niveaux élevés d'efficacité personnelle tendent à éviter les situations et les activités perçues comme menaçantes, mais s'engagent dans des activités qu'elles se sentent aptes à accomplir. Dans le cas de la saine alimentation, un plus haut niveau de connaissances en nutrition aide à augmenter le sentiment d'efficacité personnelle puisque celles-ci contribuent à améliorer la confiance qu'ont les individus quant à leurs capacités à faire des choix sains (77). D'ailleurs, les connaissances et compétences en nutrition font partie des déterminants des choix alimentaires identifiés à la figure 1-3 (10).

D'après une revue systématique récente, les connaissances en nutrition sont significativement, mais faiblement associées aux apports alimentaires (78). Dans les études, les outils utilisés pour évaluer les connaissances portent principalement sur la connaissance des recommandations alimentaires, les sources et fonctions des nutriments, les compétences pour choisir des aliments plus sains et des mythes au sujet de l'alimentation. La majorité des études incluses dans cette revue ont utilisé des rappels alimentaires complets (p. ex., questionnaires de fréquence, rappels de 24h, journaux alimentaires) pour la mesure de la qualité de l'alimentation. Cependant, sur les 29 études incluses dans la revue systématique, seulement trois ont utilisé des outils validés pour mesurer les connaissances en nutrition et les apports alimentaires, soulignant la nécessité de poursuivre les études dans ce domaine à l'aide de questionnaires validés. Par ailleurs, sur les 29 études incluses, six ont été menées auprès d'étudiants universitaires et sept auprès d'athlètes. Depuis la publication de cette revue systématique, la majorité des nouvelles études sur le sujet ont également été menées chez des athlètes. Une des difficultés dans le domaine des connaissances en nutrition est que les gens peuvent obtenir des informations sur les aliments et la nutrition à partir de nombreuses sources différentes faisant en sorte que plusieurs croyances alimentaires erronées peuvent être véhiculées par différents médias (79). En effet, selon l'enquête canadienne *Tracking Nutrition Trends* (8), deux des quatre sources d'information les plus utilisées par les adultes canadiens pour obtenir de l'information sur la nutrition sont « Internet (médias sociaux ou blogues) », utilisé par la moitié des répondants, et « amis/famille/collègues », consultés par plus de 40% des répondants. Dans ce même sondage, 80% des répondants se considéraient comme étant bien renseignés au sujet de la nutrition. Ainsi, lors de l'étude du lien entre les connaissances en nutrition et la qualité de l'alimentation, il importe d'utiliser des questionnaires spécifiquement conçus et validés à cet effet, car les individus peuvent avoir une perception erronée de leur niveau de connaissances en raison de sources d'information jugées non crédibles par les experts dans le domaine. D'ailleurs, l'association entre la perception de la connaissance des recommandations du GAC 2007 et la consommation de légumes et fruits a été évaluée par Mathe et al. (80) chez des adultes en Alberta. Selon leurs résultats, les adultes qui affirmaient connaître le GAC 2007 ne consommaient pas davantage de portions de légumes et fruits que ceux qui ne connaissaient pas les recommandations. Cependant, dans cette étude les auteurs ont seulement évalué la perception des participants quant à leur connaissance du GAC 2007 en leur demandant s'ils étaient familiers avec le GAC 2007 et s'ils

étaient familiers avec ses recommandations spécifiques (p. ex., groupes aliments, nombres de portions). À ce jour, aucune étude n'a étudié les associations entre une mesure valide de la connaissance des recommandations contenues dans le GAC 2007 et l'adhésion à celles-ci.

Comme présenté à la figure 1-3, la motivation d'un individu quant à son alimentation peut également influencer les choix alimentaires (10). Le style motivationnel, tel que décrit par la théorie de l'autodétermination (81), s'avère un déterminant potentiel de différents comportements de santé (82) et a fait l'objet d'un nombre grandissant d'études en lien avec la saine alimentation dans les deux dernières décennies. Selon cette théorie, la motivation régulant un comportement varie selon un continuum d'autodétermination, allant d'une absence de motivation (amotivation) jusqu'à une motivation intrinsèque, et passant par quatre types de motivation extrinsèques (régulation externe, introjectée, identifiée et intégrée). Un nombre croissant d'études suggèrent qu'une motivation plus autodéterminée à l'égard de l'alimentation est associée à de meilleurs apports alimentaires, tels qu'une plus grande consommation de légumes et fruits (71, 83-87), une plus faible consommation de lipides (88) et une plus faible consommation d'aliments « camelote » (84). Une motivation autodéterminée est aussi associée à une plus grande consommation d'aliments recommandés par le GAC 2007 (89-93). Inversement, la motivation non-autodéterminée a été associée à une moins bonne qualité alimentaire (84, 88, 91, 92). Bien que le lien entre la motivation dans son continuum d'autodétermination et la saine alimentation semble faire l'unanimité dans les études sur le sujet, deux limites persistent dans les études. Premièrement, la majorité des études, dont celles documentant cette association au Canada, ont été menées dans des populations uniquement composées de femmes dont la majorité étaient des étudiantes universitaires (84, 89-93). Deuxièmement, en ce qui concerne les études réalisées dans des populations adultes composées de femmes et d'hommes, l'évaluation de la qualité de l'alimentation s'est limitée à la consommation de fruits et légumes (71, 83, 85, 86, 88) et à l'apport en lipides (88). Ainsi, on en sait peu quant aux associations entre les styles motivationnels et l'adhésion globale aux recommandations en matière de saine alimentation dans des populations adultes composées d'hommes et de femmes.

1.2.1.3 Facteurs biologiques

Peu de déterminants des apports alimentaires chez l'adulte sont de nature purement biologique. En effet, plusieurs facteurs, tels que les expériences personnelles, les connaissances et l'influence des pairs, peuvent modifier la capacité des individus à reconnaître, interpréter et avoir confiance en leurs signaux internes. Ainsi les facteurs présentés dans cette section sont d'origine biologique du fait qu'ils sont présents dès la naissance, mais leur impact sur l'alimentation varie au cours de la vie sous l'influence d'autres déterminants individuels, sociaux et environnementaux.

L'un des principaux facteurs influençant les apports alimentaires est le goût (94, 95). Dans le cadre d'études menées dans différents pays, les participants ont évalué le goût des aliments comme étant un facteur très

important lors du choix d'aliments (96-99). Le goût serait d'ailleurs le principal déterminant des choix alimentaires chez les Canadiens selon le sondage *Tracking Nutrition Trends* (8). En effet, 96% des Canadiens interrogés dans le cadre de ce sondage considéraient que le goût était important pour le choix de leurs aliments et 38% ont évalué ce facteur comme étant le plus important, devant des considérations nutritionnelles, financières et de commodité. Ainsi, les gens ont tendance à consommer plus fréquemment ou en plus grande quantité les aliments dont ils apprécient le goût. Cela peut être favorable pour la santé pour les personnes qui aiment le goût des aliments sains tels que les légumes et les fruits. En effet, une plus grande appréciation des légumes a été associée à une plus grande consommation rapportée de ceux-ci (76, 100). Cependant, pour les personnes qui apprécient fortement des aliments de moins bonne valeur nutritive, leurs préférences alimentaires pourraient interférer avec l'adhésion aux recommandations en matière de saine alimentation. Le rôle important des lipides, du sucre et du sodium quant à la palatabilité des aliments (94) peut contribuer à l'appréciation d'aliments de moins bonne qualité nutritive et peut nuire à la qualité de l'alimentation. En effet, une plus grande appréciation des aliments riches en gras et une plus faible appréciation des aliments faibles en gras ont été identifiées comme des prédicteurs d'une plus grande consommation de lipides (101). Les individus qui considèrent devoir renoncer à leurs aliments préférés pour manger sainement sont également plus susceptibles de consommer plus d'aliments de type « camelote » et moins de légumes et fruits, poissons, déjeuners et mets cuisinés à la maison, selon une étude menée dans plusieurs pays d'Europe (102). Des études ont démontré des associations entre l'appréciation de certains types d'aliments et leur consommation, mais on en sait peu sur l'impact des préférences alimentaires sur la qualité alimentaire globale. En effet, on ne sait pas clairement si le fait d'apprécier le goût d'aliments riches en gras, sel ou sucre interfère avec l'adhésion aux recommandations visant la saine alimentation.

Les mécanismes de faim et de satiété sont d'autres facteurs biologiques influençant les apports alimentaires. L'alimentation dite intuitive (c.-à-d., manger en réponse aux signaux du corps, sans jugement ni règle) (103) a été associée à une plus grande variété alimentaire (104) et à une plus grande consommation de légumes (105) dans des études observationnelles. Lors d'interventions, une amélioration du score d'alimentation intuitive a été associée à une diminution des apports en énergie et en lipides (106) et à un meilleur score de saine alimentation (107). Une récente étude a observé que les femmes qui mangeaient davantage pour des raisons physiques que des raisons émotionnelles et qui avaient confiance en leurs signaux de faim et satiété avaient des scores de qualité alimentaire plus élevés (108). Certaines caractéristiques en ce qui a trait à la réponse aux signaux du corps et à la relation que les individus entretiennent avec les aliments pourraient donc également influencer la qualité alimentaire.

1.2.2 Facteurs reliés à l'environnement social

L'environnement social comprend des facteurs tels que le statut conjugal, la taille du ménage, le fait avoir des enfants et l'appartenance à des groupes (p. ex., communautés religieuses), ainsi que des facteurs relationnels tels que la modélisation parentale, l'isolement social et le soutien social. Dans des études qualitatives, les participants ont rapporté que les membres de leur entourage pouvaient aider ou nuire à l'adoption de saines habitudes alimentaires (109-111).

Dans la littérature scientifique, les facteurs sociaux étudiés varient en fonction de l'âge de la population à l'étude (112). Chez les jeunes enfants, le rôle des parents en tant que modèles est souvent étudié (112). Durant l'enfance, l'environnement social est largement dicté par les pratiques parentales (113, 114). Puis en vieillissant, les enfants sont de plus en plus influencés par leurs amis. Ainsi, leurs habitudes alimentaires sont le résultat d'une addition ou d'une interaction entre les influences des pairs et de la famille (115, 116), bien que la famille demeure la source la plus stable de contacts sociaux. Les repas en famille jouent d'ailleurs un rôle important dans le développement de saines habitudes alimentaires chez les adolescents (117) et peuvent même avoir une influence positive durable sur la qualité de l'alimentation des jeunes adultes (118). Puis, progressivement, l'influence des parents laisse la place au rôle des conjoints (119). Une étude effectuée auprès de couples nouvellement mariés a démontré que les conjoints ont tendance à tendre vers des habitudes similaires, menant à une amélioration de l'alimentation pour certains, mais à une dégradation pour d'autres (120). D'autres auteurs (121) ont également observé une grande similitude dans les aliments consommés chez des conjoints. Chez les adultes vieillissants, l'isolement social, ou la fréquence diminuée de contacts sociaux, intéresse les chercheurs et a été associée à une moins bonne qualité alimentaire (122-124).

1.2.2.1 Soutien social et alimentation

Dans l'étude des déterminants sociaux de l'alimentation, la variable la plus régulièrement étudiée est le soutien social. Le soutien social peut être défini comme un processus transactionnel de communication, comprenant la communication verbale et/ou non verbale, qui vise à améliorer les sentiments d'adaptation, de compétence, d'appartenance et/ou d'estime d'un individu (125). Le soutien social est composé de trois principales dimensions : l'existence (ou la quantité) des relations sociales, la structure des relations et la fonction des relations. Cette dernière dimension englobe les comportements de soutien qu'une personne procure à une autre (126).

D'après l'étude qualitative de McGee et al. (111), les encouragements, la motivation et les compliments de la part de la famille et des amis sont des motivateurs pour un changement de comportement et le maintien à long terme des changements. L'association entre le soutien provenant des membres de la famille et l'alimentation a été évaluée dans plusieurs études transversales et d'intervention. Le soutien des membres de la famille a été

associé à une alimentation plus faible en lipides (127, 128), une plus grande consommation de fruits et de légumes (129, 130), ainsi qu'à la saine alimentation en générale (49, 126, 131-133). Un plus haut niveau de soutien des amis est également associé à une alimentation plus faible en lipides (128) et à un indice de qualité alimentaire globale plus élevé (126). Le soutien de la part des collègues semble également être associé à la consommation d'aliments sains, quoique cette association ait été moins documentée jusqu'à présent (134, 135).

L'influence des proches peut aussi se manifester de manière négative, bien que peu d'études s'y soient attardées. Par exemple, la critique et le découragement de la part de la famille et des amis ont été identifiés comme prédicteurs d'un plus faible score de qualité alimentaire (49) et d'une alimentation plus riche en gras (127).

Certaines études ont révélé que le soutien des proches est associé à l'alimentation de manière différente chez les hommes et les femmes, mais les résultats diffèrent d'une étude à l'autre. En effet, des études suggèrent que les hommes bénéficient davantage du soutien social que les femmes pour l'adoption d'une alimentation faible en gras (136) et pour saine alimentation globale (137), alors que selon d'autres, un plus haut niveau de soutien social serait associé à une meilleure qualité alimentaire globale chez les femmes, mais pas chez les hommes (138). Dans une étude menée auprès d'adultes afro-américains membres de communautés religieuses, un plus grand pourcentage d'hommes ont nommé leur conjointe comme source de soutien à la saine alimentation, alors que les femmes étaient plus nombreuses à nommer un autre membre de la famille comme source principale de soutien (139). Dans cette étude, le soutien social n'était cependant pas différemment associé à la qualité de l'alimentation chez les hommes et les femmes. L'influence d'autres caractéristiques sociodémographiques dans la relation entre le soutien social et la qualité de l'alimentation (p. ex., âge, scolarité, revenu) semble avoir été peu étudiée.

1.2.2.2 Questionnaires sur le soutien social

Dans la littérature, l'échelle la plus souvent utilisée pour mesurer le soutien social à la saine alimentation a été développée par Sallis et al. (126), qui comprend quatre sous-échelles, soit les commentaires positifs des amis, les commentaires négatifs des amis, les actions d'encouragement de la famille et les actions de sabotage de la famille. Ce questionnaire a été adapté à plusieurs reprises par plusieurs auteurs qui ont utilisé certains items du questionnaire original dans différents contextes (49, 76, 127, 129, 132, 140, 141). Cependant, dans la plupart des études, les items ont été utilisés sans évaluation supplémentaire pour assurer leur validité dans le nouveau contexte. Par ailleurs, comme mentionné plus haut, beaucoup d'auteurs ont uniquement évalué les actions de soutien favorisant des choix alimentaires sains (p. ex., encouragements à manger des légumes et fruits) sans s'attarder aux actions nuisant à l'adoption de saines habitudes (p. ex., critiques par rapport aux aliments consommés). De plus, la nature des relations avec les proches (c.-à-d., famille, amis, collègue) n'est pas toujours spécifiée dans les études, ainsi l'impact différencié des différentes sources de soutien social n'est pas

largement documenté. À titre d'exemple, Fuemmeler et al. (83) ont utilisé trois items différents pour évaluer le soutien provenant de la famille, des amis et collègues et des membres de la communauté religieuse, mais un score moyen des trois items a été utilisé pour documenter l'association positive avec la consommation de légumes et de fruits. Par ailleurs, le soutien social n'a été évalué que très rarement en association avec un indicateur global d'adhésion aux recommandations de la saine alimentation (123, 132, 137). En résumé, bien que la majorité des études sur le sujet aient observé des associations positives entre le soutien social et la saine alimentation, des lacunes importantes quant aux outils utilisés persistent et limitent les conclusions qui peuvent en être tirées.

1.2.3 Facteurs reliés à l'environnement physique

Les facteurs environnementaux sont les conditions dans lesquelles une personne a accès aux aliments, les choisit et les consomme (21). La disponibilité, l'accessibilité, l'abordabilité des aliments sains sont ciblées comme des facteurs ayant une influence potentielle sur l'adhésion à la saine alimentation (142, 143). La disponibilité réfère principalement au nombre de détaillants alimentaires (p. ex., épiceries, dépanneurs, restaurants) dans un certain rayon autour du lieu de résidence, et au décompte d'aliments (ou de types d'aliments) offerts par un détaillant. L'accessibilité est souvent mesurée par la distance entre le lieu de résidence ou de travail (ou école) et les détaillants alimentaires. L'abordabilité réfère au coût des aliments. Plusieurs études ont été menées auprès d'enfants et d'adolescents dans le but d'étudier les environnements alimentaires autour des écoles. Puisque cette thèse porte sur les déterminants de l'alimentation chez les adultes, ces études ne seront pas abordées. Dans les études, les facteurs relatifs à l'environnement physique sont parfois explorés de manière objective, c'est-à-dire en utilisant des outils permettant de documenter précisément le nombre de détaillants ou la distance pour s'y rendre, ou la quantité de produits offerts en magasins. Des mesures subjectives sont aussi utilisées, lesquelles permettent de connaître la perception des individus quant à la disponibilité ou l'accessibilité aux aliments sains ou aux aliments « camelote ».

1.2.3.1 Mesures objectives

L'accessibilité et la disponibilité des supermarchés sont les facteurs environnementaux les plus étudiés dans la littérature. Le dénombrement des supermarchés dans les quartiers ou la distance entre la résidence et les principaux supermarchés grâce à des systèmes de géolocalisation ont souvent été mis en lien avec la qualité des apports alimentaires. L'association entre l'accessibilité aux supermarchés (ou à d'autres détaillants offrant des aliments sains) et la consommation d'aliments sains est sujette à des résultats mixtes dans la littérature; une association positive significative a été observée dans certaines études (50, 144-150), alors que d'autres n'ont pas trouvé d'association (53, 151-155). Selon l'étude de Michimi et al. (156), l'association entre l'accessibilité des supermarchés et la qualité alimentaire peut varier en fonction du type de milieu. Ces auteurs ont observé une association positive et significative dans les milieux métropolitains, mais pas dans les régions

non métropolitaines. Dans deux études, une plus grande accessibilité à des détaillants offrant des légumes et fruits frais a été associée uniquement à la consommation de légumes, et pas à celle de fruits (129, 157). Des résultats mixtes ont aussi été observés dans l'étude de Zenk et al. (146) où la présence d'un supermarché dans un quartier, mais pas la distance entre le supermarché et la résidence, a été associée à une plus grande consommation de légumes et fruits.

Des études ont mesuré les impacts de l'ouverture de nouveaux supermarchés sur la qualité alimentaire des individus vivant dans les communautés à proximité. Alors que Wrigley et al. (158) ont observé une augmentation de la quantité de fruits et légumes consommés chez les individus ayant adopté le nouveau supermarché, Cummins et al. (159) n'ont pas vu un tel impact significatif.

Concernant l'accessibilité des chaînes de restauration rapide, des études ont observé qu'une plus grande accessibilité à ce type de restaurant et une plus grande variété de restaurants sont associées à une plus grande consommation d'aliments provenant de ces établissements (160-162), particulièrement chez les individus ayant un plus faible niveau socioéconomique (151). Certaines études n'ont, pour leur part, observé aucune association significative entre l'accessibilité aux établissements de restauration rapide et la consommation d'aliments provenant de ces restaurants (163-166) ou la qualité alimentaire globale (167).

1.2.3.2 Mesures subjectives

La mixité des résultats obtenus avec l'utilisation de mesures objectives de l'environnement alimentaire physique pourrait être en partie expliquée par le fait qu'un grand nombre de consommateurs semblent faire leurs achats dans un supermarché autre que celui le plus près de leur résidence (53). Ainsi, plusieurs auteurs ont choisi de mesurer la perception des individus quant à leur environnement alimentaire (p. ex., « À quel point considérez-vous avoir facilement accès à un détaillant alimentaire ayant une grande variété d'aliments ? »). Le lien entre la perception de l'accessibilité aux aliments sains et la qualité de l'alimentation est cependant lui aussi sujet à des résultats variés. Une plus grande accessibilité perçue est significativement associée à une meilleure qualité de l'alimentation dans certaines études (49, 144, 148, 168-171), alors qu'aucune association n'est observée dans d'autres études (155, 172, 173).

De nombreuses revues, systématiques ou non, ont été publiées pour résumer l'influence de l'environnement physique sur les comportements alimentaires (59, 112, 174-181). Selon des revues narratives de revues systématiques (178, 181), la mixité des résultats obtenus dans les études empêche de conclure en une association entre l'environnement physique et les apports alimentaires. Il est cependant suggéré que les mesures de la perception de l'environnement alimentaire semblent être associées de manière plus constante aux indicateurs de qualité alimentaire (174, 178, 179). Cependant, la nature transversale de la majorité des études dans le domaine limite l'interprétation qui peut être faite des associations observées. Une autre lacune

majeure des études sur le sujet, soulevé par Brug (178) et Sacks et al. (181) est l'utilisation d'outils non validés dans la grande majorité des études, autant pour la mesure de l'environnement que celle des apports alimentaires. De plus, Sacks et al. (181) soulèvent que les mesures de l'environnement ont souvent une portée limitée, la plupart des études ayant utilisé uniquement une mesure de la densité ou de la proximité d'un seul type de détaillants alimentaires (souvent supermarchés ou établissement de restauration rapide). Le type de détaillant peut ne pas fournir à lui seul des données suffisamment complètes sans une évaluation des aliments disponibles auprès du détaillant. De plus, les études qui mesurent uniquement la disponibilité des produits en magasins peuvent ne pas avoir une image complète non plus, car ces données n'informent pas sur la manière dont les produits sont disposés ou promus et de la présence de rabais qui peuvent influencer les comportements d'achat. Pour ce qui est de la mesure des apports alimentaires, des mesures évaluant seulement un ou quelques items de l'alimentation sont souvent utilisées plutôt que des évaluations détaillées et complètes des apports alimentaires. D'ailleurs, Sacks et al. (181) ont observé que les études ayant utilisé des mesures d'évaluation alimentaire plus robustes (p. ex., rappels de 24h) étaient les plus susceptibles d'observer des associations dans la direction attendue entre l'environnement et les apports alimentaires. Finalement, une autre lacune soulevée par Brug (178) est le fait que peu d'études ont testé des modérateurs potentiels, tels que les caractéristiques sociodémographiques, qui pourraient permettre de mieux comprendre les associations entre l'environnement alimentaire et la qualité de l'alimentation. Un des modérateurs potentiels de ces associations est le niveau socioéconomique. À ce sujet, Mackenbach et al. (175) ont récemment publié une revue systématique des différences socioéconomiques dans l'association entre l'environnement alimentaire et les apports alimentaires et ont conclu que les facteurs socioéconomiques n'ont pas une influence constante sur ces associations.

En résumé, les études évaluant les associations entre l'environnement physique et la qualité de l'alimentation sont nombreuses, mais aucune conclusion globale ne peut en être tirée étant donnée la divergence dans les résultats obtenus. L'évaluation de la perception des individus quant à leur environnement physique, à l'aide d'outils validés à cet effet, semble une avenue prometteuse diminuant potentiellement l'influence de certains facteurs confondants comme le choix du supermarché visité et le statut socioéconomique.

1.2.4 Interrelations entre différents facteurs

L'étude de différents types de déterminants de la saine alimentation est primordiale dans une optique d'amélioration des connaissances pour mieux informer l'élaboration d'interventions visant l'adoption de meilleures habitudes alimentaires. Par ailleurs, l'étude des interactions entre différents facteurs associés aux habitudes alimentaires a le potentiel de rendre les interventions et recommandations davantage ciblées pour des groupes d'individus précis. Jusqu'à présent, peu d'études ont étudié ce type d'interactions. Les différents rôles sociaux et responsabilités attribués aux hommes et aux femmes dans la société (182) laissent croire que certains déterminants de la saine alimentation pourraient être associés de manière différente à la qualité

alimentaire selon le sexe. Par exemple, une motivation reliée au contrôle du poids a été associée à l'apport en fruits chez les hommes, mais pas chez les femmes (71). Dans une étude menée auprès d'adultes américains, la perception d'un plus grand soutien des proches était liée à de meilleures habitudes alimentaires chez les femmes, mais pas chez les hommes (138). Il a également été constaté qu'au sein de couples hétérosexuels le soutien du partenaire avait plus d'effets favorables dans l'adoption d'un régime faible en gras chez les hommes que chez les femmes (136). À l'aide d'analyses de médiation, Ball et al. (129) ont observé que le soutien de la famille et des amis atténuait l'association positive entre le niveau d'éducation et la consommation de fruits et de légumes. En ce qui concerne l'environnement physique, la qualité alimentaire des hommes semble être plus négativement influencée par la présence d'établissement de restauration rapide (50, 183). De plus, dans une étude menée auprès d'adultes québécois âgés de 67 à 84 ans, il a été observé que la qualité alimentaire des femmes était négativement associée à la présence de chaînes de restauration rapide et positivement associée à la présence de détaillants d'aliments sains seulement chez les celles ayant un faible niveau de connaissances en nutrition (183). Dans cette étude, l'interaction entre les connaissances et l'environnement alimentaire n'était pas significative chez les hommes. Deux études ont aussi observé que l'association entre l'environnement physique et la consommation de légumes et fruits différait selon l'ethnie des participants (145, 146). Les associations entre l'environnement alimentaire physique et la qualité de l'alimentation ont été également plus souvent analysées en interaction avec le niveau socioéconomique ou stratifiées en fonction du niveau socioéconomique. D'ailleurs, une récente revue systématique sur le sujet a conclu en l'absence d'évidence claire quant à l'impact du niveau socioéconomique sur les associations entre l'environnement et la qualité de l'alimentation (175). Davantage d'études devraient évaluer les interactions possibles entre les différents déterminants afin de permettre de mieux documenter les associations entre ces facteurs et l'adhésion aux recommandations de la saine alimentation.

1.3 Validation des outils de mesure

Tel que rapporté à plusieurs reprises dans la section précédente, un enjeu majeur concernant l'étude des facteurs influençant l'adhésion à la saine alimentation se situe au niveau de la mesure des apports alimentaires et des déterminants. À cet égard, il importe de souligner que nos connaissances limitées des déterminants de la saine alimentation sont en partie attribuables à l'utilisation d'outils non validés dans ce domaine de recherche. Les lacunes en ce qui a trait à la validation des outils de mesure peuvent, d'une part, mener à des données potentiellement biaisées, et d'autre part, limiter la capacité à comparer les résultats des études. En effet, la présence ou l'absence d'association statistiquement significative entre deux variables dans une étude peut être remise en doute si les outils de mesure utilisés ne sont pas validés, ce qui nuit à l'avancement des connaissances dans ce domaine.

La *COSMIN initiative* (*Consensus based Standards for the selection of health Measurement Instruments*) a été mise sur pied par un groupe d'experts afin d'améliorer la sélection des instruments de mesure dans le domaine de la santé. Un article scientifique (184) ainsi que des documents de références (185) ont été publiés dans le but d'établir un consensus sur une taxonomie à utiliser de même que des définitions des différentes propriétés des outils de mesure afin d'accompagner les chercheurs dans le développement d'outils de mesure valides. La figure suivante, tirée des documents de références de la *COSMIN initiative*, illustre les principales qualités de mesure d'un bon outil, regroupées sous les deux grands concepts que sont la validité et la fidélité.

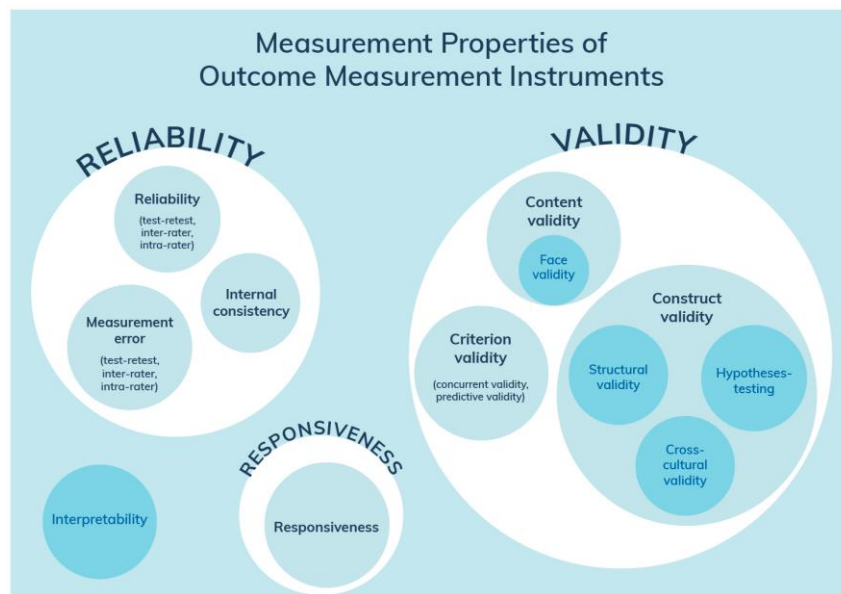


Figure 1-4. Propriétés d'un bon instrument de mesure

Les définitions des termes relatifs à la validation d'outils de mesure sont très hétérogènes dans la littérature scientifique. Dans un but de clarté, et étant donné la rigueur scientifique des travaux de la *COSMIN initiative*, les concepts décrits dans les prochaines sections seront principalement basés sur la taxonomie proposée par ce regroupement de chercheurs.

1.3.1 Validité

La validité se définit comme étant la capacité d'un outil à mesurer ce qu'il vise à mesurer (184).

1.3.1.1 Validité de contenu

La validité de contenu évalue à quel point le contenu d'un instrument est un reflet adéquat du construit qui vise à être mesuré et permet de capter toutes les dimensions importantes du construit (184). Cette vérification se fait généralement de manière subjective par exemple en consultant la littérature ou des experts dans le domaine. Cette étape donne lieu à des modifications, retraits ou ajouts d'items, selon, par exemple, l'avis d'un panel d'experts qui font une évaluation sous forme de commentaires. Dilorio (186) suggère une méthode servant à

objectiver l'évaluation du contenu par les experts à l'aide d'un indice de validité de contenu, qui mesure le pourcentage de validité des items. Chaque membre du panel d'experts évalue les items un à un, à l'aide d'une échelle à quatre niveaux et selon les quatre critères suivants : pertinence, ambiguïté, clarté et simplicité (187). Un pourcentage de 80% et plus est considéré comme acceptable pour conserver un item, alors que les items obtenant un pourcentage inférieur devraient être modifiés ou retirés du questionnaire (186).

La validité apparente (*face validity*) est un autre aspect de la validité de contenu. Elle est définie comme la mesure dans laquelle les items d'un instrument semblent être un reflet adéquat du construit à mesurer (184). La validité apparente peut être évaluée par un panel d'experts faisant un examen sommaire du questionnaire et des questions de manière à juger de la correspondance des items avec le sujet du questionnaire (186). Ce type de validité peut cependant également être évalué lors d'un prétest en recrutant des participants qui commenteront la forme et le contenu du questionnaire, permettant de vérifier que l'outil est bien compréhensible pour les répondants (186, 188). La validité apparente est parfois considérée comme une forme de validité à part entière, ne faisant pas partie de la validité de contenu.

1.3.1.2 Validité de construit

Comme son nom l'indique, la validité de construit consiste à s'assurer que l'outil à valider mesure bel et bien le construit qu'il devrait mesurer. Un construit sert à décrire une idée théorique, une entité ou un concept (189).

Un des types de validité de construit est la validité structurelle qui consiste à déterminer ou à confirmer la présence de différentes sous-échelles présentes dans un même outil. Ceci peut être vérifié à l'aide d'analyses factorielles exploratoires (dans le but de déterminer si des sous-échelles sont présentes) ou d'analyses factorielles confirmatoires (dans le but de confirmer la présence de sous-échelles déjà connues).

Les tests d'hypothèses peuvent également servir pour évaluer la validité de construit (184). Dans ce contexte, on vise à tester des hypothèses pour lesquelles les associations attendues sont reconnues dans la littérature. Les tests d'hypothèses peuvent se faire en comparant les résultats de l'outil à valider à ceux d'un autre outil ne mesurant pas les mêmes construits, mais pour lesquels des associations sont connues. Par exemple, pour un questionnaire à valider mesurant un indice de bonheur au travail, les scores pourraient être comparés à ceux d'un questionnaire déjà validé mesurant un indice de bonheur général. Ainsi, on s'attendrait à ce que les scores des deux questionnaires corrèlent l'un avec l'autre. Les tests d'hypothèses incluent également l'approche des groupes connus. Ainsi, des participants sont sélectionnés en se basant sur leur appartenance à des groupes qui diffèrent par rapport à leur connaissance du construit à l'étude. Par exemple, dans le contexte de la création d'un questionnaire sur les connaissances en nutrition, la validité de construit peut être testée en comparant les résultats du questionnaire de participants issus de la population générale à ceux de participants recrutés parmi

des nutritionnistes (190). Ainsi, il est attendu que les nutritionnistes obtiennent des scores moyens plus élevés que les non-nutritionnistes.

La validité interculturelle, quant à elle, est le degré auquel les performances d'un questionnaire traduit ou adapté culturellement reflètent adéquatement les performances de la version originale du questionnaire (184).

1.3.1.3 Validité de critère

La validité de critère est le degré d'association entre l'outil à l'étude et un autre outil reconnu comme étant une mesure valide du construit évalué (184). La comparaison se fait, lorsque possible, avec une mesure étalon (ou *gold standard*). Celle-ci n'est cependant pas toujours possible, particulièrement lors de la validation de mesures subjectives (p. ex., mesure la qualité de vie), pour lesquelles aucune « vraie » mesure n'existe.

Lorsqu'une mesure étalon existe, la validité de critère s'effectue avec l'évaluation de la sensibilité, la spécificité et les valeurs prédictives. La sensibilité est la capacité d'un test à identifier les cas positifs, alors que la spécificité est la capacité à identifier les cas négatifs. La probabilité que la condition soit présente alors que le test est positif est la valeur prédictive positive, alors que la probabilité que la condition soit absente alors que le test est négatif constitue la valeur prédictive négative.

1.3.2 Fiabilité

La fiabilité est définie comme étant le degré auquel une mesure est exempte d'erreur de mesure. Un outil fiable devrait être constant, et donc donner la même mesure dans différentes conditions (p. ex., différents items d'un questionnaire, différents temps de mesure, codé par différents évaluateurs).

1.3.2.1 Répétabilité

La répétabilité (ou répétitivité ou stabilité dans le temps) est une propriété de la fiabilité et se définit comme étant la constance dans les résultats lorsqu'une mesure est faite à plusieurs reprises chez une même personne, mais à différents moments dans le temps. Ce type de fidélité s'évalue selon la technique du *test-retest*, qui consiste en une comparaison des mesures prises à différents moments dans le temps à l'aide d'analyses de corrélation de Pearson ou de corrélation intraclasse (186). Le délai entre deux mesures doit être bien réfléchi en fonction de l'outil à valider. Si le temps entre les deux administrations est trop court, les répondants peuvent se souvenir de leurs réponses, et ainsi causer un coefficient faussement élevé. À l'inverse, si le délai entre les mesures est trop long, la variable évaluée peut avoir changé chez les participants (p. ex., niveau de connaissance d'un sujet fortement médiatisé), ce qui entraînerait un coefficient faussement abaissé.

1.3.2.2 Consistance interne

La consistance interne (ou cohérence interne) réfère au degré d'interdépendance entre les éléments d'une mesure, ou l'homogénéité de l'instrument de mesure. L'évaluation de la consistance interne repose sur le

postulat que l'instrument est unidimensionnel, c'est-à-dire qu'il mesure un seul concept. Si l'instrument de mesure contient plusieurs dimensions (sous-échelles), la consistance interne devra être évaluée pour chaque dimension. Bien que plusieurs approches différentes existent pour mesurer la consistance interne, l'alpha de Cronbach est généralement reconnu comme la mesure traditionnelle. Le coefficient alpha de Cronbach est une valeur située entre 0 et 1, et un coefficient d'au moins 0,7 est habituellement requis pour que la consistance interne soit considérée comme étant acceptable (186).

1.3.3 Interprétabilité

L'interprétabilité est le degré auquel on peut assigner une signification qualitative (ou clinique) à un score quantitatif obtenu par un outil, ou par un changement de score (184).

En résumé, pour s'assurer des bonnes qualités de mesure d'un outil, tant la validité que la fidélité doivent être vérifiées et ce, en plusieurs étapes qui varient selon le type d'outil développé et le construit évalué.

Chapitre 2 : Problématique, objectifs et hypothèses

Les plus récentes données concernant à l'alimentation des Québécois suggèrent une faible adhésion aux recommandations présentées dans le GAC 2007 (7, 26). De nombreux déterminants relatifs à l'individu ou à son environnement social ou physique peuvent influencer la qualité de l'alimentation (9, 10) et ont été étudiés dans des populations diverses à travers le monde. Cependant, beaucoup d'études ont utilisé des questionnaires non validés. De plus, peu d'études se sont intéressées spécifiquement à la population canadienne ou québécoise. Dans l'optique d'être mieux outillés afin d'aider les Québécois à faire des choix alimentaires plus sains, il s'avère essentiel de mieux comprendre quels facteurs influencent leur adhésion aux principes de la saine alimentation, et ce, en utilisant des outils de mesure validés.

Objectifs généraux

Le premier objectif général de mes travaux de doctorat était de développer des questionnaires spécifiquement conçus pour les adultes québécois et de procéder à leur validation. Pour ce faire, des questionnaires portant sur l'appréciation des aliments, le soutien des proches pour manger sainement et la perception de l'environnement alimentaire, ont été développés par les membres de l'équipe de recherche avec l'aide d'un panel d'experts composé d'une professionnelle de recherche et de chercheurs en nutrition et en psychologie. Un échantillon de 30 participants a été recruté pour évaluer la validité apparente des items. Puis, dans le cadre d'une étude de validation, 75 femmes et 75 hommes ont rempli les questionnaires à deux reprises sur une plateforme web. La fidélité et la validité ont été testées en plusieurs étapes.

Le deuxième objectif général était d'identifier des déterminants, relatifs à l'individu, à l'environnement social ou à l'environnement physique, de à l'adhésion aux recommandations du GAC 2007 chez les adultes québécois et d'étudier des interactions possibles entre les différents déterminants. Cet objectif a été atteint dans le cadre de l'étude PREDISE, pour laquelle un échantillon composé de 1200 Québécois francophones âgés de 18 à 65 ans a été recruté. Les participants provenaient de cinq régions du Québec (Capitale-Nationale/Chaudière-Appalaches, Saguenay-Lac-St-Jean, Montréal, Mauricie et Estrie) et ont été recrutés par strates démographiques basées sur le sexe et l'âge dans le but de constituer un échantillon représentatif de la population francophone de ces régions. Les participants ont eu accès à la plateforme web de l'étude sur laquelle ils ont rempli un ensemble de questionnaires, dont des rappels alimentaires de 24h. Puis, les participants étaient invités à se rendre au centre de recherche affilié au projet PREDISE dans leur région pour une prise de mesures anthropométriques et de tension artérielle ainsi que pour un prélèvement sanguin.

Objectifs spécifiques

Étude de validation

L'objectif de l'article présenté au **chapitre 5** était de développer et de procéder à la validation d'un questionnaire visant à mesurer le degré d'appréciation d'une variété d'aliments riches en sel, en sucre ou en gras chez les adultes québécois.

L'objectif de l'article présenté au **chapitre 7** était de développer et de procéder à la validation d'un questionnaire évaluant le soutien des proches pour manger sainement chez les adultes québécois.

L'objectif de l'article présenté au **chapitre 8** était de développer et de procéder à la validation d'un questionnaire portant sur la perception qu'ont les adultes québécois de leur environnement alimentaire, plus spécifiquement en ce qui concerne l'accessibilité, la disponibilité et l'abordabilité des aliments sains et des aliments de type « camelote ».

L'hypothèse principale en lien avec les travaux présentés dans ces trois chapitres est que les questionnaires développés sont reconnus comme des outils de mesure valides et fiables, selon plusieurs critères tels que la validité de contenu, la consistance interne et la répétabilité.

Étude PREDISE

L'objectif de l'article présenté au **chapitre 3** était de comparer l'autoévaluation de la qualité alimentaire à l'adhésion aux recommandations du GAC 2007 et d'examiner si des caractéristiques individuelles étaient des variables modératrices de l'association entre l'autoévaluation et l'adhésion au GAC 2007. Les hypothèses sont que les individus qui autoévaluent leur alimentation comme étant de meilleure qualité ont une meilleure adhésion au GAC 2007 et que des caractéristiques individuelles, telles qu'un indice de masse corporelle plus élevé, diminuent la capacité des individus à autoévaluer adéquatement leur alimentation.

L'objectif de l'article présenté au **chapitre 4** était d'évaluer l'association entre le niveau de connaissances en nutrition et l'adhésion aux recommandations du GAC 2007 et d'examiner si des caractéristiques sociodémographiques étaient des variables modératrices de cette association. Les hypothèses sont que de meilleures connaissances en nutrition sont associées à une plus grande adhésion au GAC 2007 et que l'association est plus forte chez les femmes que chez les hommes.

L'objectif de l'article présenté au **chapitre 6** est d'évaluer l'association entre l'appréciation des aliments salés et des aliments sucrés et l'adhésion aux recommandations du GAC 2007 et d'examiner si des caractéristiques sociodémographiques étaient des variables modératrices de cette association. Les hypothèses sont qu'une plus

grande appréciation des aliments salés et des aliments sucrés est associée à une plus faible adhésion au GAC 2007 et que l'association est plus forte chez les hommes que chez les femmes.

Le premier objectif de l'article présenté au **chapitre 9** était d'évaluer l'association entre le soutien des proches pour manger sainement et l'adhésion au GAC 2007 et d'examiner si des caractéristiques sociodémographiques étaient des variables modératrices de cette association. La première hypothèse est qu'un plus haut niveau de soutien de la famille et des pairs est associé à une plus grande adhésion au GAC 2007. Nous avons également émis comme hypothèse que l'association entre le soutien des pairs et l'adhésion au GAC 2007 est plus forte chez les individus vivant seuls que chez ceux vivant avec un(e) conjoint(e) ou un(des) enfant(s).

L'article présenté au **chapitre 9** avait également pour objectif d'évaluer l'association entre la perception de l'environnement alimentaire et l'adhésion aux recommandations du GAC 2007 et d'examiner si des caractéristiques sociodémographiques étaient des variables modératrices de cette association. La première hypothèse est qu'une plus grande accessibilité/disponibilité perçue aux aliments sains est associée à une plus grande adhésion au GAC 2007 et que l'association est inverse pour l'accessibilité/disponibilité perçue aux aliments « camelote ». Une autre hypothèse est que les associations entre la perception de l'environnement alimentaire et l'adhésion au GAC 2007 sont plus fortes chez les individus ayant un plus faible niveau socioéconomique que chez ceux ayant un niveau socioéconomique plus élevé.

L'objectif de l'article présenté au **chapitre 10** était d'évaluer l'association entre les types de motivation à l'égard de l'alimentation et l'adhésion aux recommandations du GAC 2007 et d'examiner si des caractéristiques sociodémographiques étaient des variables modératrices de cette association. Cet objectif visait également à étudier le rôle potentiel de la motivation dans les associations qui auront été observées dans les objectifs précédents. Les hypothèses sont qu'une plus grande motivation autodéterminée à l'égard de l'alimentation est associée à une plus grande adhésion au GAC et qu'un plus haut niveau de motivation non-autodéterminée est associé à une plus faible adhésion au GAC 2007. Nous avons également émis comme hypothèse que les caractéristiques sociodémographiques ne modèrent pas ces associations. Finalement, une autre hypothèse est que la motivation autodéterminée explique une partie de l'association entre le soutien social et l'adhésion au GAC 2007 ainsi que de celle entre les connaissances en nutrition et l'adhésion au GAC 2007.

Chapitre 3 : Comparaison entre l'autoévaluation de la qualité alimentaire et l'adhésion au GAC 2007

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L'article présenté dans ce chapitre s'intitule: Are French Canadians able to accurately self-rate the quality of their diet? Insights from the PREDISE study

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Résumé

Cette étude visait à comparer l'autoévaluation de la qualité alimentaire à un score de qualité nutritionnelle globale et à évaluer la prédictibilité de l'autoévaluation concernant l'adhésion aux recommandations de saine alimentation. Cette étude visait aussi à examiner la possible influence des caractéristiques individuelles sur l'association entre l'autoévaluation et le score de qualité nutritionnelle globale. Dans le cadre du projet Prédicteurs Individuels, Sociaux et Environnementaux (PRELISE), 1045 participants (51% femmes) du Québec (Canada) ont autoévalué la qualité de leur régime alimentaire (« En général, diriez-vous que vos habitudes alimentaires sont : excellentes, très bonnes, bonnes, passables ou mauvaises? »). Les données de trois rappels alimentaires de 24 h via Internet ont permis le calcul du *Healthy Eating Index* canadien (C-HEI), un indicateur de qualité nutritionnelle globale. Les participants percevaient leurs habitudes alimentaires comme étant excellentes (2,4%), très bonnes (22,7%), bonnes (49,5%), passables (20,3%) ou mauvaises (5,1%). Le C-HEI variait significativement entre les catégories d'autoévaluation dans la direction attendue ($p < 0,0001$). L'autoévaluation a permis de prédire l'adhésion aux recommandations (C-HEI > 68) de saine alimentation en présentant une sensibilité de 44,5% et une spécificité de 81,5%. L'association entre l'autoévaluation et le C-HEI était modifiée significativement par le sexe (p interaction = 0,0131); les femmes avaient un C-HEI plus élevé que les hommes dans les catégories « bonnes » et « passables ». L'autoévaluation permet de donner un aperçu de la qualité alimentaire d'une population. Cependant, les résultats de cette étude suggèrent d'utiliser ces données avec prudence compte tenu de leur faible prédictibilité concernant l'adhésion aux recommandations de saine alimentation.

