“Putting Quality Food on the Tray”: Assessing Patients’ Expectations and Experiences of Meals Served in Sixteen Ontario Hospitals

by

Vanessa Trinca

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Background: Malnutrition is prevalent among hospital patients and occurs in up to 45% of Canadian medical and surgical patients. Hospital malnutrition is associated with detrimental outcomes for patients, such as further morbidity and mortality and increases hospital-associated costs. Low food intake is a primary contributor to the development or worsening of malnutrition and may be influenced by factors such as poor appetite, illness, and perceptions of poor food quality and disliking food served. Currently there are no standards to assess patients' experiences with meals in Ontario hospitals and tools used to assess patient satisfaction are limited in their approach with respect to assessing both patients' expectations and ratings of a served meal and have not always demonstrated good measures of validity or reliability.

Purposes: 1) Assess the internal consistency reliability of the Hospital Food Experience Questionnaire (HFEQ) in addition to construct validity with the overall rating of meal quality at a meal and predictive validity with food intake. **2)** Measure patients' hospital food and food-related expectations in addition to ratings of a single meal served in hospital. **3)** Determine patient and hospital characteristics associated with three measures of meal quality from the HFEQ (i.e. a single overall meal quality rating, HFEQ score and short form HFEQ (HFEQ-sv) score). **4)** Asses meal intake and specific foods served and consumed. **5)** Determine the independent effect of three measures of meal quality in predicting overall food intake at a meal while considering selected patient and hospital characteristics.

Methods and Findings: The multi-site study collected data from sixteen Ontario hospitals and 1,087 patients. Data was collected at the hospital, unit, and patient-level. The original HFEQ included 23 questions assessed using a 5-point Likert scale. Food (n = 6) and food-related (n = 10) expectations were assessed by "not important" (1) and "very important" (5), while meal ratings (n = 7) were assessed by "very poor" (1) and "very good" (5). The HFEQ was completed at a single meal where

overall hospital expectations and ratings of the meal served were assessed. Overall food intake and intake of specific food groups were also assessed. Three studies resulted from this thesis work.

1) Internal consistency reliability was assessed using Cronbach's alpha and principal components analysis (PCA). The three subscales of the HFEQ (food expectations, food-related expectations and meal ratings) and the entire HFEQ demonstrated good internal reliability (0.80-0.91) and all but one of the HFEQ questions (the importance of food served being healthy) clustered together in PCA to reveal the following factors: Meal Ratings, Food Traits, Food-Related Traits, Meeting Patients' Dietary and Accessibility Needs, and Food Familiarity and Source. Four ordinal logistic regressions were conducted with the three subscales and entire HFEQ with overall meal quality rating. The three subscales and overall HFEQ demonstrated construct validity with overall meal quality ($p < .050$). Specifically the expectations of taste, local food provision, easy to open packaging and easy to eat foods in addition to meal ratings of taste, appearance, texture, temperature and combination of food served were significantly associated with overall meal quality ($p < .050$). A 5x2 chi-square revealed that overall meal quality rating was significantly associated with food intake at a single meal, where patients with lower overall meal quality ratings experienced low food intake. Cross validation with all 22 items of the HFEQ (relevant items identified with PCA) and overall meal intake was conducted to attempt to shorten the HFEQ, however only the expectation of food choice and meal taste ratings were significantly associated with food intake ($P < .050$). The shortened HFEQ-sv was determined using the 10 items identified in convergent validity analyses and overall meal quality ($n = 11$). A final binary logistic regression was conducted with these 11 items, which revealed that the HFEQ-sv was significantly associated with food intake, with the importance of food choice, and meal ratings of texture and taste being significantly associated with food intake ($p < .050$).

2) Food expectations most frequently rated as "very important" included: taste, freshness, and healthiness (73.75%, 70.45%, and 64.60%, respectively). Food-related expectations most frequently

were rated as “very important” included: meeting patients’ dietary needs, appropriate temperatures, easy to eat foods and receiving a sufficient amount of food (69.54%, 67.45%, 62.89, and 61.07%, respectively). Median sensory meal ratings were all scored at 4 (i.e. “good”). Overall meal quality was rated as “very good” by 28.92% of patients, while meal temperature and taste received the most “very good” ratings (34.56%, and 30.09%, respectively). Average HFEQ and HFEQ-sv scores were 90.60 (SD 10.83) and 44.22 (SD 6.55), respectively.

3) Three regressions (1 ordinal, 2 linear) were conducted to test the association between patient and hospital characteristics and measures of meal quality (i.e. overall meal quality rating, HFEQ and HFEQ-sv scores). Age was significantly associated with all three measures of meal quality, while gender was only significantly associated with HFEQ and HFEQ-sv scores ($P < .050$). Older and female patients were significantly more likely to rate meal quality more favourably. No other patient characteristics were significantly associated with any of the three measures of meal quality. Hospital characteristics associated with meal quality varied depending on the meal quality measure used as the dependent variable. Only hospital size was significantly associated with overall meal quality rating. Foodservice model and proportion of foodservice budget allocated to local food were significantly associated with HFEQ score. Average daily food cost per patient was only significantly associated with HFEQ-sv score.

4) Proportions assessed overall meal intake and intake of specific food items. Approximately 29% of patients consumed ≤50% while 42% consumed all of their meal. Beverages (i.e. tea/coffee, milk and tea), soup, and pudding/Jell-O were items frequently consumed by all patients, even those experiencing low overall meal intake.

5) Binary logistic regressions with food intake as the outcome were conducted considering hospital characteristics with each of the three meal quality measures, and selected patient characteristics stratified by gender. No hospital or patient characteristics were significantly associated with food

intake when any measure of meal quality was considered, however meal quality ratings were significantly associated with food intake (ps < .050). AIC and max-rescaled R^2 was determined for each model to assess model fit and explained variance in food intake. The models where HFEQ-sv was used as the meal quality measure demonstrated the best compromise between model fit and explained variance when patient characteristics and hospital characteristics were considered, suggesting that this version of the HFEQ may be most appropriate to assess meal quality while considering patient and hospital characteristics.

Conclusion: The HFEQ demonstrated good internal reliability and convergent validity with overall meal quality rating, and both the HFEQ and HFEQ-sv demonstrated predictive validity with food intake at a single meal. Patients generally rated food expectations and food-related attributes highly, suggesting that patients have high expectations of meals served in hospital. Ratings of meals served did not always meet these high expectations. Patient age and gender were significantly associated with perceptions of meal quality, while hospital characteristics associated with meal quality were dependent on which measure of meal quality was used. Approximately 29% of patients consumed ≤50% of their meal. Patients experiencing low food intake were more likely to consume soft, or fluid foods. When patient and hospital characteristics were considered, only perceptions of meal quality were significantly associated with food intake, where higher scores of meal quality were associated with increased odds of patients consuming their entire meal. The HFEQ-sv demonstrated the best compromise between model fit and explained variance in food intake when the three measures of meal quality (i.e. overall meal quality rating, HFEQ and HFEQ-sv scores) were considered. The HFEQ or HFEQ-sv should be implemented in practice or used in future research to assess perceptions of meal quality and aim to improve the meal experience and support subsequent food intake for patients in hospital.

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I acknowledge that I worked on the traditional territory of the Neutral, Anishinaabeg and Haudenosaunee peoples. The University of Waterloo is situated on the Haldimand Tract, the land promised to the Six Nations that includes ten kilometres on each side of the Grand River.

Dedication

This thesis is dedicated to my grandparents Giuseppina, Raffaele, Romilda and Luigi for showing me the power of hard work and determination and instilling the comforting and nourishing role food and mealtimes play in our daily lives.

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List of Abbreviations

ACHFPSQ: Acute Care Hospital Foodservice Patient Satisfaction Questionnaire

BMOS: bedside menu ordering system

CI: confidence interval

CMTF: Canadian Malnutrition Task Force

LTC: long-term care

HFEQ: Hospital Food Experience Questionnaire

HFEQ-sv: Hospital Food Experience Questionnaire short version

MAT: Meal Assessment Tool

MQAT: Meal Quality Audit Tool

ONS: Oral nutritional supplements

PCA: Principal components analysis

SGA: Subjective Global Assessment

Chapter 1
Introduction

Appropriate nutritional care while in hospital can promote patient health and recovery, however food and nutritional care are often overlooked components of hospital services.[1–6] Patients' expectations and perceptions of hospital meal quality may subsequently affect food intake and recovery.[2,4–15] Inadequate intake while in hospital can lead to worsening or development of malnutrition, resulting in adverse health outcomes including further morbidity and mortality.[7,12,14,16,17] There is currently no legislation in Ontario that mandates how hospital menus are assessed for nutritional adequacy, or that patient meal satisfaction data is collected or acted upon.[11,18] Understanding Ontario patients' experiences with hospital meals is critical to identify strategies to improve food quality and intake, as well as patient outcomes. To date, there are limited reliable and valid tools available to gain insight into patients' expectations and perceptions of hospital meals,[19] making it difficult to determine areas needing improvement. This thesis aims to determine the validity and reliability of the Hospital Food Experience Questionnaire; assess patients' experiences and expectations of hospital meals; and understand patient- and hospital-level characteristics that influence both hospital meal expectations and experiences, and subsequent food intake.

The thesis starts with a literature review that provides an overview of food and foodservice in Ontario hospitals, in addition to policy and institutional factors that influence food and foodservice. This chapter also discusses the prevalence of hospital malnutrition and its consequences, factors that influence both low food intake and malnutrition and the relationship between patients' perceptions of meal quality, satisfaction, and malnutrition. The definition of patient meal satisfaction and factors that influence patient meal satisfaction such as expectations, food quality and patient-level traits are presented. Chapter One concludes with how the patient meal experience is measured, a description of tools that have been used to

gather this data and the need for tools to be reliable and valid to accurately collect this data to best represent patients' experiences.

Discrete chapters of this thesis include three papers written in a manuscript format to address the three main research questions. All analyses are based on data collection at 16 Ontario hospitals. The first manuscript discusses the importance of using a valid and reliable tool to collect patient meal experience data as well as critiques patient food satisfaction questionnaires previously used. The development of the Hospital Food Experience Questionnaire is explained as well as the analyses and results, which includes assessing the internal consistency reliability and construct and predictive validity of the Questionnaire.

The second manuscript introduces expectations and experiences of hospital meals and patient and hospital factors that may influence perceptions of meal quality while in hospital. Descriptive statistics for meal expectations and experiences are reported in addition to logistic and linear regressions analyses to identify patient and hospital traits significantly associated with measures of meal quality. This manuscript aims to give a better understanding of how patients experience meals in Ontario hospitals in addition to contextual factors that influence perceptions of meal quality.

The final manuscript assesses food intake at a single meal, in addition to specific food and beverages (e.g. soup, juice, sandwiches, etc.) both served and consumed by all patients, and those with low overall food intake. The effect of patient and hospital characteristics and meal quality measures on overall meal intake are considered. Subsequent analyses assess how three meal quality measures determined by the Hospital Food Experience Questionnaire perform in predicting food intake to identify which meal quality measure best predicts food intake. All questionnaires and surveys used for data collection are included as appendices.

This research aims to demonstrate the important role that meal quality plays in both patients' expectations and experiences of hospital food served in Ontario, as well as how patient experiences are related to food intake. Using a valid and reliable tool to quantify patients' experiences with hospital meals

can help to monitor and implement quality improvement measures within and across hospitals in Ontario to improve meal quality perceptions and potentially subsequent food intake and recovery.

Chapter 2
Background and Literature Review

2.1 Current Hospital Food and Foodservice

Patient care in hospital includes appropriate nutritional care to promote health and recovery.[1–6] The mandate of hospital foodservice is to provide food that is nutritionally adequate and appropriate for various health conditions[20]; adhere to regulations; meet or exceed patient expectations; meet budgetary and operational constraints; and support hospital functioning and community culture.[18] Hospital foodservice can achieve this when nutritious meals are carefully planned and served and when patients consume served meals.[2]

Hospital foodservice is complex; it requires delivery of food to patients with various clinical needs[19] and also involves many stakeholders such as medical staff, foodservice staff, and patients.[3,10] Hospital foodservice is a process, therefore change in one area of foodservice will impact other areas (e.g. changes in food production can have downstream effects on food distribution and subsequently patient food intake).[2] For example, if a hospital decides to make their own homemade soup due to patient requests for healthy local options, this will require identification and testing of recipes, sourcing of local ingredients year round, storage of those ingredients, training of staff and ensuring that staff are scheduled to prepare the product. These considerations, as well as patient preferences and expectations need to be considered when planning menus.

The hospital menu is the most important foodservice operational tool because it drives procedures and processes that are used to control food, labour and equipment costs.[18] Menu planning is influenced by hospital budget, environment and foodservice department complexity.[11] In attempts to reduce or control hospital foodservice costs, strategies such as outsourcing food may be used. However, food source may affect patient food choice, variety, and quality, as well as overall patient satisfaction with hospital food.[18,21] Greig et al. interviewed 57 Ontario hospital foodservices managers and most (75%) reported that

≥70% of items on their menus were outsourced, while the remainder was produced by either scratch or semi-scratch methods.[18] A best practice for meeting the goals of foodservice is to regularly review hospital menus and to survey patients to optimize both nutritional adequacy and patient satisfaction.[11] Creating menus that meet patients' clinical needs while also accommodating patients' preferences,[11,19,20] with a focus on variety, quality, taste and overall hospital environment,[22] could potentially be a method to support food intake.

Both Ontario hospitals and long-term care (LTC) homes fall under the Ontario Ministry of Health and Long-Term Care with respect to regulations and standards.[18] Standards and legislation for menu development and quality have resulted in improvements in food served to residents living in LTC.[11] However, unlike LTC, hospitals are not legislated to assess food quality, appropriateness of their menus, nor are they obligated to interpret and act on findings from patient satisfaction surveys; this partly explains gaps and inconsistencies in foodservice practices across Ontario.[11,18]

Canada's Food Guide is typically used to plan and assess the nutritional quality of Ontario hospital menus[11,18]; peer-review literature, information from outsourced food companies or health associations and the daily recommended intakes are also used.[18] Despite a variety of resources to develop and assess menu quality, there is no standard practice.[11,18] A recent study identified that only 29% of Ontario hospitals had formal menu planning processes in place.[18] Lack of attention to patient meals has been attributed to the perception that hospital food already adheres to nutritional guidelines.[18] The Canadian Malnutrition Task Force (CMTF) recommends establishing a national standard for menu planning[23] to address some of these challenges.

There is no accepted comprehensive standard for menu evaluation in Canada as well as most other Western countries, even though menus are potentially the most important aspect of hospital foodservice and are critical to foodservice success.[11,18] The relevance and importance of foodservice is often misunderstood and is often viewed as an area where budget cuts will have the least impact on

patient care.[3] Phone interviews with Ontario hospital foodservice managers (n = 57) described resource scarcity due to budget cuts and cost of food, as well as staff training and time, to be barriers to assessing nutritional content and improving menus to satisfy patients.[3] Lack of evidence-based standards and regulations allows for decision-making regarding hospital food and menu planning to be based on operational efficiency and budgets, with little attention towards nutritional composition, patient satisfaction and experience with hospital food.[18] Determining a cost-effective foodservice system that optimizes patient food intake whilst minimizing food waste is needed in Ontario hospitals.[3]

2.2 Hospital Malnutrition

The role of hospital foodservice has become increasingly important because of the various issues that arise when patients are malnourished.[22] Malnutrition is defined as inadequate nutritional intake or uptake that results in changes in body composition or mass, which can impact clinical outcomes as well as physical and mental functioning.[24] Inadequate food intake to meet the physiological demands of disease and injury will affect patients with various diagnoses, and of all ages.[25] Undernutrition is a common worldwide problem among hospital patients and malnutrition can result from inadequate food and beverage intake.[2,12,13,16,26–28] Provision of hospital foodservice that is nutritionally adequate to meet physiological needs in these stressed states is critical to prevent and treat malnutrition, which the CMTF estimates occurs in ~45% of Canadian medical and surgical patients who are in hospital for ≥2 days.[29] The rate of malnutrition risk in hospital varies, with estimates between 13-70%, depending on the population studied, timing of assessment and tool used.[1,5,11,12,14,15,17,26–34] Factors that may contribute to malnutrition include underlying illness, age, socioeconomic status, medical procedures and symptoms that impact food intake, lack of monitoring of nutritional status and lack of standardized nutrition care protocols.[1,5,6,10,13,26,29,31,32]

Malnutrition increases the risk of adverse outcomes such as: infections,[7,14] falls and pressure injuries, further morbidity, longer length of stay,[16] mortality,[7,12,14,17] and decreased muscle mass[7] and

quality of life.[26,30] For hospitals, malnutrition can result in increased costs associated with length of stay, readmission, and greater resource utilization.[5,7,13–15,21,26,27,29,31–33,35] A Canadian study investigated factors associated with nutritional decline after 7 days of hospitalization and found that approximately ~20% of patients experienced a decline in nutritional status when assessed using the Subjective Global Assessment (SGA).[5] After adjusting for SGA at admission, low food intake attributed to food quality and illness were associated with a higher risk of nutritional decline in medical hospital patients.[5] Specifically, nutritional deterioration among medical patients was associated with greater dissatisfaction with taste, appearance, and smell of food, as well as a decrease in appetite, and experiencing sickness or pain.[5] These more detailed findings demonstrate the importance of foodservice and quality food to recovery.

2.3 Food Intake in Hospitals and Factors Associated with Low Intake

Meals are often an overlooked part of treatment, although consuming an adequate diet is needed for patient recovery.[1–3,13,26,30,36] It has been estimated that 67-94% of patients rely on hospital food as their sole source of nutrition while admitted to hospital.[1,36] Adequate food provision is necessary to ensure that energy, protein, and nutrients meet patients' physiological needs. An Australian study investigated food intake of patients on various diet orders (i.e. regular, texture modified, low allergen, low fiber or oral fluids) in 6 hospitals found that mean energy and protein provided was 1,397 ± 554 kcal and 53 ± 30 grams, respectively, but that mean food intake was significantly lower, at 977 ± 579 kcal, and 37 ± 28 grams of protein, respectively.[26] Alarmingly, both average provision and intake was lower than patients' average calculated energy and protein requirements, which were 2,100 ± 392 kcal and 86 ± 18 grams, respectively.[26] In this study, only 37% of patients were provided with enough food to meet both their estimated protein and energy requirements.[26] Inadequate food provision in relation to estimated requirements may be due to greater nutritional needs experienced during illness and treatment.[1,2,5,15,26,30] On the other hand, Dupertuis et al. found that food provided by one Swiss hospital exceeded patients'

needs where 2,007 ± 479 kcal and 78 ± 21 grams of protein were provided,[36] demonstrating that not all hospitals are providing inadequate food.

Low patient food intake is potentially more of a problem than inadequate provision of food. Dupertuis et al. found that despite adequate food provision, 59% of hospitalized patients were not undernourished due to their diagnosis, but rather due to low food intake as a result of therapeutic diets as well as other factors with 70% not meeting their recommended intakes of 1,422 ± 270 kcal and 68 ± 16 grams of protein, respectively.[36] Several other studies have documented low intake of served food.[29,30,37,38] In 309 diverse patients it was found that only 28% of patients ate all food served, whereas 48% ate most, 22% ate a small portion, and 2% ate none.[37] A smaller study that looked at spinal cord injury patients also observed low food intake, where 52% of the 67 patients did not consume all food that was served and approximately 33% missed one or more meals.[38] In the Nutrition Care in Canadian Hospitals study, approximately one-third of patients ate <50% of meals offered.[13,29] Byrnes et al. (2018) observed 100 meals consumed by post-operative patients and found that less than 50% of food served was consumed at half of the meals.[30] There was also no significant difference in food intake between post-operative day two and five,[30] suggesting that low food intake was an issue throughout patients' hospital stay. Both adequate energy and protein provision and consumption is needed for patient recovery, however food intake is often low putting patients at risk for malnutrition and its associated consequences.[1,13,26,30,36]

There are numerous reasons for poor patient food intake. These include limited food selections; decreased appetite; poor quality and appearance of food; disliking served food and feeling that food is unacceptable; nausea/vomiting; pain; fatigue; no or inappropriate food provided; interruptions at mealtimes; meal timing; and the overall hospital atmosphere.[1,5,6,13,15,16,25,30] One study found that patients may experience variability in appetite, however, even patients with a good appetite may still experience low food intake due to eating challenges such as inability to handle cutlery, dentition issues and lack of available eating assistance when required.[22] Patients may also experience increased nutritional

requirements from disease, metabolic stress,[2,25,27] treatment,[1] or malabsorption.[30] Patients who experience malnutrition are at risk for adverse outcomes,[26] therefore, understanding why patients experience both low food intake, and/or malnutrition is critical to developing specific interventions to improve both patient nutritional status, and overall health.[1,26]

Although evidence suggests the amount of food provided may be inadequate in some instances,[26] several studies also suggest that the quality of the food served is an issue.[2,6,10,12,16] It is worthwhile to pay attention to foodservice and food quality and to consider perceptions of meals and how they may be altered while in hospital to optimize food intake.[5,38,39] Specifically, low meal quality and dissatisfaction with sensory aspects (e.g. smell, appearance) has been shown to result in low food intake.[4–6,8–15] Hospital foodservice plays an important role in patient recovery and wellbeing,[2,7] therefore, promoting adequate food intake through serving quality food in hospital can lead to faster recovery, and decreased length of stay, which can also impact hospital costs.[7,9,27,31,38] The etiology of malnutrition is multifactorial,[1,21,26,30] therefore, it is worthwhile to investigate various system-level approaches to support food intake among hospital patients, potentially through fortified foods, provision of snacks, oral nutritional supplements (ONS), and support at mealtimes (i.e. eating assistance),[30] as well as serving patients+ food they consider to be high quality and enjoy.

2.4 Malnutrition and Patient Meal Satisfaction

Hospital foodservice is often the only food provided for patients,[11] but meals are not always targeted to their needs and altered appetites and tastes.[37] Stanga et al. found a negative relationship between hospital length of stay and meal satisfaction, where patients with a longer hospital stay had worse appetites and ate less food, potentially due to greater illness severity.[37] Fifty percent of patients reported having less of an appetite in hospital, however there was a positive relationship between patients' perceptions of the importance of food and their appetite, and what was consumed.[37]

It is important to assess patients' food intake and to review their hospital meal experience so that improvements can be made where necessary to optimize food intake while in hospital.[38] If patients consume food equal to their nutritional requirements, foodservice can be considered to be meeting its mandate, however intake that is greater or lower than requirements are considered problematic.[2] If patients perceive hospital meals as unappetizing, food intake will likely decrease, while food waste will increase.[12] Hospitals need to provide patients with meals that meet their cultural, nutritional and clinical needs, is presented appropriately and served in a pleasant environment, and patients should be able to receive eating assistance in a timely manner if necessary.[22] Increasing perceptions of meal quality by meeting patient food preferences and allowing for food choice can help support food intake as well as a timely recovery, which not only supports patient health, but reduces the risk of longer hospital stay, reducing hospital costs.[40] Thorough knowledge of the various dimensions of hospital foodservice satisfaction and more specifically meal quality, is needed to understand patient expectations and to determine strategies to effectively improve the meal experience, satisfaction and potentially food intake.

Analysis of patient meal satisfaction data in hospitals is limited and foodservice survey methodology could be strengthened by asking detailed questions and comparing results to previous periods or similar hospitals.[11,18] This data can inform foodservice operation decisions, especially for nutritional adequacy and patient satisfaction with menus.[18] Routinely assessing both patient satisfaction, food intake and meal quality through surveys and meal rounds could potentially address, at least partly, the discrepancy between nutrients served and consumed in hospital.[2]

Kim et al. identified a discrepancy between amount served and consumed which resulted from menus not being reflective of patients' preferences, inconsistent food quality, lack of food variety, serving food at improper temperatures and patients not understanding their own nutritional needs.[2] Completed surveys demonstrated that patients did not eat sufficiently while in hospital because they did not have an

appetite, they did not enjoy the taste of foods served, and it was also observed that patients sometimes left their rooms at meals for tests or were sleeping, all which could reduce food intake.[2]

Accommodating patient preferences[26] and improving meal quality, which has previously been demonstrated to be related to sensory aspects of the meal (e.g. appearance, taste, aroma), have the potential to improve patient food intake.[4,10,14,20,26,31,39,41] Both nutritional and sensory food quality have been shown to be related to meal satisfaction and can be useful markers for effective hospital foodservice.[4] Every patient makes implicit comparisons of what they eat in hospital to what they eat at home when answering questions regarding meal satisfaction.[19] Therefore, serving foods that patients consider to be high quality is important not only improve perceptions of meal quality, but also for recovery and overall hospital satisfaction.[31] Areas to improve meal and foodservice quality in hospital include sensory aspects of food, nutritional quality, and food presentation, as well as the menu, ordering system, meal timing and service style.[4]

2.5 Patient Satisfaction

Patient satisfaction has become a key criterion for evaluating healthcare service quality.[16] Patient satisfaction is a term that is widely used, however, is poorly understood, potentially due to its subjective nature.[42] It is widely recognized that food and other aspects of foodservice delivery are important to patients' overall perception of their hospital experience, and that hospitals have a commitment to deliver food that is appropriate for its diverse patients.[8,19] Quality foodservice involves meeting patients' needs, while also exceeding their expectations.[19] Patient food intake is a good indicator of both nutritional status and satisfaction with hospital foodservice.[19]

2.5.1 Perceptions of Hospital Food

The public generally views hospital food as being poor, unappetizing and non-nutritious often due to institutional stereotyping.[4,10] Media coverage and the fact that food is often outsourced and pre-

prepared has led to a reputation of hospital food being high in sugar, fat, salt, artificial flavours and colours,[11] and poorly presented.[4] Perceptions of poor food quality may also stem from patients who feel unwell, as they may find food undesirable due to its flavour, aroma or appearance, or they may not be familiar with the Western diet that is typically served.[11] Eating in hospital is usually compared to patients' experiences of eating at home,[4] which is likely more enjoyable. When in hospital, patients may regard adequate food intake as their responsibility for their recovery.[4]

2.5.2 Patients' Expectations for Food and Foodservice

Satisfaction with hospital foodservice is multidimensional,[19,20,25] complex[28] and difficult to assess[19] particularly due to patients having their own unique expectations.[10,28] Meal satisfaction is highly related to expectations[19,28,42] and perceptions which can be shaped by attitudes and previous experiences.[41] If meal quality expectations are low and meal quality surpasses this expectation, patient satisfaction may be rated more highly,[7] giving no incentive for hospitals to try to improve food or foodservice quality.[28] Watters et al. (2003) conducted focus groups and meal rounds and found that patients generally thought the quality of hospital food was better than they expected, and that it had improved from their past experiences.[8] Dubé et al. (1994) suggest that patient perceptions of foodservice fall into seven dimensions: food quality, meal service timeliness, service reliability, temperature of cold food, attitudes of staff who deliver menus and meals and ability to customize.[43] As patients' expectations are increasingly met during their hospital stay, ratings of foodservice, and specifically meal quality often increase.[11]

Currently, serving local food is a low priority within the Ontario healthcare system, however it may be a growing expectation of consumers.[41] Among 55 Ontario hospitals surveyed, 71% report using some local food in patient meals, cafeterias or both, with a mean of 21% of foods being offered categorized as local; however, the range was 1-80%, demonstrating variability in local food provision.[41] Local food is attractive due to its potential increased nutritional quality potentially allowing for

availability of healthier food options, which may improve health outcomes.[41] Provision of local food through hospital menus has the potential to increase patient satisfaction through improved nutrition and by catering to patient beliefs that local food has better flavour, texture and freshness.[41] Barriers for use of local food in hospital include low food budgets, government regulation and concerns about supply (i.e. seasonality of certain fruits and vegetables).[41] In hospital, there is also concern for food waste, especially from a financial viewpoint.[41] Previous studies have found that high food waste in hospital has resulted from poor food intake, patients' conditions, issues with hospital food and menu such as poor meal quality, inappropriate portion sizes and limited menu choice, as well as service issues, such as difficulty accessing food, and environmental factors, such as an unpleasant eating environment and meal times that are mismatched to patients' preferences.[12,41] Justifying the importance of local food provision in Ontario hospitals will likely rely on demonstrating that it has economic benefit and that it can increase patient satisfaction with food and foodservice.[41] Developing menus to support local food in healthcare is required to successfully incorporate local food in Ontario hospitals.[41]

Providing culturally familiar and appropriate foods has also been identified as an important part of foodservice[4,8,11] and an expectation of some consumers. However, serving foods in hospital that meet patients' cultural preferences is a challenge,[11] potentially due to budget, safety or food supply.[18] In some cases, patients of particular ethnic groups have limited cultural food selection, which poses a barrier to support food intake among diverse patients.[21] To date, there is limited evidence that availability or lack thereof of culturally familiar foods influences expectations and satisfaction with hospital meals.

2.5.3 Foodservice Quality and Patient Satisfaction

Some studies report that food quality is the most important indicator of patient satisfaction, while others suggest that interpersonal or service aspects are most important.[11,25,41] Food and other aspects of foodservice are central elements in the overall perception of the hospital experience; the greater expectations are met; the more satisfied patients seem to be.[7] When patient satisfaction and meal

experiences are assessed, typically both foodservice quality (e.g. how food is served, when, quality of dishware, etc.) and food quality (e.g. sensory aspects of food, meeting nutritional needs, etc.) are assessed.[7,19,20,22,43–46] Using factor analysis, Messina et al. (2012) found that four dimensions of foodservice – food quality, meal service quality, hunger and food quantity, staff or service issues – explained 64% of the total variance in foodservice satisfaction.[22] Foodservice quality can be assessed using many indicators, such as Dubé et al.'s seven dimensions of food satisfaction,[43] in addition to sanitation, and serving times.[2,10]

With respect to foodservice quality, literature emphasizes the quality of foodservice staff interactions[19] and identified that even small, one-off negative interactions can largely impact patients' satisfaction ratings.[8] Some patients reported the timing of meals as inconsistent with when they were used to eating at home.[15,27] Although most patients indicated that they had enough time to eat, some felt rushed when staff came to remove trays.[27] On the other hand, when foodservice is slow patients were more likely to be critical of hospital services, and rate them more negatively.[8] Watters et al. identified hospital staffs' concerns for patient food intake, including the appropriateness of foods served, availability of culturally appropriate foods, tray layout, difficulty opening food packaging, and lack of food on units outside of meals.[8] Similar to these concerns, 30% of patients required assistance with tray setup, however, 83% reported no difficulty in accessing food between meals and also did not require additional food on the unit.[8] Studies in Canada and the United Kingdom have focused on the patient experience with hospital food, and have found that inability to provide feedback, menu errors, food accessibility, tray layout and food waste are patient concerns that can negatively affect mealtimes and food intake.[25]

Some patients report difficulties ordering meals because menus lack sufficient nutritional information,[6] and patients with hearing or visual impairments may experience some difficulty accessing their meals.[27] Physical barriers at mealtimes, such as inappropriate seating or table positioning, and difficulty using utensils to independently eat presented more challenges to older patients.[27] Most patients

requiring eating assistance reported difficulty getting attention for assistance,[27] and some patients also reported that disruptive behaviours, smells and sounds from the general hospital environment as negatively impacting their meal experience and food intake.[27] Although all of these foodservice factors can potentially impact food intake and overall satisfaction, the sensory and overall quality aspects of hospital food will be the focus of this work.