Abstract

The main objective of this study was to compare self-rated diet quality with a more comprehensive score of diet quality and to assess the ability of self-rated diet quality to predict adherence to healthy eating guidelines. This study also aimed to evaluate the influence of individual characteristics on the association between self-rated diet quality and the overall diet quality score. As part of the PRédicteurs Individuels, Sociaux et Environnementaux (PRELISE) study, 1045 participants (51% women) from the Province of Québec, Canada, self-rated their diet quality (“In general, would you say that your dietary habits are excellent, very good, good, fair, or poor?”). Three Web-based 24-h food recalls were completed, generating data for the calculation of the Canadian Healthy Eating Index (C-HEI) score, an overall diet quality indicator. Participants rated their diet quality as excellent (2.4%), very good (22.7%), good (49.5%), fair (20.3%), or poor (5.1%). C-HEI scores differed significantly between diet ratings, in the expected direction ($p < 0.0001$). Self-rated diet quality predicted adherence to healthy eating guidelines (i.e., C-HEI > 68) with a sensitivity of 44.5% and a specificity of 81.5% (C-statistic = 0.63). Sex significantly modified the association between self-rated diet quality and C-HEI score (p interaction = 0.0131); women had higher C-HEI scores than did men in the “good” and “fair” ratings. Self-rated diet quality can be useful in obtaining an overview of the diet quality of a population, but the results of this study suggest that such data should be used with caution given their poor ability to predict adherence to healthy eating guidelines. Individual characteristics may influence one’s ability to appropriately self-evaluate diet quality.

Title page

Are French Canadians able to accurately self-rate the quality of their diet? Insights from the PREDISE study

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Dietary intake, diet, diet analysis, nutrition, behavioural nutrition

Introduction

Accurate dietary assessment is fundamental in nutrition studies since measurement errors can impact the detection of true associations between dietary intakes and diseases (1, 2). However, dietary assessment can be burdensome for participants and is considered expensive and time consuming for researchers. In some studies or surveys where there is no need for a detailed portrait of the diet, short diet quality assessment methods are useful (3). For instance, a short assessment method that is used in the periodically published Canadian survey Tracking Nutrition Trends is the self-reported diet quality, where participants are asked about their perception of the healthfulness of their dietary intakes using a single-item question (4). However, it is uncertain if individuals are able to accurately evaluate the overall quality of their diet. In fact, many individuals may believe that their dietary habits are better than they actually are. This is known as the “optimistic bias” (5), a phenomenon through which individuals believe they are less likely than others to be affected by negative events. Individuals who do not perceive that their behaviours (e.g. dietary habits) can represent a risk to their health are less likely to have the intention to make preventive changes (e.g. improve one’s diet) (5, 6). Using a single item assessing the perception of the overall healthiness of one’s diet, Variyam et al. (7) have observed that men, individuals with a higher education, and smokers are more likely to be affected by an optimistic bias related to their diet. Therefore, before using self-reported diet quality as a proxy of healthy eating measurement, it is crucial to assess individuals’ ability to evaluate the healthiness of their diet.

Self-rated diet quality is obtained by asking individuals to rate the overall quality of their diet using predetermined categories, usually through a single question. The validity of self-rated diet quality measures has been assessed only in few studies (7-11), and diverse comparison measures have been used (e.g. Healthy Eating Index, Diet Quality Index for Adolescents, specific food items, nutrients or energy intake, blood pressure, BMI, urinary potassium and sodium). Since dietary guidelines and nutritional interventions differ from country to country, it appears essential to evaluate the validity of self-rated diet quality measures in different populations and based on validated tools.

Self-rated diet quality measures are used in various studies and surveys and seem to be potentially influenced by sociodemographic variables and they have never been validated in the French-speaking population of Canada, who have been found to differ from other Canadians with respect to food intakes and attitudes towards eating (4, 12). Therefore, the objectives of this study were the following: 1) To compare a self-rated diet quality measure to a calculated score of overall diet quality and to assess the ability of this self-rated item to predict adherence to healthy eating guidelines, and 2) to evaluate the potential influence of individual characteristics on the association between the self-rated diet quality measure and the overall diet quality score, in sample of French-speaking adults from the Province of Québec, Canada.

Materials and methods

Validation study

In the context of a validation research project, 150 men and women from the Québec City metropolitan area were recruited from March to June 2015. Participants were aged between 18 and 65 years old and needed an Internet access since all questionnaires were completed online. Participants were recruited through electronic mailing lists comprising Laval University students and employees as well as people interested in participating in studies at the Institute of Nutrition and Functional Foods. Pregnant and breastfeeding women were excluded, as well as individuals with intestinal malabsorption since blood biomarkers of fruit and vegetable intake were also measured during the study (note that analyses pertaining to blood biomarkers are beyond the scope of this paper). Participants were asked to complete various questionnaires to be validated (13-17), including a self-rated diet quality item. Participants were asked: "In general, would you say that your dietary habits are: excellent, very good, good, fair, or poor?" (4). No definition of "healthy dietary habits" was provided with the question. Participants were allowed a one-month period to complete all questionnaires, which were presented in a random order. After a two-week delay, they had to complete all questionnaires once more within a one-month period. Therefore, the delay between the two completions ranged from a minimum of two weeks to a maximum of 10 weeks between the two completions. Data from this validation study allowed the assessment of test-retest reliability of the self-rated diet quality item.

The PREDISE study

Participants and procedures

Participants for this study were recruited in the context of a large research project (the PREDISE study) aiming at identifying determinants of healthy eating in a probability sample of French-speaking adults of the Province of Québec, Canada. Recruitment was performed in five different regions of the province (i.e. Capitale-Nationale/Chaudière-Appalaches, Saguenay-Lac-St-Jean, Montreal, Mauricie, and Estrie) by a research and survey firm, using random digit dialling, from August 2015 to April 2017. The five regions are census metropolitan areas of the Province of Québec (i.e. areas consisting of one or more neighbouring municipalities situated around a core, with a total population of at least 100 000 inhabitants) in which collaboration with researchers were established for the participants testing. Recruitment was designed so that participants represent the French-speaking adult population of each region based on sex and age (divided in three groups: 18-34 years old, 35-49 years old; 50-65 years old), resulting in 30 recruitment strata (five regions X two sexes X three age groups). As for the validation study, exclusion criteria were pregnancy, lactation, and intestinal malabsorption and the inclusion criterion was to have an Internet access.

Eligible participants were invited to visit the Internet platform of the study where a series of questionnaires were presented in a random order (see the list of all questionnaires in Supplemental material, table S3-5). They had a three-week period to complete all questionnaires. Participants then visited the research centre of their region for anthropometric and blood pressure measurements and for blood sampling (blood pressure and blood samples analyses are beyond the scope of this paper).

Measures

Self-rated diet quality. Participants were asked: “In general, would you say that your dietary habits are: excellent, very good, good, fair, or poor?” (4). This item was included in a sociodemographic questionnaire where participants were also questioned about their age, education level, household annual income, occupation, and ethnicity.

Canadian Healthy Eating Index 2007 (C-HEI). Participants completed three web-based 24-hour food recalls, using an application developed by our research team (R24W), during the three-week period they had to complete the questionnaires. Participants had to report all foods and drinks consumed from midnight to midnight on three days generated at random by the tool. The R24W was specifically developed (18) and validated for the adult French-speaking adult population from the Province of Québec (19-21). Data generated by the dietary recalls were used to calculate the C-HEI (22), which was chosen as the indicator of the overall diet quality. The index was developed to reflect Canada’s Food Guide’s recommendations for healthy eating (23). The C-HEI is composed of eight adequacy components (total fruits and vegetables, whole fruits, dark-green and orange vegetables, grain products, whole-grain products, milk and alternatives, meat and alternatives, and unsaturated fat) and three moderation components (saturated fat, sodium, and “other foods” (i.e. that are not part of the foods recommended by Canada’s Food Guide)). Each component is evaluated on 5, 10 or 20 points, for a maximum score of 100 (see full description of the C-HEI score in Supplemental Material, Table S3-6). The C-HEI was used as a continuous variable unless stated otherwise.

Anthropometry measurements. During participants’ visit to the research centre, height and weight were measured by trained professionals according to standardized procedures (24). Height was measured to the nearest millimetre, and body weight was measured to the nearest 0.1 kg on a calibrated balance.

Ethics

Both the PREDISE study and the validation study were conducted according to the guidelines laid down in the Declaration of Helsinki. The two research projects received approval from the Research Ethics Committee at Laval University and all participants gave written informed consent.

Statistical Analyses

The test-retest reliability of the self-rated diet quality item was evaluated in the validation study sample using Cohen's Kappa agreement between the two completions of the item. The Kappa coefficient was interpreted as follows: ≤ 0.2 : mediocre; 0.21-0.40: low; 0.41-0.60: moderate; 0.61-0.80: strong; 0.81-1.0: excellent (25). The following analyses were all performed on data derived from the PREDISE study. A Spearman rank correlation was performed to measure associations between ordinal self-rated diet quality (5 = "excellent," 4 = "very good," 3 = "good," 2 = "fair," 1 = "poor") and the C-HEI score. The C-HEI was also compared between diet quality ratings using the generalized linear model (GLM) procedure. Using logistic regression, sensitivity, specificity, positive and negative predictive values as well as c-statistic derived from receiver operating characteristic (ROC) curve were calculated to assess the ability of the self-rated diet quality item to predict the C-HEI score. More precisely, the model assessed if participants who rated their diet quality as being "very good" or "excellent" (representing one fourth of the sample, as shown in the Self-rated diet quality and the C-HEI section of the results), vs. those in the other categories, obtained a C-HEI in the highest quartile (binary response variable). This model was not adjusted for any variable. Diet quality ratings among different subgroups of individuals were compared using the chi-square test for categorical data or the GLM procedure for continuous data. Interactions were tested to assess how sex, age, BMI, education, and income modify the associations between self-rating diet quality and C-HEI. Statistical tests were two-sided and differences or associations at $p < 0.05$ were considered significant. Analyses were performed using the Statistical Analysis Software (SAS) version 9.4 (Copyright © 2013, SAS Institute Inc., Cary, NC, USA).

Results

Test-retest reliability

A total of 136 participants from the validation study completed the self-rated diet quality item twice. Participants were 47% female, 92% workers, highly educated (83% having a university degree), and 96% Caucasian. The mean interval between the two completions was 41 ± 12 days. Weighted Cohen's Kappa analyses revealed moderate agreement between the two completions ($\kappa=0.55$).

Self-rated diet quality and the C-HEI

Among 1849 individuals who were recruited by the research firm for the PREDISE project, 1045 were included in the analyses for the present study (see Figure 3-1 for the study flowchart and information on excluded participants). Anthropometry was measured in 995 participants. Characteristics of the participants are presented in Table 3-1.

Almost half of PREDISE participants ($n=517$) self-rated their overall diet quality as being "good" (see Table 3-2). The other participants were equally distributed among higher ratings (i.e. "excellent" or "very good") and lower ratings (i.e. "fair" or "poor"). The mean C-HEI was 57.3 ± 14.2 , with scores ranging from 20.0 to 93.4 on a scale of 0 to 100. A significant Spearman correlation was observed between self-rated diet quality and the C-HEI ($\rho=0.34$ $p<0.0001$). Differences in the C-HEI between diet quality ratings are shown in Table 3 ($p<0.0001$). While the C-HEI was significantly different between self-rated diet quality categories, the overlap between C-HEI ranges corresponding to each category was noteworthy (see Table 3-3). Significant differences were also observed between diet quality ratings for eight of the 11 components of the C-HEI (see Figure 3-2), more precisely for vegetables and fruits ($p<0.0001$), whole fruits ($p<0.0001$), dark-green and orange vegetables ($p<0.0001$), whole-grain products ($p<0.0001$), milk and alternatives ($p=0.0003$), meat and alternatives ($p=0.0044$), saturated fat ($p=0.0015$), and other foods ($p<0.0001$).

A logistic regression model assessed if participants who rated their diet quality as being "very good" or "excellent" (representing one fourth of the sample) obtained a C-HEI in the highest quartile (score > 68). Table 3-4 shows the percent agreement between categories of self-rated diet quality and categorized C-HEI. The model identified individuals with a C-HEI in the highest quartile with a sensitivity of 44.5% and a specificity of 81.5%. Positive predictive value and negative predictive value were 44.7% and 81.4%, respectively. The c-statistic (0.63) was lower than the 0.70 cut-off recommended for a reasonable model (26). The c-statistic did not reach the 0.70 cut-off value in any of the subgroup analyses based on sex, age, income, education or weight status.

Self-rated diet quality and the C-HEI according to individual characteristics

Table 3-2 shows the distribution of diet quality ratings according to sociodemographic and anthropometric characteristics. The distribution of the diet quality ratings significantly differed according to sex, education, income, and BMI. Women, participants with higher education or income, and normal-weight participants were more likely to self-rate their diet as “very good” or “good”, whereas men, participants with lower education or lower income, and obese participants were more likely to choose the “fair” or “poor” diet quality ratings. The age was also different according to diet quality ratings, with a higher mean age in the “excellent” and “very good” ratings compared to the “fair” rating.

Sex significantly modified the association between self-rated diet quality and C-HEI (p interaction=0.0131, see Figure 3-3). Although in women and men, C-HEI scores increased as self-ratings increased, women had significantly higher C-HEI scores than men in the “good” and “fair” ratings (see Figure 3-3). The association between self-rated diet quality and the C-HEI was not influenced by age groups (p interaction=0.20), BMI categories (p interaction=0.82), education (p interaction=0.25) or income (p interaction=0.29).

Discussion

This study evaluated the associations between self-rated diet quality using a single question and a measure of the overall diet quality calculated with C-HEI using 24-hour recalls in a French-speaking adult population from the Province of Québec. Results suggest that the overall diet quality score is higher in subjects who self-rate their diet as being of better quality. However, the self-rated diet quality item shows a poor ability to predict adherence to healthy eating guidelines.

Our results first showed that the distribution pattern into the different self-rating categories was quite similar to what was observed in other studies (8, 9) or reports that have used a similar item (4, 27), with half of the participants self-rating their overall diet quality as being “good”, around 20% as either “very good” or “fair”, and much fewer choosing the extreme options (i.e. “excellent” or “poor”). We found that calculated diet quality as assessed by C-HEI was significantly different between these self-rated diet categories as previously reported in the few other studies that have assessed the association between self-rated diet quality and overall diet quality indicators (7, 8, 10).

Despite the significant differences we observed in C-HEI total score and component scores between categories of diet quality ratings, a major concern regarding these associations is the very wide range of C-HEI score associated with each self-rated diet quality category, as presented in Table 3. Moreover, the low c-statistic we obtained in assessing the ability of the self-rated item to predict adherence to healthy eating guidelines suggests that many individuals either overrate or underrate the quality of their diet, which is concordant with previous studies showing high rates of misperceptions of one’s diet quality (7), fruit and vegetable consumption (28), and fat intake (29). In the present study, the positive predictive value was low while the negative predictive value was higher, suggesting that the self-rated diet quality item does better at detecting the “true poor eaters” than the “true good eaters”. Based on these results, we propose that the self-rated diet quality item may be useful to obtain a general picture of the diet quality of a population, but should not be used as a substitute to a more comprehensive evaluation of dietary intakes, in line with the conclusions by Adjoian et al. (8).

The wide range of C-HEI score in each self-rated diet quality category and the poor ability to predict healthy eating can also be explained by the fact that, prior to self-rate their diet quality, no definition of “healthy eating” was provided to participants. Thus, they evaluated their dietary habits based on their own perception of a healthy diet and maybe on what they perceive to be a realistic target related to healthy eating. The personal definitions of “healthy eating” may explain the fact that we observed significant differences in some but not all C-HEI components, similarly to Adjoian et al. (8).

Other factors such as sex, age, BMI and socio-economic factors could influence the association between the perceived healthiness of diet and the actual diet quality. To address this issue in our study, we first examined how these factors were associated with self-rating diet quality. Accordingly, we found in our study that women are more likely than men to perceive their diet as being healthy, which is not in line with the observations of Lofffield et al. (9) who did not find gender differences in the distribution of diet quality self-ratings in a sample of over 1600 New Yorkers. Also contrary to Lofffield et al. (9), but in accordance with a Canadian survey report (4), we observed that older participants self-rated their diet as being healthier than younger participants. Our results also suggest that participants with higher income and education level are more likely to have a positive opinion of the healthiness of their diet as was previously observed (9, 30, 31). These differences in the perception of diet healthiness according to sociodemographic characteristics corroborate the results from numerous studies showing significantly healthier diet in women (22, 32-37), older individuals (32, 35, 36, 38), and people with higher income (22, 33-36, 38, 39) or education level (22, 32-34, 36-38). Our results also showed that BMI decreased as the self-rated diet quality increased, as observed elsewhere (9).

We then evaluated how these individual characteristics that are associated with self-rated diet quality could influence the association between perceived healthiness of the diet and an overall score of diet quality. To our knowledge, very few studies (7, 8, 10) have previously addressed this issue. Variyam et al. (7) observed that being a man, having a higher education, smoking, and perceiving one's health as being excellent are among predictors of being optimistic about one's diet quality, i.e. perceiving quality of the diet to be better than it actually is. In the present study, among the individual characteristics evaluated (i.e. sex, age, education, income, BMI), the only one that was found to interact with self-rated diet quality to explain variance in C-HEI was sex. More precisely, for a similar C-HEI, men were likely to rate their diet as one category healthier than women. For example, men in the "very good" rating had similar C-HEI scores than women in the "good" rating (60.8 ± 14.0 and 60.1 ± 12.2 , respectively; $p=0.66$). The same pattern was observed between the other rating categories (see Table 3). Such an interaction between sex and diet quality ratings was not observed in other studies. These findings corroborate data from previous studies suggesting that factors, such as being a man, increase the likelihood of having an unrealistic perception of one's own diet quality (7) or fat intake (29). These results suggest that men and women define healthy eating according to different criteria, and that men may be more prone than women to an optimistic bias regarding diet quality. This hypothesis should be subject to further investigation since it could result in men feeling less concerned by healthy eating messages if they perceive their diet quality as being better than it actually is.

Despite the noteworthy limitations related to the use of a self-rated diet quality item in a research context, we believe that results from the present study may be helpful from a clinical perspective. More precisely, these results have the potential of helping registered dietitians and other health professionals in personalizing

interventions with their patients. On the one hand, individuals who have an overoptimistic opinion of their dietary habits may be less willing to make changes because they may not think these changes are necessary. On the other hand, people who underestimate their diet quality may be discouraged thinking that there are too many changes to perform. Therefore, knowing that most individuals have a hard time accurately self-rating their dietary habits, health professionals should include in their interventions the comparison between their patients' perception of their diet, their actual diet, and the healthy eating recommendations. In the present study, we performed analyses to assess if individuals who perceived having very good or excellent dietary habits actually had a high C-HEI. We chose this side of the scale rather than the other (i.e. assessing if poor or fair ratings can predict a low C-HEI) because we believe it is important to know if some people who would benefit from population interventions such as healthy eating campaigns (i.e. people with low C-HEI) may not feel targeted because they think their habits are already good enough (6). We suggest that individuals who consider that their eating habits are very good or excellent may not perceive themselves as the target audience of such campaigns. Our results showed that only 44.7% of participants who rated their diet as being very good or excellent actually had a great diet quality (positive predictive value). These results suggest that there is a need for population education related to what a healthy diet really is.

A major strength of the present study is the use of three 24-hour food recalls to evaluate participants' dietary intakes. Therefore, we are more likely to be able to capture participants' usual intakes than studies using only one food recall (40, 41). The fact that recruitment was performed based on a random list of phone numbers may have allowed us to reach participants who do not usually volunteer to participate in such studies. However, despite this recruitment method, our sample was rather homogenous, with more than 92% of Caucasian participants, and highly educated (45.4% having a university degree).

Being significantly associated with an overall diet quality score, the self-rated diet quality single item can be useful to obtain a general idea of the diet quality of a population. However, findings of the present study suggest that such item should be used with caution since it shows a poor ability to predict adherence to healthy eating guidelines. Characteristics of participants may influence one's ability to appropriately self-evaluate diet quality. Further studies are needed to determine the relevance of using self-rated measures of diet quality in different settings.

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Tables

Table 3-1. Sample characteristics (n=1045)

| | n (%) |
|---|------------|
| Female | 529 (50.6) |
| Age (years) | |
| 18-34 | 367 (35.1) |
| 35-49 | 311 (29.8) |
| 50-65 | 367 (35.1) |
| Ethnicity | |
| Caucasian | 956 (91.5) |
| Highest level of education | |
| High school or less | 251 (24.0) |
| College | 319 (30.5) |
| University | 474 (45.4) |
| Missing value | 1 (0.1) |
| Occupation | |
| Worker | 671 (64.2) |
| Retired | 146 (14.0) |
| Student | 116 (11.1) |
| No job | 42 (4.0) |
| Other | 58 (5.6) |
| Missing value or prefer not to answer | 12 (1.1) |
| Body mass index (BMI)* | |
| Normal weight (BMI<25 kg/m ²) | 396 (39.8) |
| Overweight (BMI=25-29.9 kg/m ²) | 330 (33.2) |
| Obese (BMI≥30 kg/m ²) | 269 (27.0) |

Note: *n=995

Table 3-2. Participants' characteristics according to self-rated diet quality.

| | Excellent n (%) or mean±SD | Very Good n (%) or mean±SD | Good n (%) or mean±SD | Fair n (%) or mean±SD | Poor n (%) or mean±SD | <i>p</i> |
|---------------------------|----------------------------------|----------------------------------|-----------------------------|-----------------------------|-----------------------------|--------------|
| Total | 25 (2.4) | 237 (22.7) | 517 (49.5) | 212 (20.3) | 54 (5.1) | |
| Sex | | | | | | |
| Women (n=529) | 14 (2.6) | 137 (25.9) | 263 (49.7) | 94 (17.8) | 21 (4.0) | 0.0213* |
| Men (n=516) | 11 (2.1) | 100 (19.4) | 254 (49.2) | 118 (22.9) | 33 (6.4) | |
| Age (years) | 46.1±13.3 ^a | 45.2±13.6 ^a | 42.6±13.3 ^{a,b} | 40.5±13.6 ^b | 42.2±13.1 ^{a,b} | 0.0042† |
| Annual income | | | | | | |
| <40 000\$CA | 6 (2.5) | 45 (18.5) | 101 (41.6) | 73 (30.0) | 18 (7.4) | <0.0001 * |
| 40-79 999\$CA | 6 (1.9) | 66 (21.6) | 153 (50.2) | 67 (22.0) | 13 (4.3) | |
| ≥80 000\$CA | 13 (3.2) | 110 (27.3) | 213 (52.9) | 52 (12.9) | 15 (3.7) | |
| Education | | | | | | |
| High school | 6 (2.4) | 49 (19.5) | 102 (40.6) | 75 (29.9) | 19 (7.6) | <0.0001 * |
| College/university | 19 (2.4) | 188 (23.7) | 414 (52.2) | 137 (17.3) | 35 (4.4) | |
| BMI | | | | | | |
| <25 kg/m ² | 17 (4.3) | 127 (32.1) | 189 (47.7) | 53 (13.4) | 10 (2.5) | <0.0001 * |
| 25-29.9 kg/m ² | 8 (2.4) | 74 (22.4) | 169 (51.2) | 65 (19.6) | 14 (4.2) | |
| ≥30 kg/m ² | 0 (0) | 26 (9.7) | 137 (50.9) | 80 (29.7) | 26 (9.7) | |

Notes: * *p* for chi-square test for categorical variables. † *p* for generalized linear model procedure for continuous data. ^{a,b,c,d} Categories with different superscripted letters are significantly different.

Table 3-3. C-HEI scores according to self-rated diet quality.

| Self-rated diet quality categories | C-HEI score (from 0 to 100) | | |
|------------------------------------|-----------------------------|-------------------|--------------|
| | Mean±SD | (minimum-maximum) | [95% CI] |
| Excellent | 73.1±14.2 ^a | (31.7-89.0) | [67.9-78.3] |
| Very good | 62.7±12.9 ^b | (34.7-93.4) | [61.0-64.4] |
| Good | 57.7±13.0 ^c | (23.7-91.0) | [56.5-58.8] |
| Fair | 50.8±14.3 ^d | (23.0-83.4) | [49.0-52.57] |
| Poor | 47.6±12.0 ^d | (20.0-77.6) | [44.1-51.1] |

Notes: ^{a,b,c,d} Categories with different superscripted letters are significantly different (p for generalized linear model <0.0001).

Table 3-4. Percent agreement between categories of self-rated diet quality and categorized C-HEI.

| | C-HEI \geq 68 | C-HEI<68 | Total |
|------------------------------------|-----------------|-------------|------------|
| “Very good” or “Excellent” ratings | 117 (44.7%) | 145 (55.3%) | 262 (100%) |
| “Good”, “Fair”, or “Poor” ratings | 146 (18.6%) | 637 (81.4%) | 783 (100%) |

Note: Values are presented as n (%).

Figures

Figure 3-1. Flowchart of the PREDISE study.

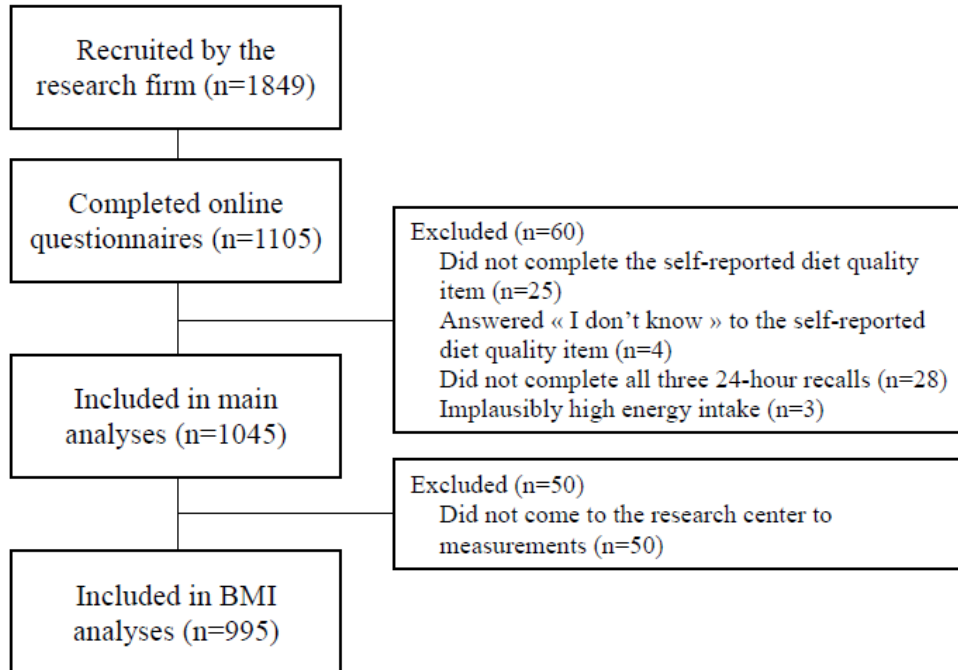
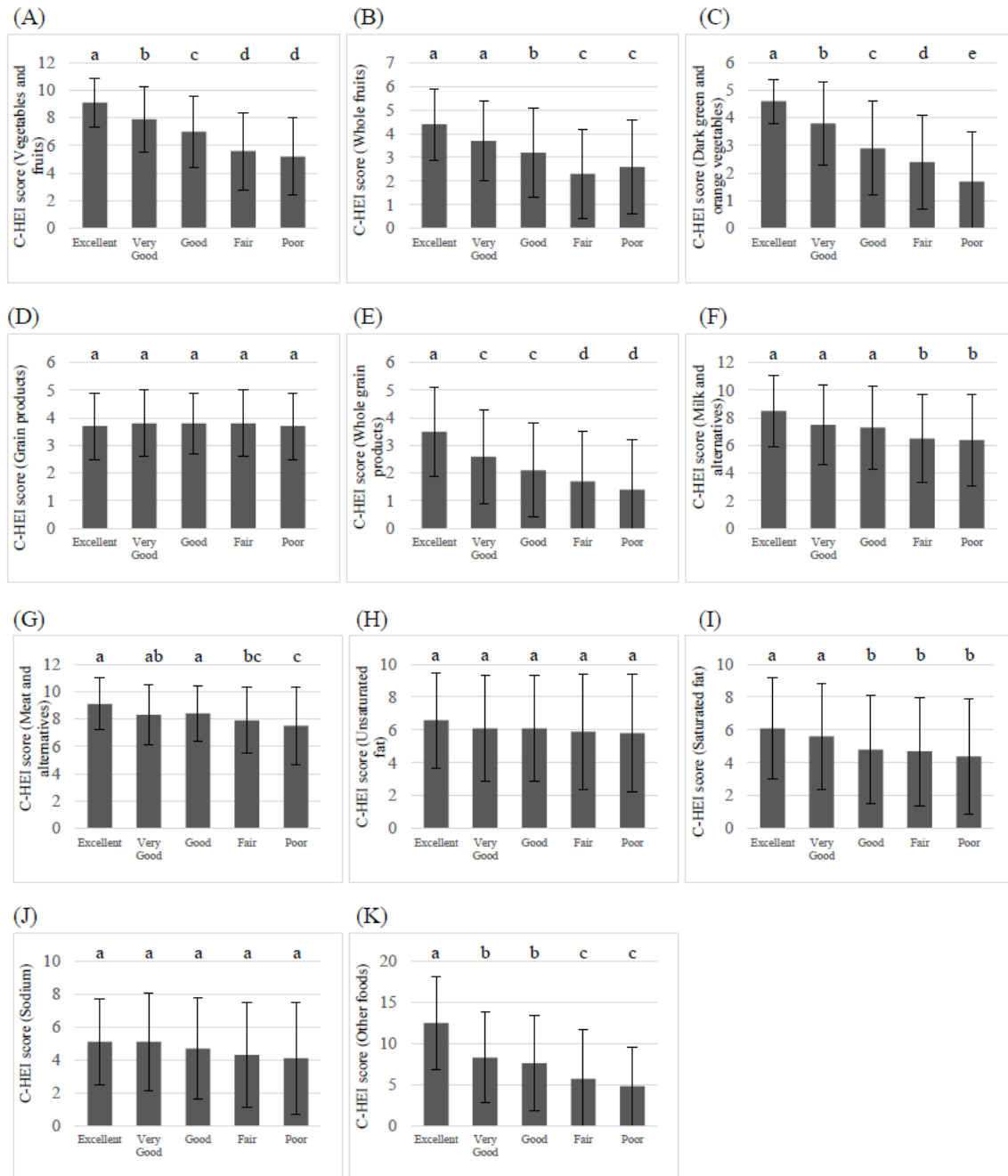
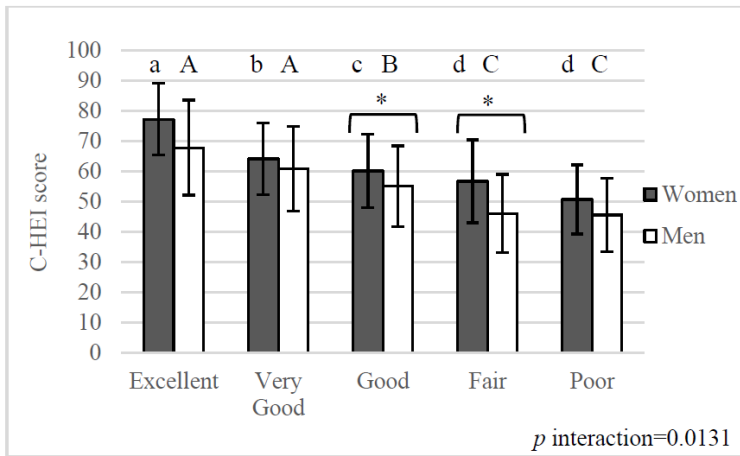


Figure 3-2. Scores for C-HEI components according to self-rated diet quality.



(A) Vegetables and fruits, $p < 0.0001$. (B) Whole fruits, $p < 0.0001$. (C) Dark-green and orange vegetables, $p < 0.0001$. (D) Grain products, $p = 0.98$. (E) Whole-grain products, $p < 0.0001$. (F) Milk and alternatives, $p = 0.0003$. (G) Meat and alternatives, $p = 0.0044$. (H) Unsaturated fat, $p = 0.95$. (I) Saturated fat, $p = 0.0015$. (J) Sodium, $p = 0.42$. (K) Other foods, $p < 0.0001$. a,b,c,d,e Categories with different superscripted letters are significantly different.

Figure 3-3. C-HEI score according to self-rated diet quality and gender.



* $p < 0.05$ between men and women. a, b, c, d Categories with different superscripted lower case letters are significantly different among women. A, B, C Categories with different superscripted capital letters are significantly different among men.

Supplemental material

Supplemental Table S3-5. List of questionnaires completed in the PREDISE study

| Questionnaires | References |
|---|---|
| Intuitive Eating Scale-2 | Carbonneau, E., Carbonneau, N., Lamarche, B., Provencher, V., Begin, C., Bradette-Laplante, M., Laramee, C., and Lemieux, S. (2016). Validation of a French-Canadian adaptation of the intuitive eating scale-2 for the adult population. <i>Appetite</i> 105: 37-45. |
| Sensitivity to punishment and sensitivity to reward questionnaire | Lardi, C., Billieux, J., d'Acremont, M., and Van der Linden, M. (2008). A French adaptation of a short version of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ). <i>Personality and Individual Differences</i> 45: 722-725. |
| Regulation of Eating Behavior Scale | Pelletier, L., Dion, S., Slovinec-D'Angelo, M., and Reid, R. (2004). Why do you regulate what you eat? Relationships between forms of regulation, eating behaviors, sustained dietary behavior change, and psychological adjustment. <i>Motivation and Emotion</i> 28: 245-277. |
| Food liking questionnaire | Carbonneau, E., Bradette-Laplante, M., Lamarche, B., Provencher, V., Begin, C., Robitaille, J., Desroches, S., Vohl, M.C., Corneau, L., and Lemieux, S. (2017). Development and Validation of the Food Liking Questionnaire in a French-Canadian Population. <i>Nutrients</i> 9. |
| Nutrition knowledge questionnaire | Bradette-Laplante, M., Carbonneau, E., Provencher, V., Begin, C., Robitaille, J., Desroches, S., Vohl, M.C., Corneau, L., and Lemieux, S. (2017). Development and validation of a nutrition knowledge questionnaire for a Canadian population. <i>Public Health Nutr</i> 20: 1184-1192. |
| Social support for healthy eating questionnaire | Carbonneau, E., Bradette-Laplante, M., Lamarche, B., Provencher, V., Begin, C., Robitaille, J., Desroches, S., Vohl, M.C., Corneau, L., and Lemieux, S. (2018). Social support for healthy eating: development and validation of a questionnaire for the French-Canadian population. <i>Public Health Nutr</i> : 1-7. |
| Perceived food Environment Questionnaire | Carbonneau, E., Robitaille, J., Lamarche, B., Corneau, L., and Lemieux, S. (2017). Development and validation of the Perceived Food Environment Questionnaire in a French-Canadian population. <i>Public Health Nutr</i> 20: 1914-1920. |
| Balanced Inventory of Social Responding | Paulhus, D.L. (1991). Measurement and control of response bias. In: P.R.S. J.P. Robinson, & L.S. Wrightsman (Ed.), <i>Measures of personality and social psychological attitudes.</i> , pp. pp.17-59. San Diego: Academic Press. |
| Three factor Eating Questionnaire | Stunkard, A.J. and Messick, S. (1985). The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. <i>J Psychosom Res</i> 29: 71-83. |
| International Physical Activity Questionnaire | Craig, C.L., Marshall, A.L., Sjostrom, M., Bauman, A.E., Booth, M.L., Ainsworth, B.E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J.F., and Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. <i>Med Sci Sports Exerc</i> 35: 1381-95. |
| Medical Questionnaire | No reference |
| Sociodemographic Questionnaire | No reference |

Supplemental Table S3-6. Description of the C-HEI scoring for adults

| Component | Range of scores | Scoring criteria |
|----------------------------------|---------------------------------|---|
| Adequacy | 0 to 60 points | |
| Total vegetables and fruit | 0 to 10 points | Minimum: 0 Maximum: 7 to 8 servings |
| Whole fruit | 0 to 5 points | Minimum: 0 Maximum: 1.5 to 1.7 servings (21% of recommendation for total vegetables and fruit) |
| Dark green and orange vegetables | 0 to 5 points | Minimum: 0 Maximum: 1.5 to 1.7 servings (21% of recommendation for total vegetables and fruit) |
| Total grain products | 0 to 5 points | Minimum: 0 Maximum: 6 to 8 servings |
| Whole grains | 0 to 5 points | Minimum: 0 Maximum: 3 to 4 servings (50% of recommendation for total grain products) |
| Milk and alternatives | 0 to 10 points | Minimum: 0 Maximum: 2 to 3 servings |
| Meat and alternatives | 0 to 10 points | Minimum: 0 Maximum: 2 to 3 servings (150 to 225 grams) |
| Unsaturated fats | 0 to 10 points | Minimum: 0 Maximum: 30 to 45 grams |
| Moderation | 0 to 40 points | |
| Saturated fats | 8 to 10 points 0 to 8 points | Minimum 7% to 10% of total energy intake 10% to maximum 15% of total energy intake |
| Sodium | 8 to 10 points 0 to 8 points | Adequate intake to tolerable upper intake level Tolerable upper intake level to twice tolerable upper intake level |
| “Other foods” | 0 to 20 points | Minimum: 5% or less of total energy intake Maximum: 40% or more of total energy intake |

Credit to: Garriguet, D. (2009). Diet quality in Canada. Ottawa: Statistics Canada.

For adequacy components, 0 points for minimum, 5 or 10 points for maximum or more, and proportional for amounts between minimum and maximum.

For moderation components, 10 or 20 points for minimum or less, 0 points for maximum or more, and proportional for amounts between minimum and maximum.

Chapitre 4 : Associations entre les connaissances en nutrition et l'adhésion au GAC 2007

Elise Carbonneau, Benoît Lamarche, Véronique Provencher, Sophie Desroches, Julie Robitaille, Marie-Claude Vohl, Catherine Bégin, Mathieu Bélanger, Charles Couillard, Luc Pelletier, Luigi Bouchard, Julie Houle, Marie-France Langlois, Louise Corneau et Simone Lemieux.

L'article présenté dans ce chapitre s'intitule: Associations between nutrition knowledge and overall diet quality: the moderating role of sociodemographic characteristics – Results from the PREDISE study

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Résumé

L'objectif de cette étude était d'étudier si les connaissances en nutrition sont associées à la qualité de l'alimentation et d'examiner si les caractéristiques sociodémographiques (c.-à-d., sexe, âge, scolarité, revenu, état matrimonial, vivre avec des enfants ou non) modèrent cette association. Un échantillon probabiliste de 1092 adultes francophones de la Province Québec (50% de femmes) a été recruté dans le cadre de l'étude transversale PREDISE, visant à identifier des déterminants de l'adhésion aux recommandations du Guide alimentaire canadien. Les participants ont complété un questionnaire validé sur les connaissances en nutrition et des rappels alimentaires de 24h, à partir desquels le *Healthy Eating Index* canadien (C-HEI), un indice de la qualité alimentaire globale, a été calculé. Les analyses de régression multiples ont été effectuées pour évaluer comment les connaissances en nutrition sont associées au C-HEI. Des termes d'interaction ont été testés pour évaluer si les caractéristiques sociodémographiques modèrent l'association entre les connaissances en nutrition et le C-HEI. Les connaissances en nutrition ont été identifiées comme un déterminant significatif du C-HEI ($B=0,141$ [95% IC 0,075, 0,208], $p<0,0001$). La scolarité était un modérateur significatif de l'association entre les connaissances et le C-HEI (p interaction=0,0038), avec une association significative chez les participants ayant un niveau de scolarité plus faible seulement ($B=0,295$ [95% IC 0,170, 0,421], $p<0,0001$). Le fait de vivre avec des enfants était également un modérateur significatif (p interaction=0,0043); les connaissances en nutrition étaient associées au C-HEI seulement chez les participants ne vivant pas avec des enfants ($B=0,261$ [95% IC 0,167, 0,355], $p<0,0001$). Cette étude suggère que l'association entre les connaissances en nutrition et l'adhésion aux recommandations de la saine alimentation n'est pas la même dans différents sous-groupes de la population. Des interventions visant à accroître les connaissances en nutrition peuvent être une approche prometteuse pour améliorer la qualité de l'alimentation, notamment chez les personnes ayant un plus faible niveau de scolarité.

Abstract

Purpose: To assess how nutrition knowledge is associated with global diet quality, and to investigate if sociodemographic characteristics (i.e., sex, age, education, income, marital status, living with children or not) moderate this association.

Design: Cross-sectional web-based study.

Setting: The PREDISE study aims at identifying correlates of adherence to healthy eating guidelines in French-speaking adults from the Province of Quebec, Canada.

Subjects: A probability sample of 1092 participants (50% female).

Measures: The Nutrition Knowledge Questionnaire and 24-hour food recalls, from which the Canadian Healthy Eating Index (C-HEI) was calculated.

Analysis: Multiple linear regressions performed to assess how nutrition knowledge is associated with the C-HEI. Interaction terms tested to evaluate whether sociodemographic characteristics moderate the association between nutrition knowledge and the C-HEI

Results: Nutrition knowledge ($B=0.141$ [95% CI 0.075, 0.208], $p<0.0001$) was identified as a significant correlate of the C-HEI. Education significantly moderated the association between nutrition knowledge and the C-HEI (p interaction=0.0038), with a significant association among participants with a lower education level ($B=0.295$ [95% CI 0.170, 0.421], $p<0.0001$) but not among participants with a higher education level ($B=0.077$ [95% CI -0.004, 0.157], $p=0.06$). Whether participants lived with or without children also significantly moderated the association (p interaction=0.0043); nutrition knowledge was associated with the C-HEI only in participants who were not living with children ($B=0.261$ [95% CI 0.167, 0.355], $p<0.0001$).

Conclusion: This study suggests that the association between nutrition knowledge and adherence to healthy eating guidelines is not the same in different subgroups of the population. Interventions aiming at increasing nutrition knowledge may be a promising approach to improve diet quality, especially among individuals with a lower education.

Title page

Associations between nutrition knowledge and overall diet quality: the moderating role of sociodemographic characteristics – Results from the PREDISE study

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Keywords: nutrition knowledge, diet quality, healthy eating index, PREDISE study

Purpose

Food intake and eating behaviors are influenced by a combination of individual, social, and environmental factors (1). Among individual factors, nutrition knowledge has been identified as a potential determinant of healthy eating (2). Nutrition knowledge, or nutrition literacy, can be defined as the “degree to which people have the capacity to obtain, process, and understand basic nutrition information” (3). Conventional approaches used by governments and health agencies to promote healthy eating usually target the improvement of nutritional knowledge. However, it is uncertain if being more knowledgeable regarding nutrition, including having good knowledge of the healthy eating guidelines, is a prerequisite for achieving a healthy diet.

A recent systematic review has reported a significant but weak relationship between nutrition knowledge and dietary intake (4). However, on the 29 studies included in the systematic review, only three used validated tools for the measurement of both nutrition knowledge and dietary intakes. This highlights the need for more studies in this field using validated questionnaires. As far as we know, no study has yet assessed the association between measured awareness of and adherence to Canadian nutritional guidelines. The 2007 Canada’s Food Guide, in force at the time of the study, was divided into four food groups (Vegetables and fruits, Grain products, Milk and alternatives, Meat and alternatives). This guide included recommended numbers of servings from each food group for each sex and age category, as well as specific guidelines to help consumers make the most of their servings.

Sociodemographic characteristics, such as age, sex, and socioeconomic status, have been extensively associated with diet quality (5, 6). Beydoun et al. (7) have suggested that the influence of the socioeconomic status on dietary intake varies according to the level of nutrition knowledge, whereas Deroover et al. (8) showed that practical nutrition knowledge can mediate the relationship between sociodemographic characteristics and diet quality. To our knowledge, no other study has considered the potential interplay between sociodemographic characteristics and nutrition knowledge to explain the variance in diet quality. This analysis may contribute to understanding why knowledge regarding a health behavior does not always lead to the adoption of the actual behavior.

Thus, the objectives of this study were firstly to assess the association between nutrition knowledge and overall diet quality, and secondly to investigate if sociodemographic characteristics (i.e., sex, age, education, income, marital status, living with children or not) are moderators of this association, in a sample of French-speaking adults from the Province of Quebec, Canada, participating in the PREDISE study.

Methods

Design

The PREDISE (“PRÉDICTeurs Individuels, Sociaux et Environnementaux” [in French], meaning “individual, social, and environmental predictors”) study is a multicenter cross-sectional study aiming at identifying correlates of adherence to Canadian guidelines for healthy eating in a probability sample of French-speaking adults from the Province of Quebec, Canada. Recruitment and procedures were described previously (9). Briefly, participants were recruited using random digit dialing in order to represent the French-speaking adult population of five regions of recruitment based on sex and age. Once recruited, participants had three weeks to complete a series of online questionnaires on an Internet platform and they visited a research center affiliated to the PREDISE study in their region for anthropometric measurements.

The PREDISE study was conducted according to the guidelines laid down in the Declaration of Helsinki. The research project received approval from the Research Ethics Committees of Université Laval (ethics number: 2014-271), Centre hospitalier universitaire de Sherbrooke (ethics number: MP-31-2015-997), Montreal Clinical Research Institute (ethics number: 2015-02), and Université du Québec à Trois-Rivières (ethics number: 15-2009-07.13). All participants gave implied consent for the first phase of the study (i.e., completion of online questionnaires) and written informed consent for the second phase (i.e., anthropometric measurements at the research center). As a compensation for the first phase of the study, participants who completed at least three of 13 online questionnaires were eligible for a random drawing of two iPads and 40 gift-certificates (CAD 100). Also, participants received a financial compensation (CAD 50) at their visit to the research center.

Sample

To be eligible, participants had to be aged 18 to 65 and have Internet access to complete the questionnaires. Pregnant and lactating women were excluded since their motivation towards healthy eating is likely to differ from the general population. Another exclusion criterion was intestinal malabsorption, because blood biomarkers of fruit and vegetable intake were also measured during the study (note that the analyses pertaining to blood biomarkers are beyond the scope of this paper). On a total of 1849 individuals who met inclusion criteria and gave consent to participate, 1147 completed at least one food recall and were included in the study.

Measures

Canadian Healthy Eating Index 2007 (C-HEI). During the three-week period allocated to complete the different questionnaires, participants completed three web-based 24-hour food recalls, using an application developed by our research team (R24W). Participants had to report all foods and drinks consumed from midnight to

midnight on three days generated at random by the R24W application. The R24W is a tool specifically developed and validated for the French-speaking adult population of the Province of Quebec (10-13). Using data generated by the R24W, the C-HEI (14), an indicator of the overall diet quality, was calculated. The C-HEI was developed to reflect the 2007 Canada's Food Guide's (CFG) recommendations for healthy eating (15), the guidelines in force when the study was initiated. The C-HEI is composed of eight adequacy components (total fruits and vegetables, whole fruits, dark-green and orange vegetables, grain products, whole-grain products, milk and alternatives, meat and alternatives, and unsaturated fat) and three moderation components (saturated fat, sodium, and "other foods" (i.e., that are not part of the foods recommended by CFG)). Each component is evaluated on 5, 10 or 20 points, for a total maximum score of 100 (see full description of the C-HEI score in Supplementary Table S4-6). The C-HEI was used as a continuous variable in the present analyses. All participants with at least one complete food recall were considered included in the study (n=1147; 94.3% of participants with three food recalls, 3.1% with two recalls, and 2.6% with one recall).

Nutrition Knowledge Questionnaire. Nutrition knowledge was assessed using a questionnaire developed and validated for the French-speaking adult population of the Province of Quebec (16). The Nutrition Knowledge Questionnaire is a 20-item tool consisting of four questions, three of which assessing familiarity with CFG, i.e., 1) number of portions recommended for each food group of the CFG for one's sex and age (i.e., "How many portions a day do you think CFG recommends, for an individual of your age and gender for each of the following food groups?"); 2) types of food in each group of the CFG (i.e., "For each of the four CFG groups, five food items are listed. Identify whether or not these items are included in the food group"); 3) complementary information presented in the CFG (e.g., "Indicate whether the following statement is included in CFG recommendations: Enriched soy beverages can be consumed as an alternative for milk."). The fourth theme consists of 6 items assessing general nutrition knowledge (e.g., "Indicate whether you agree or disagree with the following statements: All spices are high in sodium (salt)."). The questionnaire was validated in a sample distinct from the present study but with similar characteristics (16). The questionnaire had a good internal consistency in the present sample (Cronbach $\alpha=0.89$). The maximum total score for the questionnaire is 13.5 points, but results are presented in percentages to facilitate interpretation (see full questionnaire in Supplementary Material). Participants with all 20 items missing in the Nutrition Knowledge Questionnaire were excluded from the analyses (n=55).

Sociodemographic questionnaire. Participants completed a sociodemographic questionnaire, and the answers to each question were categorized for the use of sociodemographic variables in the analyses (see Table 4-1). Age was divided in three categories, in accordance with the recruitment strata (i.e., 18-34 y, 35-49 y, and 50-65 y). With regard to education, participants reported the highest degree obtained and were classified into one of the two following categories, i.e., high school or less, vs. CEGEP or university. In the Quebec education system,

CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs. Participants were also divided in two categories based on their reported annual household income: participants living under the low-income cut-off according to the Quebec Institute of Statistics, based on the household size (17), vs. those living over the low-income cut-off. Participants were also characterized according to their marital status, i.e., married (or in a common-law union) vs. other status, and on whether they live with children or not. Smoking status was classified as current smokers (frequently or occasionally) vs. non-smokers/former smokers.

Analysis

Analyses were performed using the Statistical Analysis Software (SAS) version 9.4 (Copyright © 2013, SAS Institute Inc., Cary, NC, USA). Multiple imputation was used to deal with missing items in the Nutrition Knowledge Questionnaire (62 participants (5.7%) had missing data in the questionnaire, among which the majority (n=45) had only one missing item). Multiple imputation was also used for missing data in sociodemographic characteristics and smoking status (i.e., education, n=17; income, n=114; marital status, n=85; living or not with children, n=20; smoking status, n=2). Multiple imputation inference involves three distinct phases: 1) The missing data are filled in m times to generate m complete data sets (in the present study, m=10), using the MI procedure; 2) The m complete data sets are analyzed by using standard procedures; 3) The results from the m complete data sets are combined for the inference (18), using the MIANALYZE procedure. Missing data pattern was arbitrary (i.e., no particular pattern in the missing data structure, missing observations distributed across variables in a non-systematic fashion), we therefore performed multivariate imputation using a fully conditional specification (FCS) logistic regression method for classification variables (18). Multiple imputation by FCS is proposed as a powerful and statistically valid method for creating imputations for both categorical and continuous variables (19). For participants who did not complete three food recalls, missing data on the C-HEI were not imputed. However, all participants who completed at least one food recall (i.e., 3.1% with two recalls, and 2.6% with one recall) were included in analyses, which is considered acceptable for cross-sectional studies by the Dietary Assessment Primer of the National Institutes of Health (20). The C-HEI was then calculated for each available food recall and averaged for all participants who completed multiple 24h recalls.

Differences in nutrition knowledge score according to selected characteristics were assessed using generalized linear models (GENMOD), with Tukey adjustment for multiple comparisons. Multiple linear regression analyses were performed to assess how nutrition knowledge (independent variable) is associated with the C-HEI (dependent variable). Next, interaction terms were tested to evaluate whether sociodemographic characteristics (i.e., sex, age, education, income, marital status, living with children or not) moderate the association between the nutrition knowledge score and the C-HEI. Stratified analyses were then performed according to significant

moderators. Characteristics included in all models were sex, age, education, income, marital status, living with children or not, and smoking status, and were found to be significantly associated with diet quality in previous analyses (9). They were included as covariates in all multiple linear regression models. Since misreporting of dietary intake can be an issue causing systematic bias, reporting status (i.e., under-reporter, plausible reporter, or over-reporter) was also included as a covariate in all analyses. As previously detailed (21), the reporting status was assessed using the method by Huang et al. (22) according to which under- and over-reporters are those with a calculated energy intake:predicted energy requirement ratio < 0.78 and > 1.22 , respectively. Missing data for reporting status (n=71) were imputed with the MI procedure described above. Statistical tests were two-sided and differences or associations at $p < 0.05$ were considered significant.

Results

Among the 1849 individuals recruited by the research firm for the PREDISE study, 1147 completed at least one food recall, among which 1092 had data for the Nutrition Knowledge Questionnaire and were therefore included in the analyses. Characteristics of the 1092 included participants are presented in Table 4-1. Characteristics of participants with complete (i.e., no missing data; n=817) vs. incomplete (n=275) data before imputation are presented in Table 4-2.

The mean C-HEI score of the sample was 56.7 ± 14.3 (min-max: 14.8-93.4) on a scale of 0 to 100 and the mean nutrition knowledge score was $64.7 \pm 13.0\%$ (min-max: 3.7-100.0%) on a scale of 0 to 100%. Mean nutrition knowledge scores were compared among subgroups formed on the basis of sociodemographic characteristics, smoking status and reporting status using generalized linear models (see Supplementary Table S4-7). Overall, the nutrition knowledge score was higher in women and in participants with either higher education or income level (vs. lower education or income). Participants aged 35-49 y had a significantly higher nutrition knowledge score than older participants (50-65 y). Having children, being married (or living in a common-law union), and being non-smoker were also associated with having a higher nutrition knowledge score.

A multiple linear regression analysis showed that having better nutrition knowledge was significantly associated with a higher C-HEI ($B=0.141$ [95% CI 0.075, 0.208], $p<0.0001$) independently of sociodemographic characteristics, smoking status and reporting status (see Table 4-3).

Multiple linear regressions were performed with the inclusion of interaction terms in order to assess if sociodemographic characteristics (i.e., sex, age, education, income, marital status, living with children or not) moderated the association between nutrition knowledge and the C-HEI. No significant interactions were observed for sex, age, income, and marital status (p interaction >0.05). However, education significantly moderated the association between nutrition knowledge and the C-HEI (p interaction = 0.0038). Nutrition knowledge was significantly and positively associated with the C-HEI among participants with a high school diploma or less ($B=0.295$ [95% CI 0.170, 0.421], $p<0.0001$) but not among participants with a CEGEP or university degree ($B=0.077$ [95% CI -0.004, 0.157], $p=0.06$; see Table 4).

Whether participants lived or not with children also significantly moderated the association between nutrition knowledge and the C-HEI (p interaction = 0.0043). Nutrition knowledge score was significantly associated with the C-HEI only in participants who were not living with children ($B=0.261$ [95% CI 0.167, 0.355], $p<0.0001$; vs. $B=0.015$ [95% CI -0.079, 0.109], $p=0.76$, for participants living with children; see Table 4-5).

Discussion

The present study aimed at assessing how nutrition knowledge is associated with diet quality among French-speaking adults of the Province of Quebec, Canada, using validated tools that were specifically developed for the study population. A higher level of nutrition knowledge was associated with being a woman, having higher education and income levels, being married (or living in a common-law union), and having children. These results are consistent with results of previous studies (23-28).

Multiple regression analysis revealed that, in the whole sample, having better nutrition knowledge was significantly associated with diet quality, independently of the different characteristics that were used as covariates. Conversely, Mathe et al. (29) observed that the awareness of the CFG was not associated with positive health behaviors, such as vegetables and fruit intake. Results from that study need to be interpreted with caution due to the fact that they evaluated the awareness of the CFG only by asking participants if they were familiar with the guide and its specific recommendations. This may have overestimated participants' knowledge of the food guide compared with their actual level of knowledge.

One of the novel features of the present study was the assessment of potential moderators of the association between nutrition knowledge and diet quality. The results showed that nutrition knowledge seems to have a stronger influence on healthy eating among individuals with a lower level of education, even though these individuals have less nutrition knowledge than their counterparts. In light of these results, we suggest that there may be more room for improving nutrition knowledge among individuals with lower educational attainment, and that such an improvement could result in a better overall diet quality. Increasing the nutrition content of the curriculum at early stages of the schooling, for example in elementary school and high school, may be an effective strategy to help reduce the nutrition knowledge gap between adults who achieved high vs. low levels of education, which could contribute to supporting healthier dietary patterns (30, 31). In the Province of Quebec, before 2009, all public high school students had mandatory "home economics" classes where they learned basics about cooking and healthy eating, but these classes were removed from the curriculum. We suggest that future studies should investigate if the re-implementation of such "home economics" classes could help reduce the nutrition knowledge gap between individuals with lower vs. higher education. Results of the regression analysis stratified according to the education level also suggest that for more educated individuals, an increase in nutrition knowledge is less likely to produce an improvement in diet quality, maybe because of their already higher knowledge level. We hypothesize that above a certain level of nutrition knowledge, it becomes difficult to improve dietary habits by increasing nutrition knowledge (ceiling effect). This should be investigated in future studies. Even though individuals with higher educational attainment usually have better dietary habits, they could certainly benefit from an even better diet quality. Results from the present study suggest that improvement of nutrition knowledge may not be the most promising avenue for more educated individuals.

Results of the present study also suggest that adults who live with children have better nutrition knowledge than those living without children, but also that nutrition knowledge is a significant correlate of diet quality only among the latter. When preparing family meals, parents often take into consideration the food preferences of the other family members, such as children (32, 33), which could influence overall parents' diet quality and lessen the influence of nutrition knowledge on food intake. The lack of time caused by busy schedules is another factor that strongly influences the type of food that parents prepare for their children and for themselves (34-36). It was observed in a recent study that, among parents with children aged 2 to 18, up to 20% perceived that their child's participation in organized activities interfered with family meals, resulting in lower family meal frequency, greater difficulty scheduling family meals, and more fast-food intake (37). In the context of a large survey conducted in the Province of Quebec, 3940 parents of children aged 0-12 years were asked to report the barriers to healthy family meals. Of the 1151 answers given by the parents, 33% related to the lack of time for preparing meals and 17% to preferences and whims of family members (38). The relationship between barriers related to time, health and food preferences is very complex and suggests that parents constantly need to make compromises when planning and preparing family meals (39). Better planning of the weekly meals and improvement of basic culinary skills may help parents to better take advantage of their nutrition knowledge for the benefits of all family members.

The Nutrition Knowledge Questionnaire used in the present study assessed the degree to which participants were aware of the Canadian guidelines for healthy eating in force when the study took place, namely the 2007 version of the CFG (15). The latter included recommended numbers of servings and specific guidelines for each of the four food groups. The 2007 CFG focused on what are called "declarative nutrition concepts", i.e., knowledge of nutrition facts (4). In January 2019, the Canadian government released a new version of the CFG (40), emphasizing how Canadians should eat instead of just what to eat. Compared with the previous version, the new 2019 CFG offers more visual guidelines (i.e., a picture of a plate with recommended proportions of various types of foods) and also more concrete day-to-day recommendations, such as cooking more often, eating meals with others, and enjoying food. It is likely that the new 2019 CFG will have the potential of enhancing not only declarative nutrition knowledge, but also nutrition literacy, a concept defined as the "possession of nutrition knowledge and skills that have practical relevance to dietary choices" (4). Nutrition literacy and declarative nutrition knowledge are two concepts that are certainly closely linked, but it cannot be ruled out that some individuals may have a high level of declarative nutrition knowledge but do not possess the appropriate set of food skills to make healthy food choices when grocery shopping and cooking. Further studies should investigate if awareness of the new Canadian guidelines for healthy eating vs. the 2007 CFG is more strongly associated with diet quality.

The association between nutrition knowledge and diet quality in the general population has received limited attention in the literature, as previously reported by Spronk et al. (4). In addition to the scarcity of evidence, there are major limitations in these previous studies. One of the main limitations is the use of non-validated tools for the measure of both nutrition knowledge and dietary intakes. In the present study, we addressed this limitation by using validated tools that were specifically developed for the study population. Another strength of the present study is the use of three 24-hour food recalls to evaluate dietary intakes, increasing the likelihood of capturing participants' usual intakes (41, 42). The present study is also one of the first studies to assess potential moderators of the association between nutrition knowledge and diet quality, in order to better understand the conditions under which nutrition knowledge could impact food intake. The significant interaction observed between education level and nutrition knowledge is an underlying example that nutrition knowledge may not be a significant predictor of healthy eating in all subgroups of a population.

Among the limitations of the current study is the participants' burden of completing 13 questionnaires in a three-week period, which could be responsible for some missing data in the questionnaires. Also, despite the fact that the recruitment was performed using a random list of phone numbers allowing us to reach participants who do not usually volunteer to participate in such studies, highly educated individuals are still overrepresented in our sample (44% having a university degree, vs. 31% for the population of the Province of Quebec (43)). However, the imputation of missing data allowed the inclusion of participants with missing data who were more likely to be non-Caucasian, to have lower education and income levels, to have a marital status other than "married or living in a common-law union" and not to be living with children, which are all characteristics that are underrepresented in our sample. Another limitation of the study is its cross-sectional design, because of which we cannot suggest causation in the association between nutrition knowledge and diet quality. Also, although the study was performed in Canada, findings cannot be generalized to the Canadian population as a whole. The French-speaking population of the Province of Quebec, which represents about one fifth of the Canadian population, has been found to differ from other Canadians with respect to food intakes and attitudes towards eating (44, 45). This highlights the relevance of studying determinants of healthy eating in this specific population.

In conclusion, results of this study suggest that nutrition knowledge is a significant correlate of diet quality, and that the association is stronger among individuals with a lower level of education and those living without children. Interventions aiming at increasing nutrition knowledge may be a promising approach to improve diet quality especially in some subgroups of the population.

SO WHAT? (Implications for Health Promotion Practitioners and Researchers)

What is already known on this topic? Conventional approaches used by governments and health agencies to promote healthy eating usually target the improvement in nutritional knowledge. Current evidence shows

significant but weak relationships between nutrition knowledge and dietary intake, and most studies to date used non-validated tools.

What does this article add? This study showed that having better nutrition knowledge was significantly associated with a higher diet quality. The results also suggest that the association between nutrition knowledge and adherence to healthy eating guidelines is stronger in specific sub-groups of the population, namely among individuals with lower education attainment.

What are the implications for health promotion practice or research? Interventions aiming at increasing nutrition knowledge, especially among individuals with lower educational attainment, could contribute to supporting healthier dietary patterns.

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Tables

Table 4-1. Sample characteristics (n=1092)

| | n | (%) |
|---------------------------------------|-----|--------|
| Female | 549 | (50.3) |
| Age (years) | | |
| 18-34 | 394 | (36.1) |
| 35-49 | 322 | (29.5) |
| 50-65 | 376 | (34.4) |
| Ethnicity | | |
| Caucasian | 987 | (90.4) |
| Afro-American | 25 | (2.3) |
| Arabs | 25 | (2.3) |
| Latino-American | 18 | (1.7) |
| Asians | 3 | (0.3) |
| Native Americans | 3 | (0.3) |
| Others | 11 | (1.0) |
| Missing value or prefer not to answer | 20 | (1.8) |
| Highest level of education | | |
| High school or less | 265 | (24.3) |
| CEGEP* | 330 | (30.2) |
| University | 480 | (44.0) |
| Missing value or prefer not to answer | 17 | (1.5) |
| Household annual income | | |
| Under low-income cut-off | 156 | (14.3) |
| Over low-income cut-off | 822 | (75.3) |
| Missing value or prefer not to answer | 114 | (10.4) |
| Occupation | | |
| Worker | 690 | (63.2) |
| Retired | 148 | (13.6) |
| Student | 120 | (11.0) |
| No job | 46 | (4.2) |
| Other | 59 | (5.4) |
| Missing value or prefer not to answer | 29 | (2.7) |
| Marital status | | |
| Married or in a common-law union | 675 | (61.8) |
| Other | 332 | (30.4) |
| Missing value or prefer not to answer | 85 | (7.8) |
| Living with children | | |
| Yes | 491 | (45.0) |
| No | 581 | (53.2) |
| Missing value or prefer not to answer | 20 | (1.8) |
| Smoking status | | |
| Current smoker | 151 | (13.8) |
| Non-smoker or former smoker | 939 | (86.0) |
| Missing value | 2 | (0.2) |
| Reporting status | | |
| Under-reporter | 97 | (8.9) |
| Plausible reporter | 791 | (72.4) |
| Over-reporter | 133 | (12.2) |
| Missing value | 71 | (6.5) |

Note: * In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs.

Table 4-2. Characteristics of participants with complete data and participants with incomplete data before imputation*

| Characteristics | Completers n=817 | Non-completers* n=275 | p** |
|-----------------------------------|-----------------------------|----------------------------------|------------|
| Sex | | | |
| Women | 400 (51.0) | 149 (54.2) | 0.13 |
| Men | 417 (49.0) | 126 (45.8) | |
| Age | | | |
| 18-34 y | 292 (35.7) | 102 (37.1) | 0.0499 |
| 35-49 y | 256 (31.3) | 66 (24.0) | |
| 50-65 y | 269 (32.9) | 107 (38.9) | |
| Ethnicity | | | |
| Caucasian | 764 (93.7) | 223 (85.8) | <0.0001 |
| Other | 51 (6.3) | 37 (14.2) | |
| Highest level of education | | | |
| High school or less | 179 (21.9) | 86 (33.3) | 0.0002 |
| CEGEP† or university | 638 (78.1) | 172 (66.7) | |
| Household annual income | | | |
| Under low-income cut-off | 113 (13.8) | 43 (26.7) | <0.0001 |
| Over low-income cut-off | 704 (86.2) | 118 (73.3) | |
| Marital status | | | |
| Married or in a common-law union | 573 (70.1) | 102 (53.7) | <0.0001 |
| Other | 244 (29.9) | 88 (46.3) | |
| Living with children | | | |
| Yes | 395 (48.4) | 96 (37.7) | 0.0028 |
| No | 422 (51.7) | 159 (62.4) | |
| Smoking status | | | |
| Current smokers | 102 (12.5) | 49 (18.0) | 0.0237 |
| Non-smoker or former smokers | 715 (87.5) | 224 (82.1) | |
| Reporting status | | | |
| Under-reporter | 74 (9.1) | 23 (11.3) | 0.49 |
| Plausible reporter | 633 (77.5) | 158 (77.5) | |
| Over-reporter | 110 (13.5) | 23 (11.3) | |

Note: Values are presented as n (%). * Non-completers are participants with incomplete data, i.e., they have at least one missing item in the Nutrition Knowledge Questionnaire (n=62) or missing values for education level (n=17), annual household income (n=114), marital status (n=85), living with children or not (n=20), smoking status (n=2), or reporting status (n=71). The numbers in subgroups may not sum to the total number of participants due to missing data. Analyses presented in this table were performed using unimputed data. ** Frequencies were compared using the Chi-Square statistic. † In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs.

Table 4-3. Regression analyses of the C-HEI score on nutrition knowledge.

| | C-HEI Score | | |
|---|-------------|------------------|----------|
| | B | 95% CI | <i>p</i> |
| Independent variable | | | |
| Nutrition knowledge (continuous score, 1-100) | 0.141 | [0.075, 0.208] | <0.0001 |
| Covariates | | | |
| Sex (1=female, 2=male) | -5.511 | [-7.215, -3.809] | <0.0001 |
| Age groups (1=18-34y, 2=35-49y, 3=50-65y) | 0.713 | [-0.274, 1.699] | 0.16 |
| Education (1=high school or less, 2=CEGEP* or university) | 2.222 | [0.249, 4.196] | 0.0274 |
| Household annual income (1=under low-income cut-off, 2=over low-income cut-off) | 1.711 | [-0.851, 4.273] | 0.19 |
| Marital status (1=other status,2=married or in a common-law union) | 0.318 | [-1.796, 2.432] | 0.77 |
| Smoking status (1=non-smoker/former smoker, 2=current smoker) | -7.055 | [-9.367, -4.742] | <0.0001 |
| Living with children (1=no, 2=yes) | 0.090 | [-1.713, 1.892] | 0.92 |
| Reporting status (1=under-reporter, 2=plausible reporter, 3=over-reporter) | 2.466 | [0.715, 4.216] | 0.0058 |

Note: n=1092. B= Unstandardized beta; CI= Confidence interval. Missing data for sociodemographic characteristics, smoking status, and reporting status have been imputed. See the Methods section for details *In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs.

Table 4-4. Regression analyses of the C-HEI score on nutrition knowledge stratified by education level.

| Independent variable | C-HEI Score | | | | | |
|---|---------------------|-------------------|--------|----------------------|-------------------|--------|
| | High school or less | | | CEGEP* or university | | |
| | B | [95% CI] | p | B | [95% CI] | p |
| Nutrition knowledge (continuous score, 1-100) | 0.295 | [0.170, 0.421] | <.0001 | 0.077 | [-0.004, 0.157] | 0.06 |
| Covariates | | | | | | |
| Sex (1=female, 2=male) | -5.915 | [-9.458, -2.372] | 0.0012 | -5.535 | [-7.488, -3.582] | <.0001 |
| Age groups (1=18-34y, 2=35-49y, 3=50-65y) | 0.654 | [-1.305, 2.613] | 0.51 | 0.805 | [-0.344, 1.954] | 0.17 |
| Household annual income (1=under low-income cut-off, 2=over low-income cut-off) | 2.434 | [-1.496, 6.364] | 0.22 | 1.596 | [-1.669, 4.860] | 0.34 |
| Marital status (1=other status, 2=married or in a common-law union) | -1.066 | [-4.907, 2.775] | 0.58 | 0.614 | [-1.860, 3.088] | 0.63 |
| Smoking status (1=non-smoker, 2=current smoker) | -6.072 | [-10.134, -2.011] | 0.0036 | -7.384 | [-10.240, -4.528] | <.0001 |
| Living with children (1=no, 2=yes) | -2.808 | [-6.458, 0.843] | 0.13 | 0.934 | [-1.156, 3.023] | 0.38 |
| Reporting status (1=under-reporter, 2=plausible, 3=over-reporter) | 2.581 | [-0.599, 5.761] | 0.11 | 2.461 | [0.377, 4.545] | 0.0207 |

Note: High school or less, n=270; CEGEP or university, n=822. B= Unstandardized beta; CI= Confidence interval. Missing data for sociodemographic characteristics, smoking status, and reporting status have been imputed. See the Methods section for details *In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs.

Table 4-5. Regression analyses of the C-HEI score on nutrition knowledge stratified by living or not with children.

| Independent variable | C-HEI Score | | | | | |
|---|-------------------------|------------------|--------|----------------------|-------------------|--------|
| | Living without children | | | Living with children | | |
| | B | [95% CI] | p | B | [95% CI] | p |
| Nutrition knowledge (continuous score, 1-100) | 0.261 | [0.167, 0.355] | <.0001 | 0.015 | [-0.079, 0.109] | 0.76 |
| Covariates | | | | | | |
| Sex (1=female, 2=male) | -4.282 | [-6.658, -1.906] | 0.0004 | -6.854 | [-9.295, -4.412] | <.0001 |
| Age groups (1=18-34y, 2=35-49y, 3=50-65y) | 0.906 | [-0.407, 2.219] | 0.18 | 0.407 | [-1.240, 2.053] | 0.63 |
| Education (1=high school or less, 2=CEGEP* or university) | -0.007 | [-2.595, 2.582] | 0.99 | 5.257 | [2.175, 8.339] | 0.0009 |
| Household annual income (1=under low-income cut-off, 2=over low-income cut-off) | 2.316 | [-1.175, 5.807] | 0.19 | 0.680 | [-3.014, 4.373] | 0.72 |
| Marital status (1=other status, 2=married or in a common-law union) | -0.257 | [-2.845, 2.331] | 0.85 | 0.883 | [-2.957, 4.723] | 0.65 |
| Smoking status (1=non-smoker, 2=current smoker) | -5.942 | [-9.115, -2.770] | 0.0003 | -7.803 | [-11.225, -4.381] | <.0001 |
| Reporting status (1=under-reporter, 2=plausible, 3=over-reporter) | 2.797 | [0.387, 5.206] | 0.0231 | 1.936 | [-0.743, 4.616] | 0.16 |

Note: Living without children, n=593; Living with children, n=499. B= Unstandardized beta; CI= Confidence interval. Missing data for sociodemographic characteristics, smoking status, and reporting status have been imputed. See the Methods section for details *In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs.

Supplementary Material

Supplemental Table S4-6. Description of the C-HEI scoring for adults

| Component | Range of scores | Scoring criteria |
|----------------------------------|---------------------------------|---|
| Adequacy | 0 to 60 points | |
| Total vegetables and fruit | 0 to 10 points | Minimum: 0 Maximum: 7 to 8 servings |
| Whole fruit | 0 to 5 points | Minimum: 0 Maximum: 1.5 to 1.7 servings (21% of recommendation for total vegetables and fruit) |
| Dark green and orange vegetables | 0 to 5 points | Minimum: 0 Maximum: 1.5 to 1.7 servings (21% of recommendation for total vegetables and fruit) |
| Total grain products | 0 to 5 points | Minimum: 0 Maximum: 6 to 8 servings |
| Whole grains | 0 to 5 points | Minimum: 0 Maximum: 3 to 4 servings (50% of recommendation for total grain products) |
| Milk and alternatives | 0 to 10 points | Minimum: 0 Maximum: 2 to 3 servings |
| Meat and alternatives | 0 to 10 points | Minimum: 0 Maximum: 2 to 3 servings (150 to 225 grams) |
| Unsaturated fats | 0 to 10 points | Minimum: 0 Maximum: 30 to 45 grams |
| Moderation | 0 to 40 points | |
| Saturated fats | 8 to 10 points 0 to 8 points | Minimum 7% to 10% of total energy intake 10% to maximum 15% of total energy intake |
| Sodium | 8 to 10 points 0 to 8 points | Adequate intake to tolerable upper intake level Tolerable upper intake level to twice tolerable upper intake level |
| “Other foods” | 0 to 20 points | Minimum: 5% or less of total energy intake Maximum: 40% or more of total energy intake |

For adequacy components, 0 point for minimum, 5 or 10 points for maximum or more, and proportional for amounts between minimum and maximum.

For moderation components, 10 or 20 points for minimum or less, 0 point for maximum or more, and proportional for amounts between minimum and maximum.

Reference: Garriguet D. Diet quality in Canada. Ottawa: Statistics Canada, 2009.

Supplementary Material: Nutrition Knowledge Questionnaire

Theme 1: How many portions a day do you think CFG recommends, for an individual of your age and gender for each of the following food groups?

1. Vegetables and fruit
2. Grain products
3. Meat and Alternatives

Theme 2: For each of the four CFG groups, five food items are listed. Identify whether these items are included in the food group.

- a) Vegetables and Fruit
- Legumes
 - Apple
 - Nuts
 - Broccoli
 - Tomato sauce
 - I don't know
- b) Grain Products
- Whole-wheat pasta
 - Potatoes
 - Legumes
 - Bagel
 - Humus
 - I don't know
- c) Milk and Alternatives
- Almond beverage
 - Yogurt
 - Kefir
 - Eggs
 - Skimmed milk
 - I don't know
- d) Meat and Alternatives
- Fish
 - Legumes
 - Pasta
 - Soy beverage
 - Peanut butter
 - I don't know

Theme 3: Indicate whether the following statements are included in CFG recommendations.

- a) Eat red meat every day.
- b) Limit consumption of frozen vegetables and fruit.
- c) Eat a variety of whole grains (whole wheat, whole oats, quinoa, buckwheat).
- d) Enriched soy beverages can be consumed as an alternative for milk.

- e) Avoid removing poultry skin.
- f) Consume regularly meat alternatives such as tofu.
- g) Choose 100% pure juice instead of fresh fruit.

Theme 4: Indicate whether you agree or disagree with the following statements.

- a) Non-hydrogenated margarine, or soft margarine, contains less fat than butter.
- b) To be considered balanced, half of a plate should be filled with meat and alternatives, a quarter with vegetables and a quarter with grain products.
- c) It is not necessary to eat fruit when you take vitamin and mineral supplements.
- d) All spices are high in sodium (salt).
- e) Anemia can be caused by an iron deficiency
- f) CFG is not recommended for an individual who wishes to lose weight.

Note: The French version of the instrument was validated. All items were translated from French to English using the back-translation procedure and should not be used in their English version without validation.

Reference: Bradette-Laplante, M., Carbonneau, E., Provencher, V., Begin, C., Robitaille, J., Desroches, S., Corneau, L., Lemieux, S. (2017). Development and validation of a nutrition knowledge questionnaire for a Canadian population. *Public Health Nutr*, 20(7), 1184-1192. doi:10.1017/s1368980016003372

Supplemental Table S4-7. Mean nutrition knowledge scores according to sociodemographic characteristics, smoking status and reporting status.

| | Nutrition knowledge score (%) | | |
|---------------------------------|-------------------------------|------|----------|
| | Mean | SD | <i>p</i> |
| Sex | | | |
| Women | 68.8 | 10.9 | <0.0001 |
| Men | 60.6 | 13.7 | |
| Age | | | |
| 18-34 y | 65.2 ^{a,b} | 12.4 | 0.0316* |
| 35-49 y | 65.8 ^a | 13.7 | |
| 50-65 y | 63.3 ^b | 13.0 | |
| Highest level of education | | | |
| High school or less | 59.9 | 14.2 | <0.0001* |
| CEGEP† or university | 66.3 | 12.2 | |
| Household annual income | | | |
| Under low-income cut-off | 61.6 | 14.2 | <0.0001* |
| Over low-income cut-off | 65.3 | 12.7 | |
| Marital status | | | |
| Married or living in common-law | 65.6 | 13.1 | 0.0002* |
| Other | 62.9 | 12.8 | |
| Living with children | | | |
| Yes | 66.0 | 13.0 | 0.0159* |
| No | 63.7 | 13.0 | |
| Smoking status | | | |
| Current smokers | 61.5 | 14.7 | 0.0049* |
| Non-smoker or former smokers | 65.2 | 12.7 | |
| Reporting status | | | |
| Under-reporter | 62.3 | 13.9 | 0.31* |
| Plausible reporter | 65.0 | 13.1 | |
| Over-reporter | 64.8 | 11.6 | |

Notes: n=1092. Differences in nutrition knowledge between categories were tested using generalized linear models (GENMOD), with Tukey adjustment for multiple comparisons. Missing data for sociodemographic characteristics, smoking status, and reporting status have been imputed. See the Methods section for details. ^{a,b} Categories with different superscripted letters are significantly different ($p < 0.05$). * Adjusted for sex. † In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs.

Chapitre 5 : Développement et validation d'un questionnaire sur l'appréciation d'aliments salés et d'aliments sucrés

Elise Carbonneau, Maude Bradette-Laplante, Benoît Lamarche, Véronique Provencher, Catherine Bégin, Julie Robitaille, Sophie Desroches, Marie-Claude Vohl, Louise Corneau et Simone Lemieux.

L'article présenté dans ce chapitre s'intitule: Development and Validation of the Food Liking Questionnaire in a French-Canadian Population

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Résumé

L'objectif de cette étude était de développer et valider un questionnaire portant sur l'appréciation d'aliments sucrés et d'aliments salés dans une population canadienne francophone. Un questionnaire a été développé dans lequel on demande aux participants de rapporter leur degré d'appréciation de 50 aliments. Un panel d'experts a évalué la validité de contenu. Pour l'étude de validation, 150 hommes et femmes ont rempli le questionnaire à deux reprises. Une analyse factorielle exploratoire a été effectuée pour déterminer le nombre de sous-échelles du questionnaire. La consistance interne et la répétabilité des sous-échelles ont été évaluées. La validité de construit par test d'hypothèses a été évaluée à l'aide de corrélations entre les scores d'appréciation et les fréquences rapportées de consommation des aliments. Les commentaires des experts ont mené à des changements dans la liste d'aliments inclus dans le questionnaire. L'analyse factorielle a révélé une structure à deux facteurs pour le questionnaire, soit une échelle d'appréciation des aliments salés et une échelle d'appréciation des aliments sucrés, et a mené au retrait de neuf items, résultant en un questionnaire comprenant 32 items. Les deux sous-échelles ont démontré une bonne consistance interne (alpha de Cronbach: 0,85 et 0,89) et une bonne répétabilité ($r=0,84$ et $0,86$). Le questionnaire a démontré une validité de construit adéquate avec des corrélations modérées entre l'appréciation des aliments et la fréquence rapportée de consommation ($r=0,19-0,39$, $ps<0,05$). Ce nouveau questionnaire qui évalue l'appréciation d'une variété d'aliments salés et sucrés a démontré de bonnes qualités psychométriques dans toutes les étapes de validation. Ce questionnaire sera utile pour explorer le rôle de l'appréciation d'aliments et ses interactions avec d'autres facteurs dans la détermination des habitudes alimentaires.

Abstract

The purpose of this study was to develop and validate a questionnaire assessing food liking in a French-Canadian population. A questionnaire was developed, in which participants were asked to rate their degree of liking of 50 food items. An expert panel evaluated the content validity. For the validation study, 150 men and women completed the questionnaire twice. An Exploratory Factor Analysis (EFA) was performed to assess the number of subscales of the questionnaire. Internal consistency and test-retest reliability of the subscales were evaluated. Concurrent validity was assessed through correlations between liking scores and self-reported frequencies of consumption. Comments from the experts led to changes in the list of foods included in the questionnaire. The EFA revealed a two-factor structure for the questionnaire (i.e., savory and sweet foods) and led to the removal of nine items resulting, in a 32-item questionnaire. The two subscales revealed good internal consistency (Cronbach alphas: 0.85 and 0.89) and test-retest reliability ($r = 0.84$ and 0.86). The questionnaire demonstrated adequate concurrent validity, with moderate correlations between food liking and self-reported frequency of consumption ($r = 0.19-0.39$, $ps < 0.05$). This new Food Liking Questionnaire assessing liking of a variety of savory and sweet foods demonstrated good psychometric properties in every validation step. This questionnaire will be useful to explore the role of food liking and its interactions with other factors in predicting eating behaviors and energy intake.

Title page

Development and Validation of the Food Liking Questionnaire in a French-Canadian Population

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Keywords: food liking; questionnaire; development; validation; French; Canada

Introduction

Food choices are influenced by a variety of factors interacting with one another. When many foods are available, psychophysiological (e.g., mood, hunger), situational, and hedonic cues contribute to determine what food is wanted or desired (1–3). Hedonic cues are likes and dislikes that can be innate or developed, through cultural exposition and personal experiences, among other things (2). Being important determinants of food choices, food liking and preferences have been assessed in different ways in many studies. Existing questionnaires vary through methods of assessment. Whereas some authors have chosen to evaluate food preferences (4) (i.e., choice of a food item when two or more alternatives are presented (3)), others assessed food liking (5–7) (i.e., pleasantness of a food's taste (8)), and other authors have chosen to evaluate both (9). Questionnaires also differ with the choice of foods assessed, from wide variety of food types (5,7,10) to specific food characteristics such as fat (4) or salty, sweet, and fat (9).

In the context of a large study aiming at identifying determinants of healthy eating in the French-Canadian population of the province of Quebec, our research team wanted to create a questionnaire in order to evaluate whether a strong liking for salty, sweet, and fatty foods is a barrier to healthy eating (11–13). A French questionnaire assessing liking and preferences for salt, sweet, and fat already exists (9), but it was not suitable for our needs for different reasons. The questionnaire developed by Deglaire et al. (9) is composed of four different sections, including questions on liking for different foods, preferences in the level of seasoning, preferences for types of dishes on a menu, and general questions about behaviors related to sweet, salt, and fat. Therefore, it is quite long to complete (83 items; 23 min). The questionnaire we aimed to develop was to be used as part of a comprehensive investigation comprising several other questionnaires, and in this context needed to be shorter to reduce the completion burden for the participants. Also, as recommended by Beaton et al. (14), a cultural adaptation is essential when a tool is to be used in different countries, even if the same language is spoken. In the case of a food liking questionnaire, it is all the more important to adapt the list of foods for the targeted population. The questionnaire developed by Deglaire et al. (9) was specific to France and hence, the list of food items was not applicable to French-speaking populations in Canada. Therefore, the purpose of this study was to develop and validate a food liking questionnaire adapted to an adult French-Canadian population.

Materials and Methods

Development of the Questionnaire

We decided to develop the Food Liking Questionnaire in order to evaluate whether a strong liking of salty, sweet, and fatty foods is a barrier to healthy eating. Therefore, only foods either rich in salt, sugar, or fat were included in the questionnaire. In order to develop a complete list, we first opted to classify such foods into four main categories: high-salt/high-fat, high-salt/low-fat, high-sugar/high-fat, and high-sugar/low-fat. However, as observed by other authors (9), very few food items belong to the high-salt/low-fat category; therefore, we decided not to include this category. The list of food items was developed based on existing questionnaires in the literature (4,9,15), and a food frequency questionnaire that was developed especially for the French-Canadian population (16). In order to be able to assess the liking for sweet and salty foods precisely, we identified foods that stood on their own (e.g., salted nuts, French fries, cookies), unlike other authors (4,9) who assessed combinations of food items (e.g., cream cheese on a bagel, potatoes with butter, fruits served with whipped cream). These combinations may create confusion to participants who do not equally like the two food items grouped together (e.g., strong liking for bagels, but low liking of cream cheese). A 50-item list was developed (19 high-salt/high-fat foods, 16 high-sugar/high-fat foods, and 15 high-sugar/low-fat foods). Respondents are asked to rate their liking for each food item on a nine-point scale, 1 being “I really don’t like” and 9 being “I really like”, based on what was previously done in other studies (5,7,9,10). The “I have never tasted this food” option was also proposed. In order to develop a relatively short questionnaire, it was decided that only the liking (i.e., pleasantness of a food’s taste) would be assessed, in contrast with other questionnaires also assessing food preferences (i.e., choice of a food item when two or more alternatives are presented).

Participants and Procedures

The Food Liking Questionnaire and four other questionnaires on determinants of healthy eating (17–19) were developed and validated in the context of a large validation research project. Three steps were followed in the validation process of the Food Liking Questionnaire, namely an expert panel evaluation, a pretest, and a validation study.

Expert Panel

A group of four nutrition researchers, one psychology researcher, and one registered dietitian formed the expert panel that assessed the content validity by reviewing and commenting on the questionnaire and on the list of food items. The registered dietitian is also a research assistant and has an expertise in administrating and codifying food frequency questionnaires and food recalls.

Pretest

A sample of 31 men and women from the Québec City metropolitan area were recruited for the assessment of face validity. Recruitment was performed through an internal list of people willing to participate in clinical studies. Participants had to be aged between 18 and 65 years and to have at least minimal informatics abilities to be able to complete the series of questionnaires online. The pretest was conducted according to the guidelines laid down in the Declaration of Helsinki and received approval from the Research Ethics Committee at Laval University (#2014-128/02-07-2014). Implicit informed consent was obtained from all participants.

Face validity is a validation step aiming at assessing the acceptability and comprehension of the items. Participants from the pretest were thus asked to complete the questionnaire online and to comment on the ambiguity of the items. Through participants' comments, the developers can evaluate whether the questionnaire seems to measure what it is supposed to measure (20).

Validation Study

A total of 150 men and women took part to the validation study. They were recruited through electronic mailing lists comprising Laval University students and employees, as well as people interested in participating in studies at the Institute of Nutrition and Functional Foods. As for the pretest, they had to be aged between 18 and 65 years, and to have at least minimal informatics skills. Pregnant and lactating women were not included. Participants also had to be free from any condition affecting intestinal absorption, since blood biomarkers of fruit and vegetable intake were also being validated in the context of the study.

In the validation study, participants first came to the research center for a blood sample and anthropometric measurements. Height was measured to the nearest millimeter, and body weight was measured to the nearest 0.1 kg on a calibrated balance. Measures were taken by trained professionals according to standardized procedures (21). After their visit to the research center, participants were asked to complete, at home, the series of questionnaires to be validated on the Internet platform of the study. They also had to complete a sociodemographic questionnaire and a web-based food frequency questionnaire (FFQ) validated in a French-speaking Canadian population (16). Participants were asked to complete all questionnaires, in random order, within 30 days. After a two-week period, participants were asked to complete the questionnaires a second time (except for the sociodemographic questionnaire and the FFQ), within another 30-day window.

Participants were given a financial compensation (CAD 50) for their participation in the study. This study was conducted according to the guidelines laid down in the Declaration of Helsinki. The validation study received

approval from the Research Ethics Committee at Laval University (#2014-128/02-07-2014) and all participants gave written informed consent.

Statistical Analyses

The analyses described in this section were performed on data derived from the validation study. An Exploratory Factor Analysis (EFA) was performed using data from the first completion to uncover the underlying structure of the Food Liking Questionnaire. The procedure aims at retaining as few factors (or subscales) as possible while explaining most of the variation in the data. The most commonly used methods to identify the adequate number of factors are the eigenvalue-greater-than-one rule (modified version of the rule proposed by Larsen and Warne (22)), the scree plot (23), and the analysis of the variance explained (24). Internal consistency reliability was assessed for each subscale using Cronbach alpha coefficients using data from the first completion of the questionnaire. Intra-class correlation analyses were conducted between scores of the two completions of the Food Liking Questionnaire to assess test-retest reliability. Concurrent validity is a measure of how well a particular test correlates with a presumably related construct. In the present study, concurrent validity was assessed with Pearson's correlation analyses between liking scores of each item and self-reported frequencies of consumption of equivalent foods (derived from the FFQ). Concurrent validity was not assessed for items that had no equivalent in the FFQ. Statistical tests were two-sided and differences or associations at $p < 0.05$ were considered significant. Analyses were performed using the Statistical Analysis Software (SAS) version 9.4 (Copyright© 2013, SAS Institute Inc., Cary, NC, USA).

Results and Discussion

Expert Panel

Content Validity

Following suggestions by the experts, a “neutral” label was added in the middle of the nine-point scale. Therefore, three labels appeared on the scale: (1) I really don’t like; (5) Neutral; and (9) I really like. One food item was added to the scale and seven items were judged not to be common enough to be part of the scale and were thus removed. Finally, food items that were considered to be similar were combined into a single item (e.g., various types of cheese were grouped under the “cheese” item). As a result, the questionnaire comprised 41 food items.

Pretest

A total of 17 women and 14 men participated in the pretest (mean age: 45.6 ± 13.9 years; range: 23–66 years).

Face Validity

Four participants did not complete the Food Liking Questionnaire, therefore 27 participants were included for face validity. Many participants mentioned liking a food without eating it frequently. According to comments received, it also appeared that some of them had rated their frequency of consumption rather than their actual liking of the food. Therefore, the questionnaire instructions were modified from “rate your liking of the following foods” to “rate your liking of the following foods, regardless of the frequency of consumption”. Face validity did not lead to any other change.

Validation Study

Of the 150 participants in the validation study, one participant dropped out of the study before completing all questionnaires. Six participants had more than 10% of missing data in the Food Liking Questionnaire and were therefore excluded from the analysis. Characteristics of the 143 participants included in the validation study are presented in Table 5-1. The mean (\pm SD) completion time of the questionnaire was 5.4 ± 3.2 min. The short time required for the questionnaire completion, compared to other existing tools (e.g., 23 min for the questionnaire by Deglaire et al. (9)), is adequate, as we developed this questionnaire for a study where participants will be asked to complete several questionnaires.