2.5.4 Food Quality, Patient Satisfaction and Factors that Influence

Several studies have identified that food quality is the most important determinant of patient foodservice satisfaction.[7,8,11,16,19,20,22,25,31] High quality food is critical to adequate nutrition intake, food enjoyment, and a positive hospital experience.[11] Hartwell et al. suggested that food quality and then foodservice quality (e.g. foodservice staff attitudes) were the two most important predictors of patient satisfaction.[25] Capra et al. confirmed that food quality was the main predictor of food satisfaction, whereby food quality explained 37% of the total variance (61%) in food satisfaction ratings.[20] Patients' food quality ratings are subjective,[11] and have been described as a function of taste, variety, flavour, texture, freshness, and perceptions of healthiness.[2,4,6,10–12,19,20,22,27,28,31] However, perceptions of food quality can be influenced by feelings of nausea, disease processes, altered taste perceptions, unfamiliarity with food, hospital policy, expectations, prescription of therapeutic or modified texture diets or the relative quality of food consumed outside of hospital.[1,2,4–7,10,11,18,19,22,27,31,39,42]

Sensory aspects of food, such as appearance,[20] flavour, texture, and temperature, as well as variety, and perceptions of healthiness,[18] have been found to be the most important to hospital patients when judging food quality.[2,4,6,10–12,14,19,22,25,27,37,38,41] Patients believe that hospital meals should be healthy,[8,37] and approximately 76% of patients in one study considered hospital food to be healthy.[8] However, at times, patients perceive hospital food to be unhealthy.[8] Perceived temperature and texture have been previously identified as the two most important sensory components for patient acceptance and satisfaction with hospital food.[2,10] However, other studies have suggested that temperature and variety

minimally contribute to patient food satisfaction,[20] suggesting that perceptions of satisfaction vary among diverse patient groups.

Having a range of food items to build regular, therapeutic and modified texture diets and a variety of items to put on each diet prescription enhances menu quality and the patient experience.[18] Variety in menus allows for choice,[4] which affects patient satisfaction as preferences are more likely to be met. One study found that menu cycles in hospital range between 1 to 5 weeks which can impact food variety.[18] Yet, menu cycles must balance with average patient length of stay, diet restrictions, and budgetary and storage capacities.[18] Smaller hospitals, and hospitals with shorter average admission lengths typically have shorter menu cycles to optimize operational processes; however, this can reduce variability of food provided,[11] especially for patients with longer hospital stays.[8] Messina et al. found that patients emphasized the need for food variety when in hospital.[22] A study investigating food and foodservice in Ontario hospitals reported that increased outsourcing and group purchasing helped control labour costs, but limited the amount of food items available, which can reduce variety and therefore patient satisfaction.[18] A previous Canadian study also found that participants expressed frustration due to lack of variety and flexibility with menu offerings, which was typically blamed on low food budgets and outsourcing.[21] On the other hand, another study found that a greater reliance on outsourced food could improve patient ratings by having sufficient food choice in hospital.[6]

Increasing food choice is a strategy to improve patient satisfaction, as it is one of the few components of the hospital experience patients have control over.[11,18,25,37,41] Ontario hospital foodservice managers (n = 57) reported that many menus were non-selective (38%) although patient preferences were often obtained at admission, or hospitals were able to provide patients with some food choice due to a combination of select and non-select menus (42%).[11] However, inability to choose foods patients liked has been found to be significantly associated with consuming less than 50% of the meal during the first week of hospitalization.[6] Some patients who were in hospital for a longer period report a desire for greater

food variety and choice, and the opportunity to give foodservice feedback.[8] An Australian hospital implemented a bedside menu ordering system (BMOS) which promoted choice and compared patient food intake and satisfaction scores with the regular paper menu ordering system.[40] They found that satisfaction remained consistent across both service methods but both protein and energy intake significantly increased with the BMOS system.[40] Another Australian study implemented a room service system that promoted choice and found that it significantly improved energy and protein intake, as well as patient satisfaction.[47] Thus, providing options for choice may improve perceptions of meal quality, as well as promote food intake.

Previous studies have found that perceptions of portion size can vary depending on patients' age and diagnosis.[2,8,27,37] Some patients report feeling upset when served large portion sizes because it is overwhelming[27] and increases food waste.[8] Other patients reported preferring larger portion sizes.[27,37] However, size alone likely does not drive satisfaction; if meals do not meet patients' quality or expectations, increasing portion sizes is unlikely to increase food intake or satisfaction.[38]

In addition to food-related factors, demographic and sociocultural aspects also have the potential to influence both food acceptance and intake among hospital patients.[19] Older patients and patients with lower education typically report greater satisfaction.[4,25,42] There have been mixed results on how gender influences satisfaction, where one study reported that gender does not affect satisfaction scores,[42] while some studies have found that males report greater satisfaction.[22,25] Age may also influence patients' perceptions of meals; elderly women were found to express more satisfaction especially with respect to receiving care in general.[4] Patients may potentially report greater satisfaction than what they actually feel because they believe positive feedback may be more acceptable to staff administering the survey (social-desirability bias), or to reduce the risk of jeopardizing future care (self-interest bias).[42] Determining patient- and hospital-level factors that influence the patient meal experience is needed to understand

potential determinants of meal quality perceptions and patient satisfaction as this could subsequently affect patient food intake and overall patient health.

2.6 Measuring Meal Quality and Patient Satisfaction

Successful catering can be thought of as high customer satisfaction.[10] However, the importance of assessing patient meal satisfaction is likely undervalued, as there is currently no standards or criteria among Ontario hospitals for assessment.[11] One study found that more than 80% of hospitals not associated with LTC obtained patient satisfaction feedback at the department and corporate levels, some of which were done annually, but only 33% of hospitals compared their results with previous periods.[18] At the corporate level in 45 Ontario hospitals, 17% of foodservice managers compared survey results to previous periods, 17% to other hospitals, 7% to both previous periods and other hospitals, while 27% made no comparisons and 31% were not analyzed using targets or benchmarks.[18] Lack of comparisons to previous periods and across Ontario hospitals is concerning, as it makes it difficult to track quality improvement measures and see how hospitals across the province compare. Foodservice managers have indicated that hospital priorities are often budget and staffing and not nutritional adequacy or patient satisfaction with menus.[32] Quality improvement for hospital foodservice should involve various components, such as availability of menu items, quantities of food, tray and food presentation, and service.[2]

The Ontario's Excellent Care for All Act directs hospitals to conduct patient surveys at least once every fiscal year.[11] One part of managing and maintaining hospital foodservice standards involves assessing patient satisfaction,[25] as satisfaction is an acceptable indicator to assess foodservice quality as well as healthcare quality.[11,28] There is no common or best practice to obtain patient satisfaction data at either the department or corporate level,[7,11,18] and there is also no expectation on how this data should be collected.[18] Some hospitals routinely conduct surveys, while others only do so occasionally.[11] Lack of legislation mandating that patient meal satisfaction and meal quality in hospital be measured and results

acted upon[18] may potentially explain variation in assessing patient food satisfaction and lack of comparison overtime and across Ontario hospitals.

Qualitative methods, including semi-structured interviews and focus groups,[2,4,12,48] as well as assessing patient foodservice satisfaction comments[49] have been used to gain an understanding of patient meal experiences and foodservice satisfaction. However, these are not practical for assessing satisfaction overtime and from a diverse group of patients. Open-ended questions or comment boxes on questionnaires are a way of eliciting additional and individualized feedback.[19] Questionnaires are the most used quantitative method to assess patient meal satisfaction.[19,25] However, questionnaires usually ask limited, general questions and may not provide sufficient detail to effectively improve hospital food.[2,7,20,28] Furthermore, few studies have used validated tools.[19] Measurement of patient meal satisfaction requires simple, valid (i.e. sensitive and specific) and reliable tools that also capture the various components of foodservice.[7,19,20] The following sections will present and critique the tools identified in extant literature. An overview of current tools, what they assess and what is not assessed is found in Table 2.1.

A customer opinion card, adapted from Cardello used a 7-point scale of "very good" to "very bad" to investigate food satisfaction components of flavour, texture, and the overall opinion of food, as well as a 7-point scale of "much too hot/large" to "much too cold/small" to assess temperature and portion size.[10] This tool was found to be reliable and valid based on a previous study (as cited by Hartwell[10]). This opinion card was used by Hartwell et al. to assess differences in broccoli, carrots, potatoes, poached fish, and minced beef among 180 orthopedic patients in a hospital when a plated vs. bulk trolley system was used.[10] This opinion card demonstrated utility in that there was diversity in scoring, where all foods delivered by the trolley system had better texture and for some foods better flavour and temperature than the plate system.[10] When both the trolley and plate systems were considered, food temperature and texture best predicted overall satisfaction with food, and when the plate system was

considered, flavour was also considered to be important.[10] The opinion card assessed some sensory aspects of hospital food, but did not include aroma and appearance of food, as well as patient expectations of hospital food or preferences for food choice or variety, all of which have been previously described as important to the patient meal experience.[2–4,8,11,18,26,27,31,37,38,42] The opinion card also looked at foods individually rather than as a meal, making it difficult to conclusively describe patients' experiences across meals served in hospital.

Capra et al. demonstrated that the Acute Care Hospital Foodservice Patient Satisfaction Questionnaire (ACHFPSQ) was construct valid and internally reliable using principle components factor analysis and Cronbach's alpha, respectively.[20] The ACHFPSQ contains 2 statements that assess food choice and appropriate temperatures of hot foods, in addition to 16 statements describing 4 domains of foodservice: food quality, meal service quality, staff or service issues and the physical environment.[7,20] Each question is answered on a 5-point scale ranging from "always" to "never."[7,20] This questionnaire was found to be practical and sensitive enough to detect specific quality issues to effectively explain various dimensions of patients' perceptions of foodservice quality.[7,20] The original study by Capra et al. (2005) that assessed the validity and reliability of the tool had a sample size of 2,347 patients (1,807 inpatients, 540 discharged patients); the tool was able to explain 61% of the total variance in overall foodservice satisfaction.[20] Specific to food quality, the ACHFPSQ asks eleven questions on taste, flavour, menu variety, quality of vegetables and meat, temperature of cold and hot beverages and foods, ability to choose a healthy meal and if hospital food matched patients' expectations.[20] The original study by Capra et al. performed factor analysis and did not provide how the sample of 2,347 patients answered each question.[20] Despite the ACHFPSQ having a comprehensive list of questions to assess hospital foodservice from the patient's perspective, some sensory aspects of food such as aroma and food texture (other than meat), and appearance are missing and more specific expectations (e.g. cultural, local, healthfulness) for the meals are not solicited.[20] Thus, use of the ACHFPSQ limits our understanding of what patients

specifically expect when it comes to hospital food and how they fully experience meals served. A greater understanding of patients' experiences of hospital meal quality itself is needed to better understand how patients experience meals while in hospital and to also develop and implement strategies to improve patient food satisfaction and subsequently food intake.

The original ACHFPSQ or slightly modified versions have been used in other studies assessing foodservice satisfaction.[7,22,44–46] Porter and Cant[44] assessed foodservice satisfaction using the ACHFPSQ with 117 patients in one hospital in 2006 and 2007, and Fallon et al.[45] also assessed 551 inpatients from another hospital. Messina et al. slightly modified wording of some questions of the ACHFPSQ to assess food satisfaction among 603 patients at one hospital.[22] Theurer also slightly modified the ACHFPSQ and added subcategories of meal size, hot foods, and hunger and food quantity, and assessed scores from 198 patients from one hospital.[7] These modifications did not address the previously noted sensory and expectation gaps of the ACHFPSQ. Messina et al. found that staff and service aspects were rated more highly than food quality, however food quality was the main influence for patient satisfaction.[22] Interestingly, Theurer found that ACHFPSQ questions and overall foodservice quality was generally rated highly, even though the participating hospital was chosen due to its lower than average foodservice quality ratings compared to other hospitals.[7] This suggests there may be a ceiling effect for response options on the ACHFPSQ. Additionally, although some studies using the ACHFPSQ had larger sample sizes,[22] studies were typically conducted at a single hospital[7,22,44,45] only giving a snapshot of current foodservice satisfaction in a small region.

The Meal Quality Audit Tool (MQAT) was developed by Banks et al., which assessed a total of 12 items falling into the broad categories of appearance, temperature, accuracy and sensory.[28] Each item was scored on a scale of 1 to 5, with 1 being the lowest score and 5 being the highest score for each respective category.[28] The MQAT was initially created by Banks in 1994 using expert opinion and was modified over time to improve usability and usefulness; content validity was assessed by 60

undergraduates who defined food quality.[28] Minor modifications were made after review by 12 senior dietetic staff.[28] Content validity, but not criterion or construct validity has been determined for the MQAT.[28] Inter-rater reliability of the MQAT was determined by having 8 meals rated by five audit teams which consisted of dietetic, foodservices, nursing, allied health, and medical staff.[28] Both temperature and accuracy demonstrated good inter-rater reliability, but appearance and sensory dimensions did not demonstrate good inter-rater reliability.[28] Although the MQAT specifically assesses food quality, it was created for use by staff and not patients,[28] therefore, this tool does not capture the true patient experience of hospital meals. Similar to the ACHFPSQ, only some aspects of meal quality are assessed with the MQAT, therefore, gaining an understanding of other components that could affect quality perceptions such as the meal size, expectations, combination of food present on the tray and being served local and culturally appropriate foods are needed.

Recently, the Meal Assessment Tool (MAT) was developed which assesses flavour/taste, appearance and quality specifically for meat/chicken/meat alternatives, starches and other vegetables using a 7-point scale of "very poor" to "excellent."[17] In addition, the expectation of the meal is assessed using a 5-point scale ranging from "very good compared to what I expected" to "very poor compared to what I expected" and the overall satisfaction with foodservice is rated on a 5-point scale of "very good" to "very poor."[17] At the end of the MAT, questions of age and gender as well as an additional comments box is included.[17] The content validity and feasibility of the MAT was tested by 929 patients in one hospital to confirm wording, the numbering on scales and layout of the tool. Three different tool distribution methods were also tested: placing the tool on the meal tray, leaving it with patients for thirty minutes, or having staff interview patients; the interview method yielded the greatest response.[17] Patients confirmed ease of completion and that the MAT was quick to complete and straightforward. Feedback was also obtained from staff who were experts in foodservice management to confirm content validity.[17] The MAT (n = 204 completed) was determined to be construct valid when compared to the ACHFPSQ (n = 80

completed) as there were no significant differences in mean overall satisfaction scores.[17] A multi-site study also used the MAT to assess eight variations of roast beef and vegetables from different providers among 799 patients, where significant differences in starch and meat characteristics and meal expectations were reported.[17] The MAT was also used to compare chicken cooked using different methods (i.e. in a curry dish, grilled or stewed) among 1,143 patients and significant differences in meat taste, quality and appearance of curry and grilled chicken dishes were detected, suggesting the MAT can differentiate some quality aspects between similar dishes.[17]

The MAT and MQAT were used in a study by Young et al. which aimed to compare energy and protein intake, patient satisfaction and meal quality when comparing pre-plated and bistro foodservice among geriatric patients.[50] In addition to the MAT, patients were asked to rate if staff were friendly/polite using a 7-point scale anchored by "always" and "never."[50] There was no significant difference between the two foodservice systems for ratings of "good-excellent" for flavour/taste, quality or friendliness of staff, however fewer patients rated taste as "good-excellent" for the bistro system.[50] The MQAT was completed by dietitians and found no difference in mean scores for any sensory aspects of the meal or temperature.[50] Similar to other tools, the MAT does not comprehensively assess all sensory components (e.g. missing aroma and texture) of meals, specific meal expectations, or patient choice and variety which have previously been shown to influence the patient meal experience.[4,6,8–12,14,17,19,22,25,27,31,32,37,38,40,41,47,48] The MAT evaluates different types of foods at the meal (i.e. meat, starch, vegetables), however does not consider how the combination of these foods may influence patient food satisfaction, making it challenging to understand the meal experience as a whole. The MAT was also only used to assess satisfaction at the midday and evening meals, making it difficult to determine how the tool performs when assessing foods that are typically served at breakfast (e.g. scrambled eggs, likely fewer vegetables). Lastly, poor completion by patients was reported with the MAT for all administration methods except for

staff interviews, which suggests that successful implementation of this tool may require more resources, which can be costly and potentially not practical in the clinical setting.

The opinion card, MQAT, MAT, ACHFPSQ and modified versions did not comprehensively consider patients' expectations of hospital food[10,20,28] nor have they been validated against food intake. Previous studies have demonstrated that expectations may have an impact on ratings of hospital meal quality,[10,11,42] therefore, creating a tool that is reliable and valid that assesses both patient expectations and perceptions of meal quality is needed to best understand patients' experiences with hospital meals. Regular assessment using a valid and reliable tool will provide a quantitative measure that accurately captures the patient meal experience[17,19] which can be used over time within and across Ontario hospitals to understand food satisfaction, meal quality perceptions and intake, and develop quality improvement measures to better support enjoyment, intake and patient recovery.

2.6.1 Validity and Reliability of Questionnaires

Reliability is a way to assess both systematic and random error.[51,52] There are three main types of reliability,[51–53] inter-rater, test-retest and internal consistency, which define the "true" score and error differently.[52] Inter-rater reliability measures the extent to which results from a single test or questionnaire agree when administered by more than one user.[53] When assessing inter-rater reliability, the true score is defined as what is consistent from one rater to the next, and error is the variance between raters.[52] Test-retest reliability is the agreement between a questionnaire when the same individual completes the questionnaire at two different time points.[53] Test-retest reliability defines the true score as what is consistent when a test is re-administered, and error as what varies from the original and follow-up test.[52] Test-retest reliability can only be used with relatively stable concepts, traits or status.[52] Internal consistency is a measure of how questionnaire items relate to a construct.[53] The true score for internal consistency reliability is what is consistent from one item to another, and error is defined as variance from one item to another.[52] When measuring a trait of interest, the scale being used should be homogeneous,

meaning that all items included should address different aspects of the same attribute, and not aspects of different attributes.[51] There should be moderate correlations among items on a scale to show that items are related, however, if correlations are too high it may indicate redundancy in aspects describing a trait, which can lower content validity.[51] Internal consistency reliability describes whether a sufficient number of items have been included in a questionnaire to capture attributes that make up a concept.[52] Internal consistency describes how test scores vary if different items in a questionnaire are used, which is important to determine if current questionnaire items fully cover attributes of a particular concept.[52] This form of reliability has been reported for other questionnaires, including the food and foodservice satisfaction questionnaire, the ACHFPSQ.[20]

The reliability coefficient, Cronbach's alpha is frequently used to examine summated rating scales (i.e. Likert-scale) for internal consistency reliability.[53,54] Cronbach's alpha measures the extent to which items on a questionnaire correlate with one another, estimating the proportion of systematic variance in a set of responses.[54] Cronbach's alpha should fall between 0.70 and 0.90, as a higher reliability coefficient may indicate that items in the questionnaire are redundant and therefore unnecessary.[51]

Some health measures are objective, such as heart rate and weight, whereas others are subjective, such as quality of life, or patients' perceptions of meal quality.[51] Measuring subjective health variables depends on how they are defined, as well as how they are measured.[51] Validity testing is required for subjective measures because the trait of interest is not directly observable.[51] There are numerous types of validity, all of which contribute to understanding if a measurement assesses an unobservable, subjective outcome.[51]

Content validity is frequently tested through face or clinical credibility, which uses expertise from knowledgeable informants regarding an instruments' clarity and comprehensiveness on the topic of interest.[53] Face validity assesses whether the instrument appears to be assessing qualities of interest that

make up an overall trait.[51] Similar to face validity, content validity describes whether an instrument describes all components of a construct it is supposed to.[51,53]

Criterion validity refers to how well a new instrument compares with what is considered to be the "gold standard" method when measuring the same outcome of interest.[51,53] Criterion validity can be further divided into concurrent and predictive validity.[51,53] Establishing concurrent validity involves comparing scores on the questionnaire and the criterion at the same time.[53] Predictive validity is the extent to which a score on one scale predicts a future event or score on another scale.[51,53] The future event should be meaningful and theoretically associated with the construct being measured by the new tool. Both concurrent and predictive validity can be determined using correlations between either the two instruments of interest, or the instrument and outcome of interest.[53] Instrument specificity and sensitivity is related to criterion validity, where sensitivity is the probability of correctly identifying individuals with the condition among the population with the condition and specificity being the probability of correctly identifying individuals who do not have the condition of interest among the population who do not have the condition.[55]

Construct validity is used when there is no criterion to evaluate an instrument against[53] and involves comparing underlying constructs that explain relationships among subjective traits.[51] Construct validity is the extent to which a score on a questionnaire predicts the subjective trait it intends to.[56] Construct validity can be divided into convergent and divergent validity.[51,53,56] Convergent validity determines the relationship between a new scale and other variables of the same or a hypothesized construct that it should be related to.[51,53,56] On the other hand, divergent validity assesses the relationship between a measurement or construct and an unrelated measurement or construct to demonstrate that there is no relationship between them.[51,53,56] For an instrument to be construct valid, it should have strong convergent validity and divergent validity.[51,56]

A tool used to assess patient' expectations and experiences of meal quality should have good internal consistency reliability because this would indicate that there are sufficient items on the questionnaire and that all questionnaire items are assessing different aspects of meal quality and not other unrelated variables, such as satisfaction with quality of care received by medical personnel.[52] Inter-rater reliability is less relevant as patients' experiences with hospitals meals are unique and can vary from patient to patient; low inter-rater reliability would likely not jeopardize the reliability of a meal quality questionnaire. Similarly, test-retest reliability is likely less relevant to developing a patient meal quality questionnaire as administering the questionnaire over time may change due to patient level factors such as illness severity.

Content validity of a meal quality instrument is needed to ensure all items related to the patient meal experience are included. Because there is currently no gold standard measure to assess perceptions of meal quality or satisfaction, criterion validity of a new tool cannot be established. On the other hand, predictive validity of a related health outcome can be meaningful, whereby patients' perceptions of meal quality may be predictive of a future event or score, such as food intake, or length of stay. Previous studies have suggested that satisfaction with food may be related to patient food consumption,[2,4,6,11,14,26,28,31,38,39,42] therefore a tool that demonstrates predictive validity of food intake would be of value. Because there is no criterion to evaluate a meal quality questionnaire, it is important to establish construct validity.[53] Convergent validity can be used to determine the relationship between the questionnaire, and other variables patient perceptions of meal quality should be related to.[51,53,56] Previous studies have demonstrated that patients' expectations and their perceptions of a meal served can contribute to their perceptions of their overall meal experience, therefore, an instrument assessing patients' score of overall meal quality should also have high convergent validity with their food expectations.

2.7 Conclusion

Sufficient food intake while in hospital requires adequate provision of resources and development of policies, protocols and standards for foodservice.[11,18,37] Additionally, lack of standards and criteria when assessing perceptions of meal quality makes determining patient meal experiences difficult.[11,18] Evidence-based standards would provide guidance to menu planning and assessment, leading to nutritionally adequate menus[11,18] that patients perceive to be of high quality. Additionally, provincial or nation-wide standards for menu planning and assessment will allow for comparisons over time or with similar hospitals as quality improvement measures.[11,18] Improving quality, delivery and service of hospital meals should be one of the quality standards of Ontario health authorities[37] because foodservice quality can influence patient food intake, satisfaction, the overall hospital experience and even hospital costs.[1,2,4–7,9–11,14,18,19,22,26–28,31,38,39,42] Food and nutritional care with respect to patient assistance and meal quality also must become a regular practice in Ontario hospitals,[9] as hospital food provision significantly contributes to patients' wellbeing and recovery.[1,2,4–6] At this point, it is unclear how Ontario hospitals compare with respect to patients' perceptions of meal quality and what hospital-level factors may be associated with perceptions of meal quality. Further, meal experience questionnaires that are comprehensive and include expectations are lacking and needed to drive practice. Development and testing of such a questionnaire are needed.

Table 2.1: Comparing Reliability, Validity and Items Assessed by Previous Meal Quality and Satisfaction Tools

Tool	Reliability	Validity	What is assessed	What is missing
Opinion Card [10]	Yes (as cited by Hartwell[10])	Yes (as cite by Hartwell[10])	• Specific food items • Flavour • Texture • Overall opinion of food • Portion size • Temperature	• Aroma • Appearance • Patient expectations • Preferences, choice, variety • Only looks at foods individually rather than the meal as a whole • Not validated against food intake
Acute Hospital Foodservice Patient Satisfaction Questionnaire (AHFPSQ)[20]	Internally reliable	Construct valid	• Food quality (taste, flavour, menu variety, quality of vegetables and meat, temperature of cold and hot beverages and foods, ability to choose a healthy meal and if hospital food matched patients' expectations) • Meal service quality • Staff/service issues • Physical environment • Choice • Temperature of hot foods	• Aroma • Texture (other than meat) • Appearance • Specific expectations (e.g. culturally traditional foods, variety, healthiness) • Not validated against food intake
Meal Quality Audit Tool (MQAT)[28]	Inter-rater reliable for tray accuracy and temperature	Content valid	• Appearance • Temperature • Tray accuracy • Sensory (aroma, temperature, taste, appearance, texture)	• Does not assess patients' experiences; meant to be used by staff • Expectations of food related traits not assessed (e.g. meeting dietary needs, culturally traditional foods)

				• Not validated against food intake
Meal Assessment Tool (MAT)[17]	Reliability stated as qualitatively confirmed	Content and construct valid	• Flavour/taste • Appearance • Quality of meat • Quality of starches • Quality of vegetables • Expectation of the meal	• Not validated to assess unique breakfast foods • Not validated against food intake • Did not assess expectations • Aroma • Texture • Choice and variety

Chapter 3
Study Aims

Food quality has previously been identified as one of the most important drivers of patient food satisfaction and meal quality perceptions, which may subsequently affect patient food intake and recovery, as well as hospital costs.[5,7,11,31,35,38,39] Presently, there is no legislation mandating assessing or acting upon patients' perception of meal quality data in Ontario hospitals,[11,18] and many tools currently available have either not been validated [19] or do not comprehensively assess meal quality, expectations and experiences.[7,10,17,20,22,28] A valid, reliable and practical tool is needed to assess patients' expectations and experiences of hospital meals in Ontario so that quality improvement measures within and across hospitals can be conducted to best support food intake, recovery and reduce associated hospital costs.[7,9,27,31,38] Understanding which hospital and patient characteristics affect both meal quality and intake is also important to best support practices that will improve perceptions of meal quality and support food intake. Due to the need for a reliable and valid patient meal quality tool to understand patients' expectations and experiences with hospital meals in Ontario, the following analyses will be conducted:

Aim 1: Determine the internal consistency, and construct and predictive validity of the Hospital Food Experience Questionnaire.

> **Hypothesis 1:** The three subscales (i.e. food expectations, food-related expectations, and meal ratings) and entire Hospital Food Experience Questionnaire demonstrate good internal consistency (e.g. Cronbach's alpha > 0.70);
>
> **Hypothesis 2:** The 23 items of expectations and meal ratings on the HFEQ are significantly and independently associated with factors relevant to the patient meal experience demonstrated through principal components analysis (PCA);

Hypothesis 3: The three subscales and entire Hospital Food Experience Questionnaire is construct valid, demonstrated through associations with the overall meal quality rating;

Hypothesis 4: The overall meal quality rating of the Questionnaire is predictive of overall intake at a single meal;

Hypothesis 5: Factors identified through PCA will be significantly associated with overall meal intake at a single meal;

Objective 1: Test the predictive validity of relevant HFEQ questions determined by PCA with overall meal intake to determine if a shorter version can be created using cross-validation analyses;

Objective 2: Assess which questions on the shortened HFEQ are associated with overall meal intake.

Aim 2: Assess patients' expectations and meal ratings of hospital food; identify hospital and patient traits that are associated with three measures of meal quality using the HFEQ.

Objective 1: Determine which aspects of hospital meal quality (e.g. aroma, taste, choice) and food-related attributes are most important to patients;

Objective 2: Assess patients' experiences of sensory traits of a single meal served in hospital;

Objective 3: Test which patient (e.g. gender, age, diagnosis) and hospital (e.g. size, foodservice model) characteristics are significantly associated with the overall meal quality rating, full and short versions of the HFEQ.

Aim 3: Assess overall meal intake and intake of specific food/beverages among all patients and those with low food intake; test patient and hospital characteristics associated with food intake and; determine if the overall meal quality item, full HFEQ or short version HFEQ is superior in predicting food intake.

Objective 1: Assess the proportion of food patients consume at meals and determine the frequency specific food are served and how frequently they are consumed by all patients and those with low overall meal intake;

Objective 2: Determine the predictive validity of each meal quality measure – overall meal quality rating, full HFEQ or short version HFEQ – and assess which measure is superior for predicting food intake using model fit statistic AIC and max-rescaled R^2, when considering key patient and hospital characteristics.

Chapter 4

Study 1: Assessing the Internal Consistency and Construct and Predictive Validity of the Hospital Food Experience Questionnaire in 16 Ontario Hospitals

4.1 Introduction

Adequate nutrition care is needed to support patient health and recovery,[2,25] yet food intake among hospital patients is typically poor.[1,29–31,36–38] Low food intake can lead to the development or worsening of malnutrition.[2,12,13,16,26–28] Up to 70% of adult patients experience malnutrition[1,5,11,12,14,15,26–34] which increases the risk of further morbidity and mortality as well as increases hospital costs.[5,7,13–17,21,26,27,29,31–33,35] Reasons for poor food intake and malnutrition are both complex and multidimensional and can be influenced by patient characteristics such as illness,[5,29,32] gender or age,[5,13,29] as well as expectations and perceptions of hospital meal quality.[10,11,13,19,28,41,42] It is worthwhile to consider hospital meal quality and patients' experiences of meals as a way to optimize food intake[5] and potentially reduce negative patient and hospital outcomes associated with malnutrition.[5,7,12–16,21,26,27,29,31–33,35]

A systematic review found numerous tools have been used to measure perceptions of hospital meal quality or satisfaction using both qualitative and quantitative methods.[19] Qualitative methods have included semi-structured interviews, focus groups,[2,4,12,48] and written comments provided on questionnaires.[49] These methods are not practical for assessing changes in satisfaction or meal quality perceptions over time and from diverse patient groups. Quantitative tools have been developed, but many have not been tested for reliability and validity,[19] making interpreting and comparing scores challenging. Quantitative tools have been completed by patients at different points during their admission. Some tools have been used to assess patient intake and food and foodservice satisfaction at meals,[1,2,7,8,10,14,20,22,25,26,30,37,38] in hospital outside of meals,[4,12,16] after discharge,[34] or both in and out of hospital.[2,8] Meal rounding has also been used to assess patient satisfaction, whereby staff visit patients

during meals to discuss food intake and satisfaction and also observe food served, tray setup and need for assistance.[7,8]

Quantitative tools are also diverse in their content. Previous tools used to assess meal quality and satisfaction among hospital patients have included an opinion card created by Cardello (as Cited by Hartwell[10]), the Acute Care Hospital Foodservice Patient Satisfaction Questionnaire (ACHFPSQ),[20] the Meal Quality Audit Tool (MQAT)[28] and the Meal Assessment Tool (MAT).[17] All four of these questionnaires use 5- or 7-point Likert scales to assess food and foodservice related traits,[10,17,20,28] which is common in nursing research.[26] Despite inclusion of some questions pertaining to meal quality, current questionnaires do not comprehensively assess meal quality. Some sensory traits such as food appearance,[10,20] aroma,[10,17,20] texture[17,20] and food-related traits such as meeting food and cultural preferences, food choice and variety are not assessed.[10,17,28] These components have previously been shown to be highly related to perceptions of meal quality and thus of potential value in a meal experience questionnaire for hospital use.[6,18,22,37–39,43,57,58] Additionally, current questionnaires fail to comprehensively assess patients' expectations of hospital meals,[10,17,20,28] which has previously been demonstrated to influence perceptions of the meal experience.[4,27,43,59–62] It is unclear if a tool that is more comprehensive will predict food intake.

Tools that assess patients' experiences with hospital meals should demonstrate good internal reliability to ensure sufficient items are included to accurately capture the concept of meal quality.[52] Additionally, the tool should be face and construct valid to ensure that questions appear to be assessing perceptions of hospital meals[51] and that questions are associated with the subjective construct of meal quality.[51,56] Few tools created to date have been tested for reliability and validity making it challenging to interpret results.[19] Validity and reliability have been established using rigorous methods for the ACHFPSQ,[20] however assessment of, or clear methods of how internal reliability and construct validity have been established is lacking for the MAT,[17] opinion card[10] and MQAT.[28] Finally, current

questionnaires are not validated against food intake, which is an important factor influencing patients' health outcomes and the ultimate goal of the meal experience.[6,32,63]

In addition to including key components and being valid and internally reliable, questionnaires used to assess meal quality need to be easy to complete and sufficiently short to avoid question fatigue, especially with sick hospital patients. The ACHFPSQ currently includes 18 questions,[20] and the MQAT is currently four pages long, with the number of questions in two of the four sections varying depending on the number of different foods in the meal.[28] The MAT is shorter with 11 food related questions[17] and the opinion card is the shortest with only 5.[10] It is important to balance comprehensiveness of the questionnaire with its length. On both the MAT opinion card, and other questionnaire assessing aspects of the hospital experience, a single question elicits feedback on overall meal quality or satisfaction.[10,28,64–67] As meal quality is subjective, future analyses could test the global rating of meal quality with other key food and meal characteristics that contribute to this construct.

Having a questionnaire specifically targeting hospital meal quality is a priority for development, as previous research has found that food quality is an important predictor for overall foodservices satisfaction.[8,10,11,16,18,22,25,32,43] Yet, a valid and reliable tool that assesses meal quality, expectations and experiences from patients' perspectives, evaluates current practices in hospital, and identifies potential problems and solutions is lacking.[17,19,42] Such a tool should predict food intake, as this is the ultimate goal of any such questionnaire – to make improvements that improve intake and recovery. Having a single tool that is valid, reliable and easy to complete will support the collection of data among hospitals, allowing for benchmarking and subsequent quality improvement over time and across hospitals.[18] A new comprehensive tool, the Hospital Food Experience Questionnaire (HFEQ) aims to evaluate various sensory and preferences associated specifically with hospital meals, providing insight into factors contributing to the meal experience and perceptions of meal quality.

The objectives of this study are to: a) describe the development of the HFEQ and test its principal components, b) determine the internal reliability, construct and predictive validity of the HFEQ, as well as a single proxy item on overall meal quality, and c) develop and test for predictive validity a statistically derived shorter version of the HFEQ. To address these objectives, we have constructed the following hypotheses and objectives:

Hypotheses:

1) The three subscales of food expectations, food-related expectations and meal ratings in addition to the entire HFEQ will demonstrate high internal reliability as determined by Cronbach's alpha ($\alpha > 0.70$);
2) All 23 questions of the HFEQ assessing expectations and ratings will significantly and independently load onto factors that will clearly identify components contributing to meal quality as determined by principal components analysis (PCA);
3) The three HFEQ subscales of food expectations, food-related expectations and meal ratings will be significantly associated with the single item of overall meal quality rating;
4) The overall meal quality rating item on the HFEQ will demonstrate predictive validity with food intake at a single meal;
5) Relevant factors identified in PCA will be significantly associated with overall meal intake.

Objectives

6) Assess the predictive validity of all relevant HFEQ items (as determined by PCA) with meal intake to potentially shorten the Questionnaire using cross-validation analyses;
7) Determine which items of the shortened HFEQ are significantly associated with meal intake.

4.2 Materials and Methods

4.2.1 Design

This is a multi-site study used to test and describe hospital meal experience in Ontario, Canada. Ethics review for this study was completed the University of Guelph (REB#18-02-001), University of Waterloo (ORE#22776), and each participating hospital.

4.2.2 Development of the Hospital Food Experience Questionnaire (HFEQ)

The HFEQ underwent a critical developmental process to determine how to best assess meal quality and ensure face validity. Researchers reviewed current food and foodservice satisfaction tools that have been specifically used in Canada to identify; a) key components, b) acceptable formats, and c) appropriate response options. Concepts covered by existing tools were summarized, and current gaps in items determined (e.g. if patients' expectations were being met). As several gaps were identified, a new tool, the HFEQ was developed. An advisory group of 14 Canadian stakeholders involved in food production or delivery in various institutions reviewed and edited a concept list of the proposed HFEQ content. These initial concepts were drafted into questions and responses and several iterations were reviewed by the advisory group as well as members of the NOURISH cohort.[68] Attention was paid to balancing length with comprehensiveness. The final question draft was tested by cognitively interviewing a diverse group of participants (e.g. English as a second language, age, gender; n = 18). A single trained interviewer reviewed the question draft with participants to confirm meal quality concepts and how concepts and responses were worded on the HFEQ. Finally, revisions and edits were made based on feedback from cognitive interviewing, resulting in the final Hospital Food Experience Questionnaire.

The HFEQ includes Likert-scale (n = 23; based on 3 subscales), and select (n = 3) questions and open textboxes for comments; 14-point font is used as well as significant white space to promote readability. Part 1 of the Questionnaire assesses patients' general *expectations* of hospital food and includes 6 items that elicit the importance of sensory aspects of food (i.e. taste, aroma, appearance) and

provision of food that is fresh, healthy and locally sourced and 10 items on *food-related expectations* (food temperature, variety, choice and portion sizes, ease of chewing/swallowing/independent eating and opening packaging, meeting dietary needs, and provision of familiar, preferred and culturally appropriate foods). These 16 items use a 5-point Likert scale anchored by "not important" (1) and "very important" (5). Part 2 of the Questionnaire elicits *ratings of a served meal* and assesses appearance, smell, taste, texture, temperature, combination of foods served and overall meal quality (n = 7) using a 5-point Likert scale anchored by "very poor" (1) and "very good" (5). These three subscales will be tested individually and combined in this analysis and are the main components of the HFEQ. Additional information collected on the questionnaire based on the served meal included: comparison of quality to other hospital meals previously consumed on this admission ("worse," "same," "better," or "this is my first meal"; free-text box followed for explanation); and portion size ("too little to eat," "too much to eat" or "enough to eat"; followed by a free-text box for written comments). Part 3 asked if food was delivered from outside the hospital by friends/family ("yes" or "no") with an open textbox to discuss foods brought and why and additional open textboxes to explain what could be done to improve food at the hospital, foods patients would like to see offered and any other food related comments (full HFEQ in Appendix A)

4.2.3 Sites and Participants

A call for Ontario sites to participate in this study was released through stakeholder, researcher, and healthcare networks; nineteen hospitals responded and all were screened and determined to add diversity (e.g. size, location/region, foodservice models used) to the sample and were asked to participate. Sixteen hospitals completed data collection; noncompletion was due to challenges completing ethics review or changes in the study lead and inability to continue the project. A minimum of 75 patients from each hospital (estimated sample size of 1,200 patients) was established as the quota for data collection. However due to recruitment challenges experienced at some sites, this quota was not always met. Hospitals were provided a modest stipend to support data collection ($3,000 CDN). Eligible patients were

≥18 years old and had been admitted for ≥2 days prior to completing the HFEQ. Patients who were not fluent in verbal and written English or French, had not received any meals in hospital or received parenteral or enteral nutrition, and patients with dementia or delirium were excluded. Eligible patients were identified by hospital staff, and a quota system was used to achieve patient diversity for recruitment (i.e. hospital units) and meal (breakfast, lunch dinner) assessed. Units for inclusion were not dictated by researchers but chosen by hospital sites to best represent their services.

4.2.4 Data Collection

A hospital employee was trained by the Project Coordinator on how to approach patients and procedures for data collection. The hospital employee approached eligible patients and explained the study and obtained informed written consent from interested patients. A Patient Demographic Questionnaire (Appendix B) was used to collect age, diagnosis, date of admission, diet order(s), level of attained education, living arrangements and ethnicity, through interview and/or accessing the patient's chart. The meal and date the HFEQ were completed was recorded. Patients were provided the HFEQ at a served meal and were instructed to complete the second part of the questionnaire assessing that meal's traits. At the end of the meal, the hospital employee collected the HFEQ, reviewed it to ensure completion and assisted the patient to complete the questionnaire if necessary. Food intake was assessed in two ways. The trained employee first interviewed patients using the My Meal Intake Tool[69] (Appendix C) to quickly estimate the overall amount of food and fluid consumed (0%, 25%, 50% ,75% ,100%) and identify reasons for poor intake. The tray was then removed and visual estimation by the hospital employee was conducted using the Comstock method for each food and beverage item (0%, 25%, 50%, 75%, 100%, or "not on the tray").[70]

Each hospital's site lead completed a Site Survey (Appendix D). This survey collected data on hospital size, location (i.e. Local Health Integration Network), and type (e.g. community, teaching, etc.), and number and type of long-stay beds. Unit-level data collection included: unit type, number of beds,

funding for beds on the unit, average length of stay, foodservice model, individuals who delivered meals, type of bulk foods on units and snack provision practices. Characteristics of foodservice staff included their titles, full time equivalent and role in nutrition/food/mealtime care were documented. Lastly, foodservice related questions included the percentages of foodservice budget spent on local food, and of outsourced and in-house prepared foods, foodservices provided by a contract company, between-meal nourishment practices, fiscal year spending and in-house production of oral nutritional supplements and average daily food cost.

4.2.5 Analysis

4.2.5.1 Internal Consistency Reliability

Internal consistency of the HFEQ was evaluated using Cronbach's alpha for the three subscales of patients' ratings: a) expectations for traits of the food itself (e.g. appearance, smell; n = 6), b) expectations of traits associated with food (e.g. easy to open packaging, food variety; n = 10), and c) traits of the meal served (e.g. taste, temperature; n = 7). Cronbach's alpha was also determined for the entire HFEQ (i.e. 3 subscales combined; n = 23). Acceptable internal consistency reliability was a Cronbach's alpha between 0.70 and 0.90, as a value greater than 0.90 may indicate redundancy in Questionnaire items.[53]

4.2.5.2 Principal Components Analysis

Principal components analysis (PCA) was conducted to identify underlying groupings of HFEQ questions, further assess the internal reliability of the Questionnaire and determine if some items could be removed. Spearman correlations revealed that HFEQ questions were significantly correlated, therefore oblique varimax rotation (obvarimax) was used as this rotation method is appropriate for correlated items.[71] No predetermined number of factors was indicated; factor loadings ≥0.40 were considered important to the underlying factor.[72] Items that loaded onto more than one factor were eliminated if the secondary loading was greater than 0.30 and if the difference between the primary and secondary loadings

were smaller than 0.20.[72] Factor scores were calculated for each participant resulting from this PCA. Items eliminated from the PCA were not included when generating factor scores and individual questions eliminated were not included in cross-validation analyses aiming to create a shortened Questionnaire.

4.2.5.3 Construct Validity

It is hypothesized that patients' expectations of hospital food and meal ratings would be associated with an overall meal quality rating (single proxy item on the HFEQ). Convergent validity was assessed using four ordinal regression models for each of the three subscales and entire HFEQ. The first model regressed patients' overall meal quality rating onto the importance of hospital food traits (n = 6; food smell, taste, appearance, freshness, healthiness, and local food provision). The second model regressed the overall meal quality rating onto the importance of food-related traits (n = 10; temperature; variety, preferences, portion size, familiarity, choice, and provision of culturally appropriate foods, foods that meet dietary needs and that are easy to eat and in easy to open packaging). The third regressed patients' overall meal quality ratings onto patients' sensory ratings of their meal (n = 6; meal ratings for smell, taste, texture, appearance, temperature, and combination of food served). The final model regressed overall meal quality rating onto all patients' food and food-related traits and meal ratings (n = 22). Convergent validity would be indicated if the models are significant with several individual items being significant as determined by $p < 0.050$; this would suggest that food expectations and meal ratings are associated with the overall meal quality rating, the single item on the HFEQ meant to summarize the patient's hospital food experience.

4.2.5.4 Predictive Validity

To test if the single-item overall meal quality rating was predictive of overall food intake at a single meal, a 5x2 chi-square was conducted with the 5 levels of overall meal quality (i.e. "very poor," "poor," "neutral," "good," and "very good") and food intake (dichotomized as 100% consumption, or

<100%, as 42% consumed 100% of the meal). Statistical significance was determined by $p < 0.050$. Post-hoc analyses included assessment of the standardized residuals; statistical significance determined by standardized residuals > |1.96| (i.e. 97.5th percentile). Using this method, standardized residuals > +1.96 indicate that the number of patients who rated their meal as such was significantly greater than expected if there was no association between overall meal quality and food intake; the opposite is true for standardized residuals < -1.96.

The PCA results were used to identify a refined HFEQ (i.e. including only those items that loaded on a single factor) for predictive validation. Factor scores were computed for each participant based on the factors identified in PCA. A binary logistic regression was conducted assessing the association of factors identified in PCA and dichotomized food intake (i.e. 100% or <100%). Statistical significance was determined by $p < .050$.

4.2.5.5 Cross Validation

To further validate the questions of the HFEQ and support the development of a shortened version of the HFEQ, a cross validation analysis was conducted. The dataset was randomly partitioned into training, test and validation datasets using a 50:25:25 ratio of patient cases. Cross validation was conducted using the 22 relevant questions identified in PCA with the outcome of dichotomized food intake (i.e. 100% or <100%). Backwards selection was used and HFEQ items were retained based on significance level (i.e. $p < .050$). The final model was chosen based on the lowest average square error (ASE) of the validation data. A final binary logistic model testing the determined shorter version of the HFEQ with food intake was also conducted. Statistical significance was determined by $p < .050$.

4.3 Results

4.3.1 Demographics

A final sample of 1,087 was included in this study. Table 4.1 presents demographic results of patients who participated in the study and hospital characteristics in Table 4.2. Mean age was 65.18 (SD 18.03) and 51.08% of patients were female. The most common diagnosis categories included musculoskeletal (20.04%), cardiovascular (15.57%), infection (9.97%), and mental health (9.21%). Most patients had completed high school or additional education (69.85%), while 24.61% did not finish high school. Over half of patients lived with others (59.27%) and approximately one-third lived alone (32.25%). Majority of participants were Caucasian (86.82%). Most patients were receiving either none, one or two diet orders (37.52%, 39.11% and 17.69%, respectively). Hospitals were either community (50.00%), teaching (25.00%) or mixed (25.00%) facilities. Most sites were considered large (i.e. 250+ beds; 56.25%), with the remaining being medium (i.e. 101-249 beds; 25.00%) or small (i.e. 100 or fewer beds; 18.75%). More than half of patients received meals prepared by the cold plated/rethermed centrally or on unit foodservice model (57.59%). Exactly 50% of sites' average daily food cost per patient were greater than $8.00 (M = $8.49, SD = 1.40). More than half of sites spent 10% or less of their foodservice budget on local food procurement (63.64%). Lastly, just over half of the sites prepared more than 50% of food served in-house (53.33%).

4.3.2 Internal Consistency Reliability

Cronbach's alpha was calculated for the three subscales and overall HFEQ. The first subscale (n = 6) relating to the importance of food traits demonstrated good internal consistency reliability (Cronbach's alpha, $\alpha = 0.80$). The second subscale assessing food-related expectations (e.g. food choice; n = 10) also demonstrated good internal consistency reliability ($\alpha = 0.80$). Cronbach's alpha did not improve for either of these models when any questions were removed. The third HFEQ subscale assessing patients' meal ratings (n = 7) had very good internal consistency ($\alpha = 0.91$). This model slightly improved

when the rating of "Meal Temperature" was removed ($\alpha = 0.92$). When all 23 questions of the HFEQ were considered, the questionnaire demonstrated good internal reliability ($\alpha = 0.86$) and Cronbach's alpha did not improve when any of the questions were removed.

4.3.3 Principal Components Analysis

Principal components analyses yielded 5 factors with Eigenvalues > 1.00. All questions of the HFEQ (n = 23) loaded onto a factor. One question from the HFEQ (i.e. "As a patient, how important is it that hospital food is healthy") was removed due to similar cross loadings on Factors 2 (i.e. "Food Traits") and 4 (i.e. "Meeting Patients Dietary and Accessibility Needs"). The final HFEQ is based on these 22 questions which were included in the final PCA. The five underlying factors were labelled as "Meal Ratings," "Food Traits," "Food-Related Traits," "Meeting Patients Dietary and Accessibility Needs," And "Food Familiarity and Source." The resulting five factors explained 59.38% of the variance in the data, with 25.73%, 17.27%, 6.30%, 5.15% and 4.94% of the variance attributable to factors 1 through 5, respectively. Results of PCA are in Table 4.3.

4.3.4 Convergent Validity

The first logistic regression model (Appendix E) assessing the importance of food traits (n = 6) with the outcome of patients' overall meal quality rating was statistically significant ($LRT(24) = 64.39$, $p < .001$). However, only the importance of taste was associated with overall meal quality ratings (Wald $\chi2(4) = 15.02$, $p = .005$). The odds of a "very good" meal rating was significantly lower by 95%, 82%, and 46% when the importance of taste was rated as "not important," "less important," or "neutral," rather than "very important," respectively (CIs [0.005, 0.497], [0.045, 0.701], [0.309, 0.953], respectively).

The association between importance of factors associated with food (n = 10) and overall meal quality rating was also statistically significant ($LRT(40) = 80.30$, $p < .001$) (Appendix F). Food-related expectations significantly associated with overall meal quality rating included: food choice (Wald $\chi2$ (4)

= 12.41, p = .015); easy to open packaging (Wald $\chi 2(4) = 12.17$, p = .016), and foods that are easy to eat (Wald $\chi 2(4) = 13.01$, p = .011). Patients who rated the importance of choice as "not important" or "neutral" rather than "very important" were 2.16 and 1.76 times more likely to rate overall meal quality as "very good" (CIs [1.148, 4.069], [1.198, 2.589]). When the importance of easy to open packaging was rated as "not important" or "neutral," the odds of "very good" meal quality ratings were significantly lower by 74% and 49%, respectively (CIs [0.179, 0.734], and [0.402, 0.919], respectively). Patients who rated the importance of easy to eat foods as "neutral" also had significantly lower odds of rating overall meal quality as "very good" by 44% (CI [0.348, 0.888]).

The third logistic regression model (Appendix G) assessing traits of the meal served (n = 6) with the outcome of overall meal quality rating was also statistically significant (LRT(24) = 1,244.50, p < .001). Meal appearance (Wald $\chi 2(4) = 42.16$, p < .001), taste (Wald $\chi 2(4) = 100.89$, p < .001), texture, (Wald $\chi 2(4) = 32.78$, p < .001), temperature (Wald $\chi 2$ (4) = 15.10, p = .005) and combination of food served (Wald $\chi 2$ (4) = 117.74, p < .001) significantly predicted overall meal quality rating. When meal appearance was rated as "very poor," "poor," "neutral," or "good" rather than "very good," the odds of a "very good" meal quality rating was significantly lower by 86%, 87%, 79% and 60%, respectively (CIs [0.048, 0.422], [0.056, 0.280], [0.128, 0.354], [0.264, 0.614], respectively). Similarly, when the taste of the meal was rated as "very poor," "poor," "neutral," or "good" rather than "very good," the odds of a "very good" meal quality rating was significantly lower by 99%, 96%, 89% and 66%, respectively (CIs [0.003, 0.026], [0.017, 0.083], [0.065, 0.200], [0.283, 0.680], respectively). Texture of the meal significantly predicted ratings of meal quality, whereby when texture was rated as "very poor," "poor," or "neutral," the odds of a meal quality rating of "very good" decreased by 90%, 77% and 48% than if texture was rated as "very good" (CIs [0.036, 0.252], [0.114, 0.472], [0.310, 0.874], respectively). When patients rated the temperature of their meal as "very poor," "poor," "neutral," or "good" rather than "very good," there were significantly lower odds of an overall quality rating of "very good" by 61%, 61%, 52%,

and 43%, respectively (CIs [0.177, 0.862], [0.213, 0.709], [0.305, 0.758], and [0.388, 0.837], respectively). The combination of food served in the meal was also significantly associated with meal quality ratings, where ratings of "very poor," "poor," "neutral," or "good" were significantly associated with lower odds of a "very good" rating for meal quality by 98%, 96%, 89% and 69%, respectively (CIs [0.006, 0.048], [0.012, 0.079], [0.064, 0.174], and [0.202, 0.461], respectively). The smell of the meal did not significantly predict meal quality ratings ($p > .050$).

The final logistic regression (Appendix H) tested the association among all meal expectations ($n = 16$) and meal ratings ($n = 6$) with the overall meal quality rating; this full model based on 22 HFEQ items was statistically significant, $LRT(88) = 1{,}258.22$, $p < .001$. The importance of local food provision was the only food or food-related expectation that was significantly associated with overall meal quality rating (Wald $\chi 2\ (4) = 12.81$, $p = 0.015$), which is inconsistent with the above logistic regression models of the first and second subscales ($n = 6$, $n = 10$, respectively). The importance of food taste, choice and easy to open packaging and easy to eat foods were no longer significantly associated with meal quality ratings ($ps > .050$). When patients rated the importance of receiving locally sourced food as "not important," "less important," "neutral" or "important," they were 1.98, 2.35 1.89 and 1.84 times more likely to provide a meal quality rating of "very good" than if the importance of locally sourced food was rated as "very important," respectively (CIs [1.066, 3.675], [1.217, 4.548], [1.217, 2.971] and [1.204, 2.814], respectively). With respect to ratings of meal traits ($n = 6$), meal appearance (Wald $\chi 2\ (4) = 36.87$, $p < .001$), taste (Wald $\chi 2\ (4) = 96.21$, $p < .001$), texture (Wald $\chi 2\ (4) = 27.38$, $p < .001$), temperature (Wald $\chi 2\ (4) = 17.64$, $p < .001$) and combination of food served (Wald $\chi 2\ (4) = 107.87$, $p < .001$) predicted overall meal quality; meal smell did not predict overall quality which is similar to the results above when only the third subscale was analyzed. When meal appearance was rated as "very poor," "poor," "neutral," or "good" rather than "very good," the odds of a "very good" meal quality rating was significantly lower by 89%, 86%, 80% and 61%, respectively (CIs [0.032, 0.375], [0.058, 0.355], [0.112, 0.343], and [0.242,

0.613], respectively). The odds of a "very good" meal quality rating was significantly lower by 99%, 97%, 90%, and 65%, when the taste of the meal was rated as "very poor," "poor," "neutral," or "good" rather than "very good," respectively (CIs [0.002, 0.020], [0.013, 0.073], [0.054, 0.187], and [0.279, 0.726], respectively). Lower texture ratings were associated with overall meal quality ratings, where texture ratings of "very poor," "poor," or "neutral" were significantly associated with lower odds of a "very good" meal quality rating by 89%, 80%, and 66%, respectively (CIs [0.038, 0.309], [0.092, 0.429], and [0.252, 0.775], respectively). When meal temperature was rated as "very poor," "poor," "neutral," or "good," the odds of a "very good" meal quality rating was significantly lower by 70%, 64%, 57% and 52%, respectively (CIs [0.124, 0.704], [0.185, 0.697], [0.260, 0.707], and [0.313, 0.734], respectively). Lastly, when the combination of food served was rated less than "very good," and rather as "very poor," "poor," "neutral" or "good," the odds of a "very good" meal quality rating was significantly lower by 99%, 96%, 90% and 71%, respectively (CIs [0.003, 0.027], [0.019, 0.080], [0.058, 0.175], and [0.185, 0.459], respectively).

4.3.5 Predictive Validity

Predictive validity was assessed using a 5x2 chi-square between the proportion of food consumed (i.e. 100%, or <100%) and overall meal quality rating (proxy item from HFEQ) (Table 4.4). The association between proportion of food consumed and overall meal quality was significant ($\chi 2(4) = 60.93$, $p < .001$), and a moderate effect size was calculated by Cramer's V (V = 0.24).[73]

The number of patients who rated their meal as "very poor," "poor," or "neutral" and who ate less than the entire meal was significantly higher than what was expected if there was no association between meal quality rating and food intake (standardized residuals:+4.19, +3.14, and +4.13, respectively). Patients who rated meal quality as "very good" and ate 100% of their meal was significantly greater than what was expected if there was no association between meal quality rating and food intake (standardized residual: +5.23). Although marginally non-significant, there were more patients who ate 100% of their

meal when meal quality was rated "good" (adjusted residual: +1.81). Post-hoc analyses further highlight the predictive validity of this single item on the HFEQ, in that significantly more patients who rated their meal as "very poor," "poor" or "neutral" had lower intake, and significantly more patients who rated their meal as "very good" had high food intake.

4.3.6 HFEQ Factors and Overall Meal intake

Factors identified from PCA (n = 5) based on the retained 22 HFEQ questions were tested using logistic regression to determine which factors relating to food expectations and meal experiences were related to food intake dichotomized to 100% and <100% intake. The overall model was significant (LRT(5) = 68.70, $p < .001$), however only Factor 1 (i.e. Meal Ratings) significantly predicted food intake (Wald $\chi 2$ (1) = 54.79, $p < .001$). For every 1-point increase in the score for Factor 1 the odds of consuming 100% of the meal is 1.77 times higher than the odds of consuming less than 100% of the meal (CI [1.523, 2.062]). Results for this analysis are reported in Table 4.5.

4.3.7 Cross Validation

The association between relevant individual HFEQ questions as determined by PCA and food intake (i.e. 100% consumption or <100%) were tested using cross validation. The selected model was significantly associated with food intake LRT(8) = 48.70, $p < .001$. However, only the importance of food choice (Wald $\chi 2$ (4) = 8.62 $p = .071$) and meal taste rating (Wald $\chi 2$ (4) = 50.44 $p < .001$) were retained in this final model (Table 4.6). Patients who rated the importance of food choice as "neutral" rather than "very important" were 1.23 times more likely to consume 100% of their meal (CI [1.114, 2.423]). When meal taste was rated as "very poor," "poor," or "neutral," the odds of consuming 100% of the meal decreased by 98%, 73% and 62%, respectively (CIs [0.003, 0.147], [0.144, 0.506], and [0.267, 0.547], respectively). This final model explained 11.55% of the variance in food intake.

While the aim of this analysis was to create a shorter HFEQ, a questionnaire containing only two items does not capture expectations and meal ratings relevant to the construct of meal quality and thus may be limited in its approach. Therefore, the shortened version of the HFEQ (HFEQ-sv) was determined using the 10 expectations that were significantly associated with overall meal quality in the four ordinal logistic regressions conducted for convergent validity analyses (i.e. importance of food taste; local food provision; easy to open packaging; easy to eat foods; food choice; and meal appearance; taste; texture; temperature; combination of food served in the meal) as well as the overall meal quality rating item. A second cross-validation analysis was conducted, using these 11 items in which the final model again only retained food choice and meal taste ratings; this was the exact same results of cross-validation with the full HFEQ discussed above.

A final binary logistic regression analysis was conducted for the HFEQ-sv (11 items) to assess its association with food intake (Table 4.7). When the importance of meal taste was entered in this regression using the 5-point Likert scale, quasi-separation of the data occurred due to most patients rating the importance of taste as "very important" (73.75%). To address this quasi-separation, for this analysis the importance of taste was recategorized to 3 categories: "important" (i.e. ratings of "very important" or "important" from the original 5-point scale), "neutral" (i.e. originally rated as "neutral" from the 5-point scale) and "not important" (i.e. ratings of "not important" or "less important" from the original 5-point scale). The remaining 10 predictors remained categorized by the original 5-point scale. The HFEQ-sv was significantly associated with food intake ($LRT(42) = 142.17$, $p < .001$) and explained 18.09% of the variance in food intake. The importance of food choice was significantly associated with food intake (Wald $\chi 2$ $(4) = 10.56$, $p = .032$), with patients rating this trait as "neutral" being 1.85 times more likely to consume 100% of the meal than patients rating this trait as "very important" (CI [1.199, 2.844]). The importance of easy to eat foods was marginally non-significant (Wald $\chi 2$ $(4) = 8.87$, $p = .065$). With respect to meal ratings, texture and taste were significantly associated with food intake (Wald $\chi 2$ (4) =

9.82, p = .044; Wald $\chi 2$ (4) = 17.51, p = .002). Patients who rated texture as "neutral" were 1.87 times more likely to consume 100% of their meal as compared to patients who rated texture as "very good" (CI [1.109, 3.159]). The odds of 100% meal intake were significantly lower by 96%, 72%, and 61% among patients who rated meal taste as "very poor," "poor," or "neutral" rather than "very good," respectively (CIs [0.004, 0.374], [0.110, 0.718], and [0.222, 0.686], respectively). Importance of food taste, local food provision, easy to open packaging and meal appearance, temperature, overall meal quality and combination of food served were not significantly associated with food intake (ps > .050).