Exploratory Factor Analysis

The EFA was performed on the 41 questionnaire items. The significance of Bartlett's test of sphericity ($khi^2 = 2056.22$, $p < 0.0001$) and the Kaiser-Meyer-Olkin test of sampling adequacy (measure of sample adequacy = 0.73) justified the use of an EFA given the common variance of the set of items (25). According to the modified eigenvalue-greater-than-one rule (22), 15 factors could be considered to explain the variance in the data. However, the analysis of the scree plot from the EFA revealed a notable difference in the slope after the first two factors. Moreover, only two factors accounted for more than 10% of the variance in the data (24), more precisely accounting for 36.79% and 12.60% of the variance. Therefore, it was decided that the items of the questionnaire would be divided into two main factors. In order to decide between an orthogonal and an oblique rotation, an oblique (promax) rotation was first requested to obtain a correlation matrix, as recommended by Tabachnick and Fidell (25). The correlation between the two factors exceeded 0.32, suggesting that the overlap in variance among factors justified the use of an oblique rotation (25). Using a minimum loading cut-off of 0.30 or higher, 12 items were found to load on the first factor and 20 on the second factor (see Table 5-2). A total of nine items were removed from the questionnaire, seven due to low factor loadings (< 0.30) and two due to cross-loading (i.e., loading ≥ 0.30 on both factors). The first factor comprised only savory foods and the second factor included high-sugar/high-fat and high-sugar/low-fat foods (from now on, the two factors will be considered as the savory subscale and the sweet subscale). The 32 food items included in the questionnaire are presented in Table 5-2.

Since the food item list was elaborated based on three categories (high-salt/high-fat, high-sugar/high-fat, and high-sugar/low-fat foods), it was expected that a three-factor structure would be uncovered by the EFA. The actual structure regrouping all the sweet items in one factor, regardless of the fat content, suggests that the sweet taste prevails on the fat taste for food liking categories.

Out of the nine items removed from the questionnaire, six sweet foods were removed due to low loading or cross-loading. These items (e.g., fruit juice, dried fruits, and yogurt) were less sweet or related less to dessert than the rest of the list, which could explain that they did not fit with the sweet factor. Butter and cheese were among the savory foods that were removed from the questionnaire. These foods may be less likely to be eaten alone in contrast to the other foods in the questionnaire, and this may explain their low loading on the savory factor.

Since the variance explained by the two factors (49.4%) was lower than the cut-off (70%) suggested by O'Rourke and Hatcher (24), we tested the questionnaire structure with three or four factors instead of two, to evaluate whether this would increase the variance explained by the model. However, these tests did not lead to any interpretable structure. Therefore, we decided that the original two-factor structure described previously was the most adequate for our questionnaire.

Mean scores for the two subscales are presented in Table 3. As was observed in other studies (26,27), men had significantly higher scores than women for the savory subscale ($p = 0.0057$; see Table 5-3). Scores were, however, similar for the sweet subscale ($p = 0.73$; see Table 5-3), unlike results obtained in other studies where men had higher liking for sweet foods (27), and women had higher fat-and-sweet liking (26). In the present study, liking scores were significantly lower in participants aged 50 to 65 years compared to younger participants ($ps = 0.0005$ for savory and sweet liking; see Table 5-3). The same pattern of differences according to age were obtained when analyzing men and women separately (data not shown). Similarly, results from Lampure et al. (26,27) suggest that older participants are less likely to have strong sweet, fat-and-sweet, and fat-and-salt liking than younger participants. These results are consistent with studies suggesting that age is also associated with healthier food choices, which can result from lower liking for sweet and savory foods (28–31). In the present sample, liking scores were not significantly different between body mass index (BMI) categories ($p = 0.63$ and $p = 0.87$, respectively, for savory and sweet liking; see Table 5-3). When evaluating differences between BMI categories in men and women separately, the results remained the same. The relation between adiposity and preferences or taste perception is subject to heterogeneous results in the literature. Some studies suggest that obese and overweight participants are more likely to have higher liking for sweet, savory, or fatty foods than normal-weight participants (26,32,33), whereas others have found no relation between sweet preference and adiposity (6,34,35).

Internal Consistency Reliability.

As seen in Table 5-2, both subscales were considered internally reliable, with Cronbach alpha coefficients being >0.70 .

Test-Retest Reliability

A total of 139 participants completed the questionnaire twice. The mean (\pm SD) lapse between test and retest was 40.9 ± 11.5 days. As shown in Table 5-2, intra-class correlation coefficients between repeated measures are considered good (i.e., between 0.75 and 0.90) (36) for both subscales. The high correlation coefficients observed in the present paper and in previous studies (5–8) suggest that food liking is stable over time, which is in line with the biological predispositions, the personal and cultural experiences, and the learning processes involved in the development of individual food liking and preferences (2).

Concurrent Validity

Ten out of 12 items included in the savory subscale and 10 out of 20 items included in the sweet subscale had a matching food item in the FFQ. Moderate correlations between liking and eating frequency were observed for

all items (r ranging from 0.19 to 0.39, p s < 0.05; see Table 5-2), suggesting a good concurrent validity. The fact that liking and eating frequency were not strongly correlated may be due to the fact that participants were able to dissociate their food liking from their habitual food consumption. These results also support the fact that food liking only explains a part of the variation in food choices and eating behaviors (1).

Strengths and Limitations

The three-step validation process of the questionnaire constitutes a major strength of this study. It was expressly designed for questionnaire validation, resulting in a rigorous process. However, external validity is limited due to the mostly Caucasian and highly educated sample that is not fully representative of the whole French-speaking Canadian population (37). Another limitation of this study is the fact that the questionnaire we validated assesses recalled food liking, and was not tested jointly with actual food tasting. The questionnaire could benefit from further construct validation with participants also reporting their degree of liking of foods actually tasted in a laboratory. Such validation should also include measures of hunger/satiety and food reward, as these variables can interact with food liking in predicting eating behaviors and energy intake (8).

Conclusions

The present study aimed at developing and validating the Food Liking Questionnaire for use in French-Canadian populations. The questionnaire contains 32 items assessing liking for savory and sweet foods and demonstrated good psychometric properties in every validation step. Food liking and preferences are known to contribute to food choices (1). This questionnaire will be useful to explore the role of food liking and its interactions with other factors in predicting healthy dietary habits, eating behaviors, and energy intake, and to assess to what extent liking of sweet or savory foods constitutes a barrier toward adherence to healthy eating recommendations. The questionnaire developed in this study is a valid and reliable tool for the French-speaking Canadian adult population, but additional validation has to be performed if the tool is to be used in other populations.

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Author Contributions: S.L., B.L., V.P., C.B., J.R., S.D., and M.-C.V. conceived and designed the experiments. L.C. and M.B.-L. performed the experiments. M.B.-L., S.L., and E.C. were responsible of developing the questionnaire. V.P., C.B., J.R., S.D., M.-C.V., and L.C. were members of the expert panel. E.C. analyzed the data and wrote the article. All co-authors revised and approved the final version of the paper.

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Tables

Table 5-1. Sample characteristics of the validation study (n = 143).

| Characteristic | % (n) or M ± SD |
|----------------------------|------------------------|
| Female | 49.7 (71) |
| Age (years) | 47.4 ± 13.3 |
| 18–34 years | 25.2 (36) |
| 35–49 years | 20.3 (29) |
| 50–65 years | 54.5 (78) |
| Ethnicity | |
| Caucasian | 95.8 (137) |
| Highest level of education | |
| High school | 9.8 (14) |
| College | 30.1 (43) |
| University | 60.1 (86) |
| Occupation | |
| Worker | 69.9 (100) |
| Retired | 20.3 (29) |
| Student | 6.3 (9) |
| No job | 1.4 (2) |
| Prefer not to answer | 2.1 (3) |
| Body mass index | 25.6 ± 4.4 |
| Normal weight | 48.2 (69) |
| Overweight | 37.8 (54) |
| Obese | 14.0 (20) |

Table 5-2. Subscales' items, factor loadings, and results from the concurrent validity, internal consistency reliability, and test-retest reliability.

| Subscale | Items | Factor Loadings | Correlation with Self-Reported Consumption | Cronbach α | Test-Retest ρ (95% CI) |
|------------------|---|-----------------|--|-------------------|-----------------------------|
| Savory | Chicken wings | 0.57 | 0.37 ** | 0.85 | 0.86 (0.81–0.90) |
| | Salted nuts | 0.42 | † | | |
| | Meat pâté (<i>creton</i>) | 0.50 | † | | |
| | Nuggets | 0.57 | 0.28 * | | |
| | Chips | 0.43 | 0.36 ** | | |
| | French fries | 0.36 | 0.22 * | | |
| | Hamburger | 0.64 | 0.22 * | | |
| | Hotdogs | 0.73 | 0.31 * | | |
| | Pizza | 0.33 | 0.23 * | | |
| | Poutine | 0.52 | 0.39 ** | | |
| | Sausages | 0.55 | 0.21 * | | |
| Processed meat | 0.60 | 0.33 ** | | | |
| Sweet | Popsicles | 0.58 | † | 0.89 | 0.84 (0.70–0.88) |
| | Candies | 0.54 | 0.23 * | | |
| | Jam | 0.55 | † | | |
| | Marshmallow | 0.63 | † | | |
| | Honey | 0.41 | † | | |
| | Pudding | 0.74 | † | | |
| | Fruit salad | 0.38 | 0.20 * | | |
| | Sorbet | 0.45 | † | | |
| | Doughnut | 0.52 | 0.24 * | | |
| | Cookies | 0.63 | 0.19 * | | |
| | Pastries (<i>chausson, chokolatine</i>) | 0.76 | † | | |
| | Milk chocolate/chocolate bar | 0.44 | 0.31 * | | |
| | Cream puff/chocolate <i>éclair</i> | 0.60 | 0.20 * | | |
| | Whipped cream | 0.53 | 0.20 * | | |
| | Ice cream | 0.60 | 0.23 * | | |
| | Cheese cake | 0.60 | † | | |
| | Muffin | 0.39 | 0.29 * | | |
| Sugar fudge | 0.50 | † | | | |
| Pie | 0.64 | 0.26 * | | | |
| Chocolate spread | 0.44 | † | | | |

Note: ** $p < 0.0001$; * $p < 0.05$; † No matching item in the Food Frequency Questionnaire (FFQ); CI: confidence interval.

Table 5-3. Mean liking scores for the total sample, and according to gender, age, and body mass index (BMI).

| | Savory | Sweet |
|---------------|----------------|----------------|
| Total | 6.30 ± 1.24 | 5.60 ± 1.32 |
| Sex | | |
| Women | 5.94 ± 1.27 | 5.47 ± 1.38 |
| Men | 6.66 * ± 1.10 | 5.73 ± 1.25 |
| Age | | |
| 18–34 years | 6.87 ± 0.97 | 6.20 ± 1.28 |
| 35–49 years | 6.66 ± 1.05 | 5.85 ± 1.20 |
| 50–65 years | 5.90 ** ± 1.28 | 5.23 ** ± 1.26 |
| BMI | | |
| Normal weight | 6.21 ± 1.32 | 5.65 ± 1.40 |
| Overweight | 6.31 ± 1.18 | 5.49 ± 1.28 |
| Obese | 6.55 ± 1.11 | 5.74 ± 1.16 |

Note: Score range: 1 to 9 points. * Savory score significantly higher in men than women ($p = 0.0057$). ** Savory and sweet scores significantly lower among participants aged 50 to 65 years than younger participants ($ps = 0.0005$).

Chapitre 6 : Associations entre l'appréciation d'aliments salés et d'aliments sucrés et l'adhésion au GAC 2007

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L'article présenté dans ce chapitre s'intitule: Liking for foods high in salt and fat is associated with a lower diet quality but liking for foods high in sugar is not – Results from the PREDISE study

Cet article est publié dans la revue *Food Quality and Preference*, 2021. L'article n'a pas été modifié de sa version publiée et a été reproduit avec la permission du journal.

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Résumé

Cette étude avait pour objectif d'examiner de quelle manière l'appréciation d'aliments riches en sel et en gras et l'appréciation d'aliments riches en sucre sont associées à la qualité globale de l'alimentation, et comment ces associations diffèrent selon des caractéristiques individuelles (c.-à-d., sexe, âge, scolarité, revenu, connaissances en nutrition, plausibilité des apports énergétiques rapportés) chez des adultes francophones de la province de Québec au Canada. Dans le contexte de l'étude transversale PREDISE, 1096 hommes et femmes ont complété des questionnaires en ligne. Un questionnaire validé a évalué l'appréciation rapportée d'une variété d'aliments salés (riches en sel et en gras) et d'aliments sucrés (riches en sucre et soit riches ou faibles en gras) sur une échelle de 1 à 9. Le *Healthy Eating Index* canadien (C-HEI) a été calculé à partir des données issues de rappels de 24h. Les femmes ont rapporté une plus faible appréciation des aliments salés ($5,97 \pm 1,34$ vs. $6,58 \pm 1,16$, $p < 0,0001$) et des aliments sucrés ($5,52 \pm 1,36$ vs. $5,71 \pm 1,25$, $p = 0,015$) que les hommes. Des analyses de régressions linéaires multiples ont démontré que l'appréciation des aliments sucrés n'était pas associée au C-HEI ($B = -0,10$, $p = 0,78$). Le sexe a été identifié comme un modérateur significatif de l'association entre l'appréciation des aliments salés et le C-HEI (p interaction = $0,0218$). Les analyses subséquentes ont donc été stratifiées selon le sexe. Les résultats des analyses de régressions linéaires multiples suggèrent que l'appréciation des aliments salés est plus fortement inversement associée au C-HEI chez les hommes ($B = -3,37$, $p < 0,0001$) que chez les femmes ($B = -1,46$, $p = 0,0035$). En conclusion, une forte appréciation des aliments salés pourrait interférer avec l'adhésion à la saine alimentation, particulièrement chez les hommes. De futures études devraient investiguer le potentiel d'interventions développées pour améliorer la qualité de l'alimentation chez les individus ayant une forte appréciation pour ce type d'aliments.

Abstract

The research aimed at examining how liking for foods high in salt and fat and for foods high in sugar are associated with overall diet quality and how these associations differ according to individual characteristics (i.e., sex, age, education, income, nutrition knowledge, and energy reporting status) in French-speaking adults from the Province of Quebec, Canada. As part of the web-based cross-sectional PREDISE study, 1096 men and women completed online questionnaires. The Food Liking Questionnaire assessed reported liking for a variety of salty foods (high in salt and fat) and sweet foods (high in sugar and either high-fat or low-fat) on a scale from 1 to 9. The Canadian Healthy Eating Index (C-HEI) was computed based on data collected using 24-hour food recalls. Women (vs. men) reported lower liking for salty foods (5.97 ± 1.34 vs. 6.58 ± 1.16 , $p < 0.0001$) and for sweet foods (5.52 ± 1.36 vs. 5.71 ± 1.25 , $p = 0.015$). Multiple linear regressions showed that liking for sweet foods was not associated with C-HEI ($B = -0.10$, $p = 0.78$). Given a significant sex interaction in the association between liking for salty foods and C-HEI (p interaction = 0.0218), subsequent analyses were stratified by sex. Multiple linear regressions supported that liking for salty foods was more strongly inversely associated with C-HEI in men ($B = -3.37$, $p < 0.0001$) than women ($B = -1.46$, $p = 0.0035$). In conclusion, a strong liking for salty foods may interfere with healthy eating, especially in men. Building on these results, future studies should investigate the potential of interventions designed to improve the healthiness of food habits in individuals with strong liking for these foods.

Titre page

Liking for foods high in salt and fat is associated with a lower diet quality but liking for foods high in sugar is not – Results from the PREDISE study

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Introduction

The World Health Organization recognizes that high sodium, sugar, and fat intakes are associated with the development of chronic diseases such as diabetes and cardiovascular diseases (1). Accordingly, healthy eating guidelines around the world recommend limiting the consumption of foods that contain high amounts of fat, sugar, and sodium (e.g., Health Canada (2), U.S. Department of Agriculture and U.S. Department of Health and Human Services (3)). However, adherence to these guidelines can be difficult for many individuals given the important contribution of fat, sugar, and sodium to the palatability of foods (4). The liking of foods, that can be defined as the affective evaluation of a food (5), is indeed recognized as an important determinant of food choices (4, 6). Food liking is influenced, among others, by the flavor, the odor, and the texture of foods (4). In samples of adults from different parts of the world, participants rated taste as being a very important factor for food choices (7-10). This can be favorable in terms of health for individuals who enjoy the taste of healthy foods such as vegetables and fruits since preferred foods are more likely to be frequently consumed (11, 12). Indeed, Beck et al. (13) found reported liking of specific vegetables to be correlated with the reported intake frequency of these vegetables. However, for individuals who have a strong liking for less healthy foods, their food preferences may interfere with the adoption of a healthy diet. For example, greater reported liking for high-fat foods and lower reported liking for low-fat foods were found to be predictive of higher dietary fat intake (14). It has also been reported that individuals who perceive that they have to give up on their preferred foods to eat healthy are more likely to consume more sweets, fast foods, sugar-sweetened beverages, and less fruits, vegetables, fish, breakfast and home-cooked meals (15). Using prospective association between liking for fat, sweet or salt and the onset of obesity over five years in adults, Lampure et al. (16) observed that a higher liking for fat, fat and salt, or fat and sweet was associated with a higher obesity risk, and that these associations were largely mediated by dietary intakes.

While there is evidence regarding associations of specific food liking and preferences, or the importance of taste when making food choices, with the intake of specific food groups and obesity risk (11-16), little is known about the impact of food liking on overall diet quality. Indeed, it remains unclear if reporting a strong liking for foods high in sugar, salt or fat interferes with the adoption of a healthy diet. Also, it is not known if some subgroups of the population are able to have a good overall diet quality despite their liking of unhealthy foods.

Thus, the objectives of this study were firstly to assess whether and how reported liking for foods high in salt, fat, and sugar are associated with an indicator of overall diet quality, and secondly to investigate if some individual characteristics (i.e., sex, age, education, income, nutrition knowledge, and energy reporting status) moderate these associations, in a sample of French-speaking adults from the Province of Quebec, Canada, participating in the PREDISE study. Our main hypothesis was that liking for foods high in salt and fat and liking for foods high in sugar are associated with lower overall diet quality.

Methods

Sample and Design

The web-based cross-sectional PREDISE study (“PRÉdicteurs Individuels, Sociaux et Environnementaux” [in French], meaning “individual, social, and environmental predictors”) aimed at identifying correlates of adherence to Canadian guidelines for healthy eating in a sample from the Province of Quebec in Canada. Recruitment and procedures were described previously (17). Briefly, participants aged 18 to 65 were recruited using random digit dialing in order to have an age- and sex-representative sample of French-speaking adults from 5 regions of the Province of Quebec. Eligible participants had to have Internet access in order to complete the questionnaires. Exclusion criteria were pregnancy, lactation, and intestinal malabsorption because blood biomarkers of fruit and vegetable intake were also measured during the study (note that the analyses pertaining to blood biomarkers are beyond the scope of this paper). Once recruited, participants were given a three-week period to complete a series of online questionnaires on an Internet platform. They then visited a research center affiliated to the PREDISE study in their region for various measurements, including anthropometric data. The study was conducted from August 2015 to April 2017. On a total of 1849 individuals who met inclusion criteria and gave consent to participate, 1147 completed at least one food recall and were therefore included in the PREDISE study.

Measures

Canadian Healthy Eating Index 2007 (C-HEI). Among the series of questionnaires, participants were asked to complete three web-based 24-hour food recalls, using the R24W application, a tool specifically developed and validated by our research group for the French-speaking adult population of the Province of Quebec (18-21). Participants had to report all foods and drinks consumed from midnight to midnight on three days generated at random by the R24W application. The C-HEI was calculated using data entered in the R24W and was used as an indicator of the overall diet quality. The C-HEI (22) was developed to reflect the 2007 Canada’s Food Guide’s recommendations for healthy eating (23), the guidelines in force when the study was initiated. Although there are new guidelines in Canada since 2019, a dietary index reflecting these new recommendations has yet to be developed. The C-HEI is composed of eight adequacy components (total fruits and vegetables, whole fruits, dark-green and orange vegetables, grain products, whole-grain products, milk and alternatives, meat and alternatives, and unsaturated fat) and three moderation components (saturated fat, sodium, and “other foods” (i.e., that are not part of the foods recommended by Canada’s Food Guide)). Each component is evaluated on 5, 10 or 20 points, for a total maximum score of 100 (see full description of the C-HEI score in Appendix, Table S6-7). The C-HEI was used as a continuous variable in the present analyses. All participants with at least one complete food recall were included in the study (n=1147; 94.3% of participants with three food recalls, 3.1% with

two recalls, and 2.6% with one recall). C-HEI was calculated for each available food recall and averaged for all participants who completed multiple 24h recalls. Since misreporting of dietary intake can be an issue causing systematic bias, energy reporting status (i.e., under-reporting, plausible reporting, or over-reporting) was assessed using the method by Huang et al. (24) according to which under- and over-reporters are those with a calculated energy intake:predicted energy requirement ratio < 0.70 and > 1.42 , respectively, and was previously described by Brassard et al. (25).

Food liking. Participants completed the Food Liking Questionnaire, a tool that was developed for, and validated in, the French-speaking adult population of the Province of Quebec (26). In the questionnaire, respondents were asked to report their liking for 12 food items that are high in salt and fat and 20 food items that are high in sugar (high-fat or low-fat) on a nine-point scale, 1 being “I really don’t like”, 5 being “neutral” and 9 being “I really like” (the option “I have never tried this food” is also proposed), regardless of the frequency of consumption. The food items can be mostly considered as unhealthy foods, i.e., not recommended by the Canada’s Food Guide (the complete list of food items presented in the questionnaire is provided in Appendix, Table S6-8). The questionnaire was especially developed to assess reported liking of a variety of foods either rich in salt, sugar, or fat. The list of foods was developed based on existing questionnaires and adapted by an expert panel to foods commonly consumed by Quebecers (26). The questionnaire originally targeted four main categories: high-salt/high-fat, high-salt/low-fat, high-sugar/high-fat, and high-sugar/low-fat. However, as observed by other authors (27), very few food items belong to the high-salt/low-fat category; therefore, this category was not included. The factor analysis of the questionnaire items revealed that the items in the high-sugar/high-fat and the high-sugar/low-fat categories should be regrouped in only one subscale (26). The questionnaire aims at assessing reported liking of various foods, and not the perception or the intensity of fatty, salty or sweet tastes, therefore it was not validated against sensory taste test. However, it was found that food liking questionnaires reflect laboratory-based liking assessments (28). The means of the ratings for the foods high in salt and fat and for the foods high in sugar were calculated to create two subscale scores, ranging from 1 to 9, hereinafter referred to as the “liking for salty foods” and “liking for sweet foods” subscales. The two scores showed good internal consistency in the present sample with Cronbach $\alpha=0.72$ for liking for salty foods and 0.82 for liking for sweet foods. It is important to note that the questionnaire assessed food liking (i.e., reported affective evaluation of a food) and not food preferences (i.e., choice of a food item when two or more alternatives are presented). A score of liking for salty foods and a score of liking for sweet foods were computed for each participant. Participants with all 32 items missing in the Food Liking Questionnaire were excluded from the analyses ($n=51$).

Sociodemographic questionnaire. Participants completed a sociodemographic questionnaire, and the answers to each question were categorised for the use of sociodemographic variables in the analyses. Age was divided in three categories, in accordance with the recruitment strata (i.e., 18-34 y, 35-49 y, and 50-65 y). Regarding

education, participants reported the highest degree obtained and were classified into one of the two following categories, i.e., high school or less, vs. CEGEP or university. In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs. Participants also reported their annual household income and household size, and were categorised as living under vs. over the low-income cut-off according to the Quebec Institute of Statistics, based on the household size (29). Participants were also characterised according to their smoking status, i.e., current smokers (frequently or occasionally) vs. non-smokers/former smokers. Nutrition knowledge was assessed, using a questionnaire developed and validated for the French-speaking population of the Province of Quebec (30). The nutrition knowledge was used as a covariate (continuous score from 1 to 100).

Ethics

The PREDISE study was conducted according to the guidelines laid down in the Declaration of Helsinki. The project received approval from the Research Ethics Committees of Université Laval (ethics number: 2014-271), Centre hospitalier universitaire de Sherbrooke (ethics number: MP-31-2015-997), Montreal Clinical Research Institute (ethics number: 2015-02), and Université du Québec à Trois-Rivières (ethics number: 15-2009-07.13). All participants gave implied consent for the first phase of the study (i.e., completion of online questionnaires) and written informed consent for the second phase (i.e., anthropometric measurements and blood sampling at the research center). As a compensation for the first phase of the study, participants who completed at least three of the 13 online questionnaires were eligible for a random drawing of two iPads and 40 gift certificates (100 CAD). Participants also received a financial compensation (50 CAD) at their visit to the research center.

Statistical Analyses

Analyses were performed using the Statistical Analysis Software (SAS) version 9.4 (Copyright © 2013, SAS Institute Inc., Cary, NC, USA). Multiple imputation was used to deal with missing items in the Food Liking Questionnaire (197 participants (18.0%) had missing data in the questionnaire, among which the majority had only one (n=133) or two (n=32) missing items). Multiple imputation was also performed for missing data for education (n=20), income category (i.e., living under vs. over the low-income cut-off; n=116), smoking status (n=1), reporting status (n=75), and nutrition knowledge (n=76). Multiple imputation inference involves three distinct phases: 1) The missing data were filled in m times to generate m complete data sets (in the present study, m=10), using the MI procedure; 2) The m complete data sets were analyzed by using standard procedures; 3) The results from the m complete data sets were combined for the inference (31), using the MIANALYZE procedure. Missing data pattern was arbitrary (i.e., no particular pattern in the missing data structure, missing observations distributed across variables in a non-systematic fashion), we therefore performed multivariate imputation using a fully conditional specification (FCS) method (31). Multiple imputation

by FSC is proposed as a powerful and statistically valid method for creating imputations for both categorical and continuous variables (32).

For the first objective of the study, differences in liking scores according to selected characteristics were assessed using generalized linear models (GENMOD), with Tukey adjustment for multiple comparisons. Unadjusted Pearson's correlation between liking scores and the C-HEI components were assessed. Next, a multiple linear regression model was performed with liking for salty foods and liking for sweet foods as independent variables, the C-HEI as the dependent variable, and sex, age, education, income, nutrition knowledge, smoking status, and reporting status included as covariates. These variables were found to be significantly associated with food intake or diet quality in a previous analysis (17). For the second objective, we tested interaction terms to evaluate whether individual characteristics (i.e., sex, age, education, income, nutrition knowledge, and reporting status) moderated the association between the liking scores and the C-HEI. To do so, each potential moderator was tested in a separate model, but the interactions with both liking for salty foods (e.g., [liking for salty foods*sex]) and liking for sweet foods (e.g., [liking for sweet foods*sex]) were tested simultaneously in the same model. When at least one interaction term was significant in a model (e.g., either [liking for salty foods*sex] or [liking for sweet foods*sex]), subsequent analyses were stratified according to the significant moderator. Covariates included in all models were sex, age, education, income, nutrition knowledge, smoking status, and reporting status. In all regression models, reporting status was transformed into two dummy variables, i.e., under-reporting (1=no, 2=yes) and over-reporting (1=no, 2=yes). Statistical tests were two-sided and differences or associations at $p < 0.05$ were considered significant.

Results

Among the 1147 individuals who completed at least one food recall, 1096 had data for the Food Liking Questionnaire and were therefore included in the analyses. Characteristics of the included participants are presented in Table 6-1. Characteristics of participants with complete (i.e., no missing data; n=768) vs. incomplete data (i.e., at least one missing data; n=328) before imputation are presented in Appendix (see Table S6-9). Participants with missing data were more likely to be non-Caucasian, to have lower education and income levels and to have a marital status other than “married or living in a common-law union”.

Objective 1

The mean liking scores for the whole sample and according to individual characteristics are presented in Table 6-2. Overall, men (vs. women) and younger (vs. older) participants reported a higher liking for salty foods and for sweet foods. Liking scores did not differ according to education or income level. Participants who were classified as energy under-reporters had a lower liking for sweet foods score than plausible reporters and over-reporters. Mean liking for salty foods score was significantly correlated to mean liking for sweet foods score ($r=0.54$, $p<0.0001$).

The mean C-HEI total and component scores and unadjusted correlations between liking scores and the C-HEI components are presented in Table 6-3. Both liking for salty foods and for sweet foods scores were negatively correlated with the total C-HEI and with all three moderation components, meaning that a higher liking for salty foods or sweet foods was associated with higher intakes in saturated fat, sodium, and “other foods” (i.e., that are not part of the foods recommended by Canada’s Food Guide). A higher liking for salty foods was also associated with lower scores (i.e. lower consumption) for the following adequacy components: total vegetables and fruits, whole fruits, dark green and orange vegetables, and whole grains. Liking for sweet foods was positively associated with the consumption of milk and alternatives.

Finally, the multiple linear regression model showed that liking for salty foods was negatively associated with C-HEI ($B=-2.25$, 95%CI [-3.01, -1.50]) after adjustment for covariables such as sex, age, education, income, nutrition knowledge, smoking status, and reporting status, while liking for sweet foods was not ($B=-0.10$, 95%CI [-0.82, 0.62]; see Table 6-4).

Objective 2

Multiple linear regressions were performed with the inclusion of interaction terms in order to assess if sociodemographic and individual characteristics (i.e., sex, age, education, income, nutrition knowledge, and reporting status) moderated the association between the liking scores and the C-HEI. Sex was found to

significantly moderate the association between liking for salty foods and C-HEI (p interaction=0.0218; interaction with liking for sweet foods was not significant, $p=0.12$). To explain the significant interaction, a multiple linear regression of C-HEI on liking for salty foods stratified according to sex was therefore performed and results are presented in Table 6-5. This analysis showed that the negative association between liking for salty foods and C-HEI was significant in both sexes, but the association was stronger in men than in women. Given the significant sex interaction in the relation between liking for salty foods and the C-HEI, subsequent interaction terms were tested separately in women and men. Age, annual household income, nutrition knowledge, and reporting status were not found to significantly moderate the associations between liking for salty foods and C-HEI, neither in women nor in men (p interaction >0.05). The education level significantly moderated the association between liking for salty foods and C-HEI among women (p interaction=0.0231), but not among men (p interaction=0.55). A multiple linear regression of C-HEI on liking for salty foods among women stratified according to education level was performed and results are presented in Table 6-6. Results showed that the negative association between liking for salty foods and C-HEI was significant only among women with a lower level of education (i.e., high school or less), and not among women with higher education (see Table 6-6).

Discussion

The present study aimed at examining the associations between reported liking for foods that are either high in salt and fat or high in sugar and overall diet quality in a sample of French-speaking adults in Canada. One objective of the study was also to examine if these associations are different in some subgroups of the population, based on individual characteristics.

Results suggested that men and younger participants reported a higher liking for the salty foods and the sweet foods presented in the questionnaire than their counterparts as observed in other studies (33, 34). The differences observed between men and women may be partly explained by the fact that women are known to display a higher level of cognitive dietary restraint than men (35, 36), which has been associated with a lower reported liking for unhealthy foods (34). In a study by Lampure et al. (33), women, however, reported a higher level of liking for fat-and-sweet than men. The fact that these women were significantly younger than men, and that younger individuals are more likely to have strong liking for sweet foods, can explain the discordance between their results and what we observed.

In accordance with our hypothesis, the present study also suggests that a higher liking for foods that are high in salt and fat is associated with a poorer overall diet quality in models adjusted for variables known to have a potential influence on diet quality such as sex, education, and nutrition knowledge. Correlation analyses between liking scores and C-HEI components also demonstrated that, in addition to being associated with a higher consumption of sodium, saturated fat, and “other foods” (i.e., that are not part of the foods recommended by Canada’s Food Guide), liking for salty foods was also associated with a lower consumption of total vegetables and fruits, whole fruits, dark green and orange vegetables, and whole-grain products. These results suggest that individuals who report higher liking for foods high in salt and fat have a poorer overall diet quality not only because they eat more of these liked foods, but also because they eat less healthy foods. Such associations with the adequacy components of the C-HEI score, which measure the sufficiency of intake of nutrients and foods (22), were not observed with the liking for sweet foods scores. In a recent study assessing sensory profiles of diets (37), the authors observed that higher diet quality was associated with greater sweet taste and lower salty taste. However, a recent systematic review reported no clear associations between sweet taste and dietary intake patterns (38). Although, contrary to these studies, we did not measure taste per se, the negative association between liking for salty foods and C-HEI and the non-significant association between liking for sweet foods and C-HEI we observed are concordant with these previous results. The unexpected absence of negative association between liking for sweet foods and diet quality that we and others observed could be explained by the fact that individuals with a strong liking for sweet foods can also like and consume foods that naturally contain sugar, which contribute to a healthy diet (e.g., dairy, fresh fruits), whereas individuals with a high liking for foods high in salt and fat can almost exclusively satisfy their liking by choosing highly processed foods. This is

consistent with Cox et al. (37) who observed that healthier diets had a greater proportion of sweetness coming from core foods (e.g., fruits, grains, dairy) rather than discretionary foods (e.g., chocolate, cakes and biscuits, pies and pastries). Also, since salty foods are more likely to be consumed as main courses and snacks whereas sweet foods are more likely to be consumed as desserts, salty foods can contribute to a higher proportion of the daily food and energy intake. It is thus likely that liking for foods high in salt and fat has a bigger influence on the overall diet quality than liking for foods high in sugar, consistent with van Langeveld et al. (39) who suggested the potential role of salt taste preferences in energy overconsumption and the development of obesity.

Many scores of diet quality exist, which differ in the components that are included and in the weighting of the various components (40, 41). In the present study, which aimed at identifying correlates of adherence to Canadian guidelines, the C-HEI was used since it is the only validated score assessing the adherence to the Canada's food guide. Different results could have been observed using a different diet quality score, for example including a component such as "mono- and disaccharides" or "sweets/sweet beverages" (40), which liking for sweet foods could have more likely been associated with.

One of the novel features of the present study was the assessment of potential moderators of the association between liking scores and diet quality. Moderation analyses revealed that diet quality was more strongly associated (negatively) with liking for foods high in salt and fat among men than among women. Subsequent interaction analyses also showed that the negative association between liking for salty foods and C-HEI was significant among women with a lower level of education but not among those with a CEGEP or university diploma. These results suggest that men as well as women with a lower level of education are more likely to have their diet quality negatively influenced by a strong liking for foods high in salt and fat. More educated women may rely on various tools to help them eat healthily despite their liking for salty foods. It is important to keep in mind that nutrition knowledge was included as a covariate in the analyses, so the fact that more educated women are more aware of healthy eating guidelines has been taken into account. One limitation of the present study is the fact that the degree of liking of nutritious foods such as vegetables was not assessed. This information could have helped explain the difference obtained between men and women, or between women with lower vs. higher education, as the results of a study by Beck et al. (13) suggest that women and more educated individuals may have higher liking for vegetables. Men and women also display different types of eating-related motivations (42), and we hypothesise that the way they regulate their eating behaviors influences the associations of the liking scores with actual food intake. This hypothesis deserves further exploration.

Results of the present study suggest that achieving a healthy diet can be a challenge for individuals with strong liking for foods high in salt and fat. These results are of particular concerns knowing that 97% of Canadian adults perceive taste as an important factor for food choices, and that 38% believe that it is the most important factor,

beyond nutrition, cost, and convenience (43). Food liking being largely influenced by taste preferences (4), it stresses the importance of helping people eat a healthier diet while continuing to like the foods they eat. Promising avenues have been recently explored. For example, it has been observed that self-preparation of meals (compared to the preparation by others) increases the liking of a healthy but not an unhealthy food (44, 45). In these studies, the mere act of measuring and blending the ingredients to make a raspberry milkshake (considered by the authors as being a healthy recipe) increased participants' reported liking compared to the same milkshake, already prepared by the experimenter, and presented with the recipe. However, this effect was not observed when participants were asked to prepare and/or taste a chocolate milkshake, which was chosen by Dohle et al. (44) to represent an unhealthy recipe. The authors compared their results with the so-called "IKEA effect" or the increase in valuation of self-made products, like IKEA products. According to this concept, which has only been scarcely studied in food contexts, people report a higher liking for self-made objects than objects that were created by someone else because of the effort they have put in these self-made objects and the feelings of competence they experience (46). If the concept is actually applicable to food preparation, it may be possible to help people eat healthier by having them like, and be proud of, healthy self-prepared meals. Although the two experiments on the importance of self-preparation were carried out with only one type of food, in these cases milkshakes, results tend to support public health programs encouraging people to cook more with healthy ingredients and eat less of less nutritious ready-to-eat foods. Accordingly, the new Canada's Food Guide (2) recommends that Canadians cook more often.

Our results suggest that a higher liking for foods high in salt and fat may interfere with adherence to a healthy diet. Although taste preferences for sweet and salt over bitter and sour are considered as innate or unlearned biological responses (47, 48), food liking and preferences can also be learned during childhood. For instance, parental feeding practices, such as repeated exposure to some nutrient rich foods (e.g., vegetables) can accelerate children's liking of those foods (49). Adults' food liking and taste perceptions can also be increased or decreased over time. For example, individuals who adopted a lowered-sodium diet for several weeks have come to prefer lower concentrations of sodium (50-52). Conversely, increases in salt intake have been associated with increases in preferred sodium concentrations (50, 53). Accordingly, a gradual reduction of salt concentration in usual foods might lead to a decrease in the liking of high-salt food products (54, 55) and, consequently, a decrease in their consumption and an increase in overall diet quality. However, more research is needed to assess if such a gradual salt reduction can actually help individuals eat healthier, besides a lower sodium consumption (56).

One of the limitations of the present study is that despite the fact that recruitment was performed using a random list of phone numbers in the hope of recruiting a more heterogeneous sample, highly educated individuals were overrepresented in our sample (44% having a university degree, vs. 31% for the population of the Province of

Quebec (57)). Although, the imputation of missing data allowed the inclusion of participants with missing data who were more likely to be non-Caucasian, to have lower education and income levels, and to have a marital status other than “married or in a common-law union”. These characteristics were all underrepresented in our sample. Also, as mentioned before, one limitation of the study is the fact that the degree of liking of nutritious foods such as vegetables was not assessed. Despite some limitations, our study had major strengths. For instance, we used validated tools that were specifically developed for the adult French-speaking population of the Province of Quebec. The Food Liking Questionnaire and the food recall application are composed of food items that are known and consumed by the study population, increasing the likelihood of capturing precise information reflecting the participants’ habits and perceptions.

Conclusion

In conclusion, results of this study suggest that liking for foods high in salt and fat is a significant correlate of lower diet quality whereas liking for foods high in sugar is not. A strong liking for salty foods may interfere with healthy eating especially in men as well as in women with a lower level of education. Building on these results, future longitudinal and experimental studies should investigate the potential of interventions either designed to attempt to reduce the liking of foods high in salt and fat, or to improve the healthiness of food habits among individuals with strong liking for these foods, perhaps by emphasizing the importance of home-cooked meals made with healthy and nutritious ingredients.

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Authors contribution:

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Tables

Table 6-1. Sample characteristics of participants in the PREDISE study (n=1096)

| | n (%) |
|--|------------|
| Sex | |
| Women | 549 (50.1) |
| Men | 547 (49.9) |
| Age | |
| 18-34 y | 394 (36.0) |
| 35-49 y | 322 (29.4) |
| 50-65 y | 380 (34.6) |
| Ethnicity | |
| Caucasian | 988 (90.1) |
| Other | 85 (7.8) |
| Missing values or prefer not to answer | 23 (2.1) |
| Highest level of education | |
| High school or less | 266 (24.3) |
| CEGEP* | 329 (30.0) |
| University | 481 (43.9) |
| Missing values or prefer not to answer | 20 (1.8) |
| Household annual income | |
| Under low-income cut-off | 155 (14.1) |
| Over low-income cut-off | 825 (75.3) |
| Missing values or prefer not to answer | 116 (10.6) |
| Marital status | |
| Married or in common-law union | 676 (61.7) |
| Other | 332 (30.3) |
| Missing values or prefer not to answer | 88 (8.0) |
| Occupation | |
| Worker | 692 (63.1) |
| Retired | 148 (13.5) |
| Student | 120 (11.0) |
| No job | 46 (4.2) |
| Other | 58 (5.3) |
| Missing value or prefer not to answer | 32 (2.9) |
| Smoking status | |
| Current smokers | 155 (14.1) |
| Non-smoker or former smokers | 940 (85.8) |
| Missing values or prefer not to answer | 1 (0.1) |
| Reporting status | |
| Under-reporting | 97 (8.9) |
| Plausible reporting | 791 (72.2) |
| Over-reporting | 133 (12.1) |
| Missing value | 75 (6.8) |

Note: * In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs.

Table 6-2. Mean scores for liking for salty foods and for sweet foods according to individual characteristics.

| | Liking for salty foods | | | Liking for sweet foods | | |
|-----------------------------------|------------------------|------|------------|------------------------|------|------------|
| | Mean | SD | <i>p</i> | Mean | SD | <i>p</i> |
| Overall | 6.27 | 1.29 | <i>n/a</i> | 5.62 | 1.31 | <i>n/a</i> |
| Sex | | | | | | |
| Women | 5.97 | 1.34 | <0.0001 | 5.52 | 1.36 | 0.0148 |
| Men | 6.58 | 1.16 | | 5.71 | 1.25 | |
| Age | | | | | | |
| 18-34 y | 6.55 ^a | 1.19 | <0.0001* | 5.91 ^a | 1.17 | <0.000 |
| 35-49 y | 6.36 ^a | 1.21 | | 5.65 ^b | 1.30 | 1* |
| 50-65 y | 5.92 ^b | 1.38 | | 5.30 ^c | 1.38 | |
| Highest level of education | | | | | | |
| High school or less | 6.34 | 1.34 | 0.32* | 5.61 | 1.31 | 0.89* |
| CEGEP† or university | 6.25 | 1.27 | | 5.62 | 1.31 | |
| Household annual income | | | | | | |
| Under low-income cut-off | 6.18 | 1.41 | 0.88* | 5.61 | 1.32 | 0.76* |
| Over low-income cut-off | 6.29 | 1.26 | | 5.62 | 1.31 | |
| Reporting status | | | | | | |
| Under-reporting | 6.22 | 1.35 | 0.43* | 5.35 ^a | 1.45 | 0.0034* |
| Plausible reporting | 6.28 | 1.26 | | 5.63 ^b | 1.28 | |
| Over-reporting | 6.29 | 1.40 | | 5.79 ^b | 1.36 | |

Notes: n=1096. Liking for salty foods refers to foods high in salt and fat, and liking for sweet foods refers to foods high in sugar. Scores are on a scale from 1 to 9. Differences in liking scores between categories were tested using generalized linear models, with Tukey adjustment for multiple comparisons. Missing data for sociodemographic characteristics and reporting status have been imputed. See the Methods section for details. ^{a, b, c} Categories with different superscripted letters are significantly different ($p < 0.05$). * Adjusted for sex. † In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs.

Table 6-3. Mean Canadian Healthy Eating Index (C-HEI) total and components scores and correlations with liking scores.

| | Maximum score | Mean score±SD | Correlation coefficient with liking for salty foods | Correlation coefficient with liking for sweet foods |
|----------------------------------|---------------|---------------|---|---|
| C-HEI | 100 | 56.8±14.3 | -0.27** | -0.12** |
| Adequacy components | | | | |
| Total vegetables and fruit | 10 | 6.8±2.8 | -0.13** | -0.01 |
| Whole fruit | 5 | 3.1±1.9 | -0.20** | -0.05 |
| Dark green and orange vegetables | 5 | 2.9±1.8 | -0.13** | -0.03 |
| Total grain products | 5 | 3.8±1.2 | -0.03 | 0.04 |
| Whole grains | 5 | 2.1±1.8 | -0.14** | -0.03 |
| Milk and alternatives | 10 | 7.1±3.1 | 0.01 | 0.13** |
| Meat and alternatives | 10 | 8.2±2.2 | 0.02 | -0.06 |
| Unsaturated fats | 10 | 6.0±3.3 | 0.02 | 0.06 |
| Moderation components | | | | |
| Saturated fats | 10 | 4.9±3.3 | -0.12** | -0.13** |
| Sodium | 10 | 4.7±3.1 | -0.26** | -0.14** |
| “Other foods” | 20 | 7.2±5.8 | -0.25** | -0.19** |

Notes: n=1096. Liking for salty foods refers to foods high in salt and fat, and liking for sweet foods refers to foods high in sugar. * p<0.05, ** p<0.0001. Higher C-HEI and components scores represent a higher adherence to Canadian healthy eating guidelines.

Table 6-4. Regression analyses of Canadian Healthy Eating Index (C-HEI) on liking for salty foods and liking for sweet foods.

| | C-HEI Score | | |
|---|-------------|----------------|---------|
| | B | 95% CI | p |
| Independent variables | | | |
| Liking for salty foods (continuous score, 1-9) | -2.25 | [-3.01, -1.50] | <0.0001 |
| Liking for sweet foods (continuous score, 1-9) | -0.10 | [-0.82, 0.62] | 0.78 |
| Covariates | | | |
| Sex (1=female, 2=male) | -3.76 | [-5.47, -2.05] | <0.0001 |
| Age groups (1=18-34y, 2=35-49y, 3=50-65y) | 0.08 | [-0.88, 1.04] | 0.87 |
| Education (1=high school or less, 2=CEGEP* or university) | 1.97 | [0.05, 3.89] | 0.0444 |
| Household annual income (1=under low-income cut-off, 2=over low-income cut-off) | 2.08 | [-0.27, 4.42] | 0.08 |
| Nutrition knowledge (continuous score, 1-100) | 0.16 | [0.09, 0.22] | <0.0001 |
| Smoking status (1=non-smoker/former smoker, 2=current smoker) | -6.34 | [-8.60, -4.08] | <0.0001 |
| Reporting status, under-reporting (1=no, 2=yes) | -3.10 | [-5.86, -0.35] | 0.0274 |
| Reporting status, over-reporting (1=no, 2=yes) | 2.39 | [0.03, 4.75] | 0.0469 |

Note: n=1096. Liking for salty foods refers to foods high in salt and fat, and liking for sweet foods refers to foods high in sugar. * In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs.