4.4 Discussion

Our results demonstrate that the HFEQ as a whole has good internal consistency reliability as do the three subscales. Specifically, the entire HFEQ and subscales of food traits and food-related traits demonstrated "very good" internal consistency (i.e. alpha between 80-86) and the meal ratings demonstrated "high" internal consistency (i.e. alpha ≥0.90).[74] This demonstrates that there are sufficient relevant items in each subsection of the HFEQ to capture traits that contribute to the construct of meal quality. However, a high internal reliability (i.e. alpha ≥0.90) may also demonstrate that traits are redundant[53] and potentially contribute to a longer questionnaire.

Convergent validity with the overall meal quality rating identified that five of six items on the third subscale on meal ratings were significantly associated with this proxy outcome, confirming their relevance. Sensory meal traits have previously been described as significantly predicting food intake.[2,5,6,10,37,41] Specifically taste and texture have been found to be significant drivers of patients' meal satisfaction and perceptions of meal quality.[2,5,6,10,11,20,22,27] Meal aroma did not significantly predict overall meal quality ratings, which is dissimilar to one study that found that food aroma was significantly associated with meal satisfaction.[37]

The food expectations subscale had only one item (taste) significantly associated with overall meal rating in this convergent validity analysis. Previous tools have not considered expectations of

patients.[10,17,20,28] Limited studies have investigated how patient expectations influence perceptions of meal quality,[10,11,42] however sensory traits such as taste are related to patient perceptions of meal quality, satisfaction and subsequent food intake.[5,6,38,39] Based on this analysis, taste may be the only food expectation worthy of inclusion in a shorter HFEQ. For the food-related traits subscale, only three items (choice, ease of opening packages and ease of eating) were significantly associated with overall meal quality rating. Previous studies have suggested that providing patients with the opportunity to choose their meals may further promote satisfaction with hospital meals[31,38,75] as does promoting food accessibility.[8,27,30] This convergent validity analysis suggests that the 23 items of the HFEQ could be reduced to provide a shorter questionnaire that still represents perceptions of meal quality.

Next PCA analysis was conducted to further demonstrate internal reliability of the Questionnaire and determine if items could be removed. Only one item (i.e. importance of food healthiness) did not uniquely load into the 5 factors structure. These factors measure different attributes of the food experience in hospital. The original third subscale on ratings of the meal consumed all loaded on one factor and accounted for the greatest variance (25.73%). The other two subscales split into four further factors, with expectations related to sensory traits (17.27%) also explaining more than 15% of the variance. The three other factors explained much less of the total variance observed (59.38%) with this five-factor solution. The six meal ratings and five items on expectations related to sensory traits are potential items for a shorter HFEQ.

It was not surprising that the single item "overall meal quality" rating demonstrated good predictive validity with food intake. Patients who rated their meal as neutral or worse had significantly lower intake (i.e. <100% consumed), while significantly more patients who rated their meal as "very good" ate their entire meal. This single item on the HFEQ can discriminate food intake and it is not surprising that others have used this as a single item proxy for meal experience and satisfaction.[10,17,22]

When the individual questions identified in PCA were tested for predictive validity with food intake, only the importance of food choice and meal ratings for taste were significantly associated with meal intake. As reducing the Questionnaire to these two items would be too limiting and lack comprehensiveness with respect to food expectations and meal ratings which have previously been demonstrated to be associated with overall meal quality, the HFEQ-sv was created using the 10 items significantly associated with overall meal quality ratings in the four ordinal regressions in convergent validity analyses in addition to the overall meal quality rating (n = 11). The HFEQ-sv demonstrates greater utility than the single item meal quality question as it considers key expectations and meal ratings associated with the construct of overall meal quality in addition to the overall quality ratings itself. Further, assessment of and quality improvement measures targeting sensory traits demonstrated to be significantly associated with meal quality and intake may be a more tangible approach rather than aiming to improve the subjective trait of "quality" which is challenging to assess.[19,42] For example, improving meal taste which was significantly associated with meal quality and intake may be a more tangible goal to improve overall meal quality.

The need for a valid and reliable tool that is easy to administer to assess patients' expectations and experiences of meals served in hospitals is needed, due to the negative effect malnutrition has on subsequent patient outcomes such as further morbidity and mortality, and hospital outcomes such as increased spending due to prolonged length of stay.[5,7,13–17,21,26,27,29,31–33,35] Previous tools have been used to quantify the meal experience in hospitals using both qualitative and quantitative methods,[19] however many quantitative tools have not been tested for reliability and validity,[19] making it challenging to know if the constructs being measured are truly relevant to quantifying patients' experiences with hospital food and specifically meal quality. Additionally few previous tools have specifically focused on meal quality and the meal experience, but rather assessed food and foodservice traits together,[7,20] making it challenging to gain a greater understanding of the effect of meal quality on the hospital meal experience. Tools that

have focused on meal quality did not always comprehensively assess this construct.[10,17,28] The HFEQ presents an optimal opportunity to be implemented in Ontario hospitals to quantify patients' experiences with meals served in hospital. The HFEQ has content validity and this study demonstrates that the questionnaire has good internal consistency reliability and demonstrates good construct validity with meal quality and predictive validity for food intake. Validity testing is an ongoing process in aiming to discover traits that contribute to an overarching concept (i.e. meal quality) such as through assessments using questionnaires.[76] With this view of construct validity, the results of this study further contribute to the validation of the construct of meal quality by demonstrating it is strongly associated with meal ratings and certain food expectations.

The HFEQ is easy to administer and can be self-administered making it feasible to implement in practice. While the original HFEQ assess food expectations and meal ratings using 23 Likert-scale questions, it was worthwhile to shorten the Questionnaire to further improve feasibility. Only one item was eliminated with PCA; going forward the full HFEQ is recommended to only include these 22 items that had a clear factor structure. Attempts were made to shorten the HFEQ based on questions significantly associated with overall meal quality ratings from convergent validity analyses at the subscale level. An alternative method to shorten the HFEQ would be to only include items identified in Factor 1 (i.e. Meal Ratings) of the PCA, as this factor contributed to the greatest explained variance in the data (25.73% of the total 59.38% of variance); however this approach would eliminate evaluation of patients' food expectations, which in previous[4,27,43,59–62] and this current study has demonstrated to be associated with overall meal quality. Cross validation results did not lead to a short version of HFEQ that covered the factors identified in PCA. It is thus recommended that the 10 items identified in the construct validation plus the overall meal quality rating be used as the HFEQ-sv (11 items in total); when used in a logistic regression with food intake as the outcome, this version did explain more variance than the two-item result of cross-validation analyses. Although the additional variance explained is likely due to the

inclusion of further variables, this 11-item version covers the 5 factors outlined in PCA and thus better represents the concept of meal quality (Table 4.3).

4.4.1 Strengths and Limitations

This study has many strengths. To our knowledge, this is the first study to test the reliability and validity of a tool that specifically assesses patients' expectations and experiences of hospital meal quality. Additionally, this is the largest study to our knowledge investigating patients' experiences with hospital meals and food intake specific to an Ontario context with 16 hospitals participating and data from over 1,000 patients. Both participating hospitals and patients provided diversity to the sample, with hospitals of varying sizes and locations participating, and patients with various diagnoses, age, etc., which helps better capture the patient experience with hospital meals. All hospital employees that participated in this study underwent extensive training with the Project Coordinator to best ensure that study procedures were adhered to.

Although this study presents many strengths, there are some limitations to this work. This study evaluated patients' expectations and experiences of meals as well as food intake only at one meal, making it impossible to determine how meal quality perceptions and intake fluctuates at different meals. Estimating food and beverage intake was not conducted by the same individual, but rather by an employee from each participating hospital who was trained by the Project Coordinator using a study protocol. Despite measures in place to reduce inconsistencies in estimation by hospital employees, there is always a risk of inter-rater error when estimation is performed by more than one person. Visual estimation is not as rigorous as other methods for assessing food and beverage intake such as using weighed food diaries.[77] Additionally, energy, macronutrient or micronutrient intakes cannot be determined using this estimation method as individual food products and their nutrient analysis was not completed. Pediatric and patients with delirium or dementia were excluded and patients receiving enteral or parenteral nutrition were excluded; therefore, results cannot be generalized to these populations and

validity and reliability testing would be required to use the HFEQ with these populations. Lastly, the reliability and validity of the HFEQ was only tested among Ontario hospital patients, therefore, future studies may be needed to confirm its reliability and validity among patients in other geographical contexts.

4.5 Conclusion

A valid and reliable tool that specifically assesses patients' perceptions of meal quality is needed because previous research has demonstrated that meal quality is an important predictor for overall foodservice satisfaction.[8,10,11,16,18,22,25,32,43] To date, tools to assess meal quality or patient meal satisfaction are targeted to assess specific foods,[10] or various components of foodservice, and do not comprehensively assess constructs of meal quality or expectations,[10,20] which have previously been shown to influence perceptions of meal quality.[4,10,11,18,25,37,42] Patient dissatisfaction with sensory aspects of meals and perceptions of low meal quality have been associated with low food intake[10,11] which may contribute to the development or worsening of malnutrition[5,30] and puts patients at risk of adverse health outcomes[7,12,14] while also increasing hospital costs.[5,7,13–16,21,26,27,29,31–33,35] The Hospital Food Experience Questionnaire demonstrated good internal consistency reliability and both construct and predictive validity with meal quality and intake. A shorter version that can promote uptake and use has also been developed (HFEQ-sv). These questionnaires can be implemented in hospitals to compare patients' meal quality scores and subsequent food intake over time and with similar hospitals to ensure that hospital foodservice are closer to meeting their goal of delivering nutritionally adequate foods that patients enjoy in order to promote recovery and wellbeing.[7] Future analyses investigated the implementation and sustainability of the tool are warranted.

Table 4.1: Hospital Demographics

Variable		% n
Hospital type	Community	50.00% 8
	Mixed	25.00% 4
	Teaching	25.00% 4
Active beds (i.e. hospital size) Mean = 320.25 SD = 276.15 Median = 307.00 Min = 32.00 Max =1161.00	≤100	18.75% 3
	101-249	25.00% 4
	≥250	56.25% 9
Average daily food cost per patient Mean = 8.49 SD = 1.40 Median = 8.37 Min = 6.15 Max = 11.00	≤$8.00	50.00% 8
	>$8.00	50.00% 8
Proportion of food prepared in-house (n = 15) Mean = 56.47 SD = 32.90 Median = 68.00 Min = 10.00 Max = 100.00	≤50%	46.67% 7
	>50%	53.33% 8

Proportion of food budget spent on local food (n = 11) Mean = 11.27 SD = 11.79 Median = 10.00 Min = 0.00 Max = 40.00	≤10%	63.64% 7
	>10%	36.36% 4

Note: Characteristics of the 16 participating hospitals. Variable data was available for each hospital unless otherwise specified.

Table 4.2: Patient Demographics

Variable		%/n
Age (n =1,084; mean ± SD/*min-max*)		65.18 ± 18.03 *18-100*
Length of stay (n =1,085; mean ± SD/*min-max*)		30.35 ± 57.34 *3-300*
Gender (n = 1,065)	Female	51.08% 544
	Male	48.36% 515
	Prefer not to say	0.56% 6
Diagnosis (n = 1,053)	Musculoskeletal	20.04% 211
	Cardiovascular	15.57% 164
	Infection	9.97% 105
	Mental health	9.21% 97
	Other	8.36% 88
	Gastrointestinal	6.74% 71
	Respiratory	6.46% 68
	Cancer	5.22% 55
	Frailty	4.65%

		49
	Genitourinary	3.80% 40
	Rehabilitation	3.32% 35
	Neurological	3.04% 32
	Diabetic/hypo- or hyperglycemia	2.18% 23
	Birth/delivery	1.04% 11
	Autoimmune	0.38% 4
Education (n = 1,081)	Completed high school	36.08% 390
	Graduated post-secondary	33.77% 365
	Less than high school	24.61% 266
	Informal training/education/other	2.04% 22
	Unsure/prefer not to say	1.85% 20
	Trades	1.67% 18
Living arrangement (n = 1,073)	Live with others (spouse, family members, friends)	59.27% 636
	Live alone	32.25% 346
	Live in a setting where meals are provided	5.50% 59

	Other	2.98% 32
Ethnicity (n = 1,070)	Caucasian	86.82% 929
	Indigenous	5.23% 56
	Asian	3.36% 36
	Black	2.80% 30
	Other	1.78% 19
Hospital unit (n = 1,087)	Medical	32.20% 350
	Surgery	21.90% 238
	Rehabilitation	19.69% 214
	Cardiac	7.45% 81
	Mental health	6.81% 74
	Complex continuing care	6.35% 69
	Oncology	4.05% 44
	Intensive care unit	0.83% 9
	Maternity	0.74% 8
	0 (i.e. regular)	37.52%

Number of diet orders (n = 1,074)		403
	1	39.11% 420
	2	17.69% 190
	3	3.45% 61
	≥4	2.23% 24
Foodservice model (n = 1,087)	Cold plated/rethermed centrally or on unit	57.59% 626
	Hot plated centrally/tray delivery in thermal carts	19.60% 213
	Room service model/centrally prepared/hot bedside delivery	3.59% 39
	Hot plated centrally/tray delivery with plate covers	6.99% 76
	Bulk delivery/centrally prepared/plated on unit from bulk steam cart	12.24% 133

Note: Total sample size = 1,087. Foodservice model is presented here because foodservice model processes varied across units within hospitals. This gives the number of patients receiving meals prepared by each model.

Table 4.3: Principal Components Analysis Assessing Items of the Hospital Food Experience Questionnaire (HFEQ)

HFEQ Question	**Factor 1** Meal Ratings	**Factor 2** Food Traits	**Factor 3** Food-Related Traits	**Factor 4** Meeting Patients' Dietary and Accessibility Needs	**Factor 5** Food Familiarity and Source
… Looks good [a]	0.047 *0.035*	**0.673** ***0.719***	0.051 *-0.019*	-0.040 *-0.006*	0.265 *0.252*
… Smells good [a]	0.028 *0.019*	**0.748** ***0.782***	0.099 *0.030*	-0.111 *-0.089*	0.132 *0.123*
… Tastes good [a]	0.095 *0.093*	**0.653** ***0.665***	0.352 *0.297*	-0.032 *-0.027*	-0.127 *-0.154*
… Is healthy [a]	0.025 -	**0.469** -	-0.298 -	**0.526** -	0.015 -
… Is fresh [a]	-0.039 *-0.037*	**0.625** ***0.655***	-0.044 *-0.060*	0.335 *0.247*	-0.073 *-0.086*
… Is local [a]	-0.019 *-0.020*	0.316 *0.353*	-0.223 *-0.192*	0.328 *0.284*	**0.481** ***0.467***
… offers foods that meet your dietary needs [b]	-0.017 *-0.018*	0.187 *0.211*	0.120 *0.114*	**0.485** ***0.431***	0.008 *-0.018*
…offers foods that you are used to eating [b]	0.047 *0.048*	-0.051 *-0.063*	0.158 *0.260*	0.005 *0.036*	**0.752** ***0.713***
… offers foods traditional to your culture [b]	-0.029 *-0.029*	-0.004 *0.013*	-0.026 *0.039*	0.056 *0.095*	**0.777** ***0.745***

… offers foods you like to eat [b]	0.032 *0.042*	0.202 *0.167*	**0.554** ***0.638***	-0.232 *-0.194*	0.363 *0.305*
… offers a variety of food [b]	0.011 *0.014*	0.109 *0.092*	**0.632** ***0.641***	0.146 *0.172*	0.054 *0.001*
… serves food at the right temperature [b]	-0.021 *-0.033*	0.268 *0.299*	**0.518** ***0.397***	0.247 *0.319*	-0.084 *-0.120*
… Allows you to choose your food [b]	-0.071 *-0.064*	-0.019 *-0.066*	**0.522** ***0.628***	0.015 *-0.004*	0.198 *0.155*
… Provides you with a sufficient amount [b]	0.026 *0.026*	-0.007 *-0.016*	**0.518** ***0.523***	0.256 *0.265*	-0.001 *-0.043*
… Provides food in packages that are easy to open [b]	0.081 *0.059*	-0.108 *-0.026*	0.251 *0.054*	**0.640** ***0.760***	0.092 *0.063*
… Provides food that is easy to chew, swallow, or eat on your own [b]	0.048 *0.034*	-0.160 *-0.085*	0.174 *0.034*	**0.652** ***0.751***	0.273 *0.238*
Meal look [c]	**0.785** ***0.783***	0.108 *0.112*	-0.004 *-0.004*	0.023 *0.026*	0.052 *0.051*
Meal smell [c]	**0.777** ***0.779***	0.107 *0.098*	-0.010 *0.028*	-0.133 *-0.136*	0.092 *0.090*
Meal taste [c]	**0.875** ***0.876***	-0.006 *-0.009*	-0.008 *0.008*	-0.021 *-0.018*	0.019 *0.018*
Meal texture [c]	**0.829** ***0.830***	-0.002 *-0.005*	-0.033 *-0.012*	0.048 *0.041*	0.043 *0.043*

Meal temperature [c]	**0.674** ***0.672***	-0.033 *-0.020*	0.031 *0.008*	0.083 *0.100*	-0.058 *-0.064*
Combination of food served [c]	**0.804** ***0.801***	0.004 *0.016*	0.026 *0.002*	0.086 *0.101*	-0.053 *-0.057*
Overall meal quality [c]	**0.890** ***0.889***	0.001 *-0.00002*	-0.012 *-0.011*	0.027 *0.034*	0.001 *0.002*

Note: n = 958 in the first PCA (n = 23); and n = 959 in the second PCA (n = 22).

[a] Question stem: "As a patient, how important is it that hospital food …"

[b] Question stem: "As a patient, how important is it that a hospital …"

[c] Rating of a single meal served.

Bold items are items associated with the column Factor.

Italic items are factor loadings once "As a patient, how important is it that hospital food is healthy" was removed.

Table 4.4: Chi-Square Testing the Predictive Validity of the Overall Meal Quality Rating of the Hospital Food Experience Questionnaire (HFEQ) and Overall Meal Intake

Overall Meal Quality Rating	Overall Meal Intake [a]	% (n)	Standardized Residual [b]
"Very poor" (1)	<100%	5.41% (32)	**+4.19 ***
	100%	0.67% (3)	**-4.19 ***
"Poor" (2)	<100%	9.29% (55)	**+3.14 ***
	100%	4.24% (19)	**-3.14 ***
"Neutral" (3)	<100%	26.01% (154)	**+4.13 ***
	100%	15.40% (69)	**-4.13 ***
"Good" (4)	<100%	36.66% (217)	-1.81
	100%	42.19% (189)	+1.81
"Very good" (5)	<100%	22.64% (134)	**-5.23 ***
	100%	37.50% (168)	**+5.23 ***

Note: n = 1,040 for this analysis

[a] Overall meal intake determined by trained staff visually estimating the proportion of the meal consumed.

[b] Standardized residuals used as post-hoc analyses.

[c] *** Statistical significance as determined by standardized residual >|1.96|**

Table 4.5: Binary Logistic Regression Testing Factors Identified in Principal Components Analysis with Overall Meal Intake

	DF	Estimate	Std. Error	Wald $\chi 2$	P	Overall Meal Intake Point Estimate	95% CI	
Intercept	1	-0.29	0.07	18.23	<.001	-	-	-
Factor 1 (Meal Ratings) *	**1**	**0.57**	**0.08**	**54.79**	**<.001**	**1.77**	**1.523**	**2.062**
Factor 2 (Food Traits)	1	0.12	0.08	2.31	0.129	1.13	0.966	1.313
Factor 3 (Food-Related Traits)	1	-0.11	0.07	2.26	0.133	0.90	0.776	1.034
Factor 4 (Meeting Patients' Dietary and Accessibility Needs)	1	-0.12	0.07	2.80	0.094	0.88	0.765	1.021
Factor 5 (Food Familiarity and Source)	1	-0.03	0.07	0.17	0.681	0.97	0.845	1.116

Note: n = 942; overall meal intake was dichotomized as 100% or <100% intake.

*** Bolded values indicate statistical significance.**

Table 4.6: Final Model Selected by Cross Validation Analysis Testing Hospital Food Experience Questionnaire (HFEQ) Items Deemed Relevant from PCA (n = 22) with Overall Meal Intake

HFEQ item		Overall Meal Intake Point Estimate	95% CI	
Allows you to choose your food [a]	"Not important" (1) [c]	1.72	0.866	3.396
	"Less important" (2) [c]	0.88	0.404	1.899
Wald $\chi 2$ (4) = 8.62	**"Neutral" (3) [c*]**	**1.64**	**1.114**	**2.423**
p = .071	"Important" (4) [c]	1.23	0.901	1.683
Meal taste [b]*	**"Very poor" (1) [d]***	**0.02**	**0.003**	**0.147**
	"Poor" (2) [d]*	**0.27**	**0.144**	**0.506**
Wald $\chi 2$ (4) = 50.44	**"Neutral" (3) [d]***	**0.38**	**0.267**	**0.547**
p < .001	"Good" (4) [d]	0.76	0.555	1.028

Note: n = 942; overall meal intake was dichotomized as 100% or <100% intake.

[a] Question stem: "As a patient, how important is it that a hospital …"

[b] Rating of a single meal served.

[c] vs. "Very important" (5 on 5-point Likert scale).

d vs. "Very good" (5 on 5-point Likert scale).

*** Statistically significant.**

Table 4.7: Binary Logistic Regression Testing the Short version Hospital Food Experience Questionnaire (HFEQ-sv) with Overall Meal Intake

HFEQ-sv Item		Overall Meal Intake Point Estimate	95% CI	
… Tastes good [ab]	"Not important" vs. "Important"	1.24	0.258	5.953
Wald $\chi 2$ (2) = 2.31 P = .316	"Neutral" vs "Important"	0.60	0.299	1.185
… Is local [a]	"Not important" (1) [e]	0.95	0.563	1.588
	"Less important" (2) [e]	1.01	0.570	1.789
Wald $\chi 2$ (4) = 0.25 P = .993	"Neutral" (3) [e]	1.04	0.702	1.552
	"Important" (4) [e]	0.95	0.654	1.379
… Allows you to choose your food [c*]	"Not important" (1) [e]	1.84	0.856	3.970
	"Less important" (2) [e]	0.82	0.336	2.002
Wald $\chi 2$ (4) = 10.56 **P = .032**	**"Neutral" (3) [e*]**	**1.85**	**1.199**	**2.844**
	"Important" (4) [e]	1.34	0.947	1.886
… Provides food in packages that are easy to open [c]	"Not important" (1) [e]	1.46	0.627	3.401
	"Less important" (2) [e]	1.47	0.684	3.174
Wald $\chi 2$ (4) = 2.40 P = .663	"Neutral" (3) [e]	1.00	0.600	1.673
	"Important" (4) [e]	0.89	0.597	1.334
… Provides food that is easy to chew, swallow, or eat on your own [c]	"Not important" (1) [e]	1.33	0.530	3.325
	"Less important" (2) [e]	2.45	0.925	6.482
Wald $\chi 2$ (4) = 8.87 P = .065	"Neutral" (3) [e]	0.94	0.538	1.630
	"Important" (4) [e]	0.68	0.454	1.012
Meal look [d]	"Very poor" (1) [f]	0.53	0.139	2.042
	"Poor" (2) [f]	0.56	0.214	1.444
Wald $\chi 2$ (4) = 3.364	"Neutral" (3) [f]	0.86	0.523	1.425

P = .503	"Good" (4) [f]	0.75	0.504	1.120
Meal Taste [d*]	**"Very poor" (1) [f*]**	**0.04**	**0.004**	**0.374**
	"Poor" (2) [f*]	**0.28**	**0.110**	**0.718**
Wald χ2 (4) = 17.51	**"Neutral" (3) [f*]**	**0.39**	**0.222**	**0.686**
P = .002	"Good" (4) [f]	0.75	0.487	1.160
Meal Texture [d*]	"Very poor" (1) [f]	1.04	0.299	3.643
	"Poor" (2) [f]	0.84	0.373	1.886
Wald χ2 (4) = 9.82	**"Neutral" (3) [f*]**	**1.87**	**1.109**	**3.159**
P = .044	"Good" (4) [f]	1.52	0.983	2.347
Meal Temperature [d]	"Very poor" (1) [f]	0.67	0.238	1.910
	"Poor" (2) [f]	1.51	0.779	2.921
Wald χ2 (4) = 7.13	"Neutral" (3) [f]	1.44	0.888	2.338
P =.129	**"Good" (4) [f*]**	**1.57**	**1.055**	**2.335**
Combination of food served [d]	"Very poor" (1) [f]	0.59	0.138	2.535
	"Poor" (2) [f]	0.72	0.350	1.496
Wald χ2 (4) = 3.68	"Neutral" (3) [f]	0.62	0.367	1.044
P = .451	"Good" (4) [f]	0.88	0.579	1.325
Overall Meal Quality [d]	"Very poor" (1) [f]	0.94	0.163	5.363
	"Poor" (2) [f]	1.37	0.545	3.420
Wald χ2 (4) = 6.60	"Neutral" (3) [f]	0.60	0.325	1.093
P = .159	"Good" (4) [f]	0.75	0.484	1.149

Note: n = 981; Modelling the odds of 100% vs. <100% overall meal intake.

[a] Question stem: "As a patient, how important is it that hospital food …"

[b] Recategorized to a 3-point scale due to quasi-separation of data when using the original 5-point scale.

[c] Question stem: "As a patient, how important is it that a hospital …"

[d] Rating of a single meal served.

[e] vs. "Very important" (5 on 5-point Likert scale).

[f] vs. "Very good" (5 on 5-point Likert scale).

*** Statistically significant.**

Chapter 5
Study 2: What Predicts Patients' Expectations and Experiences with Hospital Meals?

5.1 Introduction

Undernutrition is common among hospital patients often due to low food and beverage intake that fails to meet patients' physiological needs.[5,12,16,17,25–27,30] Hospital malnutrition varies depending on the patient population, tool used and timing of assessment but is estimated to occur in up to 70% of patients.[1,5,11,12,14,15,26–34] Malnutrition increases the risk of infections,[7,14] further morbidity,[16] and mortality,[7,12,14,17] decreases quality of life[26,30] and can result in increased hospital costs due to greater length of stay, readmission and greater use of resources by malnourished patients.[5,7,13–15,21,26,27,29,31–33,35]

Low food intake and increased food waste may occur if patients perceive hospital meals as unappetizing,[12] of poor quality or to have unappealing sensory traits.[4–6,8–15] Patient satisfaction with hospital food is influenced by many factors and is difficult to assess.[10,19,20,25,28] Several studies have found that food quality is the most important predictor of patient satisfaction with hospital food.[7,8,11,16,19,20,22,25,31] Patients' ratings of meal quality are highly subjective and can vary among individuals but have been identified to be highly related to sensory aspects of food and as a function of taste, variety, flavour, texture, freshness, perceptions of healthiness,[2–4,7,10–12,14,18,22,33] and customization to reflect patient preferences.[7,43] Having a variety of foods for patients on different diet orders to choose from as well as appropriate portion sizes can also influence patients' perceptions and experiences of hospital meals.[2,4,8,18,22,27,37] Providing patients with quality food, options to choose meals and serving foods patients prefer and find appealing may support food intake and a timely recovery while also lowering hospital costs by reducing length of stay.[31]

Because satisfaction and meal quality perceptions are subjective,[19,42] it is important to consider how patient and hospital traits may influence perceptions of meal quality. Previous research has yielded

mixed results of how these contextual factors are associated with satisfaction and perceptions of meal quality, some of which have suggested there is no effect of patient traits on perceptions of meal quality and satisfaction.[78] Studies have found older and female patients to rate meal quality and satisfaction parameters more positively than younger and male counterparts,[43,79,80] however other studies have found that males rate meal quality more favourably.[61,81] Wright et al. found that there was no significant association between satisfaction scores and length of stay, however a significant difference in satisfaction existed by hospital units and diet types.[61] An additional study found that patients admitted for one week or less, and on a special diet were associated with increased satisfaction at the bivariate level, however level of education was not.[80] Two studies by Naithani et al. identified that patients who were older, female, experienced a stroke or other physical disabilities had greater odds of experiencing mealtime barriers pertaining to accessibility, food quality and choice, further highlighting the potential impact of patient characteristics on the mealtime experience.[27,82] Most of the these studies were conducted only at one hospital,[27,43,46,80,82] which limits generalizability of these findings. Further, some of these studies used their own questionnaires, which have not been construct validated with meal or foodservice quality,[43,80,81] or qualitative methods[27] making it challenging to interpret and compare results.

Hospital traits may also affect meal quality ratings and satisfaction, potentially due to organizational characteristics that influence food production and foodservice capacities. Significant differences in meal-related challenges relating to hunger, physical and organizational barriers, food quality and choice by different hospitals were reported by Naithani et al.,[82] suggesting that hospital characteristics although unspecified in this study could influence meal quality and satisfaction. A Canadian study found that hospital type (e.g. community, teaching, etc.) and size were not significantly associated with food intake barriers of hunger, food quality, eating difficulties and illness, suggesting that other food, patient or hospital variables may be more influential on food quality and satisfaction,[6] such as food source. For example food outsourcing is a common practice in hospital foodservice departments.[18,75]

There has been a recent emphasis on local food provision potentially due to a desire to serve fresh foods with favourable sensory traits.[41,75] Food source may influence food variety and subsequent available food choices,[18,21] however a Canadian study found that outsourcing was negatively associated with lack of food choice, suggesting this practice may promote food variety.[6] Most research with respect to hospital characteristics has involved investigating food quality and satisfaction among different foodservice models, with recent studies suggesting bedside ordering systems and models that promote point of service ordering, customization and patient-centred approaches to be effective in improving food intake and perceptions of quality and satisfaction.[83–86] Other studies have compared foodservice models to find "superior" models with respect to sensory traits (e.g. temperature) and food intake.[50,87] When comparing cook-chill vs. cook-fresh systems, cook-chill systems were associated with less choice and challenges customizing serving sizes.[88] Similarly, cook-chill systems resulted in the highest probability of patients rating meal satisfaction as "very good" followed by a combination of fresh and frozen foods; these two models had higher probabilities of "very good" meal satisfaction when compared to the cook/freeze model.[89] When assessing foodservice models, only the study by Young et al. used a valid and reliable tool (the MAT) that assesses meal quality among geriatric hospital patients,[90] while another study used the Opinion Card (cited by Hartwell to be valid and reliable).[87] Although valid, the questionnaire used by Wright et al. is specific to geriatric populations, and therefore results may not be generalizable to other patient populations.[89] McClelland et al. used a postal survey to assess patients' satisfaction with food and foodservice traits (validity and reliability not reported),[88] however this method may be subject to recall bias due to its retrospective assessment. As none of these studies used the same meal quality questionnaire to assess foodservice models and subsequent meal experience and food intake, comparing results across these studies is challenging. It is worthwhile to further investigate hospital characteristics that influence the provision of quality food in hospitals to support recovery and wellbeing.

The aims of this study are: i) determine which aspects of hospital food (e.g. food and food-related expectations) are rated most important by patients; ii) assess patients' sensory ratings of a meal served in hospital; and iii) assess the bivariate and multivariable associations of patient- and hospital traits with patient ratings of meal quality quantified by an overall meal quality rating and scores from the full and short version of the Hospital Food Experience Questionnaire (HFEQ and HFEQ-sv, respectively).

5.2 Materials and Methods

5.2.1 Sites and Participants

Stakeholder, researcher and healthcare networks disseminated a request for expressions of interest to Ontario hospitals. Nineteen hospitals expressed interest, and all applications were considered eligible and all these hospitals were invited to participate as they provided diversity (size, region, type of foodservice production) to the sample. A total of sixteen hospitals participated; three of the hospitals that expressed interest had challenges completing their ethics review or had changes in management resulting in inability to continue with the project. A quota of 75 patients from each hospital (estimated sample size, 1,200 patients) was set to promote diversity while considering the research burden for each hospital to collect data; due to some sites experiencing challenges with recruitment, the sample size was 1,087. To support data collection, each hospital was provided a stipend of $3,000 CDN. Eligible patients were ≥18 years old and had been admitted for at least two days. Patients were excluded if they were not fluent in verbal and written English or French, if they had not received any meals in hospital, received parenteral or enteral nutrition or had either dementia or delirium. Staff identified eligible patients using a quota system to promote diversity in recruitment (i.e. hospital unit), and meal (breakfast, lunch, dinner).

5.2.2 Data Collection

Ethics review for this study was completed by the University of Guelph (REB#18-02-001), University of Waterloo (ORE#22776), and participating hospitals. Each hospital was provided a Site

Survey (Appendix D) which was completed by the Site Champion who was typically the foodservices manager/director. Data on hospital size, location (i.e. Local Health Integration Unit), hospital type (e.g. mixed facility, teaching), and number long-term beds were recorded. Data collected on participating units included unit type, number of active beds, allocated funding for unit beds, average length of stay, type of foodservice system, personnel who delivered meals, type of bulk foods available on the unit and provision of between-meal nourishment. Foodservice staff classification, number of full-time equivalent and the role staff played in nutrition/meal services were also recorded. The last section of the Survey assessed the percentage of foodservice budget spent on local food, services provided by contract companies, percentage of outsourced food, between-meal nourishment practices, average daily food cost and fiscal year spending and in-house production of oral nutritional supplements. For analyses, the following responses from the Site Survey were used: hospital type (community, teaching, or mixed), number of active beds (≤100, 101-249, ≥250), foodservice system (bulk delivery/centrally prepared/plated on unit from bulk steam cart, cold plated/rethermed centrally or on unit, hot plated centrally/tray delivery in thermal carts, room service model/centrally prepared/hot bedside delivery, hot plated centrally/tray delivery with plate covers), percentage of foodservice budget spent on local food provision (≤10%, >10%), percentage of food prepared in-house (≤50%, >50%), and average daily food cost per patient (≤$8.00, >$8.00).

A hospital employee from each site was trained by the Project Coordinator on how to approach patients and the protocol for data collection. This trained employee approached eligible patients, explained the study, and if patients' expressed interest obtained written informed consent. First, the employee completed a Patient Demographic Questionnaire (Appendix B) with participants which collects data on age, diagnosis, length of stay, diet order, education, living arrangements, and ethnicity. For analyses, the following categorizations were used for data collected on the Patient Demographic Questionnaire: age (18-39, 40-59, ≥60), gender (male, female), diagnosis (cardiovascular, gastrointestinal,

genitourinary, respiratory, neurological, mental health, infection, cancer, rehabilitation, diabetic/hypo- or hyperglycemic, frailty and musculoskeletal), attained education (less than high school, completed high school, graduated post-secondary school, informal training/education/other, trades), living situation (lives alone, lives with others, lives in a setting where meals are provided (e.g. long-term care), other), ethnicity (Caucasian, Black, Indigenous, Asian, other) and number of diet prescriptions (0, 1, 2, 3, ≥4). The internally reliable Hospital Food Experience Questionnaire (HFEQ) (Appendix A) which has also demonstrated good content, construct and adequate predictive validity with food intake was used to assess food expectations and hospital meal ratings. Food and food-related expectations (n = 6, n = 10) were assessed using a 5-point Likert scale anchored by "not important" (1) and "very important" (5), and meal ratings (n = 7) were assessed using a 5-point Likert scale anchored by "very poor" (1) and "very good" (5). The meal and date the HFEQ were administered was recorded and the Questionnaire was provided to patients before their meal. Patients were instructed to complete the HFEQ based on a served meal and the employee left the room during the meal. Meal quality was quantified using three scores. The first was the single question on overall meal quality rating indicated on the HFEQ (i.e. 5-point Likert scale, 1 = "very poor," 5 = "very good"). The second meal quality score was derived from the summated score of the full HFEQ (n = 22 questions; max score = 110, min = 0) and the third meal quality score was derived from the summated score of the HFEQ-sv (n = 11 questions; max score = 55; min = 0). Development and testing of the full and short version HFEQs are outlined in Paper 1.

5.2.3 Analyses

5.2.3.1 Descriptive Statistics: Patients Expectations, and Meal Ratings

Descriptive statistics (mean, median, SD, and proportions) were conducted to determine which 16 aspects of hospital food (i.e. food appearance, smell, taste, healthiness, freshness, temperature, variety, choice, meal size, and serving foods that are local, meet dietary needs, familiar to patients, culturally appropriate, easy to chew/swallow, easy to open packaging for and that patients like to eat) are most

important to patients when in hospital. Similarly, descriptive statistics were also conducted for sensory meal ratings (i.e. appearance, smell, taste, texture, temperature, combination of food and overall food quality) of the meal patients assessed. Similarly, descriptive statistics were conducted for the summated HFEQ and HFEQ-sv scores.

5.2.3.2 Ordinal Logistic Regression and Linear Regressions Assessing Patient and Hospital Traits and Overall Meal Quality Rating, HFEQ and HFEQ-sv Scores

Bivariate associations between patient and hospital characteristics (i.e. age, gender, diagnosis, level of attained education, living situation, ethnicity, number of diet prescriptions, hospital type, number of active beds, foodservice model, percentage of foodservice budget spent on local food provision, percentage of food prepared in-house, and average daily food cost per patient) were conducted with the three meal quality measures (i.e. overall meal quality rating, HFEQ score and HFEQ-sv score). An ordinal logistic regression was conducted considering the combined effect of patient and hospital traits and overall meal quality ratings. Two multivariable linear regression model were also conducted with the HFEQ and HFEQ-sv scores, respectively. Statistical significance was determined by $p < .050$.

5.3 Results

5.3.1 Descriptive Statistics

Descriptive statistics for participating hospitals are in Table 4.2. Half of the sites were community hospitals (8; 50.00%). Just over half of the sites were considered large (i.e. ≥250 beds; 56.25%) and exactly 50.00% of hospitals spent $8.00 or more on daily food cost per patient, but only 36.36% of sites spent more than 10% of the foodservice budget on local food provision. Just over half of sites (53.33%) prepared more than 50% of meals in-house and over half of patient received meals prepared by the cold plated/rethermed centrally or on unit foodservice model (57.59%).

Descriptive statistics for patient characteristics are in Table 4.1. On average, patients were 65.18 (SD 18.03, range = 18-100) years old, and 51.08% were female. The admission diagnosis categories with the greatest frequency included musculoskeletal (20.04%), and cardiovascular (15.57%). Most patients had completed high school (36.08%) or had completed post-secondary education (33.77%). Most patients lived with others (59.27%) or alone (32.25%). Majority of patients were Caucasian (86.82%), followed by Indigenous (5.23%), Asian (3.36%), or Black (2.80%) ethnicity. Patients were mostly admitted to either a medical, surgical or rehabilitation unit (32.20%, 21.90%, and 19.69% respectively). Just over one-third of patients were not receiving any diet order (i.e. regular diet; 37.52%) or one diet order (39.11%). The HFEQ was completed at all meals: breakfast (25.0%), lunch (46.4%) and dinner (28.6%). Only 37% of patients had the opportunity to choose the meal that was served. Approximately 74% of patients felt that their meal had a sufficient amount of food while 13% felt that there was not enough and an additional 13% though too much food was served; many patients had food brought in by friends or family (65%).

Descriptive statistics for hospital food expectations and traits are found in Table 5.1. With respect to the first subscale of the questionnaire regarding food expectations, items were most frequently rated as "very important," with taste, freshness and healthiness receiving the greatest number of "very important" ratings (73.75%, 70.45%, and 64.60%, respectively). The second subscale assessed food-related expectations. All food-related expectations had a median of 5 (i.e. "very important") with the exceptions of the importance of receiving culturally appropriate foods and familiar foods, which had medians of 3 (i.e. "neutral") and 4 ("important"), respectively. The food-related traits that received the greatest "very important" ratings included receiving foods that met patients' dietary needs (69.54%), served at appropriate temperatures (67.45%), easy to eat (62.89%), and a sufficient amount of food (61.07%) Receiving culturally traditional foods were most frequently rated as "not important" by 16.98% of patients.

The last section of the Questionnaire assessed a meal served and included sensory traits; average scores were < 4 (i.e. "good") and a median of 4 or all items. Overall meal quality was rated as "very good" by 28.92% of patients, while 10.59% provided ratings of "poor" or "very poor" (i.e. ratings of 2 or 1, respectively). Average scores for HFEQ and HFEQ-sv were 90.60 (SD 10.83) and 44.22, (SD 6.55), respectively.

5.3.2 Bivariate Associations between Patient and Hospital Traits and Overall Quality Rating, HFEQ and HFEQ-sv Scores

Bivariate associations between meal quality ratings and patient and hospital traits with the outcomes of overall meal quality rating, HFEQ and HFEQ-sv scores are in Table 5.2.

5.3.2.1 Bivariate Associations with Overall Meal Quality Rating

Age was significantly associated with meal quality rating ($LRT(2) = 21.44$, $p < .001$). Patients aged 40-59 and ≥60 were 2.18 and 2.28 times more likely to rate overall meal quality as "very good" than the youngest patients aged 18-39 (CIs [1.452, 3.272], and [1.600, 3.250]). Diagnosis category was also significantly associated with meal quality ratings ($LRT(12) = 21.44$, $p = .044$), where patients with a mental health, infection, cancer or frailty diagnosis having lower odds of rating overall meal quality as "very good" by 42%, 35%, 43%, and 46%, when compared to patients with a musculoskeletal diagnosis, respectively (CIs [0.375, 0.905], [0.420, 0.992], [0.328, 0.992] and [0.307, 0.952], respectively). Living situation prior to admission was also significantly associated with overall meal quality rating ($LRT(3) = 8.86$, $p = 0.031$, where patients who indicated they had an "other" living arrangement (e.g. homeless) had significantly lower odds of rating meal quality as "very good" by 52% (CI [0.243, 0.937]). Length of stay, gender, education and ethnicity were not associated with overall meal quality rating (ps > .050).

Type of hospital was significantly associated with overall meal quality ratings ($LRT(2) = 15.48$, $p < .001$). Patients in community and mixed hospitals were 1.71 and 1.67 times more likely to rate overall meal quality as "very good" than patients in teaching hospitals (CIs [1.295, 2.256], [1.228, 2.269]). The

association between hospital size and overall meal quality rating was significant (LRT(2) = 6.47, p = .039), where the odds of a "very good" rating was significantly lower by 30% among patients in large hospitals (i.e. ≥250 active beds) than small hospitals (i.e. ≤100 active beds) (CI [0.497, 0.987]). Foodservice model was also significantly associated with overall meal quality rating (LRT(4) = 17.35, p = .002), where patients receiving meals prepared by the cold plated/rethermed centrally or on unit, or hot plated centrally/tray delivery in thermal cart models had significantly lower odds of an overall meal quality rating of "very good" by 31% and 46%, when compared to the bulk delivery/centrally prepared/plated on unit from bulk steam cart model, respectively (CIs [0.487, 0.974], [0.363, 0.808]). Lastly, the percent of foodservice budget spent on local food was significantly associated with overall meal quality rating, where the odds of a "very good" rating was lower by 27% at sites with >10% of foodservice budget allocated to local food (CI [0.557, 0.9586]). Average daily food cost per patient and proportion of food prepared in-house were not significantly associated with overall meal quality ratings (LRT(1) = 0.84, p = .359; LRT(1) = 1.79, p = .181).

5.3.2.2 Bivariate Associations with HFEQ Scores

Length of stay was significantly associated with HFEQ score (F(1) = 13.36, p < .001) where each additional hospital day was associated with a decrease in score by 0.02 points. Age was significantly associated with HFEQ score (F(2) = 35.26, p < .001) where middle-aged patients (40-59 years) scored 7.76 and older patients (≥60 years) 8.62 points higher than younger patients (18-39 years), respectively (t = 6.31, p < .001; t = 8.05, p < .001). Males scored significantly higher scores than females (F(1) = 37.88, p < .001). Diagnosis category was associated with HFEQ score (F(12) = 4.35, p < .001). Patients with a mental health diagnosis scored 7.28 points lower than patients with a musculoskeletal diagnosis (t = 5.45, p < .001). Living situation prior to hospitalization was associated with HFEQ score (F(3) = 6.54, p < .001) Compared to patients living alone, patients who lived with others, or identified as the "other category" scored lower by 1.96 (t = 2.56, p = .011), and 8.14 points (t = 3.90, p < .001), respectively.

HFEQ score was associated with patient ethnicity ($F(4) = 4.18$, $p = .002$), with Indigenous patients scoring lower by 3.73 points ($t = 2.39$, $p = .017$) and patients identifying as "other" scoring 8.61 points lower ($t = 3.25$, $p < .001$) compared to Caucasian patients, respectively. Number of prescribed diet orders were associated with full HFEQ scores ($F(4) = 2.88$, $p = .022$), with patients prescribed one or two diet orders scoring 1.97 and 3.17 points higher than patients receiving a regular diet (i.e. no diet prescription) ($t = 2.45$, $p = .014$; $t = 3.13$, $p = .002$).

Hospital type was associated with HFEQ scores ($F(2) = 6.10$, $p = .002$), with patients admitted to a community hospital scoring 3.01 points higher than patients admitted to teaching hospitals ($t = 3.39$, $p = .001$). Foodservice model was significantly associated with HFEQ score ($F(4) = 11.74$ $p < .001$). Patients receiving meals through cold plated/rethermed centrally or on unit, or hot plated centrally/tray delivery in thermal cart systems scored significantly lower HFEQ scores by 2.77 and 5.12 points, when compared to the bulk delivery/centrally prepared/plated on unit from bulk steam cart model, respectively ($t = 2.49$, $p = .013$; $t = 4.00$, $p < .001$). Patients receiving meals by the hot plated centrally/tray delivery with plate covers system scored higher HFEQ scores by 3.79 points ($t = 2.32$, $p = .020$). Number of active beds was associated with HFEQ score ($F(2) = 15.19$, $p < .001$), with patients admitted to larger (i.e. $\geq$250 beds) or medium (i.e. 101-249 beds) hospitals having lower scores by 5.47 and 3.07 points when compared to small hospitals (i.e. $\leq$100 beds), respectively ($t = 2.67$, $p = .008$; $t = 5.20$, $p < .001$). Patient education, proportion of foodservice budget allocated to local food, average daily food cost per patient and proportion of food prepared in-house were not significantly associated with HFEQ score at the bivariate level ($F(4) = 1.71$, $p = .146$; $F(1) = 3.17$, $p = .075$; $F = 0.01$, $p = .904$; $F(1) = 0.14$, $p = .709$).

5.3.2.3 Bivariate Associations with HFEQ-sv Scores

Length of stay was significantly associated with HFEQ-sv score ($F(1) = 13.22$, $p < .001$), with each additional hospital day lowering scores by 0.01 points ($t = 3.64$, $p < .001$). HFEQ-sv score was significantly associated with patient age and gender ($F(2) = 30.90$, $p < .001$; $F(1) = 17.23$, $p < .001$).

Patients aged 40-59 and ≥60 scored higher by 4.62 and 5.05 points, compared to patients aged 18-39, respectively ($t = 6.25$, $p < .001$; $t = 7.84$, $p < .001$). Males scored significantly lower than females by 1.73 points ($t = 4.15$, $p < .001$). Patient diagnosis was significantly associated with HFEQ-sv score ($F(12) = 3.68$, $p < .001$), where patients with a mental health diagnosis scored 4.10 points lower than patients with a musculoskeletal patients ($t = 5.12$, $p < .001$). HFEQ-sv was also associated with living situation ($F(4) = 4.84$, $p = .001$). Patients living with others, or in arrangements identified as "other" scored significantly lower than patients living alone by 1.01, and 5.05 points, respectively ($t = 2.23$, $p = .026$; $t = 2.34$, $p = .019$; $t = 4.08$, $p < .001$). Patient ethnicity was associated with HFEQ-sv score ($F(4) = 3.23$, $p = .012$), where Indigenous patients and patients identifying as "other" scored significantly lower by 2.11 and 4.32 points, respectively ($t = 2.28$, $p = .0232$; $t = 2.77$ $p = .006$).

Hospital type was significantly associated with HFEQ-sv score ($F(2) = 6.49$, $p = .002$). Patients admitted to a community hospital scored 1.80 points higher than patients admitted to teaching hospitals ($t = 3.43$, $p = .001$). Foodservice model was also significantly associated with HFEQ-sv score ($F(4) = 10.99$, $p < .001$). Patients receiving meals prepared by cold plated/rethermed centrally or on unit, or hot plated centrally/tray delivery in thermal carts models scored lower by 1.47 and 3.21 points when compared to the bulk delivery/centrally prepared/plated on unit from bulk steam cart system ($t = 2.25$, $p = .025$; $t = 4.28$, $p < .001$). Patients served meals using the hot plated centrally/tray delivery with plate covers system scored 2.13 points higher than the bulk delivery/centrally prepared/plated on unit from bulk steam cart system ($t = 2.20$, $p = .028$). Number of active beds was associated HFEQ-sv scores ($F(2) = 11.25$, $p < .001$). Patients admitted to medium sized (i.e. 101-249 beds) or large hospitals (≥250 beds) had significantly lower HFEQ-sv ratings by 1.55 and 2.81 points when compared to small hospitals (i.e. ≤100 beds), respectively ($t = 2.25$, $p = .024$; $t = 4.45$, $p < .001$). Patient education, number of prescribed diet orders, proportion of foodservice budget spent on local food, average daily food cost per patient and

percentage of food prepared in-house were not associated with HFEQ-sv score at the bivariate level ($F(4) = 0.90$, $p = .466$; $F(4) = 1.33$, $p = .257$; $F(1) = 2.87$, $p = .091$; $F(1) = 0.22$, $p = .643$; $F(1) = 0.05$, $p = .826$).

5.3.3 Ordinal Logistic Regressions Assessing Patient and Hospital Traits with Meal Quality Rating

The ordinal logistic regression assessing the association between patient and hospital characteristics and overall meal quality rating was not statistically significant ($LRT(42) = 47.04$, $p = .274$) and only explained 8% of the variance in meal quality ratings. The global effects of all patient and hospital characteristics were non-significant (ps > .050). The effect of age, number of active beds and proportion of foodservice budget allocated to local food were marginally non-significant ((Wald $\chi2(2) = 5.39$, $p = .068$; (Wald $\chi2(2) = 5.96$, $p = .051$; (Wald $\chi2(1) = 3.61$, $p = .058$)). Patients aged 40-59 were 2.04 times more likely to rate overall meal quality as "very good" than patients younger than 40 (CI [1.112, 3.753]). Compared to sites where proportion of foodservice budget spent on local food was ≤10%, sites with spending >10% had lower odds of a "very good" meal quality rating by 49% [0.364, 1.016]. Patients admitted to large hospitals (i.e. active beds ≥250) were 9.71 times more likely to rate overall meal quality as "very good" compared to patients admitted to smaller hospitals (i.e. ≤100). Results of this ordinal regression are reported in Table 5.3.

5.3.4 Linear Regression Assessing Patient and Hospital Traits with HFEQ Score

Results of the linear regression assessing patient and hospital characteristics with HFEQ and HFEQ-sv scores are in Tables 5.4 and 5.5, respectively. The model testing the effect of hospital and patient characteristics on HFEQ score was statistically significant ($F(42, 556) = 2.34$, $p < .001$) and explained 15.10% of the variance in HFEQ scores. Age was significantly associated with HFEQ score ($F(2) = 3.99$, $p = .014$), where patients aged 40-59 and ≥60 scored higher HFEQ scores by 4.82 and 4.07 points, respectively ($t = 2.80$, $p = .005$; $t = 2.49$, $p = .013$) as compared to patients < 40 years of age. Males scored significantly lower HFEQ scores by 3.51 points ($t = 4.0$, $p < .001$) than females.

Foodservice model was significantly associated with HFEQ score ($F(4) = 3.04$, $p = .017$), with patients receiving meals prepared with the cold plated/rethermed centrally or on unit model having significantly lower HFEQ scores by 6.45 points ($t = 2.43$, $p = .016$) and those receiving meals prepared by the hot plated centrally/tray delivery with plate covers model scored significantly higher by 11.03 points ($t = 2.01$, $p = .045$), when compared to the bulk delivery/centrally prepared/plated on unit from bulk steam cart model. At sites where more than 10% of the foodservice budget was allocated to local food provision, HFEQ scores were lower by 2.88 points compared to sites where 10% or less was allocated to local food provision ($t = 1.98$, $p = .048$). The effect of hospital size and type were marginally non-significant ($F(2) = 2.96$, $p = .052$; $F(2) = 2.52$, $p = .082$).The global effects of length of stay, diagnosis, education, living arrangement, ethnicity, number of diet orders, average daily food cost per patient and proportion of food prepared in-house were not significantly associated with the summated HFEQ score ($ps > .050$).

5.3.5 Linear Regression Assessing Patient and Hospital Traits with HFEQ-sv Score

The model testing patient hospital traits and HFEQ-sv score was significant ($F(42, 580) = 1.73$, $p = .004$) and explained 11% of the variance in HFEQ-sv score. Age was significantly associated with the HFEQ-sv score ($F(2) = 4.36$, $p = .013$), where patients aged 40-59 and ≥60 scored higher by 3.09 and 2.35 points, compared to patients aged 18-39, respectively ($t = 2.95$, $p = .003$; $t = 2.37$, $p = .018$). Males scored significantly lower than females on the HFEQ-sv by 1.37 points ($t = 2.37$, $p = .018$). Average daily food cost per patient was significantly associated with HFEQ-sv score ($F(1) = 4.10$, $p = .043$), with sites where average daily food cost per patient were greater than $8.00 scored 2.92 points higher than sites spending more than $8.00 ($t = 2.03$, $p = .043$). The effects of hospital type and foodservice model were marginally non-significant ($F(2) = 2.91$, $p = .055$; $F(4) = 2.14$, $p = .074$). Length of stay, diagnosis, attained education, living arrangement, ethnicity, and number of diet orders, in addition to hospital size, proportion of foodservice budget allocated to local food and percentage of in-house production were not significantly associated with HFEQ-sv score ($ps > .050$).

5.4 Discussion

The aim of this analysis was to identify how patients rated food expectations and hospital meal experiences and assess the association of patient and hospital traits with three measures of meal quality. Almost all expectations were rated as either "important" or "very important" by two-thirds or more of patients, except for locally sourced and cultural foods, which were only rated as such by 60% and 47% of patients, respectively. Taste, freshness, meeting dietary needs, and temperature were most frequently rated as "very important," which is similar to other studies that have found perceptions of meal quality are influenced by sensory traits and perceptions of healthiness.[2,4,6,13–15,19,20,22,27,28,31] Although less frequent, locally sourced and cultural foods were rated as "important" or "very important" by almost half or more patients. Although not a top priority, receiving local and cultural foods is important to some patients, which is similar to findings of previous work.[4,11,14,41] Although local food was of lower importance, food traits such as taste, and freshness were frequently rated as "important" or "very important" (93%, and 91%, respectively), which could be supported through local food provision.[41] Local food provision is a potential strategy to serve fresh food with appealing sensory traits in hospital.

Having food choice was rated as either "important" or "very important" by 79% of patients, however, only 37% of patients were able to choose their meal. Similarly, Greig et al. surveyed 57 foodservice managers from Ontario hospitals and found that 38% of sites had a non-select menu.[18] Previous studies have found that increasing food choice could improve the overall hospital experience because it is one of the few aspects of care patients had control over.[11,18,25,37,41] As food choice was rated "important" or "very important" by over three-quarters of patients, and only 37% were able to choose their meal, there is potentially an unmet expectation of food choice that could influence perceptions of meal quality.[6] When patients were asked how important food and food-related traits were for meals received in hospital, almost all traits were rated as "important" or "very important" by two-thirds or more

of patients. As these traits included sensory, accessibility and food-related aspects of meals, our results suggest that patients have high expectations for hospital meals.

Approximately 68% of patients rated overall meal quality as "good" or "very good." When specific sensory aspects of the meal were considered, approximately two-thirds of respondents rated meal traits as "good" or "very good." Texture received the greatest number of combined "very poor" and "poor" ratings followed by combination of food served. Sensory aspects are important and influence how patients judge meal quality,[2,4,6,10–12,14,19,22,25,27,37,38,41] which is highlighted by our results in that ratings for overall meal quality and sensory traits received "good" or "very good" ratings at similar frequencies. Poor meal quality and specifically dissatisfaction with sensory traits of a meal have previously been shown to contribute to low food intake,[4–6,8–15] which can negatively impact patient outcomes.[7,12,14,17,26]

In multivariable analyses, the model between patient and hospital characteristics and overall meal quality rating was nonsignificant. This suggests that no patient or hospital factors predicted this single item rating meal quality. However, the effect of hospital size was significant, with the odds of higher meal quality ratings being attributable to larger hospitals than smaller ones, suggesting that foodservice processes and functioning may vary and be dependent on hospital size. Previous studies including the findings of Study 1 have demonstrated that meal ratings (e.g. meal taste) and patient expectations of food served are related to the construct of meal quality[4,10,17,20,27,28,43,59–62] and thus using a scale that quantifies meal quality beyond a single item may be more useful to understanding the contextual factors that influence patients' experiences of hospital meals.

The HFEQ and HFEQ-sv scores were significantly associated with patient and hospital characteristics in bivariate and multivariable analyses. In multivariable analyses, younger and male patients had lower HFEQ and HFEQ-sv ratings, indicating lower perceptions of meal quality, which is similar to findings of previous studies.[43,79,80] Most patients in this study were older. Perhaps younger patients admitted to hospital experienced more severe illness which influenced subsequent appetite,

attitudes towards food and the meal experience.[5,37] Alternatively, younger patients may have a greater diversity in food preference and be less accepting of the meals served in hospital. The global effect of ethnicity was not significantly associated with HFEQ score, however Black patients had significantly higher HFEQ scores in multivariable analyses; the association in bivariate analyses noted for Indigenous patients was not significant in multivariable analyses. Increasing number of diet prescriptions was only significantly associated with the full-HFEQ in bivariate analyses, which is similar to a previous study which found that diet prescriptions increased satisfaction.[80] These results highlight the importance of taking a person-centred approach to foster a positive, and high-quality meal experience. Further, patient-centred approaches that may improve perceptions of meal quality could have subsequent effects on food intake and recovery, and potentially reduce hospital associated costs attributable to poor nutritional intake.[8,9,11,25,27,31,37,40,47]

Greater differences in hospital characteristics and HFEQ and HFEQ-sv scores were observed. Significant predictors of the HFEQ score in multivariable analyses include foodservice model, and proportion of foodservice budget allocated to local food provision, while the effect of hospital size was marginally non-significant. Our results are somewhat dissimilar to the Canadian study by Keller et al. which found that hospital type and size were not significantly associated with patient meal quality ratings.[6] Larger hospitals were associated with increases in both HFEQ and HFEQ-sv scores as compared to the smallest hospitals. Perhaps foodservice policies, procedures and functioning vary across hospital type and size which has subsequent effects on meal quality. Alternatively, more staff with perhaps deeper skillsets would be employed in a larger hospital. This finding is interesting as a previous study in Ontario hospitals found that smaller hospitals may be able to more closely interact and accommodate patients meal preferences, which may increase their satisfaction[18]; however our results are similar to another study which found that foodservice quality was higher in large and medium sized hospitals when compared to smaller sites.[9] Previous research has suggested that foodservice models can influence meal quality

perceptions, satisfaction and food intake, with a recent emphasis on models that offer customization and point of service ordering.[83–86] In this study, the room service model was associated with an increase in HFEQ score (effect non-significant). Additionally, when compared to the bulk delivery/centrally prepared/plated on unit from bulk steam cart model, an increase in HFEQ score was observed when the hot plated centrally/tray delivery with plate covers foodservice model was used and a decrease in score when the cold plated/rethermed centrally or on unit was used. Previous studies have suggested that retherm processes may negatively impact sensory meal traits and perceptions of quality,[83,88] which was observed in this study. In this present study, in-house production was not associated with either the full or short HFEQ scores, while previous studies have yielded mixed results on the influence of outsourcing practices on meal quality and satisfaction.[6,18,21] Proportion of foodservice budget spent on local food provision was significantly associated with decreased HFEQ scores, which is surprising as increasing local food provision has been suggested as a way to promote freshness, healthiness and positive sensory traits,[41,75] which were rated as important by most participants. Combined with the null effect of in-house production, these findings suggest that the effect of food source is not a salient hospital characteristic influencing meal quality. The only hospital characteristic significantly associated with HFEQ-sv score was average daily food cost per patient. Budget has been a frequently cited constraint to serving quality food in hospitals.[18,75] and our finding that greater spending (>$8.00) resulted in an increase in meal quality supports the idea that increasing foodservice budget can improve meal quality. The full HFEQ accounts for greater food and food related expectations that are not included in the HFEQ-sv which may explain differences in hospital characteristics significantly predicting each score. Although hospital characteristics that significantly predicted both scores were not consistent, it is worthwhile to consider patterns in how hospital characteristics were associated with both HFEQ and HFEQ-sv scores. For example, although the effect of hospital size was not statistically significant, medium and large hospitals were associated with an increase in HFEQ-sv scores by 4.51 and 6.48 points respectively, which is similar to the trend observed

for the full HFEQ score (however, effect was statistically significant) and potentially presents clinically significance.