Table 6-5. Regression analyses of Canadian Healthy Eating Index (C-HEI) score on liking for salty foods and liking for sweet foods, stratified by sex.

| Independent variable | C-HEI Score | | | | | |
|---|-------------|----------------|---------|-------|-----------------|---------|
| | Women | | | Men | | |
| | B | [95% CI] | p | B | [95% CI] | p |
| Liking for salty foods (continuous score, 1-9) | -1.46 | [-2.43, -0.48] | 0.0035 | -3.37 | [-4.56, -2.18] | <0.0001 |
| Covariates | | | | | | |
| Liking for sweet foods (continuous score, 1-9)† | -0.56 | [-1.51, 0.40] | 0.25 | 0.41 | [-0.68, 1.50] | 0.46 |
| Age groups (1=18-34y, 2=35-49y, 3=50-65y) | 0.74 | [-0.57, 2.05] | 0.27 | -0.65 | [-2.08, 0.77] | 0.37 |
| Education (1=high school or less, 2=CEGEP* or university) | 1.46 | [-1.21, 4.13] | 0.28 | 2.35 | [-0.48, 5.18] | 0.10 |
| Household annual income (1=under low-income cut-off, 2=over low-income cut-off) | 2.77 | [-0.26, 5.81] | 0.07 | 1.12 | [-2.65, 4.90] | 0.55 |
| Nutrition knowledge (continuous score, 1-100) | 0.12 | [0.02, 0.22] | 0.0230 | 0.18 | [0.09, 0.27] | 0.0002 |
| Smoking status (1=non-smoker, 2=current smoker) | -6.57 | [-9.84, -3.31] | <0.0001 | -6.20 | [-9.36, -3.04] | 0.0001 |
| Reporting status, under-reporting (1=no, 2=yes) | -2.09 | [-6.25, 2.07] | 0.32 | -3.77 | [-7.54, -0.001] | 0.0499 |
| Reporting status, over-reporting (1=no, 2=yes) | 1.49 | [-1.68, 4.67] | 0.36 | 3.53 | [-0.07, 7.14] | 0.0548 |

Note: n=549 women; n=547 men. Liking for salty foods refers to foods high in salt and fat, and liking for sweet foods refers to foods high in sugar. * In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs. † Liking for sweet foods was considered as a covariate in this analysis given its non-significant interaction with sex.

Table 6-6. Regression analyses of Canadian Healthy Eating Index C-HEI score on liking for salty foods and liking for sweet foods among women, stratified by education level.

| Independent variable | C-HEI Score | | | | | |
|---|---------------------|----------------|--------|----------------------|-----------------|--------|
| | High school or less | | | CEGEP* or university | | |
| | B | [95% CI] | p | B | [95% CI] | p |
| Liking for salty foods (continuous score, 1-9) | -3.10 | [-4.89, -1.30] | 0.0009 | -0.65 | [-1.81, 0.50] | 0.27 |
| Covariates | | | | | | |
| Liking for sweet foods (continuous score, 1-9)† | 0.27 | [-1.60, 2.15] | 0.77 | -1.05 | [-2.18, 0.08] | 0.07 |
| Age groups (1=18-34y, 2=35-49y, 3=50-65y) | 0.74 | [-1.84, 3.32] | 0.57 | 0.91 | [-0.64, 2.46] | 0.25 |
| Household annual income (1=under low-income cut-off, 2=over low-income cut-off) | 2.35 | [-2.66, 7.36] | 0.35 | 2.65 | [-1.20, 6.51] | 0.18 |
| Nutrition knowledge (continuous score, 1-100) | 0.23 | [0.03, 0.42] | 0.0213 | 0.07 | [-0.05, 0.19] | 0.22 |
| Smoking status (1=non-smoker, 2=current smoker) | -4.66 | [-10.26, 0.95] | 0.10 | -7.79 | [-11.87, -3.71] | 0.0002 |
| Reporting status, under-reporting (1=no, 2=yes) | -6.97 | [-14.01, 0.08] | 0.05 | 0.73 | [-4.53, 5.98] | 0.79 |
| Reporting status, over-reporting (1=no, 2=yes) | -3.49 | [-10.18, 3.19] | 0.30 | 3.32 | [-0.28, 6.92] | 0.07 |

Note: High school or less, n=132; CEGEP or university, n=417. Liking for salty foods refers to foods high in salt and fat, and liking for sweet foods refers to foods high in sugar. * In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs. † Liking for sweet foods was considered as a covariate in this analysis given its non-significant interaction with sex.

Supplemental material

Supplementary Table S6-7. Description of the C-HEI scoring for adults

| Component | Range of scores | Scoring criteria |
|----------------------------------|---------------------------------|---|
| Adequacy | 0 to 60 points | |
| Total vegetables and fruit | 0 to 10 points | Minimum: 0 Maximum: 7 to 8 servings |
| Whole fruit | 0 to 5 points | Minimum: 0 Maximum: 1.5 to 1.7 servings (21% of recommendation for total vegetables and fruit) |
| Dark green and orange vegetables | 0 to 5 points | Minimum: 0 Maximum: 1.5 to 1.7 servings (21% of recommendation for total vegetables and fruit) |
| Total grain products | 0 to 5 points | Minimum: 0 Maximum: 6 to 8 servings |
| Whole grains | 0 to 5 points | Minimum: 0 Maximum: 3 to 4 servings (50% of recommendation for total grain products) |
| Milk and alternatives | 0 to 10 points | Minimum: 0 Maximum: 2 to 3 servings |
| Meat and alternatives | 0 to 10 points | Minimum: 0 Maximum: 2 to 3 servings (150 to 225 grams) |
| Unsaturated fats | 0 to 10 points | Minimum: 0 Maximum: 30 to 45 grams |
| Moderation | 0 to 40 points | |
| Saturated fats | 8 to 10 points 0 to 8 points | Minimum 7% to 10% of total energy intake 10% to maximum 15% of total energy intake |
| Sodium | 8 to 10 points 0 to 8 points | Adequate intake to tolerable upper intake level Tolerable upper intake level to twice tolerable upper intake level |
| “Other foods” | 0 to 20 points | Minimum: 5% or less of total energy intake Maximum: 40% or more of total energy intake |

For adequacy components, 0 point for minimum, 5 or 10 points for maximum or more, and proportional for amounts between minimum and maximum.

For moderation components, 10 or 20 points for minimum or less, 0 point for maximum or more, and proportional for amounts between minimum and maximum.

Reference: Garriguet D. Diet quality in Canada. Ottawa: Statistics Canada, 2009.

Supplementary Table S6-8. Food Liking Questionnaire

On a 9-point scale, 1 being “I really don’t like”, 5 being “Neutral”, and 9 being “I really like”, rate your liking of the following foods, regardless of the frequency of consumption.

1. Chicken wings
2. Salted nuts
3. Meat pâté (*creton*)
4. Nuggets
5. Chips
6. French fries
7. Hamburger
8. Hotdog
9. Pizza
10. *Poutine* (Original dish from the Province of Quebec made of French fries and cheese curds topped with a brown gravy)
11. Sausage
12. Processed meat
13. Popsicle
14. Candies
15. Jam
16. Marshmallow
17. Honey
18. Pudding
19. Canned fruit salad
20. Sorbet
21. Doughnut
22. Cookies
23. Pastries (*chausson, chocolatine*)
24. Milk chocolate/ chocolate bar
25. Cream puff/ chocolate *éclair*
26. Whipped cream
27. Ice cream
28. Cheese cake
29. Muffin
30. Sugar fudge
31. Pie
32. Chocolate spread

Items 1 to 12 score for liking for salty foods, and items 13 to 32 score for liking for sweet foods.

Reference: Carbonneau, E., Bradette-Laplante, M., Lamarche, B., Provencher, V., Begin, C., Robitaille, J., Desroches, S., Vohl M-C., Corneau, L., and Lemieux, S. (2017). "Development and Validation of the Food Liking Questionnaire in a French-Canadian Population." *Nutrients* 9(12).

Supplementary Table S6-9. Characteristics of participants with complete vs. incomplete data.

| Characteristics | Completers n=768 | Non-completers* n=328 | p** |
|-----------------------------------|-----------------------------|------------------------------|------------|
| Sex | | | |
| Women | 394 (51.3) | 155 (47.3) | 0.22 |
| Men | 374 (48.7) | 173 (52.7) | |
| Age | | | |
| 18-34 y | 261 (34.0) | 133 (40.6) | 0.09 |
| 35-49 y | 237 (30.9) | 85 (25.9) | |
| 50-65 y | 270 (35.1) | 110 (33.5) | |
| Ethnicity | | | |
| Caucasian | 723 (94.4) | 265 (85.5) | <0.0001 |
| Other | 43 (5.6) | 45 (14.5) | |
| Highest level of education | | | |
| High school or less | 158 (20.6) | 108 (35.1) | <0.0001 |
| CEGEP† or university | 610 (79.4) | 200 (64.9) | |
| Household annual income | | | |
| Under low-income cut-off | 109 (14.2) | 46 (21.7) | 0.0080 |
| Over low-income cut-off | 659 (85.8) | 166 (78.3) | |
| Marital status | | | |
| Married or in common-law union | 508 (70.5) | 168 (58.5) | 0.0003 |
| Other | 213 (29.5) | 119 (41.5) | |
| Smoking status | | | |
| Current smokers | 104 (13.5) | 51 (15.6) | 0.37 |
| Non-smoker or former smokers | 664 (86.5) | 276 (84.4) | |
| Reporting status | | | |
| Under-reporting | 65 (8.5) | 32 (12.7) | 0.07 |
| Plausible reporting | 596 (77.6) | 195 (77.1) | |
| Over-reporting | 107 (13.9) | 26 (10.3) | |

Note. Values are presented as n (%). The numbers in subgroups may not sum to the total number of participants due to missing data. Analyses presented in this table were performed using unimputed data.

*Non-completers are participants with incomplete data, i.e., they have at least one missing item in the Food Liking Questionnaire (n=197) or missing values for education level (n=20), annual household income (n=116), smoking status (n=1), reporting status (n=75), or nutrition knowledge (n=76).

** Frequencies were compared using the Chi-Square statistic (subjects with missing values are not included in the analyses).

†In the Quebec education system, CEGEP is the first level of post-secondary studies and precedes university studies. It includes pre-university programs and technical programs.

Chapitre 7 : Développement et validation d'un questionnaire sur le soutien des proches pour manger sainement

Elise Carbonneau, Maude Bradette-Laplante, Benoît Lamarche, Véronique Provencher, Catherine Bégin, Julie Robitaille, Sophie Desroches, Marie-Claude Vohl, Louise Corneau et Simone Lemieux

L'article présenté dans ce chapitre s'intitule: Social Support for Healthy Eating: Development and Validation of a Questionnaire for the French-Canadian Population

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Résumé

L'objectif de cette étude était de développer et valider un questionnaire portant sur le soutien des proches pour manger sainement dans une population canadienne francophone. Un questionnaire de 21 items a été développé. Pour chaque item, les participants devaient rapporter la fréquence, au cours du dernier mois, à laquelle les actions décrites ont été effectuées par leurs proches dans deux environnements différents (c.-à-d., à la maison et à l'extérieur de la maison). La validité de contenu a été évaluée via un panel d'experts. Des hommes et femmes (n=150) de la région de Québec ont été recrutés pour remplir le questionnaire à deux reprises sur une plateforme web. Une analyse factorielle exploratoire a été effectuée pour déterminer le nombre de sous-échelles du questionnaire. La consistance interne a été évaluée à l'aide d'alpha de Cronbach. La répétabilité a été évaluée à l'aide de corrélations intraclasse entre les scores des deux complétions. L'évaluation de la validité de contenu a mené à quelques changements, résultant en un questionnaire de 22 items. L'analyse factorielle exploratoire a mené au retrait de deux items et a révélé une structure à deux facteurs pour les deux environnements, menant à la création de quatre sous-échelles : actions favorables à domicile; actions non favorables à domicile; actions favorables à l'extérieur du domicile; actions non favorables à l'extérieur du domicile. Les quatre sous-échelles ont démontré une bonne consistance interne (alpha de Cronbach=0,82-0,94) et une bonne stabilité dans le temps (coefficients de corrélations intraclasse: 0,51-0,70). Ce questionnaire sur le soutien des proches pour manger sainement a été développé pour une population canadienne francophone et a démontré de bonnes propriétés psychométriques. Ce questionnaire sera utile pour explorer le rôle du soutien social et ses interactions avec d'autres facteurs dans la détermination des comportements alimentaires.

Abstract

Objective: The present study aimed to develop and validate a questionnaire assessing social support for healthy eating in a French-Canadian population.

Design: A 21-item questionnaire was developed. For each item, participants were asked to rate the frequency, in the past month, with which the actions described have been done by family and friends in two different environments: 1) at home and 2) outside of home. The content was evaluated by an expert panel. A validation study sample was recruited and completed the questionnaire twice. Exploratory Factor Analysis was performed on items to assess the number of subscales. Internal consistency reliability was assessed using the Cronbach's α . Test-retest reliability was evaluated with intra-class correlations between scores of the two completions.

Setting: Online survey.

Subjects: Men and women from the Québec City area (n=150).

Results: The content validity assessment led to a few changes, resulting in a 22-item questionnaire. The Exploratory Factor Analysis revealed a two-factor structure for both environments, resulting in four subscales: supportive actions at home, non-supportive actions at home, supportive actions outside of home, and non-supportive actions outside of home. Two items were removed from the questionnaire due to low loadings. The four subscales were found to be reliable (Cronbach's α = 0.82-0.94; test-retest intra-class correlation coefficients: 0.51-0.70).

Conclusions: The Social Support for Healthy Eating Questionnaire was developed for a French-Canadian population and demonstrated good psychometric properties. This questionnaire will be useful to explore the role of social support and its interactions with other factors in predicting eating behaviors.

Title page

Social Support for Healthy Eating: Development and Validation of a Questionnaire for the French-Canadian Population

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Conflict of interest: None

Authorship: SL, BL, VP, CB, JR, SD, and MCV contributed in designing the study. LC and MBL were responsible in carrying out the study. MBL, SL, and EC were responsible of developing the questionnaire. VP, CB, JR, SD, MCV, and LC were members of the expert panel. EC analysed the data and wrote the article. All co-authors revised and approved the final version of the paper.

Ethical Standards Disclosure: This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Research Ethics Committee at Laval University. Implicit informed consent was obtained from the pre-test participants and all participants from the validation study gave written informed consent.

Introduction

From an ecological perspective, eating behaviors are determined by a wide range of individual, social, and environmental factors as well as by their interactions (1). In order to effectively promote healthy eating, it is critical to better understand how these various factors influence eating behaviors. Individual factors have been extensively studied in the last decades (2, 3), and, lately, an increasing number of studies have documented the association between the physical environment and food choices (4, 5). However, the influence of social factors on healthy eating has been less studied.

Social or interpersonal factors are likely to influence food choices and eating behaviors not only since meals are frequently shared with other people, but also due to food-related tasks, such as food planning, procurement, and preparation, which are frequently divided among family members, partners or roommates (6). While children's eating behaviors are largely determined by parents' influence (7, 8), as a person grows up, a part of the social influence shifts from parents to friends, partner, and colleagues (9-11).

Social support can be defined as "a transactional communicative process, including verbal and/or nonverbal communication, that aims to improve an individual's feelings of coping, competence, belonging, and/or esteem (12)." In order to adequately assess the influence of social support on healthy eating, it is crucial that a validated tool be used. The most commonly used scales assessing social support from family and friends for diet and exercise behaviors have been developed by Sallis et al. (13) and later modified or adapted by numerous authors for different contexts (14-19). Using the original scales or items derived from it, authors have observed associations between social support from family and friends and measures of healthy eating (13, 17, 19, 20).

To our knowledge, no questionnaire in French has been developed to specifically assess social support in the context of adherence to a healthy diet. It is recognized that tools need to be adapted and validated if they are to be used across countries (21). French-Canadians from the Province of Quebec have been found to differ from other Canadians as it pertains to food intakes and attitudes towards eating (22, 23), suggesting that eating-related questionnaires validated in other parts of North America may not be suitable for them. Therefore, the purpose of the present study was to develop and validate a new questionnaire assessing social support for healthy eating in an adult French-Canadian population.

Methods

Development of the items

Based on Sallis et al. (13), it was decided that a questionnaire assessing social support from two categories of close others, namely family and friends, would be developed. Participants were asked to rate the frequency, in the past month, with which both family and friends have done the different actions described. It was decided that the actions would relate to the general concept of healthy eating or to junk foods. The majority of the items of the French-Canadian questionnaire were generated based on existing validated tools (13, 14, 24, 25). Other items were developed by the research team. A total of twenty-one items were developed. As suggested by Kiernan et al. (25), various forms of social support were assessed through the items, such as verbal support (e.g. [...] encouraged me to eat healthy foods when I was tempted to eat junk food") and behavioral support (e.g. [...] ate healthy foods in front of me). We also decided to add items pertaining to the social environment during meals (e.g. [...] contributed to create a pleasant atmosphere at mealtime). According to the recommendations in Kiernan et al. (25), we opted to use a five-point Likert scale (never, rarely, sometimes, often, very often). It was also decided that a "not applicable" option would be added to alleviate pressure on participants to answer. Using the cold deck imputation procedure, all "not applicable" answers were replaced by the "never" option, based on the questionnaire from Ball and Crawford (14) in which "not applicable" and "never" constitute the same answer option.

Participants and procedures

The questionnaire was developed and validated in the context of a larger study aiming at validating a series of questionnaires on determinants of healthy eating (26-28) and biomarkers of fruit and vegetable intake. The validation process for the Social Support for Healthy Eating Questionnaire was divided into three steps, namely an expert panel evaluation, a pretest, and a validation study.

Expert panel

Content validity was assessed by an expert panel composed of four nutrition researchers, one registered dietitian, and one psychology researcher, all familiar with questionnaire development and validation. Content validity involves an assessment of the items to ensure representation of the construct (i.e. social support for healthy eating) (29). The experts rated each item of the questionnaire on four-point scales for four criteria: relevance (not relevant (1) to very relevant (4)), clarity (not clear (1) to very clear (4)), simplicity (not simple (1) to very simple (4)), and ambiguity (ambiguous (1) to explicit (4)). Evaluations from the experts were combined to yield a content validity index for each item. According to Dilorio (29), a minimum level of 80% was considered

for an adequate content validity. Items with a content validity index lower than the cut-off needed to be modified or removed from the questionnaire.

Pretest

According to the questionnaire pretesting sample size recommendation (30), a convenience sample consisting of 31 participants was recruited from an internal list of people willing to participate in clinical studies, in order to assess the acceptability and comprehension of the items. Participants were men and women from the Québec City metropolitan area and were aged between 18 and 65 years old. Participants had to have at least minimal informatics skills since questionnaires were completed online.

To assess face validity (i.e. whether the items seemed to measure what the developers claim they measure (29)), participants from the pretest were asked to complete the questionnaires online and to comment on the ambiguity of the items in a comments box after each item.

Validation study

A convenience sample of 75 women and 75 men was used for the validation study. Participants were recruited through electronic mailing lists comprising Laval University students and employees as well as people interested in participating in studies at the Institute of Nutrition and Functional Foods. Inclusion criteria were identical to those used for the pretest. Participants suffering from conditions affecting intestinal absorption were excluded since blood biomarkers of fruit and vegetable intake were also being validated in the study. Pregnancy and lactation were exclusion criteria. Eligible participants came to the research center for a blood sample and anthropometric measurements (31).

Within a month after coming to the laboratory, participants had to complete a series of questionnaires to be validated on the Internet platform of the study. Questionnaires were assigned to participants in a random order. Following a two-week delay, participants were asked to complete each questionnaire a second time within a one-month period. The completion time for the series of questionnaires was approximately 40 minutes.

Participants received a financial compensation (CAD 50) for their participation in the study. This study was conducted according to the guidelines laid down in the Declaration of Helsinki (32).

Statistical Analyses

The analyses described in this section were performed on data derived from the validation study. An Exploratory Factor Analysis (EFA) was performed on the items to assess the number of factors (or subscales) for the

questionnaire, aiming at retaining as few factors as possible while explaining most of the variation in the data. The modified eigenvalue-greater-than-one rule (33) and the scree plot (34) were used to adequately identify the number of factors in the questionnaire. The sample size of the validation study (n=150) respected the recommended 5:1 participant-to-item ratio for factor analyses (35). Internal consistency reliability was assessed using Cronbach alpha coefficients with data from the first completion of the questionnaire. The test-retest reliability was assessed with intra-class correlation analyses conducted between scores of the two completions. Statistical tests were two-sided and associations or differences at $p < 0.05$ were considered significant. Analyses were performed using the Statistical Analysis Software (SAS) version 9.4 (Copyright © 2013, SAS Institute Inc., Cary, NC, USA).

Results

Expert panel

Content validity. Of the 21 items evaluated, only one item had a content validity index lower than 80% and it was removed from the questionnaire. One item was also removed from the questionnaire because it was judged to be too similar to another item. Seven items were slightly modified following comments from the experts. Finally, to address recommendations by the experts, three items were added to the questionnaire. These changes resulted in a 22-item questionnaire (see Table 7-2).

Pretest

Participants from the pretest were 17 women and 14 men (mean age: 45.6±13.9).

Face validity. Four participants did not complete the social support questionnaire, therefore 27 participants were included for the face validity. Comments formulated by the participants did not lead to any change in the formulation of the 22 items. However, following some comments expressed on the classification of the close others (e.g. “Is an adult child no longer living at home considered as a family member or a friend?”), the labels were changed to facilitate understanding. Therefore, “family” (defined as people living with you) was changed for “home” (defined as people living with you, e.g. family members, partner, roommate). “Friends” (defined as friends, colleagues, acquaintances) was replaced by “outside of home” (defined as people with whom you share meals, but who do not live with you, e.g. friends, colleagues).

Validation study

Of the 150 participants of the validation study, one participant dropped out of the study before completing the questionnaires, and one participant did not complete the social support questionnaire. Characteristics of the 148 remaining participants (mean age: 47.5±13.4) are presented in Table 7-1. The mean (±SD) completion time of the questionnaire was 5.5±1.9 minutes.

Exploratory factor analysis. Since items of the questionnaire were rated separately for two categories (i.e. “home” and “outside of home”), EFA was performed separately for each category. The significance of Bartlett’s test of sphericity (“home”: $\chi^2 = 1923.48$, $p < 0.0001$; “outside of home”: $\chi^2 = 1130.61$, $p < 0.0001$) and the Kaiser–Meyer–Olkin test of sampling adequacy (measures of sample adequacy > 0.50) revealed that our sets of items had adequate common variance, justifying the use of an EFA (36). When looking at data from “home” and “outside of home”, respectively five and four factors had eigenvalues (including their 95% confidence intervals) greater than 1.0. However, the analysis of the scree plots from the EFA revealed a notable difference in the slope after

the first two factors, for “home” and “outside of home”. Therefore, it was decided that the items of the questionnaire would be divided in two factors for both “home” and “outside of home”. The two factors accounted for 82.88% of the variance in the data from “home”, and 81.17% in the data from “outside of home”. In order to obtain simple and interpretable factors, and since factors were expected to covary, oblique promax rotations were used for both the “home” and “outside of home” categories. Using a minimum loading cut-off of 0.30 or higher (37), two items did not load on any factor, and were therefore removed from the questionnaire (see Table 7-2).

With this factor structure, 12 items were found to load on the first factor and 8 items on the second factor, as seen in Table 2. The same factor structure was obtained for both “home” and “outside of home”. The factors were named according to what the items of each subscale have in common. Therefore, the first factor was named “supportive actions” (e.g. “[...] proposed that we eat healthier”) and the second was named “non-supportive actions” (e.g. “[...] criticized the healthy foods I prepared”). Since the questionnaire is divided in two factors and two categories (i.e. “home” and “outside of home”), it was decided that the questionnaire would be scored on four distinct subscales: supportive actions at home, non-supportive actions at home, supportive actions outside of home, and non-supportive outside of home. Subscale scores were obtained by calculating the mean of the items. Thus, higher scores for the supportive and the non-supportive scales mean a higher frequency of these types of action. To verify if the presence of supportive actions reflects the absence of non-supportive actions, correlations between the two factors were assessed. Supportive actions and non-supportive actions score were significantly correlated within the “home” category ($r=0.27$, $p=0.0010$), and the “outside of home” category ($r=0.34$, $p<0.0001$). Mean scores for the four subscales are presented in Table 7-3.

Internal consistency reliability. As seen in Table 7-3, all scores were considered internally reliable, all Cronbach alpha coefficients being >0.70 .

Test-retest reliability. Intra-class correlation coefficients between both completions were calculated for the participants who completed the scale twice ($n=146$). As shown in Table 7-3, correlations indicate moderate reliability (38) for all subscales (ρ from 0.51 to 0.67). The mean (\pm SD) lapse between test and retest was 40.9 ± 11.5 days.

Discussion

The purpose of the present study was to develop and validate a questionnaire assessing social support for healthy eating for a French-Canadian population. We decided to create a full questionnaire and proceeded to a complete validation of the items developed, unlike many authors which have assessed social support using only a few items from other validated questionnaires, without proceeding to a validation of these items taken separately. We decided to create a questionnaire targeting the whole population, and not only people wishing to adopt a healthier lifestyle. Therefore, items pertain to the global concepts of healthy eating and junk foods. Other questionnaires already exist to assess various forms of goal support that can be provided by family and friends to an individual aiming at changing a behavior (e.g. Koestner et al. (39)). Items were generated based on existing questionnaires or developed by the research team. Given that the items developed by Sallis et al. (13) are largely used in the literature, this questionnaire was an important source of inspiration for the development of our questionnaire. We were also inspired by the modifications proposed by Ball and Crawford (14) and Kiernan et al. (25), such as using the same items for both types of close others.

Face validity was used to assess pretest participants' understanding of the items. This led to an important improvement in the wording used to describe the two categories of close others, to reduce ambiguity (change from "family" to "home", and from "friends" to "outside of home"). This change in the labels led to a classification focussing on the context of the interactions more than on the nature of the relation itself. We think that our classification will bring interesting information about the role of social support from important others whether living or not with them, which is not the case with other existing social support questionnaires. When living with someone, whether it is a partner, a family member or a friend, numerous interactions around food and eating are likely to happen, while preparing and sharing meals. However, our results may not be directly comparable to most other social support questionnaires using "family/friends" categories.

Items were developed to assess three types of social support, namely verbal support, behavioral support, and social environment during meals. Therefore, it was expected that the EFA would yield to a three-factor structure. However, the two-factor structure uncovered by the analysis is in line with the structure of the original social support scales by Sallis et al. (13) and the adapted versions (14, 25). The EFA also resulted in the removal of two items pertaining to the meal environment. Those items may not be directly related to the social support concept.

The four subscales were found to be internally reliable, meaning that items within each subscale related well with one another. The two factors were moderately correlated within the "home" category and the "outside of home" category. These results indicate that the factors are tapping distinct concepts, and that the use of two subscales is relevant. Sallis et al. (13) reported stronger correlations between the different forms of support

(family: $r = 0.45$; friends: $r = 0.38$), but yet considered that the factors did not overlap. The correlations we observed between the two types of actions suggest that many participants received both supportive and non-supportive actions from their close others. In future research, it would be interesting to assess if the presence of non-supportive actions alleviates the influence of supportive actions on healthy eating behaviors. In the present study, participants were not asked to specify who did which action. Therefore, we do not know if some individuals are perceived to be both supportive and non-supportive, or if the various actions reported by participants originate from different persons.

In the present study, intra-class correlation coefficients indicated moderate test-retest reliability (i.e. coefficients between 0.51 and 0.67) for all four subscales. The delay between the two completions was variable, from 14 to 99 days. Few authors have assessed this type of validation of a social support for healthy eating questionnaire. Sallis et al. (13) obtained stronger correlation coefficients, varying from 0.57 to 0.86, but the time period between the two completions is not mentioned in the article. Baranowski et al. (24) assessed a six-week test-retest reliability of their questionnaire on family social support for purchasing fruits and vegetables, and obtained correlation coefficients that were also higher than in the present study ($r = 0.74$ and 0.73). Our lower test-retest coefficient can be partly explained by the variable time period between the two completions due to the study design. It is also important to note that the intra-class correlation coefficients were higher for “supportive actions at home” than “supportive actions outside of home” subscales ($\rho = 0.65$ vs $\rho = 0.51$). This suggests that social support outside of home, from friends, colleagues, and acquaintances, is more likely to vary with time. Accordingly, it is possible that there is more stability in people with whom one shares meals at home than outside of home. The varying nature of social support stresses the importance of choosing wisely the time frame of the questionnaire. Therefore, when social support is compared to food intake, it is all the more important that the time period of the social support questionnaire matches with the period covered by the food intake questionnaire.

Strengths and limitations

Some limitations of this study should be acknowledged. The study population was mostly Caucasian and highly educated, and therefore not representative of the whole French-Canadian population (40), which can limit the external validity. Also, this validation study could have benefited from a comparison between the newly developed questionnaire and other tools assessing social support, as it would have increased the content validity. However, other authors have compared social support for healthy eating to a general social support score and have found no significant association, suggesting that specific types of support may vary in quantity and may come from different people than what general social support scales usually measure (13).

An important strength of this study is the fact that it was designed expressly for the validation of questionnaires. The three main steps, namely the expert panel, the pre-test, and the validation study were followed for each questionnaire to be validated, resulting in a rigorous validation process.

Conclusions

The present study aimed at validating the Social Support for Healthy Eating Questionnaire, developed in a French-Canadian population. The design of the questionnaire was inspired from existing tools and demonstrated good psychometric properties. Data from test-retest analyses suggest that social support may vary within relatively short periods of time. Hence, research schedules should be carefully planned to ensure that social support is assessed as closely as possible to other measures related to food intake and behaviors. This questionnaire will be useful to explore the role of social support and its interactions with other factors in predicting healthy dietary habits and eating behaviors. The questionnaire developed in this study is a valid and reliable tool for the French-Canadian adult population, but extra validation is recommended if the tool is to be used in other populations.

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Tables

Table 7-1. Sample characteristics of the validation study (n=148)

| | n (%) |
|---|------------|
| Female | 73 (49.3) |
| Ethnicity | |
| Caucasian | 141 (95.3) |
| Highest level of education | |
| High school | 14 (9.5) |
| College | 45 (30.4) |
| University | 89 (60.1) |
| Occupation | |
| Worker | 101 (68.2) |
| Retired | 32 (21.6) |
| Student | 9 (6.1) |
| No job | 3 (2.0) |
| Prefer not to answer | 3 (2.0) |
| Living with: | |
| Partner only | 56 (37.8) |
| Partner and children | 30 (20.3) |
| Children only | 5 (3.4) |
| Family member (other than partner and children) | 6 (4.0) |
| Roommate | 5 (3.4) |
| Alone | 46 (31.1) |

Table 7-2. Questionnaire's items and factor loadings

| | Factor 1* | Factor 2* |
|---|------------------|------------------|
| 1. [...] proposed that we eat healthier. | 0.66 / 0.40 | |
| 2. [...] minimized the importance of consuming healthy foods. | | 0.59 / 0.66 |
| 3. [...] made positive comments on my consumption of healthy foods. | 0.70 / 0.59 | |
| 4. [...] ate healthy foods in front of me. | 0.83 / 0.67 | |
| 5. [...] made negative comments when I was eating less healthily. | 0.47 / 0.45 | |
| 6. [...] encouraged me to eat healthy foods when I was tempted to eat junk foods. | 0.55 / 0.30 | |
| 7. [...] ate junk foods in front of me. | | 0.35 / 0.49 |
| 8. [...] made positive comments on healthy foods' taste. | 0.84 / 0.79 | |
| 9. [...] preferred to eat alone than with me.† | - | - |
| 10. [...] hampered my efforts to eat more healthily. | | 0.67 / 0.72 |
| 11. [...] encouraged me to buy healthy foods | 0.86 / 0.73 | |
| 12. [...] gave me ideas to eat more healthy foods. | 0.78 / 0.67 | |
| 13. [...] said that healthy foods do not taste good. | | 0.76 / 0.59 |
| 14. [...] contributed to create a pleasant atmosphere at mealtime. | 0.82 / 0.52 | |
| 15. [...] insisted for me to eat junk foods. | | 0.68 / 0.66 |
| 16. [...] took their meals with me. | 0.80 / 0.46 | |
| 17. [...] made negative comments on my healthy foods consumption. | | 0.68 / 0.74 |
| 18. [...] praised the advantages of eating healthy foods. | 0.87 / 0.81 | |
| 19. [...] criticized the healthy foods that I served them. | | 0.73 / 0.63 |
| 20. [...] contributed to create a tensed atmosphere at mealtime. | | 0.65 / 0.33 |
| 21. [...] proposed that we eat in front of the television. † | - | - |
| 22. [...] listened to my opinions regarding healthy eating even when they disagree. | 0.71 / 0.48 | |

Note: The French version of the instrument was validated. All items were translated from French to English using the back-translation procedure and should not be used in their English version without validation. *Factor loadings are presented as: "home" / "outside of home". Close others at "home" are defined as people living with you, e.g. family members, partner, roommate. Close others "outside of home" are defined as people with whom you share meals, but who do not live with you, e.g. friends, colleagues. † Items that were removed after the exploratory factor analysis.

Table 7-3. Scores obtained by participants for the four subscales, Cronbach Alpha, and intra-class correlation coefficients

| Subscales | Mean Scores [†] | SD | Cronbach Alpha Coefficients [‡] | Intra-class coefficients (Confidence interval) [§] |
|--|--------------------------|------|--|---|
| Supportive actions at home | 2.83 | 1.11 | 0.94 | 0.65 (0.55-0.73) |
| Non-supportive actions at home | 1.41 | 0.48 | 0.85 | 0.67 (0.57-0.75) |
| Supportive actions outside of home | 2.50 | 0.75 | 0.86 | 0.51 (0.38-0.62) |
| Non-supportive actions outside of home | 1.57 | 0.51 | 0.82 | 0.65 (0.55-0.73) |

Note: Scores are on a maximum of 5 points. Higher scores for the supportive and the non-supportive scales mean a higher frequency of these types of action. [†] n=148[‡] n=142; [§] n=146.

Chapitre 8 : Développement et validation d'un questionnaire sur la perception de l'environnement alimentaire

Elise Carbonneau, Julie Robitaille, Benoît Lamarche, Louise Corneau et Simone Lemieux.

L'article présenté dans ce chapitre s'intitule: Development and Validation of the Perceived Food Environment Questionnaire in a French-Canadian Population

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Résumé

Cette étude visait à développer et valider un questionnaire évaluant la perception de l'environnement alimentaire dans une population canadienne francophone. Un questionnaire a été développé pour évaluer la perception de l'accessibilité aux aliments sains (neuf items) et l'accessibilité aux aliments « camelote » (trois items). Un échantillon de 31 participants a été recruté pour un prétest. Puis pour l'étude de validation, 150 participants ont été recrutés et ont rempli le questionnaire à deux reprises sur une plateforme web. Une analyse factorielle exploratoire a été effectuée pour déterminer le nombre de sous-échelles. L'alpha de Cronbach a été utilisé pour mesurer la consistance interne. La répétabilité a été évaluée avec des corrélations de Pearson. Le prétest n'a mené à aucun changement dans les items du questionnaire. L'analyse factorielle exploratoire a révélé une structure à deux sous-échelles. La première sous-échelle est composée de six items portant sur l'accessibilité aux aliments sains et la deuxième inclut trois items portant sur l'accessibilité aux aliments « camelote ». Trois items ont été retirés du questionnaire étant donné leur faible cohésion avec les deux sous-échelles. Les sous-échelles ont démontré une consistance interne adéquate (α Cronbach=0,77 pour l'accessibilité aux aliments sains, et α Cronbach=0,62 pour l'accessibilité aux aliments « camelote ») et une répétabilité adéquate ($r=0,59$ et $0,60$, respectivement; $p<0,0001$). Le questionnaire de perception de l'environnement alimentaire développé pour une population canadienne francophone a démontré de bonnes qualités psychométriques. Une validation supplémentaire est recommandée si le questionnaire est utilisé dans d'autres populations.

Abstract

Objective: The present study aimed to develop and validate a questionnaire assessing perceived food environment in a French-Canadian population.

Design: A questionnaire, the Perceived Food Environment Questionnaire, was developed assessing perceived accessibility to healthy (nine items) and unhealthy foods (three items). A pre-test sample was recruited for a pilot testing of the questionnaire. For the validation study, another sample was recruited and completed the questionnaire twice. Exploratory factor analysis was performed on the items to assess the number of factors (subscales). Cronbach's α was used to measure internal consistency reliability. Test-retest reliability was assessed with Pearson correlations.

Setting: Online survey.

Subjects: Men and women from the Québec City area (n 31 in the pre-test sample; n 150 in the validation study sample).

Results: The pilot testing did not lead to any change in the questionnaire. The exploratory factor analysis revealed a two-subscale structure. The first subscale is composed of six items assessing accessibility to healthy foods and the second includes three items related to accessibility to unhealthy foods. Three items were removed from the questionnaire due to low loading on the two subscales. The subscales demonstrated adequate internal consistency (Cronbach's $\alpha=0.77$ for healthy foods and 0.62 for unhealthy foods) and test-retest reliability ($r=0.59$ and 0.60, respectively; both $P<0.0001$).

Conclusions: The Perceived Food Environment Questionnaire was developed for a French-Canadian population and demonstrated good psychometric properties. Further validation is recommended if the questionnaire is to be used in other populations.

Title page

Development and Validation of the Perceived Food Environment Questionnaire in a French-Canadian Population

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Keywords: Questionnaire, Food Environment, Perceptions, Validation, French

Introduction

There is a growing body of research exploring the effects of the neighbourhood environment on health behaviours, such as physical activity and healthy eating. Different methodologies are used to portray features of neighbourhoods, including food availability, that influence food intake. A popular method is to use geocoding to objectively assess the distance between respondents' home and food retailers or restaurants and to document exposure to various shop types (1-8). Other objective measures used are store audits, allowing to precisely report what kind of foods individuals are exposed to when grocery shopping (9-13). Despite the use of such objective measures, the relationship between the food environment and food choices is subject to conflicting results in the literature. Some studies have shown significant associations between food accessibility and/or availability and measures of food intake (3, 12, 13), while other studies have found no associations (1, 4-7). The fact that consumers do not always shop at the closest food retailer from home (1) may explain part of those mixed results. Given that different people may have different perceptions of the same food environment, other authors have opted for an approach that measures perceived food environment, i.e. participants' perceptions of the availability and/or accessibility and/or affordability of healthy and unhealthy foods in their neighbourhood. Generally using relatively short questionnaires, authors have once again obtained mixed results when looking at the relationship between the perceived food environment and food intakes. Many authors have reported positive associations between perceived accessibility to healthy foods and diet quality (13-17), but this has not been a systematic finding (18-20). These mixed results may be partly explained by the diversity of items used in different studies and the fact that most of them were not validated. Dibsall et al. (16) and Mujahid et al. (21) have developed and validated very short (3 items (21)) or very long scales (thirty items (16)), both assessing almost exclusively perceived access to fruit and vegetables.

In the context of a large study aimed at identifying determinants of healthy eating in the French-Canadian population of the Province of Québec, Canada, our research team wanted to create a questionnaire in order to evaluate the potential influence of the perceived food environment on healthy eating. In addition to the small number of studies having used validated items, there is, to our knowledge, no such questionnaire that was developed and validated for a French-speaking sample. As recommended by Beaton et al. (22), questionnaires should not be translated and then used without some adaptations for cultural differences between populations. In this case, it was decided that a new questionnaire would be developed since most of the existing tools were not validated and did not assess access to both healthy and unhealthy foods. Therefore, the aim of the present study was to develop and validate a questionnaire assessing perceived food environment (i.e. perceptions of the availability and/or accessibility and/or affordability of healthy and unhealthy foods in the neighbourhood) in an adult French-Canadian convenience sample. We hypothesize that the questionnaire we developed is valid and reliable for the targeted population.

Material and methods

Development of the items

For the development of the questionnaire, we were mostly inspired by items developed (but never validated) by Inglis et al. (23) and by the results obtained by Kamphuis et al. (24) in focus groups conducted in high and low socioeconomic groups. The items generated based on factors that were mentioned by their participants are therefore relevant for both high and low socio-economic groups. We were also inspired by items documented in several other studies having assessed participants' perceptions of their food environment (9, 12, 15, 16, 19, 20, 25-29). The items were developed and chosen by a team of three nutrition researchers and one health behaviour researcher to ensure the face validity of the questionnaire, i.e. the extent to which the items seemed to measure what the developers claim they measure (30).

The Perceived Food Environment Questionnaire that we developed first comprised fourteen items grouped into two distinct sections (see Table 8-1). The first section included twelve items assessing accessibility to healthy (nine items) and unhealthy foods (three items) and was developed to evaluate participants' perceptions of the food environment in their daily life (e.g. accessibility to healthy foods in food retailers, accessibility to healthy/unhealthy foods at the workplace, kitchen equipment). The items were rated on a five-point scale, from 'strongly disagree' to 'strongly agree', with the addition of a 'not applicable' option for the items pertaining to the work environment. Indeed, these items will not concern unemployed individuals. The second section included two complementary questions documenting the self-reported travel time from home to the main food retailer by car and on foot. These two items did not assess food environment perceptions. They were, however, included in the questionnaire because they would be useful for the interpretation of the results obtained in the previous section, allowing the integration of subjective (i.e. perceived food environment) and more objective (i.e. travel time) measures, as it was proposed that the two types of measures can bring complementary information (15, 25). The questionnaire's items were preceded by a short introduction text in which participants were informed that the questionnaire aims at assessing their own perceptions of their environment, and that there are no good or bad answers. A definition of 'healthy foods' was also presented: 'Healthy foods are foods recommended by the Canada's Food Guide, i.e. fruit and vegetables, whole grain products, low-fat dairy and alternatives, and low-fat meat and alternatives'.

Participants and procedures

The Perceived Food Environment Questionnaire's development and validation took place in the context of a research project aiming at validating a series of questionnaires on potential determinants of healthy eating and

blood biomarkers of fruit and vegetable intake. The Perceived Food Environment Questionnaire was validated using a two-step process, namely a pre-test and a validation study.

Pretest

In order to perform a pilot testing of the questionnaire, a convenience sample of thirty-one participants was recruited from an internal list of individuals interested in participating in clinical studies. Participants were fourteen men and seventeen women from the Québec City metropolitan area and were aged between 18 and 65 years (mean age: 45.6 (SD 13.9) years). Participants had to have at least minimal informatics skills since questionnaires were completed online. Each participant commented on the clarity of the questionnaire's items in a comment box on the Internet interface, which allowed us to assess acceptability and understanding of the items.

Validation study

For the validation study, a convenience sample of 150 participants (50% female) was recruited through electronic mailing lists comprising Laval University students and employees as well as individuals interested in participating in nutritional studies at the research centre. As for the pre-test, participants had to be aged 18 to 65 years and to have at least minimal informatics skills. Since blood biomarkers of fruit and vegetable intake were measured as part of the larger study of validation, participants had to be free from conditions affecting intestinal absorption. Pregnant and lactating women were also excluded.

Eligible participants came to the research centre for a blood sample and anthropometric measurements. After their visit to the research centre, participants were allowed a 1-month period to complete the series of questionnaires to be validated on the Internet platform of the study. Questionnaires were assigned to participants in a random order. The completion time for the series of questionnaires was approximately 40 min. After a 2-week period, participants were asked to complete the questionnaires a second time within another 30-d window.

Participants received a financial compensation (CAD 50) for their participation in the study. The study was conducted according to the guidelines laid down in the Declaration of Helsinki. The experiment had approval from the Research Ethics Committee at Laval University. Implicit informed consent was obtained from the pre-test participants and all participants from the validation study gave written informed consent.

Statistical Analyses

Analyses were performed on data derived from the validation study. An exploratory factor analysis (EFA) was performed on the twelve items of the first section of the questionnaire, using data from the first completion, in

order to assess the number of factors (subscales). The two items of the complementary section were planned to be interpreted separately, therefore they were not included in the current analysis. The requirement for sufficient sample size for factor analyses was met in the present study, with a participant-to-item ratio >10:1 (31). The EFA procedure aims at retaining as few factors as possible while explaining most of the variation in the data. The scree plot (32) and the modified eigenvalue-greater-than-one rule (33) were used to properly identify the number of factors in this specific section of the questionnaire. Internal consistency reliability was evaluated using Cronbach's α coefficients with data from the first completion of the questionnaire. The test-retest reliability was assessed using Pearson's correlations between the mean scores of the two completions for each subscale. Because of the questionnaires' random order, there is a possible time interval from 2 to 10 weeks between the two completions. To test the potential influence of this varying delay, partial Pearson's correlation analyses between the two completions, while adjusting for the time interval, were performed. Since data derived from the complementary items are categorical, the test-retest reliability of these items was evaluated using Cohen's κ agreement between the two completions. The κ coefficients were interpreted as follows: $\kappa \leq 0.2$, mediocre; $\kappa = 0.21-0.40$, low; $\kappa = 0.41-0.60$, moderate; $\kappa = 0.61-0.80$, strong; $\kappa = 0.81-1.00$, excellent (34). Statistical tests were two-sided and differences or associations at $P < 0.05$ were considered significant. Analyses were performed using the statistical software package SAS version 9.4.

Results

Pretest

Three participants did not complete the Perceived Food Environment Questionnaire; comments from twenty-eight participants were therefore considered in the pilot testing. The analyses of participants' answers and comments revealed that all items were well understood and not found to be ambiguous. Therefore, the pilot testing did not lead to changes in the questionnaire.

Validation study

A total of 150 participants were recruited for the validation study. One participant dropped out of the study before completing the questionnaires and two participants did not complete the Perceived Food Environment Questionnaire. Characteristics of the 147 remaining participants are presented in Table 8-2. The mean completion time of the questionnaire was 2.3 (SD 2.4) min.

Exploratory factor analysis. The twelve items of the questionnaire had adequate common variance, justifying the use of an EFA (Bartlett's test of sphericity: $\chi^2=356.14$, $P<0.0001$; Kaiser–Meyer– Olkin measure of sample adequacy=0.71 (35)). The analysis revealed that two factors should be considered for the set of items, accounting respectively for 73.7 and 17.5% of the variance. In order to obtain simple and interpretable factors, and since factors were not expected to co-vary, an orthogonal varimax rotation was used. Using a minimum loading cut-off of 0.30 or higher (36), three items did not load on any factor and were therefore removed from the questionnaire (see Table 8-1). With this factor structure, six items loaded strongly on the first factor (see Table 8-1) and it was decided that the factor would be named 'accessibility to healthy foods'. The second factor was named 'accessibility to unhealthy foods' since three items pertaining to fast-food restaurant and junk foods at work loaded strongly on it (see Table 8-1).

Internal consistency reliability. Both subscales were considered internally reliable, with Cronbach's α of 0.77 for the 'accessibility to healthy foods' subscale and 0.62 for the 'accessibility to unhealthy foods' subscale.

Test-retest reliability. A test–retest reliability analysis was performed using data from participants who completed the scale twice (seventy-four women and seventy-one men). Pearson's correlation coefficients between scores for the two completions for both subscales were calculated and revealed adequate reliability ($r=0.59$ and 0.60 , respectively, for the 'accessibility to healthy foods' and the 'accessibility to unhealthy foods' subscales; both $P<0.0001$). The mean time lapse between test and retest was 40.4 (SD 11.8) d (range: 14–99 d). The Pearson's coefficients remained similar when adjusted for time lapse between the two completions ($r=0.59$ and 0.60 ,

respectively; both $P < 0.0001$). As shown in Table 8-3, weighted Cohen's κ analyses revealed moderate agreement between the two completions for the two complementary items of the questionnaire.

Discussion

The purpose of the present study was to develop and validate a questionnaire assessing perceived food environment in a French-Canadian population, more specifically assessing the perception of the access to healthy and unhealthy foods. A new questionnaire was developed because of three major issues of the existing questionnaires which made them unsuitable for our needs. First of all, to our knowledge, only two of the existing questionnaires were subject to a validation process (16, 21). Second, only few existing questionnaires assessed access to both healthy and unhealthy foods, and none of them was validated. And third, to our knowledge, no such questionnaire currently exists for French-speaking populations. Therefore, the questionnaire developed and validated in the present study addressed an important gap in this area of research. Other authors have generally assessed access to either healthy foods or fast foods using one to four non-validated items (9, 12, 15, 17, 20, 26, 28, 37, 38). Mujahid et al. (21) validated a three-item availability to healthy foods questionnaire, measuring the internal consistency and the test-retest reliability of the scale. However, items were limited to the availability and the quality of fruit and vegetables, and to the variety of low-fat products in the neighbourhood. Dibsall et al. (16) also proceeded to a complete validation of their thirty-item scale assessing accessibility, affordability and motivation to eat fruit and vegetables, with methods that are similar to the ones used in the current study, such as EFA and Cronbach's α analyses. However, the length of the questionnaire, the fact that it was designed for low-income groups and the numerous items pertaining to motivation are some of the reasons why we developed a new questionnaire instead of translating this validated one.

The questionnaire we developed assessed participants' perception of their environment, rather than assessing the environment using objective measures. According to Mujahid et al. (21), one of the limitations of assessing participants' perception on the conditions in their neighbourhood is the potential bias related to some personal characteristics (e.g. socio-economic status, grocery shopping habits). However, Giskes et al. (39) and Williams et al. (17) found that perceived availability and price of foods were associated with purchase or consumption of those foods whereas objective measures were not. Behaviours may be more likely to be influenced by an individual's perception of his/her environment than by the actual environment itself (39), since perceptions include notions of noticing and understanding. Moreover, measuring perceptions is easier and less time-consuming than objectively describing food environments in participants' neighbourhood, particularly in large research projects where participants come from different geographical regions. Besides, Freedman et al. (40) observed that participants' perceptions did not differ significantly from objective measurements in terms of availability of healthy foods, suggesting similarities between results obtained from both measures. We believe that our questionnaire will help document the role of perceptions of the food environment in predicting healthy dietary habits and eating behaviours. Paired with questionnaires assessing other potential determinants of

healthy eating, this newly developed tool will eventually enable the investigation of how perceived environment interacts with other factors in predicting successful adherence to dietary recommendations.

An EFA was performed on the twelve items of the main questionnaire (i.e. excluding items of the complementary section) in order to verify whether these items should be divided into different subscales, given that different concepts are assessed (e.g. variety/quality/affordability in the main food retailer, access to healthy foods at the workplace, access to fast-food restaurant). The EFA revealed a two-factor structure, accounting for more than 91% of the variance. This structure reflects the fact that items related with perceived access to either healthy or unhealthy foods. Cronbach's α confirmed that both subscales were internally reliable. The calculation of mean subscale scores will facilitate the use of data derived from the questionnaire. However, since the items cover different concepts, it will also be possible to use items separately according to different research questions to be addressed and allow comparison with results from other studies, where tools generally assess availability, accessibility and affordability with distinct items. The EFA led to the removal of three items pertaining to access to healthy foods at work, kitchen equipment and availability of healthy foods at home. It is possible that the latter item did not load on any factor given that the home environment reflects a decision that individuals have already taken, which is to buy healthy foods and to bring them home.

In the present study, the test–rest reliability was assessed in two ways according to the nature of the data (i.e. numerical or categorical). Measures of the two subscales of the questionnaire correlated strongly when repeated in time, which is similar to results obtained elsewhere (21). The adjustment for the time lapse between the two completions did not influence the strength of the association, suggesting that the perceived food environment concept is stable at least over a 1- to 2-month period. For the two complementary items of the questionnaire, the weighted Cohen's κ coefficient showed moderate agreement between the two completions, once again suggesting a good stability over time.

Strengths and limitations

A major strength of the present study is the fact that it was designed expressly for the validation of questionnaires. Two different samples, one for the pre-test and one for the validation study, were recruited to assess the different steps using a rigorous validation process. Also, to our knowledge, the study led to the development of the first validated questionnaire assessing perceived accessibility to both healthy and unhealthy foods.

The main limitation of the study is its mostly Caucasian and highly educated sample, which is not representative of the whole French-Canadian population (41). The fact that participants for the pre-test were recruited from a list of individuals interested in participating in clinical studies constitutes another limitation since their interest in

nutrition may influence their perceptions and behaviours. These sample characteristics limit the external validity of the questionnaire. Further validation is needed for uses in different populations.

Conclusion

The aim of the present study was to develop and validate the Perceived Food Environment Questionnaire, which is, to our knowledge, the first validated tool assessing perceived accessibility to both healthy and unhealthy foods. The questionnaire demonstrated good psychometric properties and is thus considered a valid and reliable tool for the French-speaking Canadian population. This questionnaire will help document the role of the perceived food environment and its interaction with other factors in predicting healthy dietary habits and eating behaviours.

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Ethics of human subject participation: This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Research Ethics Committee at Laval University. Written informed consent was obtained from all participants.

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Tables

Table 8-1. Questionnaire items

| Items | Factor loading | |
|--|--------------------------------|----------------------------------|
| | Accessibility to healthy foods | Accessibility to unhealthy foods |
| 1. I consider that the quantity of healthy foods offered by my main food retailer is sufficient.* | 0.83 | -- |
| 2. I consider that the variety of healthy foods offered by my main food retailer is sufficient.* | 0.85 | -- |
| 3. I consider that the quality of healthy foods offered by my main food retailer is acceptable.* | 0.81 | -- |
| 4. I consider that the cost of healthy foods offered by my main food retailer is affordable.* | 0.41 | -- |
| 5. I consider that I have easily access to a food retailer with a good variety of foods near my home.* | 0.51 | -- |
| 6. I consider that I have easily access to healthy foods at work.* | -- | -- |
| 7. I consider that I possess the necessary equipment in order to integrate healthy foods to my meals.* | -- | -- |
| 8. I consider that healthy foods are always available at home.* | -- | -- |
| 9. I consider the information in the media about food and nutrition positively influences my diet.* | 0.35 | -- |
| 10. I consider that fast-food restaurants are easily accessible from my home.* | -- | 0.63 |
| 11. I consider that fast-food restaurants are easily accessible from my workplace.* | -- | 0.60 |
| 12. I consider that I have easily access to junk foods at work.* | -- | 0.60 |
| <u>Complementary questions</u> | n/a | n/a |
| 1. How much time does it take to get from home to your main food retailer by car? † | | |
| 2. How much time does it take to get from home to your main food retailer on foot? † | n/a | n/a |

Note: The French version of the instrument was validated. All items were translated from French to English using the back-translation procedure, and should not be used in their English version without validation.

* Response scale: a) Strongly disagree; b) Somewhat disagree; c) Neither agree or disagree; d) Somewhat agree; e) Strongly agree; f) Not applicable. The “not applicable” option is proposed only for items pertaining to the workplace.

† Response scale: a) Less than 10 minutes; b) From 10 to 20 minutes; c) More than 20 minutes.

Table 8-2. Validation study sample characteristics (n=147)

| | n (%) |
|-------------------------|------------|
| Female | 74 (50.3) |
| Age (y) | |
| 18-34 | 37 (25.2) |
| 35-49 | 29 (19.7) |
| 50-65 | 81 (55.1) |
| Ethnicity | |
| Caucasian | 140 (95.2) |
| Education | |
| High school | 14 (9.5) |
| College | 45 (30.6) |
| University | 88 (59.9) |
| Occupation | |
| Worker | 100 (68.0) |
| Retired | 32 (21.8) |
| Student | 9 (6.2) |
| No job | 3 (2.0) |
| Prefer nor to answer | 3 (2.0) |
| Household annual income | |
| <40 000\$CA | 26 (17.7) |
| 40 000-79 999\$CA | 47 (32.0) |
| ≥80 000\$CA | 62 (42.2) |
| Prefer nor to answer | 12 (8.1) |

Table 8-3. Weighted Cohen's Kappa

| Items | Weighted Cohen's Kappa |
|--|------------------------|
| Complementary questions | |
| Travel time from home to the food retailer on foot | 0.59 |
| Travel time from home to the food retailer by car | 0.59 |

Chapitre 9 : Associations entre l'environnement social et l'environnement physique et l'adhésion au GAC 2007

Elise Carbonneau, Benoît Lamarche, Julie Robitaille, Véronique Provencher, Sophie Desroches, Marie-Claude Vohl, Catherine Bégin, Mathieu Bélanger, Charles Couillard, Luc Pelletier, Luigi Bouchard, Julie Houle, Marie-France Langlois, Louise Corneau et Simone Lemieux.

Social Support, but Not Perceived Food Environment, Is Associated with Diet Quality in French-Speaking Canadians from the PREDISE Study

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Résumé

Les objectifs de cette étude étaient d'évaluer si le soutien des proches pour manger sainement et la perception de l'environnement alimentaire sont associés à la qualité alimentaire, et d'investiguer si des caractéristiques sociodémographiques modèrent ces associations. Un échantillon probabiliste d'adultes francophones de la province de Québec au Canada, a été recruté dans le cadre de l'étude PREDISE. Les participants ont rapporté leur perception d'actions favorables et non favorables en lien avec la saine alimentation de la part de proches à domicile et à l'extérieur du domicile (n=952), et leur perception de l'accessibilité aux aliments sains (n=1035). Le *Healthy Eating Index* canadien (C-HEI) a été calculé à partir de trois rappels de 24h. Des analyses de régressions multiples ont montré que les actions favorables (B=1,50 (95% IC 0,46, 2,54)) et non favorables (B=-3,06 (95% IC -4,94, -1,18)) des proches à domicile étaient positivement et négativement associées au C-HEI respectivement, alors que les actions des proches à l'extérieur du domicile n'étaient pas associées au C-HEI. L'association négative entre les actions non favorables à domicile et le C-HEI était plus forte chez les participants ayant un plus faible niveau de scolarité (p interaction=0,03). La perception de l'environnement alimentaire n'était pas associée au C-HEI (p>0,05). Ces résultats suggèrent que l'environnement social pourrait avoir une plus grande influence sur l'adhésion aux principes de la saine alimentation que l'environnement physique perçu. Ces résultats supportent les programmes de promotion de la saine alimentation impliquant des familles entières, particulièrement pour les individus ayant un plus faible niveau socioéconomique, chez qui des proches non aidants pourraient nuire davantage aux efforts pour manger sainement.

Abstract

The objectives were to assess whether social support for healthy eating and perceived food environment are associated with diet quality, and to investigate if sociodemographic characteristics moderate these associations. A probability sample of French-speaking adults from the Province of Québec, Canada, was recruited in the context of the PREDISE study. Participants reported their perceptions of supportive and non-supportive actions related to healthy eating from close others at home and outside of home ($n = 952$), and of the accessibility to healthy foods ($n = 1035$). The Canadian Healthy Eating Index (C-HEI) was calculated based on three Web-based 24 h food recalls. Multiple linear regression models showed that supportive ($B = 1.50$ (95% CI 0.46, 2.54)) and non-supportive ($B = -3.06$ (95% CI -4.94, -1.18)) actions related to healthy eating from close others at home were positively and negatively associated with C-HEI, respectively, whereas actions from close others outside of home were not. The negative association between non-supportive actions occurring at home and C-HEI was stronger among participants with lower (vs. higher) levels of education (p interaction = 0.03). Perceived accessibility to healthy foods was not associated with C-HEI ($p > 0.05$). These results suggest that the social environment may have a stronger influence on healthy eating than the perceived physical environment. This adds support for healthy eating promotion programs involving entire families, especially for more socioeconomically disadvantaged individuals, whose efforts to eat healthily may be more easily thwarted by non-supportive households.

Title page

Social Support, but Not Perceived Food Environment, Is Associated with Diet Quality in French-Speaking Canadians from the PREDISE Study

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Keywords: social support; food environment; diet quality; sociodemographic characteristics; healthy eating index

Introduction

A wide range of determinants have a potential influence on dietary intakes and eating behaviors (1). It has been proposed that determinants of healthy behaviors can be differentiated into three broad interrelated categories, namely motivations, abilities, and opportunities (2,3). While the first two categories are considered as personal or individual determinants, the third relates to the social and physical environments that contribute to opportunities for engaging in healthy behaviors. While various individual factors have been widely investigated in observational and intervention studies over the last decades, there is a growing scientific interest on determinants related to the social and physical environments that can influence food intake.

Although the literature has shown inconsistent evidence up until now (4–7), it has been suggested that social environment may have a more consistent influence on food behaviors than the physical environment (3). Social environment includes factors such as being married, the household size, having children, as well as relational factors such as parental modeling, social isolation, and social support, the latter being the most frequently studied. Social support can be defined as “a transactional communicative process, including verbal and/or nonverbal communication, that aims to improve an individual’s feelings of coping, competence, belonging, and/or esteem” (8). Most studies that have investigated the association between social factors and food intake to date have targeted specific subgroups of the population such as older adults (9–11), adolescents and children (12,13), or individuals affected by specific diseases (14,15). Results showed that social factors such as social support and parental modeling are usually associated with better diet quality. Social support has also been investigated in weight loss situations (16) and has been found to contribute to effective weight loss interventions (17). However, less is known regarding the association between social environment and food intake in the general population (18,19). Also, only few studies pertaining to social environment have evaluated food intake using proxies of overall diet quality (18–20), the majority having specifically studied the associations between social factors and either fruit and vegetable or fat intakes. Therefore, whether social support provided by family and friends towards healthy eating facilitates overall healthier eating habits remains uncertain.

Regarding the physical food environment, many authors have used store audits (21–23) or geocoding data (e.g., amount of food retailers in a given neighborhood, distance from participants’ home to groceries) (24–27) to evaluate how objectively measured features of the environment influence dietary intakes. These studies have come to conflicting results, which could be explained by consumers not always shopping at the food retailer closest to home (24,28) and by different individuals having different perceptions of the same food environment. In order to overcome these confounding factors, others have chosen to use subjective measures of the food environment, such as participants’ perceptions of the availability, accessibility or affordability of healthy and unhealthy foods in their neighborhood (29–32). Although measures of the perceived availability of healthy foods are more consistently related to dietary outcomes (7), the use of non-validated tools in the vast majority of studies

limits inferences that can be drawn from these studies. Also, many of these studies were performed in socioeconomically disadvantaged samples (23,29,30,33,34). Therefore, less is known about the impact of the physical food environment among individuals drawn from the general population and with various socioeconomic status. The use of non-validated instruments for the measures of both the environment and food intakes was raised by Brug (3) who also pointed to the lack of consideration for potential covariates and moderators (such as sociodemographic characteristics) to better understand the associations between the social and physical food environment and diet quality in the literature.

In order to overcome these methodological issues, the present study was preceded by validation studies aimed at developing specific instruments for the measure of the perceived social (35) and physical food environment (36) as well as the assessment of dietary intakes (37,38), in a sample distinct from the present study but with similar characteristics. Using these validated tools, the objectives of this study were 1) to assess whether and how social support for healthy eating is associated with overall diet quality and to investigate if sociodemographic characteristics moderate these associations, and 2) to assess whether and how perceived food environment is associated with overall diet quality to investigate if sociodemographic characteristics moderate these associations, in a sample of French-speaking adults from the Province of Québec, Canada.

Materials and Methods

Participants and Procedures

Participants were recruited as part of the PREDISE (PRÉDICTeurs Individuels, Sociaux et Environnementaux) study, a multicentre cross-sectional study aimed at identifying determinants of the adherence to dietary guidelines among French-speaking adults from the Province of Québec, Canada. Recruitment and procedures were described previously (39). Briefly, a probability sample of French-speaking men and women from the Province of Québec aged 18 to 65 were included in the study. They were recruited using random digit dialing in order to represent the French-speaking adult population of five regions of recruitment based on sex and age. Individuals had to have an Internet access for the completion of questionnaires. Exclusion criteria were pregnancy, lactation, and intestinal malabsorption. Once recruited, participants had three weeks to complete a series of online questionnaires on an Internet platform and they visited a research center affiliated to the PREDISE study in their region for anthropometric and blood pressure measurements, and for blood sampling.

On a total of 1849 individuals recruited, 1206 were included in the PREDISE project. A total of 1081 completed three 24 h recalls, among which 952 completed the Social Support for Healthy Eating Questionnaire and 1035 completed the Perceived Food Environment Questionnaire (see Figure 9-1 for the study flowchart and information on excluded participants).

Measures

Social support for healthy eating was assessed using the Social Support for Healthy Eating Questionnaire, a validated tool that was developed for the French-speaking adult population of the Province of Québec (35). The questionnaire consists of 20 items in which participants are asked to rate how frequently, in the past month, close others had taken particular actions or said particular statements related to healthy and unhealthy eating in two different environments, i.e., at home (defined as “people living with you, e.g., family members, partner, roommate”) and outside of home (defined as “people with whom you share meals, but who do not live with you, e.g., friends, colleagues”). Twelve items relate to supportive actions (sample items include: “...proposed that we eat healthier” or “... gave me ideas to eat more healthy foods”) and eight items relate to non-supportive actions (sample items include: “...criticized the healthy foods that I served them” or “...said that healthy foods do not taste good”). Items were rated on a five-point Likert scale (“never”, “rarely”, “sometimes”, “often”, and “very often”). Answers were scored on four subscales for each participant, i.e., supportive actions at home; non-supportive actions at home; supportive actions outside of home; and non-supportive actions outside of home. Subscales scores were obtained by calculating the means of the items, with a maximum score of five. Higher scores for the

supportive and the non-supportive scales mean a higher frequency of these types of action. All four subscales showed good internal consistency in the present sample with Cronbach α ranging from 0.76 to 0.90.

Perceived food environment was assessed using the Perceived Food Environment Questionnaire, specifically developed and validated to assess perceived accessibility to healthy and unhealthy foods among French-speaking adults in the Province of Québec (36). The tool is composed of two subscales, the first assessing accessibility to healthy foods through six items (e.g., “I consider that the quantity of healthy foods offered by my main food retailer is sufficient”) and the second including three items related to accessibility to unhealthy foods (e.g., “I consider that fast-food restaurants are easily accessible from my home”). The questionnaire contains items related to the food environment near home and workplace. Items are rated on a five-point scale, from “strongly disagree” to “strongly agree”, with the addition of a “not applicable” option for the items pertaining to the work environment. In the present sample, the subscale assessing accessibility to healthy foods showed adequate internal consistency (Cronbach α = 0.70), but the three items related to accessibility to unhealthy foods were not considered as internally reliable (Cronbach α = 0.49). It was therefore decided that the subscale assessing perceived accessibility to healthy foods would be the only one used in the present study. In the questionnaire, participants were also asked to report travel time (less than 10 min, 10–20 min, or more than 20 min) from home to the main food retailer by car and on foot.

It is important to specify that we decided not to provide participants with a precise definition of “healthy eating” and “unhealthy eating” to be sure not to influence their answers in the 24 h food recalls. However, in the Social Support for Healthy Eating questionnaire, “junk foods” was defined and examples of “healthy foods” were given to participants. In the Perceived Food Environment questionnaire, a brief definition of “healthy foods” was also presented.

Diet quality was assessed with the Canadian Healthy Eating Index 2007 (C-HEI). Participants completed three Web-based 24 h food recalls, using an application (R24W) developed by our research team (38). Participants had to report all foods and drinks consumed from midnight to midnight on three days generated at random by the Web-based system. The R24W was validated for the French-speaking adult population of Province of Québec (37,40,41). Using data generated by the R24W, participants’ overall diet quality was calculated through the C-HEI (42). The index was developed to reflect 2007 Canada’s Food Guide recommendations for healthy eating (43). The C-HEI is composed of eight adequacy components (total fruits and vegetables, whole fruits, dark-green and orange vegetables, grain products, whole-grain products, milk and alternatives, meat and alternatives, and unsaturated fat) and three moderation components (saturated fat, sodium, and “other foods” i.e., foods that are not part of those recommended by Canada’s Food Guide). Each component is evaluated on 5, 10, or 20 points, for a total maximum score of 100 (see full description of the C-HEI score in Supplementary

Table S9-7). The C-HEI was computed as a continuous variable in the analyses based on the average intake of foods and nutrients from the three 24 h recalls (42).

In a sociodemographic questionnaire, participants reported their age, their highest level of education (i.e., no diploma, elementary school, high school, college, or university), and their annual household income. For the analyses, education was classified in two categories, i.e., high school or less vs. college or university, and income was divided in two categories, i.e., participants living under the low-income cut-off according to the Québec Institute of Statistics, based on the household size (44) vs. those living over the low-income cut-off. Participants also provided information on marital status, i.e., married (or living common-law) vs. other status, and living arrangement (i.e., living with partner and children, partner only, children only, other family member, roommate, or living alone). Smoking status was assessed, and participants were classified as current smokers (frequently or occasionally) vs. non-smokers/former smokers. Nutrition knowledge was also assessed (45).

Ethics

The PREDISE study was conducted according to the guidelines laid down in the Declaration of Helsinki. The research project received approval from the Research Ethics Committees of Université Laval (ethics number: 2014-271), Centre hospitalier universitaire de Sherbrooke (ethics number: MP-31-2015-997), Institut de recherches cliniques de Montréal (ethics number: 2015-02), and Université du Québec à Trois-Rivières (ethics number: 15-2009-07.13). All participants gave implied consent for the first phase of the study (i.e., completion of online questionnaires) and written informed consent for the second phase (i.e., anthropometric and blood pressure measurements and blood sampling at the research center). As a compensation for the first phase of the study, two iPads and 40 gift certificates (CAD 100) were randomly drawn among participants who completed the online questionnaires. Participants also received a CAD 50 compensation at their visit to the research center.

Statistical Analyses

For the first objective of the study, participants included were those having completed all three 24 h recalls and having no missing data in the Social Support for Healthy Eating Questionnaire. Differences in social support according to sociodemographic characteristics were assessed using Student's t-test and generalized linear models (GENMOD). Multiple linear regression analyses were performed to assess how social support was associated with the C-HEI, the proxy of diet quality (dependent variable). The four social support subscales (i.e., supportive actions at home, non-supportive actions at home, supportive actions outside of home, and non-supportive actions outside of home) were used as the independent variables. We also tested interaction terms to evaluate if some sociodemographic characteristics (i.e., sex, age, income, education, living with a partner vs. living with someone else, living alone vs. not living alone) moderate the association between social support and

the diet quality. Stratified analyses were then performed according to significant moderators. For the second objective of the study, participants included were those having completed all three 24 h recalls, and having no missing data in the Perceived Food Environment Questionnaire. The same analyses as described for the first objective were used, and the independent variables in the regression models were the perceived accessibility to healthy foods and the travel time by car (travel time was dichotomised: 10 min or less vs. more than 10 min). The potential moderators tested were sex, age, income, and education. Covariates included in all models were sex, age, education, income, nutrition knowledge, marital status, and smoking status, and were all found to be significantly associated with diet quality in previous analyses (46). Since misreporting of dietary intake can be an issue causing systematic bias, reporting status (i.e., under-reporter, plausible reporter, or over-reporter) was also included as a covariate. As previously detailed (47), the reporting status was assessed using the method by Huang et al., (48) according to which under- and over-reporters are those with a calculated energy intake: predicted energy requirement ratio <0.78 and >1.22 , respectively. Missing data for education, income, marital status, smoking status, and reporting status were imputed using the MI procedure. Less than 10% of participants had missing information, and missing data pattern was arbitrary, we therefore performed multivariate imputation using a fully conditional specification (FCS) logistic regression method for classification variables. The unstandardized betas are presented for the results of the regression analyses. Statistical tests were two-sided and differences or associations at $p < 0.05$ were considered significant. Analyses were performed using the SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Objective 1: Social Support for Healthy Eating

Characteristics of the 952 participants included for the first objective are presented in Table 9-1.

The mean C-HEI was 57.1 ± 14.1 on a scale of 0 to 100 (note that scores from 50 to 80 can be categorized as a “diet that require improvements (42)”). Mean scores for the four subscales of the Social Support for Healthy Eating questionnaire are presented in Table 9-2. Overall, participants seemed to perceive more supportive actions than non-supportive ones from their close others both at home and outside of home. Women perceived less supportive actions and more non-supportive actions at home than men. However, women perceived more supportive actions outside of home than men (see Table 9-2). Age groups’ differences were also observed (see details in Table 9-2). Overall, older participants perceived less supportive and non-supportive actions from family and friends at home and outside of home. Social support at home also varied according to participants’ living arrangement (Table 9-2). Participants living either with a partner, with a partner and children, or with another family member were the ones who perceived the highest supportive actions at home. As expected, participants who reported living alone perceived less social support at home. As presented in Table 9-2, more supportive actions at home were reported by individuals with higher income, and more supportive actions outside of home were reported by individuals with higher income and education levels.

Unadjusted correlations between the four subscales of social support for healthy eating and C-HEI are presented in Supplementary Table S9-8. Both supportive actions both at home and outside of home were positively associated with C-HEI ($p < 0.05$).

Multiple linear regression analyses showed that supportive and non-supportive actions at home were respectively associated positively and negatively with C-HEI while neither type of actions outside of home was associated with C-HEI (Table 9-3).

Sex, age, and annual household income were not found to significantly moderate the associations between social support subscales and C-HEI (p interaction > 0.05). However, education significantly moderated the association between non-supportive actions at home and C-HEI (p interaction = 0.03). Results of the multiple linear regression analyses stratified by education levels showed that the non-supportive actions at home were negatively associated with C-HEI in all participants, but the association was stronger among participants with a high school diploma or less (see Table 9-4). No significant interactions were found between social support subscales and the two variables related to living arrangement ($p > 0.05$).

Objective 2: Perceived Food Environment

Characteristics of the 1035 participants included for the second objective were similar to those of participants included for the first objective (see Supplementary Table S9-9).

On a scale of one to five, the average accessibility to healthy foods score was 3.8 ± 0.5 (5.4% of participants had a score below three, 50.0% had a score between three and four, and 44.6% had a score of four or higher). As shown in Table 5, there were no differences in the score between men and women nor between age groups. The accessibility to healthy foods score was, however, lower for participants with lower annual household income and for participants with lower educational attainment. The accessibility to healthy foods score did not differ between the 5 recruitment regions ($p = 0.26$). Travel time from home to the main food retailer on foot was less than 10 min for 28.7% of the participants, 10 to 20 min for 28.2% of the participants, and more than 20 min for 43.1% of the participants. Travel time from home to the main food retailer by car was less than 10 min, 10 to 20 min, and more than 20 min for respectively 75.6%, 21.1%, and 3.4% of the participants.

As shown in Table 9-6, neither perceived accessibility to healthy foods score nor travel time by car was significantly associated with C-HEI. Results were similar when the variable “travel time on foot” was used instead of “travel time by car”. None of the sociodemographic characteristics tested (i.e., sex, age, income, and education) was found to moderate the association between the accessibility to healthy foods score and C-HEI (p interaction > 0.05).

Discussion

The present study aimed to explore the role of social and perceived physical food environment in the adherence to healthy eating recommendations in a probability sample of French-speaking adults from the Province of Québec. Representing about one fifth of the population of Canada, the French-speaking population of the Province of Québec has been found to differ from other Canadians with respect to food intakes and attitudes towards eating (49,50), stressing the relevance of studying determinants of healthy eating in this specific population.

To the best of our knowledge, the present study is one of the first to assess social support from two different sources (i.e., close others at home and outside of home) in association with a proxy of overall diet quality. Our results suggest that supportive and non-supportive actions from individuals with whom one lives have the potential of enhancing or thwarting the adherence to a healthy diet whereas supportive and non-supportive actions from individuals outside of home were not found to significantly influence diet quality. These results may be explained by the fact that many individuals share more meals with people they live with than with friends and coworkers (50). In this regard, there may be more social interaction regarding food at home due to food-related tasks, such as food planning, procurement, and cooking, which can be shared with family members, partners, or roommates (51). Furthermore, as we have previously proposed, there may be more stability in individuals with whom one shares meals at home than outside of home (35), which may offer more opportunities for influencing one's opinion about healthy eating and intention to eat healthily in the home environment than outside of home. In other studies, family support, compared to support from friends, has been found to be more consistently associated with intake of fruit and vegetable and fast food, or with low-fat diets (52–54). The type of support received from close others in different contexts can impact on the styles of motivation regulating one's health-related behaviors. Indeed, the role of social support has been positively associated with autonomous motivation for behavioral change in interventions aiming at weight loss (16), tobacco cessation (55), and increased physical activity (56), but less is known regarding specifically the adherence to healthy eating recommendations (57). Therefore, it can be hypothesized that motivational processes play a role in the association between social support and diet quality observed in the present study and this avenue should be further investigated.

There is a growing body of literature on the impact of social support on food intake, and more specifically on healthy eating. However, as raised by Brug (3) in a narrative review of systematic reviews on the topic, very few studies to date have assessed the influence of sociodemographic characteristics as potential moderators of the association between food environment and diet quality. Studying moderators of the associations between social/physical food environment and diet quality may be helpful for a better understanding of the conditions under which the food environment impacts food intake. Among the sociodemographic characteristics tested in

the present study, education was found to be a significant moderator of the association between social support and diet quality. These results suggest that some individuals, namely those with lower education level, may be more vulnerable to non-supportive actions from their close others. These findings provide insights for the explanation of the well-documented differences in diet quality between socioeconomically advantaged and disadvantaged individuals (42,58–60). Our results are in line with previous research (52) suggesting that healthy eating promotion programs involving entire families for an enhanced social support at home may help reduce the impact of the socioeconomic status on diet quality.

The nonsignificant interaction between sex and social support we noted suggests that men and women do not benefit differently from social support when it comes to overall diet quality, as other authors have previously reported (61). However, gender differences have previously been observed. In fact, in a sample of US adults, the perception of a higher social support from close others was related to better dietary practices among women but not men (62). It was also found that men benefited more from the support of their heterosexual partner than women in terms of dietary change intentions and dietary behavior (low-fat diet) (63).

Our results have shown that the perceived accessibility to healthy foods and the distance from home to the main food retailer are not significantly associated with the overall diet quality in our French-Canadian sample from the Province of Québec. Many other studies have found no significant association between food environment and food intake (24,31,34,64), although it has been suggested that associations between environment and behaviors are stronger when subjective (e.g., perception of the accessibility to healthy foods) rather than objective (e.g., store audits) measures are used (7,65,66). In the present study, the absence of association may be due to the low variability in the independent variables studied. Indeed, less than 6% of the sample had a negative perception of the accessibility to healthy foods (i.e., mean score below three out of five; three representing a neutral opinion), and 44% had a mean score of four or higher, meaning that they agreed or strongly agreed with most of the items. More than 75% of the sample also reported that travel time by car from home to the main food retailer was less than 10 min. This low variability in the independent variables may be due to the study design, where participants had to visit one of the research centers for blood sampling as well as for measurements of anthropometric variables and blood pressure. Therefore, we may have recruited participants living near city centers where the accessibility to healthy foods is often higher. Different results may have been observed if we had recruited more participants living in rural areas. Based on the results we obtained, it can be hypothesized that the perception of physical food environment is less likely to have an impact on diet quality in urban areas, but more research is needed to further examine this hypothesis.

One of the objectives of the present study was to assess whether some sociodemographic characteristics moderated the association between perceived physical food environment and diet quality, or in other words,

whether some subgroups of the population are more likely to be influenced by their perception of the physical environment when it comes to healthy eating. Such interactions have been rarely tested, and it has been previously pointed out as a major issue of studies interested in the association between environment and food intake (3). A recent systematic review on socioeconomic differences in the association between the food environment and dietary behaviors concluded that there is no clear evidence of such differences (67). Two studies have observed differences between ethnicities in the association between physical environment and fruit and vegetable intake (23,25). In the present study, interactions tested revealed that sex, age, annual income, and education did not moderate the association between perceived accessibility to healthy foods and diet quality. It would have been relevant to know if participants were the primary food shopper of their household since it could be expected that individuals who are in charge of grocery shopping are more influenced by or conscious of the food accessibility.

Strengths and limitations of this study deserve to be acknowledged. First, the exclusive use of validated tools that were specifically developed for the study population improves the reliability of the results obtained. Also, the use of an index of the overall diet quality brings novelty to this field of research where most studies to date have used specific proxies of healthy eating, such as intake of fruits and vegetables. Moreover, diet quality was measured based on three 24 h food recalls, increasing the likelihood of capturing participants' usual intakes (68,69). The fact that recruitment was performed using a random list of phone numbers is another strength of this study, allowing us to reach participants who do not usually volunteer to participate in such studies. Unfortunately, this recruitment method was not enough to prevent highly educated individuals to be overrepresented in our sample (45.8% having a university degree vs. 31% for the population of the Province of Québec (70)), thus limiting the generalizability of the results. Another limitation of this study is its cross-sectional design; therefore, it is not possible to know if improvement in the social or physical food environment would lead to improved diet quality.

Conclusions

In conclusion, the present study sheds light on the associations of social and perceived physical environment with overall diet quality among French-speaking adults of the Province of Québec. Consistent with previous observations (65), our results suggest that social environment, more precisely social support from close others at home, may have a stronger influence on healthy eating than perceived physical environmental factors. These findings support the added value of healthy eating promotion programs focusing on social support at home, especially for more socioeconomically disadvantaged individuals, whose efforts to eat healthily may be more easily thwarted by non-supportive households.

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Tables

Table 9-1. Sample characteristics.

| Characteristics | <i>n</i> (%) |
|---|---------------------|
| Female | 471 (49.5) |
| Age (years) | |
| 18–34 | 348 (36.6) |
| 35–49 | 283 (29.7) |
| 50–65 | 321 (33.7) |
| Ethnicity | |
| Caucasian | 868 (91.2) |
| Highest level of education | |
| High school or less | 216 (22.7) |
| College | 290 (30.5) |
| University | 436 (45.8) |
| Missing value or prefer not to answer | 10 (1.1) |
| Occupation | |
| Worker | 604 (63.5) |
| Retired | 127 (13.3) |
| Student | 114 (12.0) |
| No job | 36 (3.8) |
| Other | 49 (5.2) |
| Missing value or prefer not to answer | 22 (2.3) |
| Marital status | |
| Married or living under common law | 604 (63.4) |
| Other status | 284 (29.8) |
| Missing value or prefer not to answer | 64 (6.7) |
| Living arrangement (living with...) | |
| Partner only | 243 (25.5) |
| Partner and children | 367 (38.6) |
| Children only | 55 (5.8) |
| Family member (other than a partner and children) | 125 (13.1) |
| Roommate | 22 (2.3) |
| Alone | 127 (13.3) |
| Missing value or prefer not to answer | 13 (1.4) |
| Smoking status | |
| Current smoker | 120 (12.6) |
| Non-smoker or former smoker | 830 (87.2) |
| Missing value | 2 (0.2) |

Note: *n* = 952 participants included for the analyses for the objective regarding social support for healthy eating.

Table 9-2. Scores for the four subscales of the Social Support for Healthy Eating questionnaire for the whole sample and according to sociodemographic characteristics.

| | Supportive Actions at Home | | Non-Supportive Actions at Home | | Supportive Actions Outside of Home | | Non-Supportive Actions Outside of Home | |
|-----------------------|----------------------------|------------|--------------------------------|------------|------------------------------------|------------|--|------------|
| | Mean ± SD | <i>p</i> | Mean ± SD | <i>p</i> | Mean ± SD | <i>p</i> | Mean ± SD | <i>p</i> |
| Whole sample | 3.2 ± 0.9 | <i>n/a</i> | 1.6 ± 0.5 | <i>n/a</i> | 2.6 ± 0.8 | <i>n/a</i> | 1.6 ± 0.5 | <i>n/a</i> |
| Sex | | | | | | | | |
| Women | 3.1 ± 0.9 | 0.0343 | 1.7 ± 0.6 | 0.0001 | 2.7 ± 0.8 | 0.0008 | 1.6 ± 0.5 | 0.79 |
| Men | 3.2 ± 0.9 | | 1.6 ± 0.5 | | 2.6 ± 0.8 | | 1.6 ± 0.5 | |
| Age | | | | | | | | |
| 18–34 year | 3.2 ± 0.9 | 0.0179 * | 1.7 ± 0.5 | <0.0001 * | 2.8 ± 0.7 | 0.0004 * | 1.8 ± 0.6 | <0.0001 * |
| 35–49 year | 3.2 ± 0.9 | | 1.7 ± 0.5 | | 2.7 ± 0.8 | | 1.6 ± 0.4 | |
| 50–65 year | 3.0 ± 1.0 | | 1.5 ± 0.5 | | 2.5 ± 0.8 | | 1.6 ± 0.5 | |
| Education | | | | | | | | |
| High school or less | 3.1 ± 0.9 | 0.19 † | 1.7 ± 0.5 | 0.11 † | 2.6 ± 0.9 | 0.0405 † | 1.7 ± 0.5 | 0.48 † |
| College or university | 3.2 ± 0.9 | | 1.6 ± 0.5 | | 2.7 ± 0.8 | | 1.6 ± 0.5 | |
| Income | | | | | | | | |
| <low-income cut-off | 3.0 ± 1.0 | 0.0219 † | 1.6 ± 0.6 | 0.49 † | 2.6 ± 0.9 | 0.07 † | 1.7 ± 0.7 | 0.20 † |
| >low-income cut-off | 3.2 ± 0.9 | | 1.6 ± 0.5 | | 2.7 ± 0.8 | | 1.6 ± 0.5 | |
| Living with | | | | | | | | |
| Partner only | 3.4 ^a ± 0.7 | | 1.6 ^a ± 0.5 | | 2.6 ± 0.8 | | 1.6 ^{a,b} ± 0.5 | |
| Partner and children | 3.3 ^{a,b} ± 0.7 | | 1.8 ^b ± 0.5 | | 2.6 ± 0.8 | | 1.6 ^c ± 0.5 | |
| Children only | 3.1 ^{b,c} ± 0.7 | <0.0001 * | 1.7 ^{a,b} ± 0.5 | <0.0001 * | 2.8 ± 0.9 | 0.26 * | 1.7 ^{a,b,c} ± 0.6 | 0.0124 * |
| Family member | 3.3 ^{a,b,c} ± 0.8 | | 1.7 ^{a,b} ± 0.5 | | 2.6 ± 0.8 | | 1.8 ^b ± 0.6 | |
| Roommate | 3.0 ^c ± 0.8 | | 1.6 ^{a,b} ± 0.5 | | 2.8 ± 0.8 | | 1.7 ^{a,b,c} ± 0.4 | |
| Alone | 2.0 ^d ± 1.1 | | 1.2 ^c ± 0.3 | | 2.6 ± 0.8 | | 1.5 ^{a,c} ± 0.4 | |

Note. *N* = 952. Scores are on a maximum of 5 points. Higher scores for the supportive and the non-supportive scales mean a higher frequency of these types of action. Differences in social support scores between categories were tested using generalized linear models (GENMOD), with Tukey adjustment for multiple comparisons. ^{a, b, c} Categories with different superscripted letters are significantly different (*p* < 0.05). * Adjusted for sex. † Adjusted for sex and age.

Table 9-3. Regression analyses of Canadian Healthy Eating Index (C-HEI) score on social support variables.

| | C-HEI Score | |
|--|-------------|----------------|
| | B | (95% CI) |
| Independent variables | | |
| Supportive actions at home | 1.50 | (0.46, 2.54) |
| Non-supportive actions at home | -3.06 | (-4.95, -1.18) |
| Supportive actions outside of home | 0.71 | (-0.46, 1.87) |
| Non-supportive actions outside of home | 0.73 | (-1.20, 2.65) |
| Covariates | | |
| Sex (1 = female, 2 = male) | -5.62 | (-7.45, -3.80) |
| Age groups (1 = 18–34 year, 2 = 35–49 year, 3 = 50–65 year) | 0.87 | (-0.18, 1.92) |
| Education (1 = high school or less, 2 = college or university) | 2.05 | (-0.04, 4.15) |
| Household annual income (1 = <low-income cut-off, 2 = >low-income cut-off) | 1.19 | (-1.46, 3.85) |
| Marital status (1 = other status, 2 = married or living in common-law) | -0.36 | (-2.47, 1.74) |
| Smoking status (1 = non-smoker/former smoker, 2 = current smoker) | -6.93 | (-9.47, -4.40) |
| Nutrition knowledge (continuous score from 0 to 100) | 0.13 | (0.06, 0.19) |
| Reporting status (1 = under-reporter, 2 = plausible reporter, 3 = over-reporter) | 2.66 | (0.82, 4.51) |

Note: $n = 952$. B = Unstandardized beta.

Table 9-4. Regression analyses of Canadian Healthy Eating Index (C-HEI) score on social support variables, stratified by education levels.

| | C-HEI Score | | | |
|---|-----------------------|----------------|--------------------------|-----------------|
| | High School or Less * | | College or University ** | |
| | B | (95% CI) | B | (95% CI) |
| Independent variables | | | | |
| Supportive actions at home | 1.37 | (-0.69, 3.44) | 1.55 | (0.32, 2.77) |
| Non-supportive actions at home | -6.09 | (-9.92, -2.25) | -2.24 | (-4.42, -0.06) |
| Supportive actions outside of home | 1.10 | (-1.19, 3.38) | 0.77 | (-0.60, 2.13) |
| Non-supportive actions outside of home | 0.90 | (-3.33, 5.13) | 0.55 | (-1.66, 2.76) |
| Covariates | | | | |
| Sex (1 = female, 2 = male) | -5.01 | (-9.02, -1.00) | -5.82 | (-7.89, -3.76) |
| Age groups (1 = 18–34 year, 2 = 35–49 year, 3 = 50–65 year) | 1.37 | (-0.80, 3.53) | 0.84 | (-0.37, 2.05) |
| Household annual income (1 = under low-income cut-off, 2 = over low-income cut-off) | 1.18 | (-3.38, 5.75) | 1.39 | (-1.90, 4.67) |
| Marital status (1 = other status, 2 = married or living in common-law) | -3.26 | (-7.29, 0.78) | 0.34 | (-2.16, 2.85) |
| Smoking status (1 = non-smoker, 2 = current smoker) | -5.20 | (-9.69, -0.72) | -7.66 | (-10.75, -4.57) |
| Nutrition knowledge (continuous score from 0 to 100) | 0.30 | (0.17, 0.43) | 0.07 | (-0.01, 0.14) |
| Reporting status (1 = under-reporter, 2 = plausible reporter, 3 = over-reporter) | 2.21 | (-1.05, -5.47) | 2.94 | (0.70, 5.19) |

Note: * $n = 218$; ** $n = 734$. B = Unstandardized beta.

Table 9-5. Accessibility to healthy foods scores for the whole sample and according to sociodemographic characteristics.

| Accessibility to Healthy Foods | | |
|---------------------------------------|------------------|-----------------|
| | Mean ± SD | <i>p</i> |
| Whole sample | 3.8 ± 0.5 | <i>n/a</i> |
| Sex | | |
| Women | 3.8 ± 0.5 | 0.61 |
| Men | 3.8 ± 0.5 | |
| Age | | |
| 18–34 year | 3.8 ± 0.6 | 0.23 * |
| 35–49 year | 3.9 ± 0.5 | |
| 50–65 year | 3.8 ± 0.5 | |
| Income | | |
| <low-income cut-off | 3.7 ± 0.6 | 0.0007 † |
| >low-income cut-off | 3.9 ± 0.5 | |
| Education | | |
| High school or less | 3.7 ± 0.6 | 0.0027 † |
| College or university | 3.9 ± 0.5 | |

Note. *N* = 1035. Scores are on a maximum of 5 points. Differences in accessibility to healthy foods between categories were tested using generalized linear models (GENMOD), with Tukey adjustment for multiple comparisons. * Adjusted for sex. † Adjusted for sex and age.