While differences in patient and hospital characteristics observed is dependent on how meal quality was defined (i.e. overall meal quality rating, HFEQ and HFEQ-sv scores), this analysis demonstrated that patient characteristics, prominently age, and gender influence experiences of meal quality. Thus, patient-centred approaches should be taken to ensure that patients have positive perceptions of meal quality and experience improvements in subsequent food intake. For example, serving foods that better appeal to younger patients (e.g. a variety of healthy options) and choice of serving size are potential strategies to appeal to these patients who scored lower on meal quality perceptions. This analysis suggests that the more comprehensive assessment of meal quality using the full HFEQ provides a better understanding of hospital factors that can influence food experiences and meal quality ratings. To improve meal quality and the patient experience, focusing on food production and meal delivery methods associated with meal quality[2–4,7,10,14,18,33] is a first step. In this analysis, providing hot, fresh food that is closer to the patient is recommended. Larger hospitals may have greater budgetary slack or personnel capacity that promotes higher meal quality ratings. Additionally, increased daily food cost per patient was associated with an increase in meal quality rating, perhaps suggesting that this increase allows for the provision of food variety, or preferred foods. Considering the contextual factors of the hospital experience is critical to understand and improve meals served in hospitals to support food intake, recovery and reduce hospital associated costs.

5.4.1 Strengths and Limitations

This is the first and largest study investigating patients' expectations and experiences of meals served in addition to food intake at meals in Ontario hospitals. Participating hospitals provided diversity to the sample, with hospitals of varying sizes and locations participating, and the quota-system for patient recruitment ensured that diverse patients (diagnoses, age, etc.) were recruited. Hospital employees that

assisted with data collection underwent extensive training with the Project Coordinator to ensure that study procedures were adhered to in order to reduce biases. The Hospital Food Experience Questionnaire has previously demonstrated strong internal reliability and construct validity with respect to meal quality (Study 1). This study assessed meal quality using three different ways of defining quality, which provides a better picture of the contextual factors that influence meal quality.

Although this study presents many strengths, there are some limitations to this work. We are unable to determine how individual meal ratings and food intake changes during patients' hospital stay because the HFEQ and food intake was only assessed at one meal. Although efforts were made to randomly approach patients for participation, predominantly Caucasian patients participated in the study, and subsequent results of ethnicity may not be as representative of diverse patient groups. Although data collection on patient characteristics was highly completed, some hospital characteristics (e.g. percentage of foodservice budget spent on local food) was not reported, resulting in missing data. Despite training, some data on patients was missing and 5 hospitals were unable to provide some details on the Site Survey. Most sensory related expectations were rated as "important" or "very important," which may reflect a ceiling effect for this component of the HFEQ. Lastly, pediatric, populations with delirium or dementia and patients receiving enteral or parenteral nutrition were not eligible, therefore, we cannot conclude if these findings can be generalized to other patient populations.

5.5 Conclusion

Previous studies have suggested numerous reasons for low food intake including perceptions of poor meal quality[5,16,30] sensory traits, variety and ability to choose food.[2–4,7,10–12,14,16,18,22] Our study found that patients typically rated food and food-related traits as important, suggesting that they have high expectations for meals served in Ontario hospitals. However, actual meals were viewed less positively on their sensory aspects. Hospital and patient characteristics associated with perceptions of meal quality varied depending on how meal quality was quantified (i.e. overall meal quality rating, HFEQ and HFEQ-

sv scores). Age and gender were prominent predictors of patient food expectations and meal quality ratings. Foodservice models and size of hospital were also important factors that predicted patient meal quality ratings as measured by the HFEQ. Our results suggest that patient-centred approaches and considering hospital-level traits that directly influence food quality (e.g. foodservice models) may be more relevant for interventions aiming to improve meal quality. Future interventions aiming to improve hospital meal quality are critical to improve meal quality perceptions, satisfaction, support food intake and reduce hospital costs associated with poor intake.[5,7,13–15,21,26,27,29,31–33,35]

Table 5.1: Descriptive Statistics for Patients' Hospital Food Expectations and Meal Ratings

	1	2	3	4	5	Mean SD	Median
Food Expectations [a]							
… Looks good [b] (n = 1,079)	3.61% 39	4.54% 49	16.31% 176	25.21% 272	50.32% 543	4.14 1.07	5
… Smells good [b] (n = 1,078)	3.06% 33	2.41% 26	12.43% 134	29.13% 314	52.97% 571	4.27 0.98	5
… Tastes good [b] (n = 1,082)	0.55% 6	0.83% 9	5.45% 59	19.41% 210	73.75% 798	4.65 0.67	5
… Is healthy [b] (n = 1,082)	1.94% 21	1.29% 14	9.61% 104	22.55% 244	64.60% 699	4.47 0.87	5
… Is fresh [b] (n = 1,083)	1.20% 13	1.20% 13	7.02% 76	20.13% 218	70.45% 763	4.57 0.78	5
… Is local [b] (n = 1,072)	11.38% 122	7.65% 82	21.18% 227	23.32% 250	36.47% 391	3.66 1.34	4
Food-Related Expectations [a]							
… offers foods that meet your dietary needs [c] (n = 1,067)	2.16% 23	1.41% 15	6.28% 67	20.62% 220	69.54% 742	4.54 0.85	5
…offers foods that you are used to eating [c] (n = 1,070)	4.39% 47	4.39% 47	22.34% 239	32.99% 353	35.89% 384	3.92 1.07	4
… offers foods traditional to your culture [c] (n = 1,060)	16.98% 180	13.02% 138	22.92% 243	21.51% 228	25.57% 271	3.26 1.41	3
… offers foods you like to eat [c] (n = 1,073)	1.96% 21	2.52% 27	13.05% 140	27.77% 298	54.71% 587	4.31 0.93	5
… offers a variety of food [c]	1.22%	1.68%	9.54%	30.4%	57.16%	4.41	5

(n=1,069)	13	18	102	325	611	0.82	
… serves food at the right temperature [c] (n = 1,069)	0.94% 10	1.12% 12	6.17% 66	24.32% 260	67.45% 721	4.56 0.74	5
… Allows you to choose your food [c] (n = 1,070)	3.93% 42	3.08% 33	13.64% 146	24.21% 259	55.14% 590	4.24 1.05	5
… Provides you with a sufficient amount [c] (n = 1,066)	1.31% 14	1.78% 19	8.54% 91	27.3% 291	61.07% 651	4.45 0.83	5
… Provides food in packages that are easy to open [c] (n = 1,066)	3.75% 40	4.50% 48	12.01% 128	20.26% 216	59.47% 634	4.27 1.08	5
… Provides food that is easy to chew, swallow, or eat on your own [c] (n = 1,067)	2.72% 29	2.81% 30	9.65% 103	21.93% 234	62.89% 671	4.39 0.96	5
Meal Ratings [d]							
Meal Look [e] (n = 1,068)	3.37% 36	4.96% 53	24.91% 266	37.36% 399	29.40% 314	3.84 1.01	4
Meal Aroma [e] (n = 1,050)	4.57% 48	6.19% 65	27.24% 286	35.81% 376	26.19% 275	3.73 1.06	4
Meal Taste [e] (n = 1,057)	4.45% 47	6.15% 65	22.33% 236	36.99% 391	30.09% 318	3.82 1.07	4
Meal Texture [e] (n = 1,054)	4.65% 49	7.87% 83	24.67% 260	36.24% 382	26.57% 280	3.72 1.08	4
Meal Temperature [e] (n = 1,062)	4.43% 47	7.16% 76	18.83% 200	35.03% 372	34.56% 367	3.88 1.10	4
Combination of Food Served [e] (n = 1,061)	3.49% 37	8.29% 88	23.85% 253	36.48% 387	27.90% 296	3.77 1.05	4
Meal Quality [e] (n = 1,058)	3.50% 37	7.09% 75	21.74% 230	38.75% 410	28.95% 306	3.83 1.04	4

HFEQ scores [f]							
Hospital Food Experience Questionnaire score [g] (n = 959)	-	-	-	-	-	90.60 10.83	92 (51-110) [h]
Hospital Food Experience Questionnaire Short Version score [i] (n = 999)	-	-	-	-	-	44.22 6.55	45 (22-55) [h]

[a] 1 = "Not important," 2 = "Less important," 3 = "Neutral," 4 = "Important," 5 = "Very important."

[b] Question stem: "As a patient, how important is it that hospital food …"

[c] Question stem: "As a patient, how important is it that a hospital …"

[d] 1 = "Very poor," 2 = "Poor," 3 = "Neutral," 4 = "Good," 5 = "Very good. "

[e] Rating of a single meal served.

[f] Summated score.

[g] Maximum = 110; minimum = 0.

[h] Median/range.

[i] Maximum = 55; minimum = 0.

Table 5.2: Bivariate Association Between Patient and Hospital Characteristics with Overall Meal Quality Rating, Hospital Food Experience Questionnaire (HFEQ) and Hospital Food Experience Questionnaire Short Version (HFEQ-sv)

		Overall Meal Quality Rating [a]			HFEQ Score [b]				HFEQ-sv Score [c]			
		Odds Ratio	95% CI	95% CI	Estimate	Std Error	t-value	p-value	Estimate	Std. Error	t-value	p-value
Length of stay		0.998	0.997	1.000	**-0.02**	**0.001**	**-3.66**	**<.001**	**-0.01**	**0.004**	**-3.64**	**< .001**
Age	40-59 years	**2.18**	**1.452**	**3.272**	**7.76**	**1.23**	**6.31**	**<.001**	**4.62**	**0.74**	**6.25**	**<.001**
	60+ years	**2.28**	**1.600**	**3.250**	**8.62**	**1.07**	**8.05**	**<.001**	**5.05**	**0.64**	**7.84**	**<.001**
	18-39 years	Reference										
Gender	Male	0.95	0.764	1.191	**-4.27**	**0.69**	**-6.16**	**< .001**	**-1.73**	**0.42**	**-4.15**	**< .001**
	Female	Reference										
Diagnosis	Cardiovascular	1.01	0.694	1.482	-0.77	1.17	-0.65	0.513	0.11	0.69	0.15	0.880
	Gastrointestinal	1.15	0.692	1.908	1.46	1.55	0.94	0.346	0.90	0.94	0.97	0.335
	Genitourinary	0.76	0.409	1.425	-1.66	1.98	-0.84	0.402	-0.77	1.17	-0.66	0.510
	Respiratory	0.88	0.530	1.461	0.30	1.60	0.18	0.854	-0.21	0.93	-0.23	0.817
	Neurological	0.65	0.327	1.290	1.38	2.13	0.65	0.516	0.16	1.27	0.13	0.897
	Mental health	**0.58**	**0.375**	**0.905**	**-7.28**	**1.34**	**-5.45**	**<.001**	**-4.10**	**0.80**	**-5.12**	**<.001**
	Infection	**0.65**	**0.420**	**0.992**	-1.66	1.33	-1.25	0.213	-0.79	0.79	-1.00	0.319
	Cancer	**0.57**	**0.328**	**0.992**	-2.64	1.73	-1.53	0.128	-1.52	1.01	-1.50	0.133
	Other	1.18	0.757	1.824	2.27	1.33	1.70	0.089	1.16	0.78	1.45	0.148
	Rehabilitation	0.72	0.370	1.386	-2.56	2.04	-1.26	0.209	-1.17	1.20	-0.97	0.333
	Diabetic/hyper-hypoglycemic	0.70	0.316	1.564	-0.89	2.59	-0.34	0.732	-0.06	1.54	-0.04	0.967
	Frailty	**0.54**	**0.307**	**0.952**	0.52	1.74	0.30	0.765	-0.67	1.04	-0.65	0.516
	Musculoskeletal	Reference										
Education	Completed high school	0.95	0.716	1.272	-1.59	0.91	-1.75	0.081	-0.52	0.54	-0.97	0.332
	Graduated post-secondary	1.15	0.858	1.537	-0.06	0.92	-0.06	0.950	-0.04	0.55	-0.07	0.948

	Informal training/ education/other	1.70	0.761	3.799	3.03	2.51	1.21	0.228	1.74	1.52	1.14	0.253
	Trades	1.30	0.540	3.104	0.06	2.78	0.02	0.982	1.01	1.68	0.60	0.549
	Less than high school	Reference										
Living arrangement	Live with others	0.80	0.625	1.014	**-1.96**	**0.76**	**-2.56**	**0.012**	**-1.01**	**0.45**	**-2.23**	**0.026**
	Live in setting where meals are provided	1.24	0.747	2.062	0.59	1.73	0.34	0.73	0.157	0.98	0.16	0.873
	Other	**0.48**	**0.243**	**0.937**	**-8.14**	**2.09**	**-3.90**	**<.001**	**-5.05**	**1.24**	**-4.08**	**< .001**
	Live alone	Reference										
Ethnicity	Indigenous	0.74	0.453	1.214	**-3.73**	**1.56**	**-2.39**	**0.017**	**-2.11**	**0.93**	**-2.28**	**0.023**
	Asian	1.40	0.754	2.609	0.46	1.92	0.24	0.810	0.50	1.16	0.43	0.667
	Black	0.71	0.362	1.381	1.50	2.15	0.70	0.485	-0.49	1.28	-0.38	0.702
	Other	0.61	0.261	1.407	**-8.61**	**2.65**	**-3.25**	**0.001**	**-4.32**	**1.56**	**-2.77**	**0.006**
	Caucasian	Reference										
Diet orders	1	1.00	0.774	1.279	**1.97**	**0.80**	**2.45**	**0.014**	0.67	0.48	1.41	0.159
	2	0.97	0.705	1.341	**3.17**	**1.01**	**3.13**	**0.002**	**1.30**	**0.61**	**2.16**	**0.031**
	3	0.99	0.527	1.854	1.44	1.97	0.73	0.464	1.16	1.17	0.99	0.324
	≥4	0.74	0.350	1.557	1.03	2.48	0.42	0.677	0.38	1.44	0.26	0.792
	0 (i.e. normal diet)	Reference										
Hospital type	Community	**1.71**	**1.295**	**2.256**	**3.01**	**0.89**	**3.39**	**0.001**	**1.80**	**0.52**	**3.43**	**0.001**
	Mixed	**1.67**	**1.228**	**2.269**	1.41	0.99	1.43	0.154	0.73	0.58	1.26	0.207
	Teaching	Reference										
Foodservice model	Cold plated/rethermed centrally or on unit	**0.69**	**0.487**	**0.974**	**-2.77**	**1.11**	**-2.49**	**0.013**	**-1.47**	**0.65**	**-2.25**	**0.0249**
	Hot plated centrally/tray delivery in thermal carts	**0.54**	**0.363**	**0.808**	**-5.12**	**1.28**	**-4.00**	**<.001**	**-3.21**	**0.75**	**-4.28**	**<.001**
	Room service model/centrally prepared/hot bedside delivery	0.67	0.345	1.287	1.46	2.02	0.72	0.469	-0.26	1.21	-0.22	0.8283
	Hot plated centrally/tray delivery with plate covers	1.29	0.759	2.198	**3.79**	**1.63**	**2.32**	**0.020**	**2.13**	**0.97**	**2.20**	**0.028**

	Bulk delivery/centrally prepared/plated on unit from bulk steam cart	Reference										
Proportion of foodservice budget spent on local food	>10%	**0.73**	**0.557**	**0.958**	-1.48	0.83	-1.78	0.075	-0.83	0.49	-1.70	0.091
	≤10%	Reference										
Average daily food cost per patient	>$8.00	1.12	0.890	1.380	0.08	0.70	0.12	0.904	0.19	0.41	0.46	0.643
	≤$8.00	Reference										
Active beds (i.e. hospital size)	101-249	0.90	0.618	1.310	**-3.07**	**1.150**	**-2.67**	**0.008**	**-1.55**	**0.69**	**-2.25**	**0.024**
	≥250	**0.70**	**0.497**	**0.987**	**-5.47**	**1.05**	**-5.20**	**<.001**	**-2.81**	**0.63**	**-4.45**	**<.001**
	≤100	Reference										
Proportion of food prepared in-house	>50%	0.86	0.682	1.075	0.27	0.73	0.37	0.709	-0.10	0.43	-0.22	0.826
	≤50%	Reference										

[a] Overall meal quality rating determined by a 5-point Likert scale; 1 = "Very poor," 2 = "Poor," 3 = "Neutral," 4 = "Good," 5 = "Very good."

[b] Summated Hospital Food Experience Questionnaire (HFEQ) score; n = 22 questions, score range 0-110.

[c] Summated Hospital Food Experience Questionnaire Short Version (HFEQ-sv) score; n = 11 questions, score range 0-55.

Statistically significant terms are bolded

Table 5.3: Ordinal Logistic Regression Assessing Patient and Hospital Characteristics with Overall Meal Quality Rating

Variable		Overall Meal Quality Rating			Max rescaled R^2	Model Statistics
		Point Estimate [a]	95% CI		0.08	LRT(42) = 47.04, p = .274
Length of Stay Wald $\chi2(1) = 0.37$, p = .544		1.00	0.994	1.003		
Age	**40-59 vs. 18-39 ***	**2.04**	**1.112**	**3.753**		
 Wald $\chi2(2) = 5.39$, p = .068	≥60 vs. 18-39	1.64	0.920	2.912		
Gender Wald $\chi2(1) = 0.0004$, p = 0.985	Male vs. Female	1.00	0.743	1.353		
Diagnosis Wald $\chi2(12) = 15.69$, p = .206	Cardiovascular [b]	1.07	0.644	1.788		
	Gastrointestinal [b]	1.40	0.736	2.655		
	Genitourinary [b]	0.75	0.346	1.617		
	Respiratory [b]	0.89	0.479	1.644		
	Neurological [b]	0.99	0.421	2.342		

	Mental health [b]	0.77	0.331	1.776	
	Infection [b]	0.87	0.498	1.501	
	Cancer [b*]	**0.41**	**0.182**	**0.908**	
	Other [b]	1.42	0.799	2.526	
	Rehabilitation [b]	0.62	0.278	1.389	
	Diabetic/hypo- or hyperglycemic [b]	0.90	0.336	2.421	
	Frailty [b]	0.49	0.235	1.028	
Education Wald $\chi2(4) = 3.16$, $p = .532$	Completed high school [c]	0.89	0.603	1.317	
	Graduated post-secondary/grad degree [c]	1.21	0.811	1.806	
	Informal training/education/other [c]	1.31	0.499	3.426	
	Trades [c]	0.93	0.334	2.603	
Living arrangement Wald $\chi2(3) = 2.03$, $p = .567$	Live with others [d]	0.80	0.573	1.101	
	Live in a setting where meals are provided [d]	0.95	0.457	1.951	
	Other [d]	0.99	0.333	2.923	
Ethnicity Wald $\chi2(4) = 0.61$, $p = .962$	Indigenous [e]	0.94	0.417	2.099	
	Asian [e]	1.01	0.373	2.735	
	Black [e]	1.52	0.498	4.660	
	Other [e]	1.14	0.277	4.688	
Number of diet orders	1 [f]	0.80	0.554	1.143	
	2 [f]	0.82	0.533	1.273	

Wald $\chi2(4) = 3.38$, $p = .497$	3 [f]	0.62	0.280	1.380	
	≥4 [f]	1.86	0.394	8.787	
Hospital type Wald $\chi2(2) = 3.60$, $p = .165$	Community vs Teaching	1.58	0.948	2.630	
	Mixed vs Teaching	1.22	0.538	2.773	
Foodservice model Wald $\chi2(4) = 4.92$, $p = .296$	Old plated/rethermed centrally or on unit [g]	0.50	0.210	1.203	
	Hot plated centrally/tray delivery in thermal carts [g]	0.79	0.332	1.860	
	Room service model/centrally prepared/hot bedside delivery [g]	1.45	0.224	9.435	
	Hot plated centrally/tray delivery with Plate covers [g]	3.21	0.509	20.251	
Average daily food cost per patient Wald $\chi2(1) = 2.85$, $p = .091$	>$8.00 vs ≤$8.00	2.03	0.893	4.595	
Active beds (i.e. hospital size)	101-249 vs ≤100	5.25	0.949	29.026	

Wald $\chi2(2) = 5.96$, $p = .051$	**≥250 vs ≤100 ***	**9.71**	**1.408**	**66.948**	
Proportion of food prepared in-house Wald $\chi2(1) = 0.46$, $p = .495$	>50% vs ≤50%	0.84	0.499	1.400	
Proportion of foodservice budget spent on local food Wald $\chi2(1) = 3.61$, $p = .058$	>10% vs ≤10%	0.61	0.364	1.016	

Note: n = 652 in this analysis.

[a] Overall meal quality rating determined by a 5-point Likert scale; 1 = "Very poor," 2 = "Poor," 3 = "Neutral," 4 = "Good," 5 = "Very good."

[b] vs. musculoskeletal diagnosis.

[c] vs. less than high school.

[d] vs. living alone.

[e] vs. Caucasian.

[f] vs. No diet prescription (i.e. regular diet).

[g] vs. Bulk delivery/centrally prepared/plated on unit from bulk steam cart.

*** Bolded terms are statistically significant.**

Table 5.4: Linear Regression Assessing Patient and Hospital Characteristics with Hospital Food Experience Questionnaire (HFEQ) Score

		HFEQ score estimate [a]	Std. error	t-value	p-value	95% CI		R^2	F-values, P
Intercept		81.74	5.93	13.79	<.0001	70.092	93.379	0.15	**F(42, 556) = 2.34, p < .001**
Length of stay F(1) = 0.01, p = .936		0.001	0.01	0.08	0.936	-0.023	0.025		
Age *	**40-59 years ***	**4.82**	**1.72**	**2.80**	**0.005**	**1.431**	**8.199**		
F(2) = 3.99, p = .019	**60+ years ***	**4.07**	**1.63**	**2.49**	**0.013**	**0.861**	**7.276**		
	18-39 years	Reference							
Gender *	**Male ***	**-3.51**	**0.87**	**-4.06**	**<.0001**	**-5.213**	**-1.812**		
F(1) = 16.45, p < .001	Female	Reference							
Diagnosis F(12) = 1.02, p = .427	Cardiovascular	-0.53	1.47	-0.36	0.718	-3.412	2.352		
	Gastrointestinal	2.18	1.83	1.19	0.235	-1.418	5.769		
	Genitourinary	-0.98	2.28	-0.43	0.669	-5.463	3.508		
	Respiratory	-0.99	1.82	-0.55	0.586	-4.578	2.589		
	Neurological	3.16	2.42	1.31	0.192	-1.598	7.928		
	Mental Health	-1.80	2.39	-0.75	0.452	-6.496	2.899		
	Infection	0.48	1.60	0.30	0.764	-2.662	3.622		
	Cancer	-0.17	2.36	-0.07	0.941	-4.808	4.461		
	Other	2.65	1.62	1.64	0.102	-0.523	5.826		
	Rehabilitation	-3.24	2.32	-1.40	0.163	-7.786	1.315		
	Diabetic/hyper- hypoglycemic	0.30	2.93	0.10	0.920	-5.461	6.052		

	Frailty	-0.35	2.08	-0.17	0.869	-4.441	3.750		
	Musculoskeletal	Reference							
Education F(4) = 1.77, p = .133	Completed high school	-1.63	1.13	-1.44	0.151	-3.852	0.595		
	Graduated post-secondary/graduate degree	0.16	1.16	0.14	0.889	-2.120	2.443		
	Informal training/education/other	3.67	2.76	1.33	0.183	-1.743	9.087		
	Trades	2.83	3.06	0.92	0.356	-3.188	8.840		
	Less than high school	Reference							
Living arrangement F(3) = 0.32, p = .809	Live with others	-0.57	0.95	-0.61	0.545	-2.430	1.283		
	Live in a setting where meals are provided	0.76	2.13	0.36	0.721	-3.421	4.940		
	Other	-1.97	3.04	-0.65	0.517	-7.942	3.998		
	Live alone	Reference							
Ethnicity F(4) = 1.71, p = .146	Indigenous	-0.98	2.29	-0.43	0.668	-5.478	3.511		
	Asian	0.59	2.76	0.21	0.831	-4.836	6.012		
	Black *	**7.69**	**3.35**	**2.29**	**0.022**	**1.103**	**14.267**		
	Other	-4.68	4.23	-1.11	0.269	-12.982	3.624		
	Caucasian	Reference							
Number of diet orders F(4) = 0.91, p = .458	1	0.36	1.06	0.34	0.732	-1.716	2.441		
	2	2.20	1.25	1.76	0.078	-0.249	4.647		
	3	0.47	2.23	0.21	0.833	-3.908	4.851		
	≥4	2.63	4.24	0.62	0.536	-5.706	10.959		
	0 (i.e. normal diet)	Reference							
Hospital type F(2) = 2.54, p = .080	Community	1.79	1.44	1.25	0.213	-1.034	4.619		
	Mixed	-1.99	2.40	-0.83	0.406	-6.706	2.718		
	Teaching	Reference							

Foodservice model * **F(4) = 3.04, p = .017**	**Cold plated/rethermed centrally or on unit ***	**-6.45**	**2.66**	**-2.43**	**0.016**	**-11.669**	**-1.231**		
	Hot plated centrally/tray delivery in thermal carts	-3.00	2.86	-1.05	0.293	-8.614	2.606		
	Room service model/centrally prepared/hot bedside delivery	6.16	5.71	1.08	0.281	-5.056	17.381		
	Hot plated centrally/tray delivery with plate covers *	**11.03**	**5.50**	**2.01**	**0.045**	**0.227**	**21.824**		
	Bulk delivery/centrally prepared/plated on unit from bulk steam cart	Reference							
Proportion of foodservice budget spent on local food* **F(1) = 3.92, p = 0.048**	**>10% ***	**-2.88**	**1.46**	**-1.98**	**0.048**	**-5.745**	**-0.022**		
	≤10%	Reference							
Average daily food cost per patient F(1) = 1.45, p = .228	>$8.00	2.95	2.45	1.21	0.228	-1.855	7.759		
	≤$8.00	Reference							
Active beds (i.e. hospital size) F(2) = 2.96, p = .052	**101-249 ***	**11.30**	**5.05**	**2.24**	**0.026**	**1.380**	**21.218**		
	≥250 *	**13.74**	**5.66**	**2.43**	**0.015**	**2.632**	**24.848**		
	≤100	Reference							

Proportion of food prepared in-house F(1) = 0.17, p = .681	>50%	-0.60	1.46	-0.41	0.681	-3.480	2.274		
	≤50%	Reference							

Note: n = 599 for this analysis.

[a] Hospital Food Experience Questionnaire (HFEQ) summated score; min = 0, max = 110.

*** Bolded terms are statistically significant**

Table 5.5: Linear Regression Assessing Patient and Hospital Characteristics with the Hospital Food Experience Questionnaire Short Version (HFEQ-sv) Score

		HFEQ-sv score estimate [a]	Std. error	t-value	P	95% CI		R^2	F-value, P
Intercept		40.27	3.44	11.70	<.0001	33.510	47.024	0.11	**F(42, 580) = 1.73, p = .004***
Length of Stay F(1) = 0.01, p = .924		0.001	0.01	0.10	0.924	-0.014	0.015		
Age* **F(2) = 4.36, p = .013**	**40-59 years ***	**3.09**	**1.04**	**2.95**	**0.003**	**1.034**	**5.138**		
	60+ years *	**2.35**	**0.99**	**2.37**	**0.018**	**0.400**	**4.298**		
	18-39 years	Reference							
Gender* **F(1) = 7.02, p =.008**	**Male ***	**-1.38**	**0.52**	**-2.65**	**0.008**	**-2.411**	**-0.358**		
	Female	Reference							
Diagnosis	Cardiovascular	0.21	0.88	0.24	0.810	-1.523	1.949		

F(12) = 1.28, p = .226	Gastrointestinal	1.88	1.12	1.67	0.095	-0.330	4.081	
	Genitourinary	-0.34	1.36	-0.25	0.802	-3.003	2.322	
	Respiratory	-0.86	1.08	-0.80	0.423	-2.979	1.251	
	Neurological	2.16	1.49	1.45	0.148	-0.768	5.085	
	Mental health	-0.68	1.44	-0.48	0.634	-3.509	2.139	
	Infection	0.43	0.96	0.45	0.652	-1.459	2.328	
	Cancer	-1.07	1.42	-0.75	0.453	-3.866	1.728	
	Other	1.64	0.99	1.67	0.096	-0.292	3.579	
	Rehabilitation	-1.69	1.38	-1.22	0.224	-4.406	1.033	
	Diabetic/hyper- hypoglycemic	0.67	1.75	0.38	0.703	-2.765	4.095	
	Frailty	-1.19	1.26	-0.94	0.349	-3.667	1.296	
	Musculoskeletal	Reference						
Education F(4) = 0.64, p = .637	Completed high school	-0.47	0.68	-0.68	0.494	-1.810	0.875	
	Graduated post-secondary/graduate degree	-0.09	0.69	-0.14	0.892	-1.460	1.270	
	Informal training/education/other	1.27	1.68	0.76	0.450	-2.031	4.573	
	Trades	1.88	1.87	1.01	0.315	-1.795	5.559	
	Less than high school	Reference						
Living arrangement F(3) = 0.50, p = 0.767	Live with others	-0.50	0.57	-0.88	0.377	-1.625	0.616	
	Live in a setting where meals are provided	-0.88	1.24	-0.71	0.481	-3.313	1.561	
	Other	-1.66	1.86	-0.89	0.374	-5.316	1.999	

	Live alone	Reference					
Ethnicity F(4) = 0.85, p = 0.496	Indigenous	-0.98	1.40	-0.70	0.485	-3.740	1.778
	Asian	1.46	1.69	0.86	0.390	-1.871	4.783
	Black	2.23	1.96	1.14	0.256	-1.621	6.083
	Other	-2.24	2.41	-0.93	0.352	-6.969	2.485
	Caucasian	Reference					
Number of diet orders F(4) = 0.46, p = .767	1	-0.53	0.64	-0.83	0.408	-1.776	0.722
	2	0.28	0.76	0.36	0.716	-1.210	1.761
	3	-0.39	1.37	-0.28	0.777	-3.070	2.295
	≥4	1.51	2.60	0.58	0.561	-3.600	6.627
	0 (i.e. normal diet)	Reference					
Hospital type F(2) = 2.91, p = .055	Community	1.19	0.88	1.35	0.176	-0.534	2.912
	Mixed	-1.19	1.42	-0.84	0.402	-3.970	1.595
	Teaching	Reference					
Foodservice model F(4) = 2.14, p = .074	**Cold plated/rethermed centrally or on unit***	**-3.13**	**1.56**	**-2.00**	**0.046**	**-6.193**	**-0.063**
	Hot plated centrally/tray delivery in thermal carts	-1.84	1.59	-1.16	0.247	-4.970	1.281
	Room service model/centrally prepared/hot bedside delivery	-0.02	3.28	0.00	0.996	-6.462	6.431

	Hot plated centrally/tray delivery with plate covers	4.28	3.20	1.34	0.182	-2.004	10.556	
	Bulk delivery/centrally prepared/plated on unit from bulk steam cart							
Proportion of foodservice budget spent on local food F(1) = 2.04, p = .153	>10%	-1.27	0.89	-1.43	0.153	-3.016	0.475	
	≤10%	Reference						
Average daily food cost per patient * **F(1) = 4.10,** **p = .043**	**>$8.00***	**2.92**	**1.44**	**2.03**	**0.043**	**0.089**	**5.745**	
	≤$8.00	Reference						
Active beds (i.e. hospital size) F(2) =2.18, p = .114	101-249	4.24	2.94	1.44	0.151	-1.548	10.018	
	≥250	6.22	3.33	1.87	0.062	-0.311	12.751	
	≤100	Reference						

Proportion of food prepared in-house	>50%	-0.56	0.89	-0.63	0.528	-2.317	1.189	
F(1) = 0.40, p = .528	≤50%	Reference						

Note: n = 623 for this analysis.

[a] Hospital Food Experience Questionnaire Short Version (HFEQ-sv) summated score; min = 0, max = 55.

*** Bolded terms are statistically significant.**

Chapter 6
Study 3: What Do Hospital Patients Eat and is Ratings of Meal Quality Important for Food Consumption?

6.1 Introduction

Meeting patients' nutritional needs while in hospital is an important aspect of care as it supports recovery.[1–6] Despite the important role food plays in the hospital experience and recovery, up to 70% of adult patients are malnourished,[1,5,11,12,14,15,17,26–34] increasing the risk of further morbidity, mortality and hospital associated costs.[5,7,12–17,21,26,27,29–33,35] Most hospital patients rely on food served in hospital as their sole source of nutrition.[1,36] Therefore, adequate food provision while also accounting for altered nutritional needs due to disease state, condition or treatment[1,2,25,27,30] is one of the first steps that can be taken to improve food intake and reduce malnutrition. Previous studies have found mixed results for adequate food provision in hospitals. For example, an Australian study found energy and protein served did not meet patients' needs, while a Swiss study observed their menu exceeded patients' needs.[26,36] Differences in provision could be due to variations in menu planning and foodservice regulations. However, regardless of if menus adequately met patients' nutritional needs, food intake was insufficient to meet patients' needs in both studies.[26,36] In the Swiss hospital where menu provision exceeded patients' needs, 70% of patients did not meet their estimated requirements of 1,422 ± 270 kcal and 68 ± 16 grams of protein, respectively.[36] Adequate food provision is needed to meet patients' nutritional needs, however sufficient food must also be paired with strategies to support patient food intake (e.g. eating assistance, appetizing meals) and patient recovery.

To date, some studies have assessed patient food intake in hospitals with respect to overall energy and macronutrient intake,[15,26,36,40] however, studies investigating types of foods patients consume most often are lacking. In one study, approximately half of patients preferred hot meals for breakfast, lunch and

dinner.[8] Stanga et al. found that many patients (i.e. at least 50% of patients) preferred bread, soup, salad, vegetables, meat and tea/coffee at meals.[37] A Danish study found that patients with low appetite preferred between meal snacks that were beverages and easy to eat, soft items.[39,91] Understanding which foods are served to patients and most frequently consumed is important so that menu planning can be based on these preferences. An examination of frequently consumed foods can help modify hospital menus to reflect patients' preferences, which may improve intake and reduce food waste.

Additionally, patient characteristics such as age, gender and symptoms from illness may contribute to worsening or development of malnutrition.[1,5,6,10,13,26,29,31,32] Previous studies have found that older[13] and male patients are at risk for low food intake or worsening nutritional status[15,29]; alternatively, Curtis et al. found that females were at greater risk of poor food intake.[13] Length of stay has also been demonstrated to be negatively associated with food intake as menus are typically one-week in length.[5,15,37] Diagnosis (with the exception of cancer) has not previously demonstrated to significantly affect food intake,[5,13] however symptoms such as nausea/vomiting, fatigue and generally feeling unwell have been associated with lower food intake.[6,15,63] Diagnoses and pre-existing conditions may also warrant diet prescriptions, which previous studies have found to affect food intake among patients receiving modified texture diets.[15,63,92]

Hospital and foodservice characteristics could alter perceptions of food quality, acceptability and subsequent food intake. A previous Canadian study by Keller et al. found that neither hospital type or size contributed to barrier domain scores associated with hunger, eating difficulties, food quality or illness.[6] However, hospital size was associated with meal quality (as per Study 2). Studies investigating the effect of hospital characteristics with food intake have focused on foodservice models and delivery systems, with recent emphasis on bedside ordering systems, point of service or person-centred models which can improve both food intake and satisfaction.[83–85,93] Strategies to improve food intake are needed due to the detrimental effects low food intake and malnutrition have for patient outcomes and hospital associated

costs.[5,7,11,31,35,38,39] Due to the multidimensional and complex factors that influence food intake and malnutrition,[1,21,26,30] adopting system-level approaches with a food focus to improve intake is needed.

There are numerous food and foodservice related reasons why patients may experience low food intake including: limited food selection, lack of appropriate eating assistance, perceptions of poor meal quality and appearance, disliking food and mealtime interruptions.[1,5,16,25,27,30] When considering food served, low food intake can result from perceptions of poor food quality and dissatisfaction with sensory traits of meals served.[4–6,8–15] Despite the negative effect poor food quality and satisfaction have on food intake, standards and criteria for assessing meal quality and food intake are lacking, which suggests that this area of the hospital experience is undervalued.[11] Few available tools to assess the meal experience comprehensively test the construct of meal quality and have demonstrated good reliability and validity.[19] Therefore, the Hospital Food Experience Questionnaire (HFEQ) was developed, which demonstrated good internal reliability and construct validity with meal quality in previous analyses (Study 1). In this present study, the HFEQ will be evaluated further to determine if perceptions of meal quality predict food intake when adjusting for relevant patient and hospital characteristics. Three ways of measuring the patient food experience will be used: the 22 item HFEQ summated score; the abbreviated 11-item version HFEQ-sv summated score; and a single question on the overall meal quality.

This following study aims to assess food intake, determine patient and hospital characteristics associated with food intake and if measures of meal quality from the HFEQ also predict food intake when adjusting for these covariates. This research had the following objectives: a) to determine meal intake, and foods and beverages that are consumed by patients, including those patients with low (≤50%) intake, and b) determine the patient and hospital characteristics associated with food intake and if patient perceptions of meal quality are independent predictors of food intake.

6.2 Materials and Methods

6.2.1 Site and Participants

A request for Ontario hospitals to participate in this study was sent through stakeholder, research and healthcare networks. Initially nineteen hospitals (e.g. location, type) expressed interest and were eligible to participate, however only sixteen hospitals completed data collection due to three sites experiencing challenges with ethics, or changes in employees who were supposed to lead the project. A minimum of 75 patients from each hospital was established as the quota for data collection, however some sites experienced challenges with recruitment, therefore this quota was not always met. To support data collection each site was provided a stipend of $3,000 CDN. Patients were eligible to participate if they were ≥18 years old and had been admitted for a minimum of two days and were excluded if they were not fluent in written and verbal English or French, if they had not receiving any meals during or if they received parenteral or enteral nutrition during this admission or if patients had a diagnosis of delirium or dementia. Eligible patients were identified by staff using a unit-level quota system for recruitment to support diversity in patient recruitment and meal assessed (breakfast, lunch, dinner).

6.2.2 Study Protocol

Ethics review for this multi-site study was completed by the University of Guelph (REB#18-02-001), University of Waterloo (ORE#22776), and participating hospitals. The Site Champion (typically foodservices manager/director) of each hospital completed a Site Survey (Appendix D), which collected data at the hospital, foodservice department, unit and staff level. Information from this Survey were categorized based on text responses and numeric values for analyses. Only items of this Survey relevant to this analysis are further discussed. Hospital-level information elicited included size (small, ≤100 beds; medium 101-249 beds; large ≥250 beds), and type (community, mixed, teaching). At the foodservice level, information collected included: foodservice model (bulk delivery/centrally prepared/plated on unit from bulk steam cart, cold plated/rethermed centrally or on unit, hot plated centrally/tray delivery in

thermal carts, room service model/centrally prepared/hot bedside delivery, hot plated centrally/tray delivery with plate covers), average daily food cost per patient (≤$8.00, >$8.00), percentage of foodservice budget allocated to local food provision (≤10%, >10%) and percentage of food prepared in-house (≤50%, >50%).

The Project Coordinator trained a hospital employee at each site on how to approach patients and protocol for data collection. Eligible patients were approached by the employee and written informed consent was provided. Patients completed the Patient Demographic Questionnaire (Appendix B), which gathered data on age, gender, diagnosis, length of stay (i.e. day of admission when participation occurred), diet prescription, education level, living situation and ethnicity using numeric values for age and drop-down selection for remaining variables. Categories from these response were created for analyses: age (18-39, 40-59, ≥60), gender (male, female), diagnosis (cardiovascular, gastrointestinal, genitourinary, respiratory, neurological, mental health, infection, cancer, rehabilitation, diabetic/hypo- or hyperglycemic, frailty, musculoskeletal or other), education level (less than high school, completed high school, graduated post-secondary school, informal education/training/other, trades), living situation (lives alone, lives with others, lives in a setting where meals are provided (e.g. long-term care), or other), ethnicity (Caucasian, Black, Indigenous, Asian, other) and number of diet orders prescribed (none, one, two, three, four or more).

The HFEQ (Appendix A) which has demonstrated good internal reliability, content and construct validity with food quality and some predictive validity with food intake was used (Study 1). Prior to a served meal, the employee delivered patients the HFEQ and instructed them to complete the meal rating section of the Questionnaire based on the meal that was currently being served. The first part of the Questionnaire assessed patients' general expectations of hospital food. Date and meal that the HFEQ was completed was recorded. Employees left the room during the duration of the meal and returned to review and ensure completion of the HFEQ. Meal intake was assessed by the employee using the valid and

reliable My Meal Intake Tool[69] (Appendix C), to determine proportion of the meal consumed (0%, 25%, 50%, 75%, 100%) and also identify potential reasons for low food intake (i.e. feeling unwell, low appetite, etc.). Following this assessment of overall meal intake, the hospital employee removed patients' meal trays for a more comprehensive assessment of intake by assessing the proportion of specific food items consumed. Food groups for this assessment included: juice, tea/coffee, liquid supplement, other beverage, hot cereal, cold cereal, egg dish, bacon/sausage, toast/bread, muffin, cheese, sliced loaf (e.g. banana bread), fruit, yogurt, salad, soup, crackers, sandwich, meat based casserole, meat (e.g. veal, pork, lamb), chicken, fish, potatoes, cooked vegetables, raw vegetables, lasagna, other pasta dish with meat, cookie, cake/pastry/pie, pudding/Jell-O, and four additional "other" food groups if an item did not fit well with a pre-determined group. The proportion of each food or beverage consumed was described on a 5-point scale of 0%, 25%, 50%, 75%, 100% or identified if the item "was not on the tray."[70]

6.2.3 Analyses

Overall meal intake and individual food items was analyzed using descriptive statistics, specifically proportions. If a patient was served the food item, consumption was categorized as ≤50% or >50%. To determine food/beverage intake among patients with low overall food intake (i.e. ≤50% of total meal) proportion of each food group consumed was analyzed specifically among these patients. For this analysis low food intake for a beverage/food item was determined by intake of ≤50%, or >50%.

Bivariate associations between hospital and patient characteristics and food intake were also determined. Separate analyses were conducted considering the effects of hospital and patient characteristics and food intake, as quasi-separation was detected when patient and hospital characteristics were analyzed together. For hospital characteristics, four binary logistic regressions were conducted. In the first model only hospital characteristics were entered, which included hospital type and size, foodservice model, average daily food cost per patient, and percentage of food made in-house and percentage of foodservice budget allocated to local food provision. Models 2, 3 and 4 considered the

effect of hospital characteristics in addition to overall meal quality rating, HFEQ-sv score and HFEQ score, respectively. Analyses that considered patient characteristics were stratified by gender as preliminary analyses revealed that gender accounted for much of the variance observed in food intake. Four additional binary logistic regression analyses were conducted, where the first model considered the stratified effect of patient characteristics – age, admission diagnosis, highest level of attained education, living arrangement, number of diet orders, ethnicity and length of stay – on food intake. The second, third and fourth models considered meal quality measures of overall meal quality rating, HFEQ-sv score and HFEQ score, respectively. Statistical significance was determined by $p < .050$. Additionally, AIC and max-rescaled R^2 were compared across models to determine if the addition of any of the three meal quality measures added value in understanding patient food intake beyond these contextual factors. Lower AIC indicates better model fit of non-nested models.[94]

6.3 Results

6.3.1 Descriptive Statistics

Descriptive statistics for hospital and patient characteristics are in Tables 4.1 and 4.2, respectively. Most participating hospitals were large sites, (i.e. ≥250 active beds 56.25%), and 50% were teaching hospitals. Average daily food cost per patient was ≥$8.00 at 50.00% of hospitals and 36.36% of sites allocated >10% of their foodservice budget on local food provision. Approximately half of participating hospitals (53.33%) prepared >50% of served meals in-house and 57.59% of patient received meals prepared by the cold plated/rethermed centrally or on unit model.

Mean patient age was 65.18 ± 18.03, however age ranged from 18-100 years. Just over half of patients were female (51.08%). Musculoskeletal and cardiovascular diagnoses were the most frequent admission diagnosis (20.04% and 15.57%, respectively). Just over two-thirds of patients had completed high school or post-secondary education (36.08% and 33.77%, respectively). Prior to admission, most

patients lived with others (59.27%) or alone (32.25%). Most patients identified as Caucasian (86.82%). Diet prescriptions were not ordered for 37.52% of patients, while most 39.11% were prescribed one diet order. Average length of stay was 30.35 (SD 57.34), with the median being 10 days. Average length of stay was higher due to the large range observed in patients who participated (3-300 days). The HFEQ was completed at breakfast (25.02%), lunch (46.37%) and dinner (28.61%). Most patients rated overall meal quality as "good," followed by "very good", "neutral," "poor," and "very poor" (38.75% 28.95%, 21.74%, 7.09%, 3.50%, respectively). Mean HFEQ score was 90.60 (SD 10.83), with a median score of 92 (scores ranged from 51-110) and mean HFEQ-sv score was 44.22 (SD 6.55) with a median score of 45 (scores ranged from 22-55).

6.3.2 Proportion of Overall Meal Consumed and Food Groups Consumed

Approximately 29% of patients consumed 50% of their meal or less; fewer than half (42%) of patients consumed their full meal. Food groups that were most frequently consumed (i.e. >50%) by patients overall included: sausage/bacon (90.00%), cake (80.85%), meat pasta (80.65%), and lasagna (79.55%). Foods that were the least frequently consumed (i.e. ≤50%) when served included cookies (55.93%), fruit (40.12%), tea/coffee (39.90%) and cooked vegetables (38.31%). It is important to note that the number of times these items were offered was not equal (e.g. bacon was a highly consumed food however only served to 10 patients). Tables 6.1 and 6.2 provides the proportion of the meal consumed by patients and which foods were served and proportion consumed for all patients, respectively.

6.3.3 Food Item Intake by Patients with Low Overall Meal Intake

Low food intake as defined by ≤50% overall meal consumption, which was experienced by 29% of patients. Beverages were typically the best consumed items (i.e. >50% intake), with juice, tea/coffee, milk and oral nutritional supplements each being consumed by 43.20%, 41.30% and 42.68%, 30.43% of patients, respectively. Pudding/Jell-O, soup, crackers, salad and fruit were food items that were most

frequently consumed (i.e. >50% intake) by 37.21%, 34.43%, 34.25%, 33.33%, and 32.47%, respectively. Cooked vegetables, egg dishes, meat and fish products and bread were typically poorly consumed (i.e. ≤50%) by patients identified as experiencing low food intake. Descriptive results on consumption of all food items by patients with low overall food intake are in Table 6.3.

6.3.4 Bivariate Associations Between Patient and Hospital Characteristics and Food Intake

Bivariate analyses of patient- and hospital-level traits and food intake are in Table 6.4. Gender was significantly associated with food intake LRT(1) = 40.61, $p < .001$, where males were 2.25 times more likely to consume 100% of their meal compared to female patients (CI [1.747, 2.888]). Patient age (LRT(2) = 0.82, p = .142), diagnosis (LRT(12) = 10.30, p = .589), level of education (LRT(4) = 6.07, p = .194), living arrangements (LRT(4) =4.93, p = .295), heritage (LRT(4) = 0.46, p = .978), number of diet orders (LRT(4) = 2.05, p = 0.726) and length of stay (LRT(1) = 2.16, p = .142) were not significantly associated with food intake.

Type of foodservice model was significantly associated with food intake (LRT(4) = 14.69, p = .005). Patients served meals from either a cold plated/rethermed centrally or on unit, or hot plated centrally/tray delivery in thermal cart model had lower odds of consuming 100% of their meal by 51% and 49%, respectively compared to the bulk delivery/centrally prepared/plated on unit from bulk steam cart model (CIs [0.344, 0.713], and [0.328, 0.794], respectively). Hospital size was also significantly associated with food intake, where patients admitted to medium sized hospitals (i.e. 101-249 beds) were 1.44 times more likely to consume 100% of their meal compared to patients admitted to large hospitals (i.e. ≥250 beds) (CI [1.09, 1.89]). Hospital type, average daily food cost per patient, percent of foodservice budget spent on local food and proportion of food prepared in-house were not significantly associated with food intake (ps > .050).

6.3.5 Binary Logistic Regression Testing Association of Patient and Hospital Characteristics and Measures of Meal Quality with Food Intake

Results of the four binary logistic regression models considering the effect of patient characteristics and three measures of meal quality stratified by gender are in Tables 6.5 (females) and 6.6 (males). The first model considering only the effect of patient traits on food intake was non-significant for both female and male patients (LRT(29) = 22.89, p = .782; LRT(30) = 29.04, p = .515, respectively). When the overall meal quality rating was also considered (Model 2), the overall model was marginally non-significant for female patients (LRT(33) = 45.09, p = .078), and significant for male patients (LRT(34) = 76.78, p < .001). However, the global effect of overall meal quality rating was significantly associated with food intake among female patients (Wald $\chi 2(4) = 21.44$, p < .001), where patients who rated overall meal quality as "very poor," "poor," "neutral" or "good" rather than "very good" had significantly lower odds of consuming 100% of their meal by 84%, 74%, 70% and 48%, respectively (CIs [0.033, 0.737], [0.096, 0.706], [0.159, 0.551], and [0.385, 0.983], respectively). Similarly, the global effect of overall meal quality was significantly associated with food intake among male patients (Wald $\chi 2(4) = 32.20$, p < .001), where patients rating overall meal quality as "very poor," "poor," "neutral," or "good" rather than "very good" had significantly lower odds of consuming 100% of their meal by 98%, 86%, 73% and 48%, respectively (CIs [0.003, 0.187], [0.058, 0.356], [0.145, 0.494], and [0.312, 0.872], respectively). No other patient characteristics in Model 2 were significantly associated with food intake for either male or female patients.

Model 3 considered the addition of the HFEQ-sv score with patient characteristics, which resulted in significant models for both female and male patients (LRT(30) = 47.29, p = .023; LRT(31) = 50.87, p = .014, respectively). No patient characteristics were significantly associated with food intake for either female or male patients. HFEQ-sv score was significantly associated with food intake (Wald $\chi 2(1) = 21.50$, p < .001; Wald $\chi 2(1) = 22.56$, p < .001), with female and male patients being 1.10 and 1.08 times

more likely to consume 100% of their meal per point increase in HFEQ-sv (CIs [1.054, 1.138], and [1.048, 1.121], respectively). For only male patients, the effect of length of stay was marginally non-significant (Wald $\chi 2(1) = 3.58$, $p = .058$).

In the final gender-stratified model where HFEQ score was considered in addition to patient characteristics, only the model for female patients was statistically significant while the male model was marginally non-significant. ($LRT(30) = 46.90$, $p = .026$; $LRT(31) = 41.76$, $p = .094$ respectively). Similar to Models 2 and 3, only the meal quality measure, in this case HFEQ score, was significantly associated with food intake for female and male patients (Wald $\chi 2(1) = 20.13$, $p < .001$; Wald $\chi 2(1) = 11.40$, $p < .001$ respectively). For a one-point increase in HFEQ score, female and male patients were 1.06 and 1.03 times more likely to consume 100% of their meal (CIs [1.032, 1.085] and [1.014, 1.055], respectively). In Models 1-4 for male patients, the global effect of education level was non-significant ($p > .050$), however the comparison between patients who completed high school and patients who did not complete high school were statistically significant (i.e. odds ratios do not span 1), with patients who completed high school being less likely to consume 100% of their meal. Caution should be taken when interpreting this finding as the global effect of education level was not significant ($p > .050$).

When considering binary logistic regressions conducted with female patients, Model 4 (HFEQ score) explained the greatest variance in food intake (14.1%), followed by Model 3 (13.7%), Model 2 (12.4%) and Model 1 (6.3%). AIC was lowest for Model 4, and increased across Models 3, 2 and 1, respectively (574.88, 598.57, 635.34, and 661.43, respectively). As Model 4 had the lowest AIC, this model demonstrates the best fit for assessing food intake, and also explained the most variance in food intake. On the other hand, when binary logistic regressions for male patients were considered, Model 2 which included overall meal quality rating explained the most variance in food intake (8.6%), followed by Model 3 (HFEQ-sv score, 5.3%), Model 4 (HFEQ score, 3.5%) and Model 1 (patient characteristics only,

1.2%). AIC for Models 1-4 were 960.16, 919.30, 894.90, and 872.99, respectively. Based on lowest AIC, Model 4 demonstrates the best fit for assessing food intake.

Table 6.7 includes the results of the four binary logistic regression models testing the effect of hospital characteristics and the three independent measures of meal quality on food intake. Model 1 considering hospital characteristics and food intake was non-significant (LRT(11) = 6.23, p = .857). In the second model, the overall meal quality rating was added, and the model was significantly associated with food intake (LRT(15) = 45.13, p < .001). Only the effect of overall meal quality rating was significant (Wald $\chi 2(4) = 33.22$, p < .001), where patients who rated meal quality as "very poor," "poor," "neutral," or "good" rather than "very good had significantly lower odds of consuming 100% of their meal by 92%, 76%, 64% and 44%, respectively (CIs [0.017, 0.337], [0.102, 0.574], [0.233, 0.567], and [0.456, 0.955], respectively). No other hospital characteristics were associated with food intake in Model 2. Model 3 tested the effect of hospital characteristics and HFEQ-sv score with food intake, which was statistically significant (LRT(12) = 26.39, p = .009). No hospital characteristics were significantly associated with food intake, however HFEQ-sv score was associated with intake (Wald $\chi 2(1) = 19.35$, p < .001). For every one-point increase in HFEQ-sv score, patients were 1.06 times more likely to consume 100% of their meal (CI [1.034, 1.091]). The final model tested the association of hospital characteristics and HFEQ score with food intake which was not statistically significant (LRT(12) = 16.69, p = .162) with HFEQ score being the only predictor significantly associated with food intake (Wald $\chi 2(1) = 10.37$, p = .001). For every one-point increase in HFEQ score, patients were 1.03 times more likely to consume 100% of their meal (CI [1.011, 1.044]).

For hospital characteristics, the greatest variance in food intake was explained by Model 2, which considered overall meal quality rating followed by Model 3, 4 and 1 which considered HFEQ-sv score, HFEQ score and hospital characteristics only (respective explained variances: 8.6%, 5.3%, 3.5%, and 1.2%. When evaluating AIC, Model 4 which included hospital characteristics and HFEQ score resulted in

the lowest AIC, followed by Model 3, 2 and 1 (respective AIC values: 872.99, 894.90, 919.30, and 960.16). Suggesting that Model 4 (HFEQ score) best fit the data, however Model 2 (overall meal quality rating) explained the greatest variance in food intake.

6.4 Discussion

In our study, 29% of patients ate 50% of their meal or less, which is similar to Canadian study which found that one-third of patients consumed 50% or less of their meal.[13,29] Low food intake can lead to the development or worsening of malnutrition.[5,30] From the hospital's perspective, low food intake and malnutrition can be costly due to increased length of stay, and resource utilization.[5,7,13–15,21,26,27,29,31–33,35] Identifying foods that are well received and consumed by patients in hospital is one strategy to support patient food intake, as it could be assumed that patients are more likely to consume foods they enjoy and perceive to be of good quality. In this study, food and beverages most frequently served included juice (45%), tea/coffee (78%), milk (56%), and fruit (49%). Interestingly, tea/coffee and fruit, although frequently served were only consumed (i.e. >50% of portion served) by just over half of patients. Items that are frequently served however not as frequently consumed such as tea/coffee and fruit suggest that these items are often wasted potentially due to patients' preferences not being met, or dissatisfaction with sensory aspects. Foods that were consumed (i.e. >50% of portion served) were offered less frequently (e.g. bacon/sausage, cake, pasta with meat, and lasagna, consumed by 80% or more of patients). The novelty of these items, that is, being offered less often, may have influenced consumption and caution should be used in interpreting these results. Patients with low food intake (i.e. ≤50% overall meal intake) had greater consumption of fluids and soft foods (i.e. tea/coffee, juice, milk, soup and pudding/Jell-O), which is similar to previous findings which observed that patients with low appetite had an increased preference for fluid and soft foods.[39,91] Future studies investigating why certain foods are consumed to a better extent than others are needed.[95]

Bivariate analyses demonstrated that hospital size and foodservice models in addition to gender were significantly associated with food intake, however hospital level characteristics were not significantly associated with food intake in multivariable analyses. In preliminary analyses, gender accounted for most of the variance in food intake, which is not surprising as males have higher nutritional needs and generally eat more than females.[96] Therefore, multivariable analyses with patient characteristics were stratified by gender. No other patient characteristics were associated with food intake in multivariable analyses, which is surprising as previous studies have found that lower food intake is associated with older age,[13,15,29] length of stay,[5,15,37] certain diagnoses such as cancer, [5,13] and diet prescriptions, especially among prescriptions that can result in less favourable sensory traits (i.e. modified texture diets).[15,63,92] Larger organizational factors at the hospital level were also not significantly associated with food intake in multivariable analyses. This result is also somewhat surprising as hospital characteristics such as foodservice models, and budget influence subsequent food served and foodservice procedures and processes.[75] While previous studies have found that foodservice models influence food intake, potentially due to changes in sensory traits during processing,[83,97] or the ability to accommodate patients' preferences,[83–85] this was not a finding of this present study. Our insignificant findings may be due to multivariable analyses considering other factors that could influence food intake, which were not considered in some of these previous studies,[83,85] or due to study design of other studies assessing a foodservice intervention.[83] Despite these insignificant findings, previous work with this data demonstrated that hospital characteristics such as foodservice models and hospital size were associated with perceptions of meal quality (Study 2), which themselves have been associated with food intake in this analysis. Therefore, processes that influence perceptions of meal quality deserve attention as they may indirectly influence food intake. Future interventions aiming to improve meal quality, whether through improving food itself, or at the organizational level may be more impactful to support food intake.

As meal quality, satisfaction and sensory traits have been found to be associated with food intake,[4–6,8–15] determining the best method of quantifying meal quality to predict food intake is important to clinical practice. When any of the three meal quality measures were used (i.e. overall meal quality rating, HFEQ-sv and HFEQ scores), most were significantly associated (exceptions noted for female Model 2, male Model 4 and hospital traits Model 4) with food intake and an increase in explained variance in food intake was observed. This suggests that assessment of perceptions of meal quality are relevant to understanding factors that influence food intake and should be measured on an on-going basis to support foodservice improvements and ultimately food intake of patients. Based on the AIC values, the full HFEQ score provided the best fit for models. Although Model 4 contributed to the lowest AIC across analyses considering patient and hospital characteristics it explained the least variance (i.e. max-rescaled R^2) in models testing male stratified patient characteristics and hospital characteristics. It may therefore be worthwhile to consider a model that explained greater variance in food intake that also had a lower AIC. In this case, this compromise would likely be attained using the HFEQ-sv score to measure patient perceptions of meal quality. Further, when the HFEQ-sv score was entered into stratified patient and hospital characteristic analyses, this was the only meal quality measure that was significantly associated with food intake across all models, suggesting this meal quality measure may be more appropriate when considering patient and hospital characteristics. This is a critical finding as previous studies have relied on an overall food quality/satisfaction rating to make inferences on the meal experience.[10,17,67] However, such questions, as also noted in this survey, are prone to ceiling effects and do not provide detail on how to make improvements. The full HFEQ, although comprehensive, includes 22 questions which may not be as feasible to administer in practice, and may also result in patients experiencing question fatigue. Going forward, the HFEQ-sv could be implemented in hospitals to assess patients' expectations and experiences with meals and results can be used to predict subsequent intake while also considering contextual factors of the hospital experience that can be improved. Using a tool that has demonstrated good internal

reliability, and face, construct and predictive validity can help to understand and create quality improvement measures to both improve both quality of meals served and food intake to support patient recovery and reduce hospital associated costs.[5,7,12–17,21,26,27,29–33,35]

6.4.1 Strengths and Limitations

Our present study has many strengths. This is both the first and largest project to date to comprehensively assess expectations and experiences with meals served in addition to overall and specific food intake among Ontario hospital patients. Participating hospitals were diverse, with respect to both hospital (i.e. size, region, etc.) and foodservice (i.e. foodservice model, proportion of food prepared in-house vs. outsourced, etc.) characteristics. Further, a quota system was used to recruit diverse patients (e.g. age, diagnoses, etc.) and demographic data from participants demonstrated diversity in recruitment for most characteristics. All hospital employees at each site were meticulously trained by the Project Coordinator to reduce biases in data collection for both HFEQ administration and assistance and assessment of food intake. Hospital employees were available to assist patients with completing the Questionnaire, which removed barriers for patients to answering HFEQ items. With respect to food intake assessment, overall meal intake and comprehensive food and beverage categorization with the option of "other" foods/beverages were included to best capture the variety of foods that are consumed.

Despite this novel study presenting many strengths, limitations of this work must also be acknowledged. Only 11 of the 16 sites provided data on foodservice budget allocated to local food provision, which decreased the sample size in the regression models assessing patient and hospital characteristics. Patients could choose not to answer certain items on the Demographic Questionnaire and HFEQ which reduced the total number of participants with complete data collection. The HFEQ and food intake assessment was only completed based on one meal, therefore we are unable to comment on how the meal experience and intake changed throughout patients' admission. Although efforts were made to randomly approach patients for participation, predominantly Caucasian patients participated in the study,

and subsequent results of ethnicity may not be as representative of diverse patient groups. Patients with a diagnosis of dementia or delirium in addition to pediatric patients were excluded, therefore these results cannot be generalized to these populations. Despite measures in place to reduce inconsistencies in food intake estimation by hospital employees, there is always a risk of inter-rater error when estimation is performed by more than one person. The food and beverage intake assessment, visual estimation is not as rigorous as other methods for assessing food and beverage intake such as using weighed food diaries, however has previously demonstrated to be sufficient for assessing food intake.[77] Dichotomizing intake for analyses was a strategy to also mitigate this potential error. Additionally, energy, macronutrient or micronutrient intakes cannot be determined as food categories were used for data entry. Although data was collected on the proportion of specific items served and consumed, we cannot specifically comment on why certain items were better received than others (e.g. if certain dishes do not retherm well, poor taste, etc.).