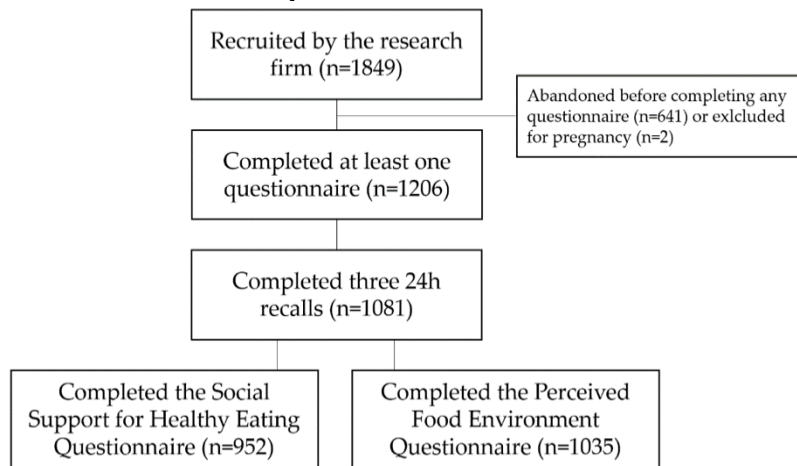
Table 9-6. Regression analyses of Canadian Healthy Eating Index (C-HEI) score on perceived food environment variables.

| | C-HEI Score | |
|---|-------------|----------------|
| | B | (95% CI) |
| Independent variables | | |
| Perceived accessibility to healthy foods | 0.01 | (-1.51, 1.53) |
| Travel time from home to the main retailer (by car; 1 = Less than 10 min, 2 = 10 min or more) | 1.31 | (-0.62, 3.24) |
| Covariates | | |
| Sex (1 = female, 2 = male) | -5.50 | (-7.22, -3.78) |
| Age groups (1 = 18–34 year, 2 = 35–49 year, 3 = 50–65 year) | 0.68 | (-0.32, 1.69) |
| Education (1 = high school or less, 2 = college or university) | 2.21 | (0.18, 4.25) |
| Household annual income (1 = under low-income cut-off, 2 = over low-income cut-off) | 1.74 | (-0.77, 4.24) |
| Marital status (1 = other status, 2 = married or living in common-law) | 0.50 | (-1.39, 2.39) |
| Smoking status (1 = non-smoker/former smoker, 2 = current smoker) | -6.71 | (-9.14, -4.27) |
| Nutrition knowledge (continuous score from 0 to 100) | 0.13 | (0.06, 0.19) |
| Reporting status (1 = under-reporter, 2 = plausible reporter, 3 = over-reporter) | 2.33 | (0.54, 4.11) |

Note: $n = 1035$. B = Unstandardized beta.

Figure

Figure 9-1. Flowchart of the PREDISE study.



Supplemental material

Supplemental Table S9-7. Description of the C-HEI scoring for adults

| Component | Range of scores | Scoring criteria |
|----------------------------------|---------------------------------|---|
| Adequacy | 0 to 60 points | |
| Total vegetables and fruit | 0 to 10 points | Minimum : 0 Maximum : 7 to 8 servings |
| Whole fruit | 0 to 5 points | Minimum: 0 Maximum: 1.5 to 1.7 servings (21% of recommendation for total vegetables and fruit) |
| Dark green and orange vegetables | 0 to 5 points | Minimum: 0 Maximum: 1.5 to 1.7 servings (21% of recommendation for total vegetables and fruit) |
| Total grain products | 0 to 5 points | Minimum : 0 Maximum : 6 to 8 servings |
| Whole grains | 0 to 5 points | Minimum: 0 Maximum: 3 to 4 servings (50% of recommendation for total grain products) |
| Milk and alternatives | 0 to 10 points | Minimum : 0 Maximum : 2 to 3 servings |
| Meat and alternatives | 0 to 10 points | Minimum: 0 Maximum: 2 to 3 servings (150 to 225 grams) |
| Unsaturated fats | 0 to 10 points | Minimum : 0 Maximum : 30 to 45 grams |
| Moderation | 0 to 40 points | |
| Saturated fats | 8 to 10 points 0 to 8 points | Minimum 7% to 10% of total energy intake 10% to maximum 15% of total energy intake |
| Sodium | 8 to 10 points 0 to 8 points | Adequate intake to tolerable upper intake level Tolerable upper intake level to twice tolerable upper intake level |
| “Other foods” | 0 to 20 points | Minimum: 5% or less of total energy intake Maximum: 40% or more of total energy intake |

For adequacy components, 0 point for minimum, 5 or 10 points for maximum or more, and proportional for amounts between minimum and maximum.

For moderation components, 10 or 20 points for minimum or less, 0 point for maximum or more, and proportional for amounts between minimum and maximum.

Reference: Garriguet D. Diet quality in Canada. Ottawa: Statistics Canada, 2009.

Supplemental Table S9-8. Unadjusted Pearson's correlations between C-HEI and subscales of the Social Support for Healthy Eating.

| Independent variables | Correlation with C-HEI | |
|--|------------------------|----------|
| | <i>r</i> | <i>p</i> |
| Supportive actions at home | 0.09 | 0.0086 |
| Non-supportive actions at home | -0.05 | 0.07 |
| Supportive actions outside of home | 0.10 | 0.0025 |
| Non-supportive actions outside of home | -0.01 | 0.67 |

Note : n=952.

Supplemental Table S9-9. Sample characteristics

| | n (%) |
|---|------------|
| Female | 517 (50.0) |
| Age (years) | |
| 18-34 | 373 (36.0) |
| 35-49 | 307 (29.7) |
| 50-65 | 355 (34.3) |
| Ethnicity | |
| Caucasian | 938 (90.6) |
| Highest level of education | |
| High school or less | 243 (22.4) |
| College | 319 (30.8) |
| University | 461 (44.5) |
| Missing value or prefer not to answer | 12 (1.2) |
| Occupation | |
| Worker | 658 (63.6) |
| Retired | 140 (13.5) |
| Student | 117 (11.3) |
| No job | 40 (3.9) |
| Other | 56 (5.4) |
| Missing value or prefer not to answer | 24 (2.3) |
| Marital status | |
| Married or living under common law | 654 (63.2) |
| Other status | 309 (29.9) |
| Missing value or prefer not to answer | 72 (7.0) |
| Living arrangement (living with...) | |
| Partner only | 268 (25.9) |
| Partner and children | 393 (38.0) |
| Children only | 58 (5.6) |
| Family member (other than a partner and children) | 133 (12.9) |
| Roommate | 20 (1.9) |
| Alone | 148 (14.3) |
| Missing value or prefer not to answer | 15 (1.4) |
| Smoking status | |
| Current smoker | 135 (13.0) |
| Non-smoker or former smoker | 898 (86.8) |
| Missing value | 2 (0.2) |

Note: n=1035 participants included for the analyse for the objective regarding perceived food environment.

Chapitre 10 : Associations entre les types de motivation à l'égard de l'alimentation et l'adhésion au GAC 2007

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L'article présenté dans ce chapitre s'intitule: Individuals with self-determined motivation for eating have better overall diet quality: Results from the PREDISE study

Cet article a été soumis à la revue *Appetite* en août 2020.

Résumé

Cette étude visait à documenter les styles motivationnels à l'égard de l'alimentation tels que définis par la théorie de l'autodétermination et leurs associations avec des caractéristiques sociodémographiques et la qualité globale de l'alimentation. Un autre objectif était de mener des analyses exploratoires dans le but d'examiner si la motivation autodéterminée à l'égard de l'alimentation explique une partie des associations déjà documentées entre des facteurs individuels et sociaux et la qualité de l'alimentation. Dans le contexte de l'étude PREDISE, 550 femmes et 547 hommes francophones, âgés de 18 à 65 ans et vivant dans la province de Québec au Canada, ont complété des questionnaires web. L'échelle de régulation des comportements alimentaires, basée sur la théorie de l'autodétermination, a été utilisée pour mesurer la motivation autodéterminée et la motivation non-autodéterminée à l'égard de l'alimentation. Trois rappels alimentaires de 24h ont été remplis et ont servi à calculer le score *Healthy Eating Index* canadien (C-HEI), un indicateur de l'adhésion aux recommandations du GAC 2007. Des régressions linéaires multiples ont évalué l'association entre les types de motivation et le C-HEI. Un plus haut niveau de motivation autodéterminée à l'égard de l'alimentation a été rapporté par les femmes ($p < 0,0001$), les participants plus âgés ($p = 0,0002$), ceux ayant un plus haut niveau de scolarité ($p < 0,0001$) et les non-fumeurs ($p < 0,0001$). La motivation autodéterminée était positivement associée au C-HEI ($B = 3,82$, $p < 0,0001$) alors que la motivation non-autodéterminée y était négativement associée ($B = -1,63$, $p = 0,0006$). La motivation autodéterminée a permis d'expliquer, en partie, les associations déjà connues entre des facteurs individuels et sociaux (c.-à-d., le sexe, la scolarité, le tabagisme, les connaissances en nutrition et le soutien social) et le score C-HEI ($p < 0,05$). La présente étude suggère que certains groupes de la population ont une motivation plus autodéterminée à l'égard de l'alimentation, et que ce type de motivation est associé à une meilleure qualité de l'alimentation. Les résultats suggèrent aussi que la motivation autodéterminée explique une partie des associations entre certaines variables et la qualité alimentaire. Des stratégies visant à aider les individus à internaliser leur motivation à l'égard de l'alimentation devraient être davantage étudiées.

Abstract

The study aimed at documenting motivational orientations for the regulation of eating as defined by self-determination theory and their association with sociodemographic characteristics and overall diet quality. The study also aimed at performing exploratory analyses to assess whether the level of self-determined motivation accounts for the associations of individual factors and social support with diet quality. As part of the PREDISE study, French-speaking women (n=550) and men (n=547), aged 18 to 65 years, living in the Province of Québec, Canada, completed online validated questionnaires. The Regulation of Eating Behavior Scale, based on the self-determination theory, assessed self-determined and non-self-determined motivation to regulate one's eating behavior. Three web-based 24-hour food recalls were completed and used to compute the Canadian Healthy Eating Index 2007 (C-HEI), an indicator of the overall adherence to Canadian guidelines for healthy eating. Multiple linear regressions were performed to assess how regulation styles are associated with the C-HEI. Women ($p < 0.0001$), older individuals ($p = 0.0002$), those with a higher education level ($p < 0.0001$), and non-smokers ($p < 0.0001$) reported higher self-determined motivation score than their counterparts. Self-determined motivation was positively ($B = 3.82$, $p < 0.0001$) and non-self-determined motivation was negatively ($B = -1.63$, $p = 0.0006$) associated with C-HEI. Self-determined motivation partly accounted for the associations of sex, smoking status, and nutrition knowledge with C-HEI ($p < 0.05$). Self-determined motivation also completely accounted for the associations of education and social support with C-HEI ($p < 0.05$). The present study suggests that some subgroups of the general adult population show more self-determined motivation for eating, which is associated with a better diet quality. Results also suggest that self-determination partly explains the associations between various factors and diet quality. Strategies to help individuals internalize the regulation of eating should be further investigated.

Title page

Individuals with self-determined motivation for eating have better overall diet quality: Results from the PREDISE study

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Introduction

Healthy diet is recognized as one of the main targets for the prevention of noncommunicable diseases (1). Although some individuals may have a healthy diet, the weak improvement of the diet quality in the population over the years (2) suggests that several individuals are struggling to adhere to healthy eating guidelines. Healthy eating represents a demanding self-regulatory process influenced by several factors, including individual, social, and environmental factors (3). Since motivation can help individuals take actions towards a behavior, the way individuals regulate their eating behaviors may contribute to the healthiness of the diet.

The Self Determination Theory (SDT) is a general theory of human motivation (4, 5) that has been largely applied to domains such as health, education, work, and sport. According to SDT, the ways individuals regulate their behaviors vary on a self-determination continuum. The different types of regulation underlying individuals' behaviors are, from the least to the most self-determined forms of regulations: amotivation, external, introjected, identified, integrated and intrinsic motivation (4). Amotivation refers to a state where individuals fail to perceive that their actions (e.g., eating) can lead to significant outcomes (e.g., global health). Thus, amotivated individuals question the value of engaging in a behavior (6) and are unable to explain why they would engage in a particular behavior. External regulation refers to a behavior that is perceived as constrained by external sources, engaged in to obtain a reward, or performed to avoid negative consequences. Next, introjected regulation typically refers to a behavior performed to avoid feelings of guilt or anxiety and marks the beginning of the internalization process. Identified regulation is the next form of motivation and it represents a behavior that is viewed as important and/or valuable by a person. Following is integrated regulation, which occurs when a behavior is perceived as being in congruence with a person's core values and being part of the larger self. Finally, intrinsically motivated behaviors are engaged in for the pleasure, the interest, and the satisfaction derived from participation itself. The more internalized is the motivation for a behavior, the more it generates positive outcomes and the more likely the positive outcomes are to be maintained (6). According to Ryan et al. (6), regulations styles that are situated at the lower end of the continuum (i.e., amotivation, external and introjected regulations) are considered to be "non-self-determined", whereas the regulation styles that are at the upper end of the continuum (i.e., identified, integrated, and intrinsic regulations) are considered to be "self-determined".

In the last decades, regulation styles for various health behaviors, such as tobacco cessation (7-9), physical activity (for a review, see Teixeira et al. (10)), medication compliance (11-13), and long-term weight loss (for a review, see Teixeira et al. (14)) have been studied. Evidence suggests that higher level of self-determined (or autonomous) motivation is associated with positive physical and mental health outcomes (15). There is also a growing body of literature showing that being self-determined toward eating is associated with positive physical and psychological health outcomes, such as more adaptive eating practices (16), concern with quality rather than the quantity of foods eaten (17, 18), lower BMI (16, 19), and lower level of internalization of sociocultural

beliefs about thinness and obesity (18). Conversely, non-self-determined motivation has been associated with more body dissatisfaction (20, 21), more bulimic symptoms (17, 21), and higher BMI (16, 17, 19).

Scientific interest for the associations between SDT concepts and diet quality has grown in the last decade, yet there is still only scarce evidence on the benefits of more self-determined regulation styles on overall diet quality. To date, higher self-determined motivation has been associated with higher intakes of fruits and vegetables (8, 19, 22-25), lower fat intake (26), and lower junk foods consumption (19). Self-determined motivation has also been positively associated with “healthy eating behaviors”, measured using reported general consumption (from “never” to “always”) of various food items recommended by the Canada’s Food Guide (27) (e.g., “I eat vegetables”, “I eat foods that are low in fat, saturated fat, and cholesterol”) (17, 21, 28-30). At the other end of the self-determination continuum, non-self-determined (or controlled) motivation has been associated with higher fat intake (26), higher junk food consumption (19), and less “healthy eating behaviors” (as described above) (17, 21). Associations between non-self-determined motivation and fruits and vegetables intake are inconsistent, with studies reporting positive (8, 23) or negative (19) associations, or no association at all (22). Current available evidence suggests that a more self-determined motivation for eating is associated with a healthier diet, but two major issues limit the literature on the topic. First, most studies cited above were performed in samples including only female undergraduate university students (17, 19, 21, 28-30). Therefore, less is known regarding the associations between regulation styles for eating behaviors and diet quality among the general adult population, including among men. Second, the studies performed among adult populations including women and men limited their assessment of diet quality to measures of fruits and vegetables intake (22-26) and fat intake (26). To our knowledge, no study has yet investigated associations between regulation of eating behaviors and an overall diet quality indicator among women and men at a population level.

Although the associations between regulation styles for eating behaviors and healthy eating indicators have not been widely studied, current evidence suggests that more self-determined motivation for eating regulation is associated with better diet quality, independently of potential sociodemographic confounders. This suggests that self-determination may constitute a key element when it comes to the adherence to healthy eating guidelines. However, less is known regarding how the level of self-determination interplays with other individual and contextual factors (24) in the determination of diet quality.

The first objective of the study was to examine associations between sociodemographic and individual characteristics such as sex, age, education, income, and smoking status and regulation styles for eating behaviors. The second objective was to investigate how regulation styles for eating behaviors are associated with an overall diet quality indicator. Finally, in order to better understand the potential key role of self-determined motivation in the adherence to healthy eating guidelines, the third objective was to perform exploratory analyses

to assess whether self-determined motivation accounts for other already documented associations between either individual (i.e., sex, age, education, smoking status, nutrition knowledge) (31, 32) or contextual (i.e., social support for healthy eating) (33) variables and diet quality.

Methods

Participants and procedures

The web-based cross-sectional PREDISE (“PRÉDicteurs Individuels, Sociaux et Environnementaux” [in French], meaning “individual, social, and environmental predictors”) study aimed at identifying correlates of adherence to Canadian guidelines for healthy eating in a sample from the Province of Québec in Canada. Procedures and recruitment have already been described elsewhere (34). In short, from August 2015 to April 2017, participants aged 18 to 65 were recruited using random digit dialing in order to have an age- and sex-representative sample of French-speaking adults from 5 regions of the Province of Québec. Inclusion criteria was to have Internet access in order to complete the questionnaires. Exclusion criteria were pregnancy, lactation, and intestinal malabsorption because blood biomarkers of fruit and vegetable intake were also measured during the study (note that the analyses pertaining to blood biomarkers are beyond the scope of this paper). Participants were given a three-week period to complete a series of online questionnaires on an Internet platform. Then, they visited a research center affiliated to the PREDISE study in their region for various measurements, including anthropometric measures and blood collection. A total of 1849 individuals met inclusion criteria and gave consent to participate, of which 1147 completed at least one food recall and were therefore included in the PREDISE study.

Measures

Canadian Healthy Eating Index 2007 (C-HEI). Participants' usual dietary intakes were evaluated through three 24-hour food recalls completed during the three weeks allocated to complete the questionnaires. The food recalls were completed using a Web-based interface (R24W) specifically developed and validated by our research team for the adult French-speaking population of the Province of Québec (35-38). Participants had to report all foods and drinks consumed from midnight to midnight on three days generated at random by the tool within a 3-week timeframe. Data generated by the R24W were used to compute the C-HEI (39), an indicator of the overall diet quality. The index was developed by Statistics Canada to reflect 2007 Canada's Food Guide's (CFG) recommendations for healthy eating (27), the guidelines in force when the study was initiated. The C-HEI is composed of eight adequacy components (total fruits and vegetables, whole fruits, dark green and orange vegetables, grain products, whole grain products, milk and alternatives, meat and alternatives, and unsaturated fat) and three moderation components (saturated fat, sodium, and “other foods” [i.e. that are not part of the foods recommended by CFG]). Each component is evaluated on 5, 10 or 20 points, for a total maximum score of 100 (see full description of the C-HEI score in Appendix 1). The C-HEI was used as a continuous variable in the analyses. Participants who completed at least one food recall were selected for the study (n=1147; 94.3% of participants completed three food recalls, 3.1% completed two recalls, whereas and 2.6% completed only one

recall). Since misreporting of dietary intake can be an issue causing systematic bias, energy reporting status (i.e., under-reporter, plausible reporter, or over-reporter) was assessed using the method by Huang et al. (40) according to which under- and over-reporters are those with a calculated energy intake: predicted energy requirement ratio < 0.78 and > 1.22 , respectively, and was previously described by Brassard et al. (31).

Regulation of eating behaviors. Participants completed the Regulation of Eating Behavior Scale developed by Pelletier et al. (17) and based on the SDT. The scale is composed of 24 items assessing the reasons why individuals regulate their eating behaviors, with four items for each of the six regulation styles (i.e. amotivation, external, introjected, identified, integrated, and intrinsic regulations). Responses were scored on a 7-point Likert scale, ranging from (1) “Does not correspond at all” to (7) “Corresponds exactly.” Sample items are: “I don’t know. I can’t see how my efforts to eat healthy are helping my health situation” (amotivation), “Because other people close to me insist that I do” (external regulation), “Because I would feel ashamed of myself if I was not eating healthy” (introjected regulation), “Because I believe it’s a good thing I can do to feel better about myself in general” (identified regulation), “Because eating healthy is an integral part of my life” (integrated regulation), “Because it is fun to create meals that are good for my health” (intrinsic regulation). In the present study, all subscales were internally reliable, with Cronbach alpha values ranging between 0.78 and 0.94. Following the procedure adopted by Pelletier et al. (21), intrinsic, integrated, and identified regulations were aggregated to form a global score of self-determined motivation, whereas the three other subscales were grouped together to form a global score of non-self-determined regulation. Participants with all 24 items missing in the Regulation of Eating Behavior Scale were excluded from the analyses ($n=50$). A total of 1097 had data for the Regulation of Eating Behaviors Scale and were therefore included in the analyses.

Sociodemographic characteristics. Participants completed a sociodemographic questionnaire, and the answers to each question were categorized for the use of sociodemographic variables in the analyses. Age was categorized in accordance with the three recruitment strata (i.e., 18-34 y, 35-49 y, and 50-65 y). Participants reported the highest education degree obtained and were classified into one of the two following categories, i.e., high school or less, vs. CEGEP or university. In the Québec education system, CEGEP is the first level of post-secondary education and includes pre-university programs and technical programs. Regarding annual household income, participants were also divided into two categories: participants living under the low-income cut-off according to the Québec Institute of Statistics, based on the reported annual income and household size (41), vs. those living over the low-income cut-off. Participants also reported their marital status, i.e., married (or in a common-law union) vs. other status. Smoking status was classified as current smokers (frequently or occasionally) vs. non-smokers (or former smokers).

Nutrition knowledge. Participants' nutrition knowledge was assessed using a questionnaire developed and validated for the French-speaking population of the Province of Québec (42). The Nutrition Knowledge Questionnaire is a 20-item tool consisting of four questions, three of which assessing familiarity with 2007 CFG (e.g., "How many portions a day do you think CFG recommends, for an individual of your age and gender for each of the following food groups?", "For each of the four CFG groups, five food items are listed. Identify whether or not these items are included in the food group"). The last question assesses general nutrition knowledge (e.g., "Indicate whether you agree or disagree with the following statements: All spices are high in sodium (salt)."). The maximum total score for the questionnaire is 13.5 points, but results are presented in percentages to facilitate interpretation. Nutrition knowledge was previously found to be significantly associated with C-HEI in the PREDISE study (32).

Social support for healthy eating. The Social Support for Healthy Eating Questionnaire is a validated tool that was developed for the French-speaking adult population of the Province of Québec (43). In this questionnaire, participants are asked to rate how frequently, in the past month, close others had taken 20 particular actions (or said particular statements) related to healthy and unhealthy eating. The questionnaire is composed of four subscales (i.e., supportive actions at home; non-supportive actions at home; supportive actions outside of home; and non-supportive actions outside of home) of which the two related to close others at home were found to be significantly associated with the C-HEI (33). Therefore, for the purpose of the present study, only these two subscales were used (i.e., supportive actions at home; non-supportive actions at home). Twelve items relate to supportive actions (sample item includes: "... proposed that we eat healthier") and eight items relate to non-supportive actions (sample item includes: "... said that healthy foods do not taste good"). Subscales scores were obtained by calculating the means of the items with a maximum score of five. Higher scores for the supportive and the non-supportive scales mean a higher frequency of these types of action.

Ethics

The PREDISE study was conducted according to the guidelines laid down in the Declaration of Helsinki. The project received approval from the Research Ethics Committees of Université Laval (ethics number: 2014-271), Centre hospitalier universitaire de Sherbrooke (ethics number: MP-31-2015-997), Montreal Clinical Research Institute (ethics number: 2015-02), and Université du Québec à Trois-Rivières (ethics number: 15-2009-07.13). All participants gave implied consent for the first phase of the study (i.e., completion of online questionnaires) and written informed consent for the second phase (i.e., anthropometric measurements and blood sampling at the research center). As a compensation for the first phase of the study, participants who completed at least three of 13 online questionnaires were eligible for a random drawing of 40 gift certificates (100 CAD) and those

who completed all 13 questionnaires were eligible for a random drawing of two iPads. Participants also received a financial compensation (50 CAD) at their visit to the research center.

Statistical analyses

Analyses were performed using the Statistical Analysis Software (SAS) version 9.4 (Copyright © 2013, SAS Institute Inc., Cary, NC, USA). Missing data for the items of the Regulation of Eating Behavior Scale were dealt with using multiple imputation (109 participants [9.7 %] had missing data in the questionnaire, among which the majority [n=94] had only one missing item). Multiple imputation was also performed for missing data for education (n=21), income category (i.e., living under vs. over the low-income cut-off; n=116), smoking status (n=2), energy reporting status (n=76), nutrition knowledge (n=75), and social support variables (n=79). Multiple imputation inference involves three distinct phases: 1) The missing data are filled in *m* times to generate *m* complete data sets (in the present study, *m*=10), using the MI procedure in SAS; 2) The *m* complete data sets are analyzed by using standard procedures; 3) The results from the *m* complete data sets are combined for the inference (44), using the MIANALYZE procedure in SAS. Missing data pattern was arbitrary (i.e., no particular pattern in the missing data structure, missing observations distributed across variables in a non-systematic fashion), we therefore performed multivariate imputation using a fully conditional specification (FCS) logistic regression method for classification variables (44). Multiple imputation by FCS is proposed as a powerful and statistically valid method for creating imputations for both categorical and continuous variables (45). For participants who did not complete three food recalls, missing data on the C-HEI were not imputed. All participants who completed at least one food recall (94.3% of participants had three food recalls, 3.1% had two recalls, and 2.6% had one recall) were included in analyses, which is considered acceptable for cross-sectional studies by the Dietary Assessment Primer of the National Institutes of Health (46). The C-HEI was calculated for each available food recall and averaged for all participants who completed multiple 24h recalls.

For the first objective, differences in self-determined and non-self-determined motivation according to selected characteristics (i.e., sex, age, education, income, smoking status) were assessed using the GENMOD procedure in SAS that fits generalized linear models, with Tukey adjustment for multiple comparisons. The second objective was firstly assessed using unadjusted Pearson's correlation between self-determined and non-self-determined motivation and the C-HEI components. Secondly, a multiple linear regression model was performed using self-determined and non-self-determined motivation as independent variables, the C-HEI as dependent variable, and sex, age, education, income, smoking status, and energy reporting status included as covariates. These variables were found to be significantly associated with food intake or diet quality in previous analyses (34). In all regression models, energy reporting status was transformed into two dummy variables, i.e., under-reporting (1=no, 2=yes) and over-reporting (1=no, 2=yes). Then, we tested interaction terms to evaluate whether selected

characteristics (i.e., sex, age, education, and income) moderate the association between self-determined and non-self-determined motivation and the C-HEI. For the third objective, mediation analyses were conducted to assess whether self-determined motivation accounted for the association between correlates of healthy eating (i.e., sex, age, education, smoking status, nutrition knowledge, social support for healthy eating [i.e., supportive and non-supportive actions from close others to eat healthily]) and the C-HEI. The analyses were conducted with the use of model 4 in the PROCESS macro version 3.5 for SAS (47) that calculates bias-corrected 95 % CI using bootstrapping with 5000 samples. The PROCESS macro was run in the 10 complete data sets generated by the MI procedure, and inferences from the 10 sets were combined manually. Note that mediation models should usually be used only when there is a defined time-ordered relationship between the variables (48). Although the cross-sectional design of the present study prevents from establishing this time-ordered relationship between the variable studied, we used mediation models to assess, with exploratory intention, the indirect effect of self-determined motivation in previously documented associations of correlates with C-HEI. For each selected correlate, the macro provides the total effect (which is the regression of C-HEI on the correlate), the direct effect (which is the regression of C-HEI on the correlate while taking into account self-determined motivation), and the indirect effect (or mediation effect) of the correlate on the C-HEI through self-determined motivation. A complete mediation occurs when the direct effect is not significant once the mediator is taken into consideration, and a partial mediation is considered when the direct effect remains significant. The following variables were included as covariates in all regression models (except for the model in which it is used as the independent variable): sex, age, education, income, smoking status, and energy reporting status. Statistical tests were two-sided and differences or associations at $p < 0.05$ were considered significant.

Results

Characteristics of the 1097 participants included before imputation are presented in Table 10-1.

Objective 1

Mean regulation styles for eating behaviors scores for the whole sample as well as according to individual characteristics are presented in Table 10-2. Women (vs. men), participants aged 35 to 65 y (vs. 18-34 y), those with higher education (vs. high school diploma or less) and non-smokers (vs. smokers) had significantly higher scores for self-determined motivation. No difference was observed for non-self-determined motivation scores.

Objective 2

The mean C-HEI score of the sample was 56.9 ± 14.3 . Unadjusted correlations between motivation styles for eating behaviors scores and the C-HEI components are presented in Table 10-3. Self-determined motivation was positively correlated with the C-HEI and all its components except for total grain products. Non-self-determined motivation was negatively correlated with the C-HEI, total vegetables and fruits, whole fruits, dark green and orange vegetables, and percentage of total energy intake from other foods.

The first regression model showed that self-determined motivation was positively associated with C-HEI, whereas non-self-determined motivation was negatively associated with C-HEI (see Table 10-4). Other multiple linear regressions were performed with the inclusion of interaction terms in order to assess if sociodemographic and individual characteristics (i.e., sex, age, education, and income) moderated the associations of self-determined motivation and non-self-determined motivation with the C-HEI. None of the variables tested were found to be significant moderators of the associations (p interaction > 0.05).

Objective 3

Analyses for this objective were conducted with independent variables (i.e., sex, age, education, smoking status, nutrition knowledge, and social support) that have all been previously associated with diet quality in the PREDISE study (31-33). Analyses performed showed a partial mediation effect of self-determined motivation for the associations relating sex, smoking status, nutrition knowledge, and non-supportive actions from close others to eat healthily with C-HEI (Table 10-5). Mediation models also showed a complete mediation effect of self-determined motivation for the associations of education and supportive actions from close others to eat healthily with C-HEI. Given age was not associated with C-HEI in the model adjusted for covariates ($p=0.24$), we did not test it further in a model including self-determined motivation.

Discussion

To our knowledge, the present study is one of the firsts to document how self-determined and non-self-determined motivation for eating behaviors vary according to individual characteristics in the general adult population. We found that women, individuals aged 35y or more, those with educational attainment higher than high school, and non-smokers had higher scores for self-determined motivation. Satia et al. (26) conducted one of the few other studies in which motivations to regulate eating behaviors are documented according to sociodemographic characteristics, although they used a different questionnaire to assess motivations. Asking participants “How important is it that you change your diet”, they found that women had higher scores than men for motives related to self-image (i.e., “so that you like yourself better”, “so that you feel better”, and “to lose or control weight”), whereas men had higher scores than women for motives related to personal health (i.e., “because your doctor told you to”, “to control an existing medical problem”, and “to prevent cancer or another serious illness”) and social pressure (i.e., “so that people will stop nagging you” and “because people will be upset with you if you don't change your diet”). Older participants were also more likely to report motives related to personal health than younger participants. The authors found no significant differences in motives reported by participants according to household income. In that study, the authors considered motives related to self-image and personal health as being intrinsic types of motivation, and motives related to social pressure as being external motivation. In a sample of adults presenting cardiovascular risk factors, Leblanc et al. (49) used the eating-related Self-Determination Index and observed that men's regulation of eating behavior was less self-determined. More specifically, intrinsic motivation and integrated regulation were lower in men than in women. Overall, as scarce as current evidence is, the results of the present study add to the literature suggesting that women present a more self-determined motivation for eating. Such differences are also poorly documented in studies regarding motivation styles towards other behaviors. Women, compared to men, were found to display a more self-determined motivation towards education (50, 51), but a more non-self-determined motivation for exercise (52) and tobacco cessation (53). This suggests that sociodemographic differences in regulation styles, such as differences between men and women, may vary according to the nature of the behavior studied.

As expected and concordant with the literature suggesting that self-determined motivation is associated with the adherence to numerous health-related behaviors (15), we observed that self-determined motivation and non-self-determined motivation were respectively positively and negatively associated with diet quality as assessed by the C-HEI. Similarly, Guertin et al. (30) have recently found that self-determined motivation was positively associated with healthy eating behaviors and negatively associated with unhealthy eating behaviors using a new scale they developed based on the recommendation of the Canada's Food Guide. Healthy and unhealthy eating behaviors were measured by asking participants to indicate the extent to which they generally consume different food items (e.g., “I eat vegetables,” “I eat snack foods, such as chips, chocolate, and/or candy.”) on a scale going

from “never” to “always”. However, previous studies have shown high rates of misperceptions of one’s diet quality (54-56), fruit and vegetable consumption (57), and fat intake (58). Therefore, our method using food recalls for the calculation of an overall diet quality index may have provided less subjective information about one’s eating habits. To our knowledge, the present study is the first to examine associations between motivation and eating behaviors using an index of the overall diet quality derived from food recalls.

Whereas we observed differences in eating regulation style scores according to sociodemographic characteristics, none of the characteristics tested in the moderation models (i.e., sex, age, education, and income) was found to moderate the association of self-determined and non-self-determined motivation with diet quality as assessed by the C-HEI. These results suggest that tending towards a more self-determined motivation for healthy eating is associated with better overall eating habits independently of sociodemographic characteristics. To our knowledge, very few studies have looked at sex differences in the associations of healthy eating motivation and diet quality, and the moderator effect of other sociodemographic characteristics seems to have been assessed for the first time in the present study. Some evidence suggests that eating-related self-determined motivation may be more positively associated with diet quality among men than women (22, 59). The fact that the present study did not document differences between men and women in the associations of motivation with diet quality, but others did (22, 59) can be due to other variables that we did not evaluate, such as stages of change (i.e., detection, decision, implementation, maintenance, and habit) (30). As suggested by Guertin et al. (30), the identification of individuals’ stages of change may be helpful to better understand the association between self-determined motivation and diet quality, since the association is likely to differ from one stage to another.

An exploratory objective of the study was to assess whether self-determined motivation could mediate previously documented associations between either individual or social determinants of healthy eating and diet quality. The determinants chosen for these analyses (i.e., sex, age, education, smoking status, nutrition knowledge, and social support) have all been previously associated with adherence to dietary guidelines in the PREDISE study (32-34). Our results suggest that the associations between all of these variables (except for age) and C-HEI could be partially (sex, smoking status, nutrition knowledge, and non-supportive actions from close others to eat healthily) or completely (education and supportive actions from close others to eat healthily) mediated by self-determined motivation. Although the cross-sectional design of the study prevent causal assumption, these results suggest that self-determined motivation could be one of the reasons (or the main reason) why women, individuals with higher education, non-smokers, individuals with better nutrition knowledge, as well as those receiving more social support for healthy eating at home are more likely to adhere to dietary guidelines. These results shed light on the largely documented difference in diet quality observed between men and women (e.g., (60-62)). The present study suggests that helping men move towards a more self-determined motivation could

contribute to reduce the gap between men and women when it comes to healthy eating. Regarding the smoking status, it seems that part of the negative association between smoking and diet quality could be explained by a less self-determined eating motivation among smokers. Studies have suggested that regulation of eating behaviors is associated with general level of self-determination (i.e., reasons for which people perform their different life activities) (21) and that motivations towards various health behaviors can be interrelated (63). Findings of the present study corroborate this hypothesis, suggesting that individuals who value health are likely to adhere to different health-related behaviors such as non-smoking and eating a healthy diet. Regarding the other variables that were examined in the present study, the results suggest that the associations of education, nutrition knowledge, and social support with the healthiness of the diet are largely explained by self-determined motivation for eating. To our knowledge, such associations have not been explored yet in the literature and more studies are needed to better understand the interplay between these variables. The analyses for this objective were performed for an exploratory purpose. Future longitudinal studies are warranted to examine the temporal order of the potential mediation effect of motivation between other determinants of diet quality and C-HEI.

The current observations suggest that helping individuals move towards a more self-determined motivation for eating is likely to contribute to better diet quality. Among strategies to promote self-determination, motivational interviewing techniques are recognized as effective to facilitate the process of internalization of extrinsic motivations (64) by supporting the basic psychological needs of self-determined motivation. SDT posits that the satisfaction of three basic psychological needs, which are autonomy (i.e., the need to feel volitional), competence (i.e., the need to feel capable of achieving the behavior), and relatedness (i.e., the need to feel connected to and understood by important others), is essential in the internalization process of motivation (5). Health professionals using the motivational interview try to empower their patients in their desired behavior change (64) while promoting more sustainable forms of motivation (4). One of the limitations of motivational interviewing as a strategy to increase self-determination is its one-to-one or small groups context (65) (vs. populational campaigns), with the premise that the person in need has access to a health professional using the motivational interviewing techniques. The literature on the subject should investigate strategies to facilitate the internalization of motivation that could reach a larger population, using a public health nutrition approach. Analyses we performed to assess the indirect effect of motivation in association between healthy eating determinants and diet quality suggested that higher levels of nutrition knowledge and social support for healthy eating are associated with higher self-determined motivation, which is, in turn, associated with better diet quality. These findings open new research directions for the promotion of self-determined motivation, that need to be explored in prospective study designs.

The literature on the associations between motivational orientations for eating behaviors and diet quality has grown in the last decades. However, two major issues limit the current state of knowledge. First, studies so far

predominantly comprise young women, thus limiting the generalization of the results. Secondly, proxies of the diet quality (i.e., fat intake, fruit and vegetable consumption) were used in many studies and there is a lack of evidence using validated measures of overall diet quality. We addressed these issues by recruiting a more diverse adult sample and by using validated tools that were specifically developed for the study population, notably for the measure of diet quality. One of the strengths of our study lays in the use of three 24-hour food recalls to evaluate dietary intakes, increasing the likelihood of capturing participants' usual intakes (66, 67), and the calculation of an overall indicator of the adherence to dietary guidelines (i.e., C-HEI).

Although the study was conducted in Canada, findings cannot be generalized to the whole Canadian population. It has been reported that the French-speaking population of the Province of Québec, which represents about one fifth of the Canadian population, differs from other Canadians with respect to food intakes and attitudes towards eating (68, 69), highlighting the relevance of examining determinants of healthy eating in this specific population. Another limitation is that highly educated individuals are overrepresented in our sample (44% having a university degree, vs. 31% for the population of the Province of Québec (70)) despite recruitment procedures using a random list of phone numbers in order to reach participants who do not usually volunteer to participate in such studies. The imputation of missing data allowed to minimize the impact of this overrepresentation by the inclusion of participants with missing data who were more likely to be non-Caucasian, to have lower education and income levels, to have a marital status other than "married or living in a common-law union" and not to be living with children. Another limitation is the cross-sectional nature of the design, from which causality cannot be inferred.

Conclusion

The present study makes an important contribution to the literature on eating-related motivation in the adult population and its association with adherence to dietary guidelines. These findings suggest that some subgroups of the adult population, such as women, older adults, and more educated individuals, are more likely to show higher self-determined motivation towards healthy eating, and that this type of motivation is associated with a better diet quality, independently of individual characteristics. This is consistent with the foundations of the SDT and highlights the importance of self-determined forms of eating-related motivation. Our results also suggest that self-determined motivation accounts for the associations between various healthy eating determinants and diet quality. Both at individual and population-level, strategies to help individuals internalize their eating-related motivation should be further investigated.

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Tables

Table 10-1. Sample characteristics (n=1097)

| | n (%) |
|---|------------|
| Women | 550 (50.1) |
| Age (years) | |
| 18-34 | 396 (36.1) |
| 35-49 | 321 (29.3) |
| 50-65 | 380 (34.6) |
| Ethnicity | |
| Caucasian | 987 (90.0) |
| Highest level of education | |
| Highschool or less | 265 (24.2) |
| CEGEP* | 329 (30.0) |
| University | 482 (43.9) |
| Missing value or prefer not to answer | 21 (1.9) |
| Annual household income status | |
| Under low-income cut-off | 155 (14.1) |
| Over low-income cut-off | 826 (75.3) |
| Missing value or prefer not to answer | 116 (10.6) |
| Occupation | |
| Worker | 693 (63.2) |
| Retired | 148 (13.5) |
| Student | 119 (10.9) |
| No job | 46 (4.2) |
| Other | 58 (5.3) |
| Missing value or prefer not to answer | 33 (3.0) |
| Marital status | |
| Married or living in common-law | 676 (61.6) |
| Other | 332 (30.3) |
| Missing value or prefer not to answer | 89 (8.1) |
| Smoking status | |
| Current smoker | 153 (13.9) |
| Non-smoker or former smoker | 942 (85.9) |
| Missing value | 2 (0.2) |
| Reporting status | |
| Under reporters | 97 (8.8) |
| Plausible reporters | 791 (72.1) |
| Over reporters | 133 (12.1) |
| Missing value | 76 (6.9) |
| Body mass index category | |
| Normal weight (<25.0 kg/m ²) | 407 (37.1) |
| Overweight (25.0-29.9 kg/m ²) | 337 (30.7) |
| Obese (≥30.0 kg/m ²) | 277 (25.3) |
| Missing value | 76 (6.9) |

Note: *In the Quebec education system, CEGEP is the first level of post-secondary education and includes pre-university programs and technical programs.

Table 10-2. Regulation styles for eating behaviors: mean scores according to individual characteristics.

| | Self-determined | Non-self-determined |
|-------------------|-----------------|---------------------|
| Whole sample | 4.97±1.24 | 2.07±0.81 |
| Sex | | |
| Women | 5.33±1.11 | 2.05±0.83 |
| Men | 4.61±1.27 | 2.09±0.78 |
| p | <0.0001 | 0.47 |
| Age group | | |
| 18-34 y. | 4.77±1.29a | 2.10±0.79 |
| 35-49 y. | 5.09±1.16b | 2.08±0.81 |
| 50-65 y. | 5.08±1.24b | 2.03±0.83 |
| p* | 0.0002 | 0.27 |
| Education level | | |
| Highschool | 4.67±1.40 | 2.15±0.90 |
| CEGEP†/University | 5.07±1.17 | 2.04±0.78 |
| p** | <0.0001 | 0.10 |
| Income level | | |
| Under low-income | 4.92±1.32 | 2.08±0.92 |
| Over low-income | 4.98±1.23 | 2.076±0.79 |
| p** | 0.12 | 0.90 |
| Smoking status | | |
| Non-smokers | 5.05±1.23 | 2.06±0.81 |
| Current smokers | 4.52±1.28 | 2.10±0.84 |
| p* | <0.0001 | 0.70 |

Notes: Scores are on a maximum of 7 points. Differences in scores between categories were tested using generalized linear models (GENMOD), with Tukey adjustment for multiple comparisons. a,b Categories with different superscripted letters are significantly different ($p < 0.05$). * Adjusted for sex. ** Adjusted for sex and age group. †In the Quebec education system, CEGEP is the first level of post-secondary education and includes pre-university programs and technical programs.

Table 10-3. Regulation styles for eating behaviors: correlations coefficients with the Canadian Healthy Eating Index (C-HEI) score and its components

| | Self-determined | Non-self-determined |
|----------------------------------|-----------------|---------------------|
| C-HEI | 0.42** | -0.14** |
| Adequacy components | | |
| Total vegetables and fruits | 0.35** | -0.15** |
| Whole fruits | 0.33** | -0.15** |
| Dark green and orange vegetables | 0.35** | -0.12** |
| Grain products | 0.00 | 0.06 |
| Whole grain products | 0.21** | -0.03 |
| Milk and alternatives | 0.12** | -0.06 |
| Meat and alternatives | 0.11* | 0.02 |
| Unsaturated fat | 0.15** | 0.01 |
| Moderation components | | |
| Saturated fat | 0.13** | -0.06 |
| Sodium | 0.15** | -0.05 |
| Other foods | 0.24** | -0.12** |

Note: **p<0.0001, *p<0.05

Table 10-4. Regression analyses of Canadian Healthy Eating Index (C-HEI) on regulation styles for eating behaviors

| | C-HEI Score | | |
|---|-------------|----------------|---------|
| | B | 95% CI | p |
| Independent variables | | | |
| Self-determined motivation (continuous score, 1-7) | 3.82 | [3.18, 4.47] | <0.0001 |
| Non-self-determined motivation (continuous score, 1-7) | -1.63 | [-2.56, -0.70] | 0.0006 |
| Covariates | | | |
| Sex (1=women, 2=men) | -3.68 | [-5.25, -2.11] | <0.0001 |
| Age groups (1=18-34y, 2=35-49y, 3=50-65y) | 0.00 | [-0.90, 0.90] | 0.99 |
| Education (1=high school or less, 2=CEGEP* or university) | 1.65 | [-0.18, 3.47] | 0.08 |
| Household annual income (1=under low-income cut-off, 2=over low-income cut-off) | 2.36 | [0.18, 4.54] | 0.0338 |
| Smoking status (1=non-smoker/former smoker, 2=current smoker) | -5.83 | [-8.02, -3.65] | <0.0001 |
| Reporting status | | | |
| Under-reporting (1=no, 2=yes) | -1.74 | [-4.46, 0.99] | 0.21 |
| Over-reporting (1=no, 2=yes) | 1.55 | [-0.77, 3.87] | 0.19 |

Note: n=1097. * In the Quebec education system, CEGEP is the first level of post-secondary education and includes pre-university programs and technical programs.

Table 10-5. Regression coefficients for the association between individual and contextual correlates and Canadian Healthy Eating Index (C-HEI) as mediated by self-determined motivation

| Determinants of C-HEI | Total effect | | Direct effect | | Indirect effect of self-determined motivation | |
|------------------------|--------------|---------|---------------|---------|---|---------|
| | B±SE | p | B±SE | p | B±SE | p |
| Sex | -6.39±0.82 | <0.0001 | -3.63±0.80 | <0.0001 | -2.76±0.36 | <0.0001 |
| Education | 3.04±0.97 | 0.0020 | 1.75±0.92 | 0.06 | 1.29±0.37 | 0.0006 |
| Smoking | -7.38±1.18 | <0.0001 | -5.79±1.12 | <0.0001 | -1.59±0.45 | 0.0004 |
| Nutrition knowledge | 0.14±0.03 | <0.0001 | 0.08±0.03 | 0.0124 | 0.06±0.01 | <0.0001 |
| Supportive actions | 1.54±0.44 | 0.0006 | 0.31±0.43 | 0.47 | 1.23±0.19 | <0.0001 |
| Non-supportive actions | -2.38±0.78 | 0.0028 | -1.74±0.74 | 0.0205 | -0.64±0.27 | 0.0223 |

Note: Total effect: B coefficient for the association between the correlates and C-HEI. Direct effect: B coefficient for the association between the correlates and C-HEI while taking into account self-determined motivation. Indirect effect: mediation effect of the self-determined motivation in the association between the correlates and C-HEI. Covariates included in all regression models (except for the model in which it is used as the independent variable): sex, age, education, income, smoking status, and energy reporting status.

Supplemental material

Supplemental Table S10-6. Description of the C-HEI scoring for adults

| Component | Range of scores | Scoring criteria |
|----------------------------------|-----------------------|---|
| Adequacy | 0 to 60 points | |
| Total vegetables and fruit | 0 to 10 points | Minimum : 0 Maximum : 7 to 8 servings |
| Whole fruit | 0 to 5 points | Minimum: 0 Maximum: 1.5 to 1.7 servings (21% of recommendation for total vegetables and fruit) |
| Dark green and orange vegetables | 0 to 5 points | Minimum: 0 Maximum: 1.5 to 1.7 servings (21% of recommendation for total vegetables and fruit) |
| Total grain products | 0 to 5 points | Minimum : 0 Maximum : 6 to 8 servings |
| Whole grains | 0 to 5 points | Minimum: 0 Maximum: 3 to 4 servings (50% of recommendation for total grain products) |
| Milk and alternatives | 0 to 10 points | Minimum : 0 Maximum : 2 to 3 servings |
| Meat and alternatives | 0 to 10 points | Minimum: 0 Maximum: 2 to 3 servings (150 to 225 grams) |
| Unsaturated fats | 0 to 10 points | Minimum : 0 Maximum : 30 to 45 grams |
| Moderation | 0 to 40 points | |
| Saturated fats | 8 to 10 points | Minimum 7% to 10% of total energy intake |
| | 0 to 8 points | 10% to maximum 15% of total energy intake |
| Sodium | 8 to 10 points | Adequate intake to tolerable upper intake level |
| | 0 to 8 points | Tolerable upper intake level to twice tolerable upper intake level |
| “Other foods” | 0 to 20 points | Minimum: 5% or less of total energy intake Maximum: 40% or more of total energy intake |

For adequacy components, 0 point for minimum, 5 or 10 points for maximum or more, and proportional for amounts between minimum and maximum.

For moderation components, 10 or 20 points for minimum or less, 0 point for maximum or more, and proportional for amounts between minimum and maximum.

Reference: Garriguet D. Diet quality in Canada. Ottawa: Statistics Canada, 2009.

Discussion et conclusion

Les évidences au sujet du rôle de la saine alimentation dans la prévention des maladies chroniques sont sans équivoque. Cependant, les habitudes alimentaires des Québécois ne reflètent pas les recommandations nationales en matière de saine alimentation. C'est dans le contexte de cet écart entre l'alimentation souhaitable selon les évidences scientifiques et les habitudes alimentaires actuelles des Québécois que prend origine la présente thèse. L'objectif principal de ce projet de doctorat était d'analyser des déterminants individuels, sociaux et reliés à la perception de l'environnement de l'adhésion aux recommandations du GAC 2007, qui étaient en vigueur au moment de l'étude, au sein de la population québécoise. Ainsi, nous visons à mieux comprendre les facteurs qui facilitent l'adhésion à la saine alimentation ainsi que ceux qui peuvent y nuire. Dans le cadre des travaux présentés dans cette thèse, les déterminants qui ont été étudiés sont les connaissances en nutrition, l'appréciation d'aliments de type « camelote », le soutien des proches pour manger sainement, la perception de l'environnement alimentaire et la motivation à l'égard de l'alimentation telle que définie par la théorie de l'autodétermination. Les résultats des articles présentés dans les précédents chapitres contribuent à l'avancement des connaissances dans le domaine. Plus particulièrement, ils ont permis de documenter que chez les adultes francophones de la province Québec :

- 1) L'autoévaluation de la qualité de l'alimentation ne reflète pas adéquatement l'adhésion mesurée aux recommandations du GAC 2007;
- 2) La connaissance des recommandations du GAC 2007 est associée positivement à l'adhésion à celles-ci, plus particulièrement chez les individus ayant un niveau de scolarité plus faible et chez ceux vivant sans enfant;
- 3) L'appréciation d'aliments riches en sel et en gras est associée négativement à l'adhésion au GAC 2007, plus particulièrement chez les hommes ainsi que chez les femmes ayant un niveau de scolarité plus faible;
- 4) L'appréciation d'aliments riches en sucre n'est pas associée significativement à l'adhésion aux recommandations du GAC 2007;
- 5) Le soutien des proches à domicile pour manger sainement est associé à l'adhésion au GAC 2007;
- 6) La perception de l'environnement alimentaire physique n'est pas associée à l'adhésion au GAC 2007;
- 7) La motivation autodéterminée est positivement associée à l'adhésion au GAC 2007, alors que la motivation non-autodéterminée y est négativement associée;

- 8) La motivation autodéterminée explique en partie l'association entre certaines variables (c.-à-d., le sexe, l'éducation, le tabagisme, les connaissances en nutrition et le soutien social) et l'adhésion au GAC 2007.

Dans le contexte d'une analyse des déterminants de l'adhésion à la saine alimentation, il nous est paru pertinent d'examiner la capacité des individus à autoévaluer la qualité de leur alimentation en leur demandant « En général, diriez-vous que vos habitudes alimentaires sont : excellentes, très bonnes, bonnes, passables, mauvaises? » Si des différences entre les catégories d'autoévaluation ont été observées dans la direction attendue, il en demeure qu'une grande proportion d'individus surestiment ou sous-estiment la qualité de leur alimentation, à l'instar des résultats obtenus dans d'autres études (45, 47, 48). Ceux qui sous-estiment leur qualité alimentaire ont le risque d'être plus sévères envers eux-mêmes et de possiblement s'imposer plus de règles alimentaires s'ils souhaitent s'améliorer. À l'inverse, les individus qui surestiment la qualité de leur alimentation sont susceptibles de ne pas chercher à faire des changements s'ils considèrent que leur alimentation est déjà adéquate. Ce biais d'optimisme amène une personne à croire qu'elle est moins exposée à un événement négatif que d'autres personnes (191). Dans le présent contexte, ce biais touche les individus qui surestiment leur qualité alimentaire, et suggère que ceux-ci pourraient se sentir moins à risque de développer des maladies chroniques en lien avec l'alimentation. Ainsi, ces individus peuvent ne pas se sentir ciblés par les campagnes de promotion des saines habitudes alimentaires ou des services offerts à la communauté. Dans une optique de santé publique, de telles campagnes de promotion de la santé peuvent donc s'avérer inefficaces auprès de ces individus. Les résultats présentés au chapitre 3 suggèrent que les hommes seraient plus susceptibles que les femmes à surestimer la qualité de leur alimentation. Cette différence pourrait être expliquée par le plus faible niveau de connaissances des recommandations du GAC 2007 chez les hommes que chez les femmes (tel qu'observé au chapitre 4), faisant en sorte que leur définition personnelle de la saine alimentation ne concorde peut-être pas avec les recommandations nationales. Puisqu'aucune définition du concept de saine alimentation n'a été fournie aux participants, leur alimentation reflète peut-être davantage leur propre définition de la saine alimentation, mais lorsque comparée au score C-HEI, se trouve à être de qualité inférieure à leur perception. Il est probable que les personnes qui sont plus familières avec les recommandations du GAC 2007 aient une définition qui s'en rapproche plus. Puisque les sources d'informations en nutrition utilisées par les Canadiens sont aussi diverses en termes de médias utilisés que de crédibilité des auteurs, des définitions très divergentes de la saine alimentation peuvent exister (8). Dans une revue de littérature sur les perceptions d'une alimentation saine, Paquette (192) rapporte que, bien que les différentes définitions de la saine alimentation soient généralement relativement homogènes, certains concepts (p. ex., équilibre, variété, modération) ont des significations variées dans les différentes études.

Nos résultats suggèrent que la question d'autoévaluation a une meilleure capacité à identifier les individus qui ont une moins bonne qualité alimentaire que ceux qui respectent davantage les recommandations. En effet, la valeur prédictive positive (capacité à identifier les individus ayant un C-HEI supérieur à 68) obtenue n'est que de 44,7% alors que la valeur prédictive négative (capacité à identifier les individus ayant un C-HEI inférieur à 68) est de 81,4%. Par conséquent, bien que l'item d'autoévaluation ne soit pas fortement associé au score C-HEI, il pourrait être utile pour cibler les individus plus à risque de maladies chroniques associées à une faible qualité alimentaire. En effet, une étude menée aux États-Unis a observé que le risque d'hypertension et d'avoir un poids élevé (c.-à-d., embonpoint ou obésité) était quatre à cinq fois supérieur chez les individus ayant évalué leur alimentation comme étant de faible qualité comparativement à ceux l'ayant évaluée comme étant excellente (193). Ainsi, cette question pourrait être utilisée dans des outils de surveillance de la santé de la population afin d'estimer la prévalence d'une alimentation de qualité passable ou mauvaise ou pour identifier les individus et les populations à cibler pour des interventions nutritionnelles.

Ces résultats sur la capacité des Québécois à autoévaluer leurs habitudes alimentaires mettent en lumière trois constats. Premièrement, une question d'autoévaluation peut donner un aperçu général de la qualité alimentaire d'une population, mais ne peut remplacer des outils plus détaillés et précis pour l'évaluation individuelle de l'alimentation. Deuxièmement, une proportion importante d'individus a du mal à évaluer la qualité de leur alimentation. Et troisièmement, la définition de ce qu'est la saine alimentation semble varier d'une personne à l'autre, et cette hypothèse mériterait d'être étudiée davantage.

Quelques limites de cette étude méritent d'être nommées. Premièrement, le projet PREDISE ne visait pas initialement à analyser spécifiquement les réponses à la question portant sur l'autoévaluation. Ainsi, elle n'a pas été formulée en référence au GAC 2007, que nous avons utilisé comme mesure étalon. Des résultats différents auraient pu être observés si la question avait été, par exemple, « En général, diriez-vous que vos habitudes alimentaires correspondent aux recommandations du GAC? » De cette manière, la variabilité en ce qui concerne des différentes définitions d'une saine alimentation aurait pu être diminuée. Par ailleurs, puisque le C-HEI ne possède pas de seuil validé pour déterminer ce qui est considéré comme une « bonne » et une « mauvaise » qualité alimentaire, il a été difficile de déterminer à quels intervalles du score C-HEI devait correspondre chacun des choix de réponse de l'autoévaluation. Pour les analyses de spécificité et de sensibilité, nous avons donc opté pour une approche propre à notre échantillon, soit de considérer le quartile supérieur des scores C-HEI comme étant une « saine alimentation », puisque le quart des répondants avaient autoévalué leurs habitudes alimentaires comme étant très bonnes ou excellentes.

Tel que mentionné plus haut, mais non évalué dans le cadre de cette thèse, la capacité à autoévaluer adéquatement la qualité de son alimentation est potentiellement liée au niveau de connaissances en nutrition.

À ce sujet, les résultats présentés au chapitre 4 mettent en lumière le faible niveau de connaissances en nutrition en général au sein de la population étudiée, bien que des différences ont été observées selon les caractéristiques individuelles. En effet, la moyenne obtenue dans l'échantillon pour le questionnaire de connaissances en nutrition est de 64,7%, et les scores moyens les plus élevés ont été observés chez les femmes (69%), les individus ayant un diplôme collégial ou universitaire (66%), ceux ayant un revenu supérieur au seuil de faible revenu (65%) et les individus vivant en couple (66%) ou avec des enfants (66%). Les résultats de cette étude montrent également qu'un plus grand niveau de connaissances relatives au GAC 2007 est associé à une meilleure adhésion aux recommandations du GAC, et ce, malgré un ajustement statistique pour des caractéristiques associées au niveau de connaissances. Les résultats des modèles de régressions suggèrent qu'à chaque question additionnelle réussie dans le questionnaire de connaissances, le score C-HEI augmente de 0,5 point à 1 point sur 100. Cette association modeste entre le niveau de connaissances et le C-HEI est cohérente avec les résultats d'une revue de littérature sur le sujet, qui concluait en une association positive, mais généralement faible, entre les deux variables (78).

Malgré l'association relativement faible entre les connaissances en nutrition et la qualité alimentaire, les résultats obtenus appuient la pertinence des campagnes de promotion des saines habitudes alimentaires ciblant une amélioration des connaissances en nutrition dans le but d'engendrer des changements positifs dans les comportements et les apports alimentaires de la population. Les résultats de l'étude PREDISE suggèrent qu'une augmentation des connaissances pourrait avoir un effet favorable sur la qualité de l'alimentation, et ce, davantage chez les individus ayant un faible niveau de scolarité ainsi que chez les adultes vivant sans enfant. En effet, chez ces deux groupes d'individus, pour chaque question additionnelle réussie dans le questionnaire de connaissances en nutrition, le score C-HEI est supérieur de 1 à 2 points sur 100. Dans un but d'amélioration des connaissances en nutrition au sein de la population, une avenue à considérer serait d'augmenter les apprentissages en lien avec la nutrition et les compétences culinaire à l'école secondaire, potentiellement via un retour des cours d'économie familiale à l'école est une avenue à considérer. Dans la province de Québec, ces cours, qui étaient obligatoires pour les élèves du secondaire, ont été abolis en 2009. Les cours d'économie familiale permettaient aux adolescents d'acquérir des connaissances de base en cuisine et en matière de saine alimentation. Étant obligatoires dans le cursus scolaire, ces cours avaient le potentiel de diminuer l'écart entre les enfants issus de milieux socioéconomiques variés et dont les familles ont des habitudes et compétences culinaires très différentes. D'après les résultats du chapitre 4, il y aurait plus de place à l'amélioration des connaissances en nutrition chez les individus ayant un plus faible niveau de scolarité. Les cours d'économie familiale (ou autre cours de ce type, visant à augmenter la littératie nutritionnelle) pourraient aider ces individus qui ne poursuivront pas leur parcours scolaire après le secondaire et qui auront donc possiblement moins d'autres occasions d'acquérir de telles connaissances. La modification du cursus scolaire au secondaire représente sans aucun doute un défi majeur, mais le jeu en vaut possiblement la chandelle si ces cours peuvent

avoir le potentiel d'améliorer les habitudes alimentaires des Québécois. Si ces cours devaient être réintroduits, la priorité devrait aller aux écoles situées dans des zones où la population a un statut socioéconomique inférieur. Les résultats d'une étude récente (194) suggèrent qu'une implication plus fréquente dans des activités de cuisine pendant l'enfance est associée de meilleures compétences culinaires à l'âge adulte. Ainsi, les compétences acquises pendant l'enfance et l'adolescence peuvent contribuer à former des adultes mieux outillés pour préparer des repas sains.

Une des forces de notre étude est le fait que le questionnaire de connaissances et le score de qualité alimentaire utilisés sont tous deux spécifiques au GAC 2007. Ainsi, nous avons mesuré l'atteinte des recommandations desquelles nous avons mesuré la connaissance. Cette force n'est cependant pas sans limites. En effet, il est possible que des individus aient une bonne qualité alimentaire telle que mesurée par le C-HEI, sans toutefois connaître spécifiquement les recommandations du GAC 2007, par exemple le nombre de portions recommandées pour chaque groupe d'aliments. De plus, certains types de connaissances qui n'ont pas été évaluées dans le questionnaire pourraient être davantage associés à la capacité à faire de bons choix alimentaires. Le concept de littératie alimentaire ou nutritionnelle, qui pourrait être plus fortement associé à la saine alimentation (78), inclut des connaissances plus variées que la familiarité avec les recommandations populationnelles. Si de nombreuses définitions différentes de la littératie alimentaire existent, certaines composantes du concept semblent être plutôt unanimes telles que les connaissances reliées aux aliments et la nutrition ainsi que les concepts de compétences culinaires et d'efficacité personnelle (195). Par exemple, le fait d'être capable de faire des changements mineurs à des recettes pour les rendre plus « santé » était fortement associé à la qualité alimentaire mesurée par le C-HEI dans une étude menée auprès de parents canadiens (196). Des connaissances « procédurales », c'est-à-dire les stratégies et techniques liées au savoir-faire alimentaire, sont, selon certains auteurs, nécessaires pour faire des choix alimentaires sains (197) et davantage utilisées au quotidien donc plus représentatives de la réalité de la population (198). Il serait intéressant d'examiner si les connaissances dites « déclaratives », c'est-à-dire la connaissance de faits reliés à la nutrition, et les celles dites « procédurales » sont associées de manière différente, complémentaire ou même séquentielle à la qualité de l'alimentation. Par exemple, des connaissances déclaratives (p. ex., savoir que la consommation de légumes et fruits permet de diminuer les risques de maladies chroniques ou qu'une consommation excessive de sodium augmente le risque d'hypertension) doivent potentiellement être acquises avant des connaissances procédurales (p. ex., comment faire cuire des légumes; comment substituer le sodium dans des recettes). Cette idée n'est qu'à titre hypothétique et mériterait d'être explorée davantage. Dans l'article présenté au chapitre 4, nous avons observé que les individus ayant atteint un plus haut niveau de scolarité avaient de meilleures connaissances en nutrition, mais que leurs connaissances n'étaient pas significativement associées à la qualité de leur alimentation. Nous avons émis comme hypothèse qu'un « effet plafond » pouvait potentiellement faire en sorte qu'au-delà d'un certain niveau de connaissances, il peut être difficile d'améliorer ses habitudes

alimentaires en augmentant davantage ses connaissances en nutrition. Si nous avons également questionné les participants sur les connaissances procédurales, nous n'aurions peut-être pas observé cet effet plafond. Après l'atteinte d'un certain bagage de connaissances concernant les types d'aliments à privilégier, il se peut que l'augmentation des compétences alimentaires permette de mieux les mettre en pratique. Des études d'interventions pourraient permettre de mieux comprendre le rôle de différents types de connaissances en nutrition sur la qualité des apports alimentaires.

Bien que le questionnaire que nous avons utilisé évaluait uniquement des connaissances de type déclarative, il est probable que les individus ayant obtenu des scores élevés avaient également des compétences alimentaires et des connaissances procédurales plus élevées que ceux ayant obtenu des scores plus faibles. Différents types de connaissances et compétences alimentaires semblent en effet interreliés. À titre d'exemple, les connaissances en nutrition (évaluées à l'aide de questionnaires variés) ont été associées à une plus grande utilisation des étiquettes nutritionnelles selon une revue de la littérature sur le sujet (199). L'utilisation des étiquettes nutritionnelles fait d'ailleurs partie des recommandations principales du GAC 2019 (23). Étant donné la publication récente de ce nouveau guide alimentaire, le questionnaire de connaissances en nutrition développé par notre équipe de recherche devra être adapté dans le but de refléter les nouvelles recommandations. Les informations véhiculées à la population dans le GAC 2019 reflètent davantage le concept de littératie alimentaire que de connaissances nutritionnelles uniquement, contrairement à son prédécesseur. En effet, en plus des concepts plus théoriques (p. ex., manger des légumes et fruits en abondance, limitez la consommation d'aliments élevés en sodium, en sucres ou en gras saturés), on y retrouve également des recommandations reliées aux compétences (p. ex., cuisinez plus souvent, utilisez les étiquettes des aliments) et aux contextes des repas (p. ex., savourez vos aliments, prenez vos repas en bonne compagnie). Cependant, quoique ces nouvelles recommandations soient en vigueur depuis 2019, il est possible que les Canadiens aient besoin d'un certain temps pour s'y familiariser et qu'ils continuent de référer au GAC 2007 pendant quelques années. En effet, les résultats d'une revue systématique effectuée aux États-Unis démontrent que la connaissance d'un guide alimentaire augmente avec les années, et ce, même après la publication d'un nouveau guide (200). Ainsi, cela pourrait prendre quelques années avant de pouvoir évaluer si la connaissance des recommandations du GAC 2019, comparativement à celles du GAC 2007, est davantage associée à la qualité de l'alimentation.

Au chapitre 10 de cette thèse, nous avons effectué des analyses exploratoires qui suggèrent que l'association positive entre les connaissances en nutrition et la qualité alimentaire est en partie expliquée par le niveau de motivation autodéterminée. Bien que le devis transversal de l'étude PREDISE ne permette pas d'identifier de relation causale entre les variables, une hypothèse est que les individus ayant plus de connaissances en nutrition se sentent plus compétents et soient en mesure de prendre une décision informée et autonome par

rapport à leurs habitudes alimentaires, les rendant ainsi plus aptes à adhérer aux recommandations du GAC. Le sentiment de compétence étant l'un des trois besoins fondamentaux de la motivation autodéterminée, il est plausible que le fait d'avoir de meilleures connaissances en nutrition soit associé positivement à ce type de motivation. Ces associations ne semblent pas avoir été précédemment documentées dans la littérature et devraient être examinées dans le cadre d'études longitudinales afin de pouvoir les examiner dans des modèles de médiation.

Concernant la motivation à l'égard de l'alimentation, les résultats présentés au chapitre 10 ont permis de documenter des associations entre les motivations de type autodéterminé et non-autodéterminé et des caractéristiques sociodémographiques ainsi que l'adhésion aux recommandations du GAC 2007. Nous avons observé que les femmes, les participants âgés de 35 ans ou plus, ceux ayant un niveau de scolarité plus élevé et les non-fumeurs avaient des niveaux de motivation autodéterminée plus élevés à l'égard de l'alimentation alors qu'aucune différence en lien avec ces variables sociodémographiques n'a été observée pour la motivation non-autodéterminée. À notre connaissance, cette étude est la première à avoir examiné les types de motivations selon des caractéristiques sociodémographiques autres que le sexe. Notre étude est également la première à avoir étudié les associations entre les types de motivation à l'égard de l'alimentation et un indice de qualité alimentaire globale au sein d'une population adulte composée d'hommes et de femmes. Nos résultats suggèrent qu'indépendamment des caractéristiques sociodémographiques, la motivation autodéterminée est associée à une plus grande adhésion aux recommandations du GAC 2007 alors que l'association est inverse pour la motivation non-autodéterminée. Par ailleurs, cette étude a permis de mettre en lumière le rôle de premier plan que semble avoir la motivation autodéterminée à l'égard de l'alimentation dans l'adhésion au GAC 2007. En effet, les analyses exploratoires présentées au chapitre 10 suggèrent que les associations bien connues et documentées qui relient plusieurs variables, telles que le sexe, la scolarité, le tabagisme, les connaissances en nutrition et le soutien des proches pour manger sainement, à la qualité de l'alimentation sont en partie expliquées par une variation dans le niveau de motivation autodéterminée. Les résultats obtenus enrichissent la littérature sur le thème de l'autodétermination en lien avec l'alimentation qui gagne en popularité depuis une quinzaine d'années. Nos observations suggèrent que dans un contexte clinique, les nutritionnistes et autres professionnels de la santé auraient avantage à utiliser les principes de l'entretien motivationnel (201) dans une perspective d'aider leurs clients/patients à développer une motivation plus autodéterminée à l'égard de l'alimentation. L'entretien motivationnel supporte la satisfaction des besoins d'autonomie, de compétence et du sentiment d'attachement, qui permettent aux individus d'internaliser leur motivation (201, 202).

Lorsqu'il est question de saine alimentation, une des principales recommandations visant à réduire les risques de maladies chroniques reliées à la nutrition est de limiter les apports en lipides, sucre et sel (2). Le GAC 2007 ne fait pas exception et invite la population à « limiter la consommation d'aliments et boissons riches en calories,

lipides, sucre ou sel (sodium), tels que : beignes et muffins, biscuits et barres granola, chocolat et bonbons, crème glacée et desserts surgelés, croustilles, nachos et autres grignotines salées, frites, gâteaux et pâtisseries, alcool, boissons aromatisées aux fruits, boissons gazeuses, boissons sportives et énergisantes, boissons sucrées chaudes ou froides » (24). Si sa pertinence est scientifiquement démontrée (2), cette recommandation demeure toutefois difficile à respecter pour bon nombre d'individus en raison du rôle du gras, du sel et du sucre dans la palatabilité des aliments (94). Bien que ces nutriments puissent augmenter l'appréciation des aliments qui en contiennent, il demeure cependant méconnu si l'appréciation de ces aliments de type « camelote » est à son tour associée à la qualité alimentaire générale des individus. Les résultats présentés au chapitre 6 suggèrent que ce serait principalement l'appréciation d'aliments riches en sel et en gras, mais pas celle d'aliments riches en sucre, qui rendrait plus difficile l'adhésion aux recommandations du GAC 2007. Les hommes ainsi que les femmes ayant un plus faible niveau de scolarité sont les groupes chez qui une grande appréciation des aliments salés et gras est plus fortement associée à une alimentation de moins bonne qualité telle que mesurée par le C-HEI. Selon les résultats du chapitre 6, l'appréciation d'aliments salés et gras semble être associée à une plus grande consommation de ce type d'aliments, mais également à une plus faible consommation d'aliments sains tels les légumes et fruits et les produits céréaliers à grains entiers. L'étude de validation du questionnaire d'appréciation présentée au chapitre 5 suggère d'ailleurs que les corrélations entre le degré d'appréciation et la consommation des aliments présents dans le questionnaire sont modérées, ce qui suggère qu'une grande appréciation n'est pas nécessairement associée à une grande consommation. Le fait d'apprécier les aliments salés et gras paraît donc être associé à un patron alimentaire généralement moins sain et non seulement à la consommation de certains aliments « camelote » spécifiques.

Comme nous l'avons suggéré dans la discussion du chapitre 6, encourager et outiller les gens pour les rendre aptes à préparer plus de repas à la maison pourrait aider à diminuer l'impact de l'appréciation des aliments « camelote » sur la qualité alimentaire globale. Cette proposition appuie celle suggérée précédemment quant à l'augmentation des connaissances procédurales dans le but d'améliorer les habitudes alimentaires. Selon la théorie de l'effet IKEA, les gens auraient tendance à apprécier davantage les objets qu'ils fabriquent eux-mêmes (203). Cette théorie n'a été que peu testée en lien avec la préparation d'aliments et mériterait d'être étudiée davantage notamment pour explorer si certaines barrières peuvent en limiter les effets. À ce jour, deux études à ce sujet rapportent que des smoothies préparés par des participants étaient perçus comme meilleurs au goût par les participants que les mêmes smoothies préparés par des assistants de recherche (204, 205). Ainsi, les repas cuisinés maison pourraient bénéficier de cette aura « fait soi-même » et rendre leurs créateurs plus satisfaits suite à la consommation d'un repas maison comparativement à un repas acheté. Une plus grande appréciation des repas maison, que nous supposons être plus faibles en gras, en sodium et en sucre, pourrait provoquer une augmentation dans leur fréquence, et engendrer progressivement, une plus grande appréciation des aliments moins salés, moins sucrés ou moins gras. À cet égard, des études ont observé qu'une diminution

(ou une augmentation) progressive de la consommation de sodium était associée à une diminution (ou une augmentation) de la concentration de sodium préférée (206-209).

Les résultats de l'étude PREDISE suggèrent que chez certains groupes d'individus, la qualité globale de l'alimentation ne semble pas être influencée par l'appréciation des aliments salés. Par exemple, chez les femmes ayant un diplôme collégial ou universitaire, l'association entre les deux variables n'est pas significative. Ces femmes possèdent donc des outils ou ont des caractéristiques communes, qui n'ont pas été identifiées dans la présente étude, qui font en sorte que leur alimentation n'est pas négativement influencée par l'appréciation d'aliments « camelote ». Certains comportements alimentaires comme la restriction cognitive, qui peut être définie comme un contrôle des apports alimentaires dans un but de contrôle du poids corporel (210), ou la désinhibition (c.-à-d., la tendance à surconsommer des aliments (211)) pourraient jouer un rôle dans les associations entre l'appréciation des aliments salés et la qualité alimentaire et pourraient aider à expliquer les associations différentes observées entre certains sous-groupes de notre échantillon. Chez les individus présentant de plus hauts niveaux de restriction cognitive, l'appréciation des aliments salés pourrait ne pas se traduire en la consommation de ces aliments, en raison d'un plus grand contrôle sur les apports alimentaires. À l'inverse, chez les individus présentant une forte désinhibition alimentaire, il pourrait être attendu que l'appréciation de certains aliments soit plus fortement associée à la consommation de ceux-ci, due à une certaine perte de contrôle dans l'apport alimentaire et une vulnérabilité accrue face aux stimuli externes (210). L'alimentation intuitive pourrait également aider à comprendre les associations entre l'appréciation et la consommation d'aliments « camelote ». En effet, on dit des mangeurs intuitifs qu'ils mangent en réponse aux besoins de leur corps, pour lui donner énergie et vigueur (103). Ainsi, les individus mangeant de manière plus intuitive pourraient avoir une forte appréciation d'aliments « camelote » sans toutefois les consommer régulièrement puisque ces aliments ne contribuent pas à fournir les nutriments dont le corps a besoin pour bien fonctionner. Quelques études ont examiné des associations entre l'appréciation des aliments riches en sel, en sucre ou en gras et des caractéristiques du comportement alimentaire (212, 213), mais davantage d'études devraient s'y attarder en évaluant également la qualité globale de l'alimentation.

Par ailleurs, une autre variable qui mériterait d'être considérée dans de futures études pour mieux documenter ces associations est l'appréciation des aliments sains, tels que les légumes. En effet, selon Beck et al. (100), les femmes et les individus plus scolarisés semblent démontrer une plus grande appréciation des légumes, ce qui pourrait aider à expliquer les résultats obtenus dans notre population. L'étude de l'appréciation de plusieurs catégories d'aliments sains en plus des aliments de type « camelote » pourrait permettre de mieux expliquer l'importance de l'aspect hédonique des aliments dans les habitudes alimentaires. Ce type d'études revêt une importance particulière dans l'optique d'aider les Québécois à manger plus sainement puisque 96% des adultes canadiens rapportent que le goût des aliments est un facteur important lors du choix des aliments (8). Cela

souligne l'importance d'aider les gens à faire des choix sains tout en continuant d'apprécier les aliments qu'ils consomment. Des techniques culinaires simples pourraient faire l'objet de campagne de promotion des saines habitudes alimentaires dans le but d'aider les individus à devenir plus compétents en cuisine et aptes à faire des substitutions à certaines recettes pour les rendre meilleures pour la santé tout en gardant un bon goût. De nombreuses nutritionnistes partagent d'ailleurs des recettes et des trucs culinaires sur les réseaux sociaux, ce qui peut aider à augmenter les connaissances et compétences alimentaires pour les aider à préparer des repas gouteux à la maison. La suggestion présentée plus tôt de réintroduire les cours d'économie familiale trouve à nouveau sa pertinence dans ce contexte, dans le but de mieux outiller les gens, et ce, dès l'enfance ou l'adolescence.

Un autre déterminant de l'adhésion au GAC 2007 qui a été identifié dans le cadre de la présente thèse est le soutien des proches pour manger sainement. Ce facteur a souvent été ciblé dans la littérature comme déterminant de la saine alimentation, mais de nombreuses études à ce sujet étaient limitées par leur utilisation de questionnaires non validés. D'ailleurs, les questionnaires utilisés font référence, pour la plupart, au soutien des membres de la famille uniquement, ou ne précisent pas la nature des relations avec les proches prodiguant ou non du soutien social. Le questionnaire que nous avons développé dans le cadre du projet PREDISE référerait originalement de manière distincte au soutien des membres de la famille et au soutien des amis/collègues. Comme présenté au chapitre 7, une des étapes de validation du questionnaire nous a amenés à réaliser que la manière dont les proches influencent l'alimentation pouvait être plus fortement liée au fait de cohabiter ou non avec eux. En effet, plusieurs interactions en lien avec l'alimentation ont lieu au sein d'un domicile comme la planification des repas, l'achat des aliments, la préparation des aliments et le partage des repas (214), ce qui a le potentiel d'augmenter la fréquence d'actions ou de paroles en lien avec la saine alimentation. Ainsi, le questionnaire que nous avons développé se démarque des autres en raison de cette distinction entre les sources potentielles de soutien social.

Les résultats présentés au chapitre 9 suggèrent que les actions et paroles des proches à domicile, mais pas des proches à l'extérieur du domicile, ont le potentiel d'aider ou de nuire à l'adhésion aux recommandations du GAC 2007. D'autres études rapportent que le soutien des membres de la famille, comparativement au soutien des amis, est plus fortement associé à l'apport en légumes et fruits (129), à une consommation plus faible d'aliments de restauration rapide (76) et une alimentation plus faible en gras (127). Il serait donc avantageux pour les individus d'une même famille de partager des objectifs communs en lien avec la saine alimentation afin de se soutenir mutuellement, et, surtout, d'éviter de se nuire. Comme suggéré par Ball et al. (129) des campagnes de promotion ou des programmes d'interventions devraient cibler des familles (ou des foyers, selon la distinction des sources de soutien utilisée dans notre questionnaire) dans le but de les motiver à améliorer leurs habitudes alimentaires ensemble, plus particulièrement dans les milieux où le niveau socioéconomique

est plus faible. À cet égard, les analyses de modération effectuées ont dévoilé que les actions non favorables des proches à domicile nuisaient davantage aux individus ayant un moins haut niveau de scolarité que ceux ayant un diplôme collégial ou universitaire. Ces individus plus vulnérables aux actions et paroles non favorables de leurs proches (p. ex., critiquent les repas préparés, offrent des aliments « camelote ») sont possiblement moins bien outillés pour y faire face. Par exemple, leur plus faible niveau de connaissances en nutrition tel que documenté au chapitre 4 supporte cette hypothèse. Par ailleurs, les analyses exploratoires présentées au chapitre 10 suggèrent une association négative entre les actions non favorables des proches et la motivation autodéterminée à l'égard de l'alimentation. Bien que le devis transversal de l'étude PREDISE ne permette pas de supposer des relations causales, les résultats obtenus appuient l'hypothèse selon laquelle une plus grande fréquence d'actions non favorables des proches pourrait prédire un niveau plus faible de motivation autodéterminée, qui, à son tour, serait associé à une alimentation de plus faible qualité. En effet, des individus qui perçoivent que leurs proches ne partagent pas leurs intentions de manger sainement peuvent remettre en question leurs intentions et se sentir moins compétents par rapport aux comportements qu'ils tentent d'adopter. Selon Ryan et al. (202), un des besoins fondamentaux à satisfaire pour internaliser la motivation est le sentiment d'attachement qui réfère au besoin d'entrer en relation avec les autres et de ne pas se sentir en rupture avec les valeurs associées à son milieu social de référence. Ainsi, des proches non soutenant peuvent nuire au développement d'une motivation autodéterminée à l'égard de l'alimentation. Les résultats des analyses exploratoires suggèrent en revanche que le fait d'avoir des proches soutenant puisse aider au développement d'une motivation plus autodéterminée. À ce sujet, McSpadden et al. (85) ont observé qu'un haut niveau de soutien social pouvait diminuer l'impact négatif d'une motivation non-autodéterminée sur la consommation de légumes et fruits. Les associations entre le soutien des proches à domicile et la qualité de l'alimentation devraient être étudiées à l'aide de devis longitudinaux afin d'identifier le rôle potentiel de la motivation autodéterminée dans ces associations.

Dans une revue narrative de revues systématiques sur les déterminants de la saine alimentation reliés à l'environnement social, physique et économique, Brug (178) suggère que l'environnement social semble avoir une influence plus constante sur les comportements alimentaires que l'environnement physique. Les résultats présentés au chapitre 9 corroborent cette proposition. En effet, la perception de l'environnement alimentaire telle que mesurée par le questionnaire développé par notre équipe n'était pas associée au C-HEI. Les items inclus dans le questionnaire portent sur les trois principales composantes de l'environnement alimentaire généralement étudiées soit l'accessibilité (réfère à la distance pour se rendre au détaillant alimentaire), la disponibilité (réfère au nombre de détaillants différents ou à la quantité et qualité des aliments offerts) et l'abordabilité (réfère au coût). Les différentes composantes n'ont pas été analysées séparément puisque l'analyse factorielle du questionnaire, effectuée dans le processus de validation détaillé au chapitre 8, avait révélé que les items portant sur l'accessibilité, la disponibilité et l'abordabilité des aliments sains faisaient tous

partie d'une même sous-échelle cohérente. Lors de la validation du questionnaire, une deuxième sous-échelle a résulté de l'analyse factorielle, regroupant trois items portant sur l'accessibilité aux aliments « camelote ». Cependant, cette sous-échelle n'a pas été utilisée dans l'article présenté au chapitre 9 en raison d'une trop faible consistance interne entre les trois items au sein de la population à l'étude. Cette faible consistance interne est potentiellement due au fait que deux des trois items de cette sous-échelle réfèrent aux aliments « camelote » accessibles dans le milieu de travail ou à proximité de celui-ci, et qu'environ le tiers des participants de l'étude PREDISE n'étaient pas des travailleurs. Ceci suggère qu'une version améliorée de la sous-échelle sur l'accessibilité aux aliments « camelote » incluant un plus grand nombre d'items pourrait être développée et validée dans le but de pouvoir étudier l'association entre l'accessibilité/disponibilité à des aliments « camelote » et l'adhésion aux recommandations du GAC chez les Québécois.

L'étude des associations entre l'environnement alimentaire et les habitudes alimentaires a fait couler beaucoup d'encre dans les deux dernières décennies, comme le démontre le nombre de revues, systématiques ou non, qui ont été publiées sur le sujet (59, 112, 174-181). La mixité des résultats obtenus dans les études empêche de conclure en la présence d'une association entre l'environnement physique et les apports alimentaires, bien qu'il soit suggéré que les mesures de la perception de l'environnement alimentaire semblent être associées de manière plus constante aux indicateurs de qualité alimentaire que les mesures objectives (174, 178, 179). Notre étude, qui se conclut en une absence d'association entre une mesure de la perception de l'environnement et la qualité globale de l'alimentation, s'ajoute à cette mixité de résultats. Cette absence d'association peut être due à la faible variabilité dans la perception de l'environnement dans la population à l'étude. En effet, moins de 6% des participants avaient une perception « négative » de leur environnement alimentaire (c.-à-d., un score moyen inférieur à 3 sur 5; 3 étant une opinion neutre). Aussi, plus de 75% de l'échantillon a rapporté que le temps pour se rendre de la maison au principal détaillant alimentaire en voiture était inférieur à 10 minutes. Les participants vivaient donc principalement dans des milieux urbains, où les détaillants alimentaires sont plus nombreux, variés et accessibles. Par ailleurs, le niveau de scolarité élevé dans la population recrutée peut être une autre raison de l'absence d'association entre l'environnement alimentaire et le C-HEI, puisqu'un haut niveau socioéconomique semble pouvoir jouer un rôle « protecteur » contre l'exposition à un environnement alimentaire non favorable aux choix sains (175). Cette hypothèse demeure à être étudiée davantage. Dans le cadre de cette thèse, nous avons principalement utilisé les mesures reliées à la perception de l'environnement alimentaire, à l'exception de la question sur le temps pour se rendre au principal détaillant alimentaire. Des analyses complémentaires pourraient être effectuées à partir des codes postaux (résidence et milieu de travail) récoltés dans le cadre de l'étude PREDISE, qui pourraient permettre d'obtenir des mesures objectives de l'environnement alimentaire. Ces analyses permettraient de comparer les résultats issus de mesures subjectives et objectives de l'environnement, et pourraient potentiellement documenter si les différentes mesures sont associées différemment à la qualité de l'alimentation dans certains sous-groupes de la population.

Bien que les études scientifiques peinent à établir un lien clair entre l'environnement alimentaire et la qualité de l'alimentation, Rodgers et al. (215) proposent que les changements dans les habitudes alimentaires et l'augmentation du poids corporel à l'échelle de la population américaine dans les dernières décennies semblent être inévitablement liés au fait que la population dans son ensemble est exposée à des changements dans l'environnement alimentaire. En examinant la prévalence de l'obésité de 1960 à 2000, les auteurs ont constaté que dans tous les sous-groupes de la population, selon le sexe, l'âge et l'ethnie, une augmentation de l'obésité a été observée à peu près au même moment dans les années 1970. Les auteurs suggèrent qu'il serait invraisemblable que tous les sous-groupes de la population américaine aient simultanément commencé à faire de mauvais choix alimentaires individuels, et que cette augmentation de la prévalence de l'obésité est donc probablement due en grande partie à l'environnement alimentaire (215). De manière similaire, dans la publication *Pour une vision commune des environnements favorables à la saine alimentation, à un mode de vie physiquement actif et à la prévention des problèmes reliés au poids* du Ministère de la Santé et des Services sociaux du Québec (216), on mentionne que le fait que tous les individus soient affectés par l'environnement peut expliquer en partie pourquoi l'évaluation de l'environnement à l'échelle individuelle n'est pas clairement associée à la qualité alimentaire. C'est dans cette optique que le Ministère de la Santé et des Services sociaux vise la création d'environnements favorables à la santé, regroupant des conditions qui aident à faire des choix sains (216). L'environnement politique (10), qui n'a pas été étudié dans le cadre de la présente thèse, revêt ainsi un rôle d'une grande importance pour encadrer les conditions de l'environnement alimentaire physique dans lesquelles les individus doivent faire des choix au quotidien. En résumé, l'environnement alimentaire influence fort probablement les choix alimentaires des individus, mais l'association avec la qualité alimentaire mérite d'être étudiée à l'échelle populationnelle pour identifier quelles conditions créent des environnements réellement favorables à la santé en matière de saine alimentation.

Conclusion générale

Les travaux présentés dans cette thèse ont permis d'identifier pour la première fois des déterminants associés à une meilleure adhésion aux recommandations du GAC 2007 chez les adultes québécois. En résumé, les individus ayant de meilleures connaissances en nutrition, une plus faible appréciation des aliments salés et gras, un plus haut niveau de motivation autodéterminée ou vivant avec des proches soutenant sont plus susceptibles d'adhérer aux recommandations canadiennes en matière de saine alimentation. Nos travaux ont également permis de cibler des sous-groupes de la population (p. ex., les individus ayant un plus faible niveau de scolarité) chez qui certains déterminants, tels que les connaissances en nutrition et le soutien social, semblent être plus fortement associés à la qualité de l'alimentation. Ces résultats permettent de mieux comprendre qui sont les Québécois qui font de meilleurs choix alimentaires de même que de cibler des pistes d'action dans le but d'aider ceux qui peinent à rencontrer les recommandations du GAC.

Les articles présentés dans les précédents chapitres de cette thèse contribuent à l'avancement des connaissances scientifiques au sujet des déterminants de la saine alimentation en comblant une importante lacune de nombreuses études dans le domaine, soit l'utilisation d'outils de mesure non validés. En plus de nous avoir permis de mesurer différentes variables de manière valide et adaptée à notre population, les différents questionnaires que nous avons développés et validés pourront être utilisés par d'autres chercheurs ou leur servir d'inspiration pour la création d'outils pour des populations différentes.

Cette thèse porte spécifiquement sur l'adhésion aux recommandations présentées dans le GAC 2007. Cependant, cet outil n'est plus la référence canadienne en matière de saine alimentation depuis la publication du nouveau guide en 2019. Bien que la présentation visuelle du GAC 2019 soit largement différente de la précédente version et que les recommandations en nombres de portions aient été retirées, les grandes lignes directrices derrière les recommandations demeurent semblables. Ainsi, les résultats obtenus dans le cadre de ce projet sont tout aussi valides et pertinents malgré la nouvelle mouture des recommandations nationales en matière de saine alimentation. D'ailleurs, plusieurs facteurs identifiés dans le cadre de cette thèse (p. ex., soutien social, connaissances en nutrition) ou discutés en tant que perspectives reliées aux résultats obtenus (p. ex., compétences culinaires, fréquence des repas cuisinés) sont étroitement liés aux nouvelles recommandations du « comment manger » (p. ex., cuisinez plus souvent, prenez vos repas en bonne compagnie) qui s'ajoutent, dans cette nouvelle version du GAC, aux recommandations plus traditionnelles axées sur le « quoi manger » (p. ex., mangez des légumes et fruits en abondance, choisissez des aliments à grains entiers). À la lumière des résultats présentés dans cette thèse, on pourrait donc s'attendre à ce que les individus qui adhèrent mieux aux recommandations du « comment manger » respectent également davantage celles du « quoi manger ».

Certains déterminants ont été analysés dans le cadre de cette thèse, mais d'autres facteurs tels que des caractéristiques du comportement alimentaire (p. ex., restriction cognitive, désinhibition, alimentation intuitive) pourraient contribuer à améliorer notre compréhension de ce qui influence la qualité de l'alimentation des Québécois. Une autre perspective pour des études futures est l'utilisation de devis longitudinaux, tels que des études de cohorte prospectives, pour examiner l'impact sur les habitudes alimentaires de changements en ce qui a trait aux déterminants ciblés dans le cadre de cette thèse. Des études d'interventions devraient également être menées afin d'évaluer si certains facteurs ont plus de potentiel pour améliorer la qualité de l'alimentation dans certains sous-groupes de la population comme suggéré dans cette thèse (p. ex., augmenter les connaissances en nutrition chez les individus ayant un plus faible niveau de scolarité). Des études d'intervention en milieu naturel pourraient être menées, par exemple, pour étudier la faisabilité et les impacts de l'implantation de cours d'économie familiale dans des écoles secondaires situées dans des milieux socioéconomiquement désavantagés. Des interventions randomisées contrôlées seraient également pertinentes, notamment pour

étudier les impacts de l'augmentation des connaissances « déclaratives » et des connaissances « procédurales » sur la qualité alimentaire.

En somme, les travaux présentés dans cette thèse sont le résultat de la première étude visant spécifiquement l'analyse de déterminants de l'adhésion aux recommandations canadiennes en matière de saine alimentation chez les adultes québécois. Ils ont permis d'identifier des déterminants importants, tels que les connaissances en nutrition, la motivation autodéterminée et le soutien des proches à domicile, qui pourront dorénavant devenir des cibles de choix pour les professionnels de la santé ainsi que pour les programmes de promotion des saines habitudes alimentaires dans le but de guider les Québécois vers des choix alimentaires plus sains.

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