6.5 Conclusion

Perceptions of meal quality influence patients' experiences and satisfaction with hospital meals, which subsequently affects food intake.[4–6,8–15] Approximately 29% of patients in this study consumed ≤50% or less of their meal, which can increase the risk of experiencing adverse effects associated with poor food intake and malnutrition such as further morbidity and mortality.[5,7,12–17,21,26,27,29–33,35] Commonly consumed foods/beverages included tea/coffee, juice, milk, soup, crackers and salads, however patients with low food intake were more likely to consume fluid items (i.e. juice, milk, tea/coffee, soup and pudding/Jell-O). Understanding which foods are served and well consumed by patients can help support menu planning processes to incorporate foods patients enjoy and will eat, while also reducing costs associated with food waste. Despite insignificant effects of patient and hospital characteristics on food intake in multivariable analyses, previous findings from this work have demonstrated that meal quality, which has significant effects on food intake is influenced by hospital characteristics. Therefore, an

indirect effect between hospital characteristics, meal quality and food intake should be considered. Patient perceptions on meal quality, regardless of how measured, was significantly associated with food intake when considering patient and hospital characteristics. Although the model considering the full HFEQ score consistently had the lowest AIC, it did not always explain the most variance in food intake. The HFEQ-sv provides a balance of explained variance in intake as well as a lower AIC and may be the best measure of patient meal quality perception to use going forward, especially as it is half the length of the full HFEQ. Monitoring perceptions of meal quality and food intake with the valid and reliable HFEQ with timely assessments can help to understand patients' meal experiences and lead to implementation of quality improvement measures based on HFEQ findings to support quality food provision and food intake and reduce hospital associated costs.

Table 6.1: Patients' Overall Meal Intake

Proportion Consumed [a]	n (%)
0%	33 (3.10%)
25%	112 (10.54%)
50%	164 (15.43%)
75%	303 (28.50%)
100%	451 (42.43%)

Note: n = 1,063

[a] Intake determined by trained staff visually estimating the proportion of the meal consumed

Table 6.2: Frequency of Foods Offered and Consumed by All Patients

			Proportion consumed if item was on the tray	
	Not on the tray	**On the tray**	**≤50%**	**>50%**
Juice (n = 1,021)	54.55% 557	45.45% 464	35.13% 163	64.87% 301
Tea/coffee (n = 1,059)	22.38% 237	77.62% 822	39.90% 328	60.10% 494
Milk (n = 1,061)	44.30% 470	55.70% 591	32.99% 195	67.10% 494
Liquid supplement (n = 997)	88.47% 882	11.53% 115	50.43% 58	49.57% 57
Hot cereal (n = 990)	90.40% 895	9.60% 95	30.53% 29	69.47% 66
Cold cereal (n = 1,001)	86.71% 868	13.29% 133	28.57% 38	71.43% 95
Egg (n = 988)	86.34% 853	13.66% 135	31.11% 42	68.89% 93
Bacon/sausage (n = 985)	98.98% 975	1.02% 10	10.00% 1	90.00% 9
Bread (n = 998)	78.26% 781	21.74% 217	32.26% 70	67.74% 147
Muffin (n = 989)	95.35% 943	4.65% 46	28.26% 13	71.74% 33
Cheese (n = 986)	93.10% 918	6.90% 68	32.35% 22	67.65% 46
Loaf (n = 985)	97.66% 962	2.34% 23	39.13% 9	60.87% 14
Fruit (n = 1,008)	50.79% 512	49.21% 496	40.12% 199	59.88% 297
Yogurt (n = 990)	91.21% 903	8.79% 87	28.74% 25	71.26% 62
Salad (n = 990)	85.15% 843	14.85% 147	29.93% 44	70.07% 103
Soup (n = 1015)	65.71% 667	34.29% 348	33.33 116	66.67% 232
Crackers (n = 1,000)	76.70% 767	23.30% 233	36.91% 86	63.09% 147
Sandwich (n = 992)	80.44%	19.56%	30.93%	69.07%

	798	194	60	134
Casserole (n = 995)	93.17% 927	6.83% 68	29.41% 20	70.59% 48
Meat (n = 988)	89.17% 881	10.83% 107	25.23% 27	74.77% 80
Chicken (n = 989)	93.02% 920	6.98% 69	28.99% 20	71.01% 49
Fish (n = 993)	93.45% 928	6.55% 65	26.15% 17	73.85% 48
Potatoes (n = 998)	77.66% 775	22.34% 223	33.63% 75	66.37% 148
Cooked vegetables (n = 1,014)	64.99% 659	35.01% 355	38.31% 136	61.69% 219
Raw vegetables (n = 986)	96.55% 952	3.45% 34	35.29% 12	64.71% 22
Lasagna (n = 988)	95.55% 944	4.45% 44	20.45% 9	79.55% 35
Pasta with meat (n = 985)	96.85% 954	3.15% 31	19.35% 6	80.65% 25
Cookie (n = 995)	94.07% 936	5.93% 59	55.93% 33	44.07% 26
Cake (n = 993)	95.27% 946	4.73% 47	19.15% 9	80.85% 38
Pudding/Jell- (n=989)	85.04% 841	14.96% 148	31.08% 46	68.92% 102

Note: Intake determined by trained staff visually estimating the proportion of the meal consumed. Some items were less frequently served, however demonstrated high or low rates of consumption; these results should be interpreted with caution.

Table 6.3: What Foods are Consumed by Patients with Low Overall Meal Intake (≤50%)

	Proportion consumed if item was on the tray	
	≤50%	**>50%**
Juice (n = 125)	56.80% 71	43.20% 54
Tea/coffee (n = 230)	58.70% 135	41.30% 95
Milk (n = 157)	57.32% 90	42.68% 67
Liquid supplement (n = 46)	69.57% 32	30.43% 14
Hot cereal (n = 27)	81.48% 22	18.52% 5
Cold cereal (n = 35)	77.14% 27	22.86% 8
Egg (n = 37)	89.19% 33	10.81% 4
Bacon/sausage (n = 1)	100.00% 1	0% 0
Bread (n = 55)	81.82% 45	18.18% 10
Muffin (n = 11)	63.64% 7	36.36% 4
Cheese (n = 9)	100% 9	0% 0
Loaf (n = 5)	100% 5	0% 0
Fruit (n = 154)	67.53% 104	32.47% 50
Yogurt (n = 24)	62.50% 15	37.50% 9
Salad (n = 39)	66.67% 26	33.33% 13
Soup (n = 122)	65.57% 80	34.43% 42
Crackers (n = 73)	65.75% 48	34.25% 25
Sandwich (n = 61)	77.05% 47	22.95% 14
Casserole (n = 23)	78.26%	21.74%

	18	5
Meat (n = 27)	81.48% 22	18.52% 5
Chicken (n = 22)	81.82% 18	18.18% 4
Fish (n = 21)	76.19% 16	23.81% 5
Potatoes (n = 64)	79.69% 51	20.31% 13
Cooked veg (n = 109)	93.58% 102	6.42% 7
Raw vegetables (n = 7)	71.43% 5	28.57% 2
Lasagna (n = 10)	90% 9	10% 1
Pasta with meat (n = 8)	75% 6	25% 2
Cookie (n = 19)	73.68% 14	26.32% 5
Cake (n = 8)	37.50% 3	62.50% 5
Pudding/Jell-O (n= 43)	62.79% 27	37.21% 16

Note: n = 309 patients who had overall meal intake ≤50%. Intake determined by trained staff visually estimating the proportion of the meal consumed. Some items were less frequently served, however demonstrated high or low rates of consumption; these results should be interpreted with caution.

Table 6.4: Bivariate Associations of Patient and Hospital Characteristics with Food Intake

Variable		Point Estimate	95% Confidence Interval	
Length of stay n = 1,061 LRT(1) = 2.16, p = .142		1.00	0.996	1.001
Age n = 1,060 LRT (2) = 0.82, p = .663	40-59 vs. 18-39 years	1.04	0.664	1.626
	≥60 vs. 18-39 years	0.91	0.616	1.348
	40-59 vs. ≥60 years	1.14	0.843	1.543
Gender * **n =1,036** **LRT(1) = 40.61, p < .001**	**Male vs. Female***	**2.25**	**1.747**	**2.888**
Diagnosis n = 1,033 LRT(12) = 10.30, p = .589	Cardiovascular [a]	0.95	0.459	1.979
	Gastrointestinal [a]	1.21	0.572	2.537
	Genitourinary [a]	0.66	0.286	1.527
	Respiratory [a]	0.61	0.237	1.572
	Neurological [a]	0.71	0.305	1.640
	Mental health [a]	1.12	0.424	2.947
	Infection [a]	1.05	0.479	2.308

	Cancer [a]	0.92	0.422	2.019
	Other [a]	0.72	0.303	1.731
	Rehabilitation [a]	1.06	0.485	2.316
	Diabetic/hypo- or hyperglycemic [a]	1.27	0.432	3.713
	Frailty [a]	0.76	0.311	1.859
Education	Completed high school [b]	0.76	0.551	1.045
	Graduated post-secondary/graduate degree [b]	0.90	0.649	1.236
n = 1,038	Informal training/education/other [b]	1.19	0.497	2.834
LRT(4) = 6.07, p = .194	Trades [b]	1.86	0.701	4.962
Living arrangement	Live with others [c]	1.12	0.855	1.462
n = 1,049	Live in a setting where meals are provided [c]	0.81	0.453	1.437
LRT(3) = 2.08, p = .0.559	Other [c]	0.32	0.404	1.801
Ethnicity	Indigenous [d]	1.18	0.667	2.093
	Asian [d]	1.11	0.568	2.170
n = 1,046	Black [d]	1.06	0.509	2.210
LRT(4) = 0.46, p = .978	Other [d]	1.11	0.434	2.838
Number of diet orders	1 [e]	0.92	0.695	1.212
	2 [e]	0.92	0.648	1.318
n = 1,055	3 [e]	0.62	0.302	1.267
LRT(4) = 2.05, p = 0.726	≥4 [e]	1.09	0.477	2.494

Hospital type n = 1,063 LRT(2) = 4.41, p = .110	Community [f]	1.30	0.954	1.757
	Mixed [f]	1.00	0.707	1.400
Foodservice model* **n = 1,063** **LRT(4) = 14.69, p = .005**	**Cold plated/rethermed centrally [g*]**	**0.49**	**0.344**	**0.713**
	Hot plated centrally/tray delivery thermal carts [g*]	**0.51**	**0.328**	**0.794**
	Room service/centrally prepared [g]	0.68	0.327	1.392
	Hot plated centrally and delivered on trays with plate covers [g]	0.59	0.329	1.067
Proportion of foodservice budget spent on local food n = 698 LRT(1) = 0.59, p = .442	>10% vs ≤10%	1.13	0.833	1.521
Average daily food cost per patient n = 1,063 LRT(1) = 2.56, p = .109	>$8.00 vs ≤$8.00	0.82	0.642	1.046
Active beds (i.e. hospital size) * **n = 1,063** **LRT(2) = 6.91, p = .032**	101-249 vs ≤100	1.13	0.741	1.727
	≥250 vs ≤100	0.79	0.534	1.164

Proportion of food prepared in-house n = 989 LRT(1) = 1.25, p = .263	>50% vs ≤50%	0.87	0.671	1.115

[a] vs. musculoskeletal diagnosis.

[b] vs. less than high school.

[c] vs. living alone.

[d] vs. Caucasian.

[e] vs. No diet prescription (i.e. regular diet).

[f] vs. Teaching hospital.

[g] vs. Bulk delivery/centrally prepared/plated on unit from bulk steam cart.

Bolded values indicate statistical significance.

Table 6.5: Binary Logistic Regression Models Testing Patient Characteristics and Three Measures of Meal Quality Stratified by Gender (Female)

		Model 1 [a]			Model 2 [b]			Model 3 [c]			Model 4 [d]		
Variable		**Point Estimate**	**95% CI**		**Point Estimate**	**95% CI**		**Point Estimate**	**95% CI**		**Point Estimate**	**95% CI**	
Length of stay		1.00	0.991	1.002	1.00	0.992	1.003	1.00	0.991	1.003	1.00	0.991	1.002
Age	40-59 vs. 18-39	1.36	0.594	3.094	1.02	0.435	2.381	0.99	0.414	2.373	1.09	0.452	2.622
	60+ vs. 18-39	0.87	0.397	1.896	0.68	0.299	1.522	0.68	0.297	1.565	0.75	0.324	1.716
Diagnosis	Cardiovascular [e]	1.66	0.839	3.266	1.64	0.808	3.322	1.59	0.763	3.325	1.52	0.711	3.235
	Gastrointestinal [e]	0.64	0.271	1.518	0.61	0.253	1.489	0.76	0.308	1.890	0.75	0.303	1.840
	Genitourinary [e]	0.72	0.230	2.227	0.75	0.234	2.413	0.69	0.211	2.254	0.79	0.234	2.668
	Respiratory [e]	1.08	0.472	2.451	1.04	0.446	2.421	1.15	0.485	2.709	0.89	0.346	2.281
	Neurological [e]	1.00	0.321	3.131	1.13	0.339	3.754	0.85	0.236	3.043	0.83	0.231	2.946
	Mental health [e]	1.13	0.377	3.416	1.02	0.325	3.188	1.39	0.442	4.350	1.36	0.435	4.273
	Infection [e]	1.44	0.692	3.005	1.50	0.702	3.212	1.75	0.794	3.874	1.88	0.839	4.190
	Cancer [e]	1.31	0.491	3.490	1.48	0.506	4.342	1.25	0.411	3.772	0.91	0.284	2.900
	Other [e]	1.54	0.738	3.222	1.48	0.690	3.189	1.55	0.717	3.364	1.50	0.685	3.267
	Rehabilitation [e]	2.24	0.823	6.076	2.48	0.871	7.034	3.15	1.074	9.213	4.07	1.318	12.547
	Diabetic/hypo- or hyperglycemic [e]	2.01	0.480	8.431	2.04	0.474	8.798	3.83	0.738	19.878	3.90	0.749	20.293

	Frailty [e]	0.79	0.285	2.209	0.92	0.318	2.652	0.97	0.333	2.850	0.89	0.306	2.611
Education	Completed high school [f]	0.82	0.478	1.393	0.84	0.481	1.461	0.74	0.417	1.302	0.81	0.451	1.441
	Graduated post-secondary/grad degree [f]	0.88	0.515	1.493	0.92	0.529	1.591	0.92	0.527	1.621	0.99	0.553	1.761
	Informal education/training [f]	0.53	0.095	2.957	0.56	0.096	3.322	0.27	0.029	2.539	0.25	0.027	2.377
	Trades [f]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Living arrangement	Live with others [g]	0.86	0.559	1.334	0.90	0.572	1.415	0.94	0.587	1.501	0.95	0.585	1.530
	Live in a setting where meals are provided [g]	0.74	0.305	1.814	0.71	0.286	1.780	0.83	0.318	2.173	1.03	0.383	2.784
	Other [g]	0.55	0.093	3.302	0.81	0.127	5.160	0.79	0.127	4.908	0.72	0.117	4.361
Ethnicity	Indigenous [h]	2.06	0.539	7.840	2.04	0.514	8.111	2.16	0.547	8.534	2.72	0.669	11.041
	Asian [h]	0.67	0.163	2.784	0.56	0.133	2.326	0.76	0.176	3.267	0.84	0.194	3.635
	Black [h]	0.57	0.165	1.956	0.75	0.205	2.717	0.94	0.250	3.512	1.02	0.257	4.004
	Other [h]	4.61	0.609	34.883	5.83	0.658	51.621	6.00	0.752	47.834	10.24	1.203	87.239
Number of diet orders	1 [i]	0.88	0.562	1.379	0.96	0.603	1.541	0.93	0.574	1.498	0.92	0.568	1.503
	2 [i]	0.64	0.348	1.181	0.72	0.382	1.355	0.71	0.374	1.362	0.63	0.327	1.223
	3 [i]	0.51	0.151	1.756	0.65	0.179	2.373	0.64	0.174	2.354	0.60	0.162	2.231

	4+ [i]	1.20	0.252	5.751	1.46	0.281	7.561	1.76	0.317	9.742	0.85	0.126	5.666
Meal Quality Rating [j]	"Very poor" [k]	-	-	-	**0.16**	**0.033**	**0.737**	-	-	-	-	-	-
	"Poor" [j]	-	-	-	**0.26**	**0.096**	**0.706**	-	-	-	-	-	-
	"Neutral" [k]	-	-	-	**0.30**	**0.159**	**0.551**	-	-	-	-	-	-
	"Good" [k]	-	-	-	**0.62**	**0.385**	**0.983**	-	-	-	-	-	-
HFEQ-sv score [l]		-	-	-	-	-	-	**1.10**	**1.054**	**1.138**	-	-	-
HFEQ score [m]		-	-	-	-	-	-	-	-	-	**1.06**	**1.032**	**1.085**
Max- Rescaled R^2		0.063			0.124			0.137			0.141		
AIC		661.43			635.34			598.57			574.88		

[a] n = 493 [b] n = 480 [c] n =439 [d] n = 456

[e] vs. musculoskeletal diagnosis.

[f] vs. less than high school.

[g] vs. living alone.

[h] vs. Caucasian.

[i] vs. No diet prescription (i.e. regular diet).

[j] Overall Meal Quality rating from the Hospital Food Experience Questionnaire; 5-point Likert scale anchored by "Very poor" (1) and "Very good" (1).

[k] vs. "Very good" (5) rating on the 5-point Likert scale.

[l] Hospital Food Experience Questionnaire short version (HFEQ-sv) summated score; min = 0, max = 55.

[m] Hospital Food Experience Questionnaire (HFEQ) summated score; min = 0, max = 110.

Bolded values indicate statistical significance.

Table 6.6: Binary Logistic Regression Models Testing Patient Characteristics and Three Measures of Meal Quality Stratified by Gender (Male)

		Model 1 [a]			Model 2 [b]			Model 3 [c]			Model 4 [d]		
Variable		**Point Estimate**	**95% CI**		**Point Estimate**	**95% CI**		**Point Estimate**	**95% CI**		**Point Estimate**	**95% CI**	
Length of stay		1.00	0.993	1.000	1.00	0.992	1.000	1.00	0.993	1.000	1.00	0.992	1.000
Age	40-59 vs. 18-39	0.90	0.447	1.831	0.78	0.369	1.662	0.64	0.305	1.361	0.70	0.331	1.477
	60+ vs. 18-39	1.11	0.566	2.160	0.87	0.426	1.793	0.70	0.341	1.442	0.76	0.373	1.568
Diagnosis	Cardiovascular [e]	0.85	0.442	1.646	0.66	0.324	1.336	0.77	0.382	1.533	0.91	0.455	1.806
	Gastrointestinal [e]	0.64	0.241	1.714	0.44	0.153	1.260	0.46	0.159	1.331	0.54	0.189	1.551
	Genitourinary [e]	0.68	0.214	2.157	0.63	0.184	2.164	0.78	0.216	2.819	0.89	0.245	3.220
	Respiratory [e]	0.44	0.166	1.181	0.46	0.160	1.318	0.50	0.170	1.438	0.48	0.161	1.454
	Neurological [e]	2.04	0.549	7.570	2.48	0.569	10.804	1.74	0.437	6.902	2.50	0.564	11.034
	Mental health [e]	0.99	0.450	2.191	0.87	0.370	2.025	1.00	0.433	2.315	1.00	0.436	2.288
	Infection [e]	0.58	0.269	1.247	0.53	0.231	1.197	0.58	0.253	1.306	0.60	0.264	1.346
	Cancer [e]	0.47	0.178	1.216	0.41	0.141	1.201	0.50	0.178	1.426	0.65	0.232	1.837
	Other [e]	0.69	0.320	1.506	0.49	0.207	1.138	0.55	0.238	1.274	0.60	0.258	1.371
	Rehabilitation [e]	0.56	0.150	2.093	0.45	0.116	1.766	0.50	0.130	1.948	0.58	0.150	2.215
	Diabetic/hypo- or hyperglycemic [e]	0.93	0.250	3.464	0.96	0.233	3.928	0.85	0.215	3.352	1.28	0.306	5.324

	Frailty [e]	0.99	0.344	2.817	1.03	0.330	3.189	1.04	0.335	3.228	1.28	0.402	4.068
Level of Education	Completed high school [f]	**0.57** [g]	**0.342**	**0.936**	**0.54** [g]	**0.312**	**0.915**	**0.55**	**0.322**	**0.944**	**0.54** [g]	**0.311**	**0.925**
	Graduated post-secondary/grad degree [f]	0.77	0.462	1.294	0.63	0.362	1.099	0.66	0.383	1.150	0.60	0.343	1.049
	Informal education/training [f]	1.67	0.458	6.069	1.42	0.371	5.450	1.60	0.378	6.752	1.59	0.378	6.670
	Trades [f]	0.86	0.294	2.531	0.69	0.226	2.136	0.55	0.175	1.753	0.56	0.176	1.779
Living arrangement	Live with others [h]	1.12	0.725	1.717	1.20	0.759	1.902	1.17	0.737	1.855	1.06	0.664	1.686
	Live in a setting where meals are provided [h]	0.71	0.242	2.086	0.66	0.213	2.028	0.70	0.222	2.203	0.59	0.178	1.935
	Other [h]	1.03	0.326	3.232	1.07	0.320	3.550	1.22	0.376	3.973	1.06	0.327	3.430
Ethnicity	Indigenous [i]	0.86	0.354	2.091	0.88	0.352	2.210	0.93	0.368	2.340	0.91	0.363	2.275
	Asian [i]	1.08	0.376	3.119	1.16	0.359	3.745	1.12	0.357	3.538	1.14	0.367	3.561
	Black [i]	2.10	0.621	7.115	1.87	0.524	6.661	1.80	0.522	6.211	1.73	0.506	5.938
	Other [i]	0.61	0.181	2.035	0.75	0.186	3.054	0.78	0.213	2.857	0.96	0.256	3.581
Number of diet orders	1 [j]	0.74	0.470	1.172	0.71	0.436	1.144	0.74	0.456	1.205	0.64	0.391	1.047
	2 [j]	1.07	0.603	1.885	1.30	0.703	2.412	1.09	0.597	1.995	0.97	0.527	1.768
	3 [j]	0.58	0.195	1.719	0.45	0.139	1.455	0.42	0.133	1.346	0.42	0.131	1.345

	4+ [j]	2.56	0.591	11.087	2.29	0.467	11.247	2.34	0.527	10.417	2.22	0.504	9.775
Meal Quality Rating [k]	"Very poor" [l]	-	-	-	**0.02**	**0.003**	**0.187**	-	-	-	-	-	-
	"Poor" [l]	-	-	-	**0.14**	**0.058**	**0.356**	-	-	-	-	-	-
	"Neutral" [l]	-	-	-	**0.27**	**0.145**	**0.494**	-	-	-	-	-	-
	"Good" [l]	-	-	-	**0.52**	**0.312**	**0.872**	-	-	-	-	-	-
HFEQ-sv score [m]		-	-	-	-	-	-	**1.08**	**1.048**	**1.121**	-	-	-
HFEQ score [n]		-	-	-	-	-	-	-	-	-	**1.03**	**1.014**	**1.054**
Max- Rescaled R^2		0.080			0.205			0.146			0.124		
AIC		679.58			631.16			622.00			612.48		

[a] n = 467 [b] n = 461 [c] n = 427 [d] n = 439

[e] vs. musculoskeletal diagnosis.

[f] vs. less than high school.

[g] Global effect not significant.

[h] vs. living alone.

[i] vs. Caucasian.

[j] vs. No diet prescription (i.e. regular diet).

[k] Overall Meal Quality rating from the Hospital Food Experience Questionnaire; 5-point Likert scale anchored by "Very poor" (1) and "Very good" (1).

[l] vs. "Very good" (5) rating on the 5-point Likert scale.

[m] Hospital Food Experience Questionnaire short version (HFEQ-sv) summated score; min = 0, max = 55.

[n] Hospital Food Experience Questionnaire (HFEQ) summated score; min = 0, max = 110.

Bolded values indicate statistical significance.

Table 6.7: Binary Logistic Regression Assessing Hospital Characteristics and Three Measures of Meal Quality with Food Intake

Variable		Model 1 [a]			Model 2 [b]			Model 3 [c]			Model 4 [d]		
		Point Estimate	95% CI		Point Estimate	95% CI		Point Estimate	95% CI		Point Estimate	95% CI	
Hospital type	Community [e]	0.82	0.492	1.367	0.73	0.427	1.231	0.67	0.397	1.133	0.66	0.387	1.107
	Mixed [e]	0.84	0.373	1.899	0.81	0.350	1.861	0.86	0.373	1.988	0.74	0.313	1.754
Foodservice model	Cold plated/rethermed centrally or on unit [f]	1.02	0.433	2.390	1.19	0.491	2.882	1.32	0.525	3.306	1.18	0.454	3.060
	Hot plated centrally/tray delivery in thermal carts [f]	1.64	0.680	3.940	1.73	0.696	4.276	1.91	0.715	5.083	1.53	0.526	4.421
	Room service model/centrally prepared/hot bedside delivery [f]	2.21	0.494	9.883	1.65	0.337	8.058	1.83	0.363	9.186	1.43	0.272	7.539
	Hot plated centrally/tray delivery with plate covers [f]	1.89	0.455	7.846	1.06	0.235	4.810	1.00	0.218	4.572	1.03	0.221	4.789
Average daily food cost per patient	>$8.00 vs ≤$8.00	0.74	0.332	1.645	0.60	0.260	1.364	0.54	0.233	1.265	1.34	0.789	2.264
Proportion of foodservice budget spent on local food	>10% vs ≤10%	1.13	0.680	1.887	1.38	0.810	2.340	1.32	0.781	2.232	0.61	0.255	1.465
Active beds (i.e. hospital size)	101-249 vs ≤100	1.08	0.316	3.720	0.62	0.164	2.312	0.64	0.173	2.370	0.66	0.178	2.413
	≥250+ vs ≤100	0.89	0.195	4.074	0.41	0.081	2.062	0.40	0.081	1.976	0.40	0.081	1.981

Proportion of food prepared in-house	>50% ≤50%	0.78	0.467	1.298	0.87	0.512	1.473	0.87	0.518	1.475	0.83	0.489	1.395
Meal Quality Rating [g]	"Very poor" [h]	-	-	-	**0.08**	**0.017**	**0.337**	-	-	-	-	-	-
	"Poor" [h]	-	-	-	**0.24**	**0.102**	**0.574**	-	-	-	-	-	-
	"Neutral" [h]	-	-	-	**0.36**	**0.233**	**0.567**	-	-	-	-	-	-
	"Good" [h]	-	-	-	**0.66**	**0.456**	**0.955**	-	-	-	-	-	-
HFEQ-sv score [i]		-	-	-	-	-	-	**1.06**	**1.034**	**1.091**	-	-	-
HFEQ score [j]		-	-	-	-	-	-	-	-	-	**1.03**	**1.011**	**1.044**
Max- Rescaled R^2		0.012			0.086			0.053			0.035		
AIC		960.16			919.30			894.90			872.99		

[a] n = 692; [b] n = 683; [c] n = 630; [d] n = 654

[e] vs. Teaching hospital.

[f] vs. Bulk delivery/centrally prepared/plated on unit from bulk steam cart.

[g] Overall Meal Quality rating from the Hospital Food Experience Questionnaire; 5-point Likert scale anchored by "Very poor" (1) and "Very good" (1).

[h] vs. "Very good" (5) rating on the 5-point Likert scale.

[i] Hospital Food Experience Questionnaire short version (HFEQ-sv) summated score; min = 0, max = 55.

[j] Hospital Food Experience Questionnaire (HFEQ) summated score; min = 0, max = 110.

Bolded values are statistically significant.

Chapter 7
Discussion

The primary purposes of this thesis were to determine if a) a newly created tool, the HFEQ would be useful for hospitals to attain a comprehensive view of the patient meal experience and meal quality perceptions and b) what patients considered important in their food and meal experience in hospital and what predicts these perceptions. Validity and reliability were assessed for a full version of the HFEQ and an abbreviated version created. Assessment of patients' food, and food-related expectations and meal ratings was conducted, and analyses considered how patient and hospital characteristics were associated with three measures of meal quality (i.e. overall meal quality rating, full HFEQ score, HFEQ-sv score). Although not a focus of this work, overall meal intake and specific foods consumed by all patients and those with low consumption were determined. The independent association of these three measures of meal quality when considering selected patient and hospital traits was demonstrated.

7.1 Is the HFEQ and HFEQ-sv Reliable and Valid?

Currently, there are no standards regarding menu assessment and assessment of patient perceptions of meal quality data across Ontario hospitals.[18] A need for a reliable and validated tool that comprehensively assesses patient perceptions of meal quality has been identified, as current tools available have not considered key elements of meal quality and satisfaction, such as comprehensive assessment of sensory traits and food expectations.[10,17,20,28] In Study 1, the three subscales of food expectations (n = 6), food-related expectations (n = 10) and meal sensory ratings (n = 7), as well as the entire HFEQ (n = 23), demonstrated good internal consistency reliability (Cronbach alphas 0.80-0.91). This indicates that each subscale includes a sufficient number of items that captures the concepts of food expectations, food-related expectations and meal sensory ratings.[52] Additionally, the

overall HFEQ demonstrated good internal reliability, suggesting that the entire questionnaire included a sufficient number of questions that encompasses the construct of meal quality.[52]

While the full HFEQ demonstrated good internal reliability, in its current form the Questionnaire includes 23 questions, which although comprehensive, may not be feasible to implement in practice, especially considering the population completing this Questionnaire may be feeling unwell. PCA was conducted to determine how the 23 items of the HFEQ grouped together to identify underlying concepts assessed by the HFEQ and to identify items that could be removed. Five factors emerged from analyses: meal ratings, food traits, food-related traits, meeting patients' dietary and accessibility needs and food familiarity and source, with all questions loading onto a factor. Only one question was removed, which was "the importance of food served being healthy" as this item cross-loaded onto two factors. The five factors that emerged were similar to the subscales of the HFEQ, however expectations were further subdivided into patients' needs and accessibility and food source and familiarity. Although five factors emerged rather than three to match the original subscales, PCA results indicate that meal sensory ratings and various food and food-related concepts grouped together in this data and were relevant to a questionnaire assessing the hospital food and meal experience. However, the PCA analysis did little to reduce the number of HFEQ items.

Previous research has identified that meal quality and dissatisfaction with meal sensory traits can subsequently affect food intake.[4–6,8–15] The single meal quality rating on the HFEQ demonstrated significant predictive validity with food intake. This single item may serve as a proxy for the overall meal experience, as previous studies have done to assess meal quality or satisfaction.[10,17,28,64–67,87] However, this single item does not capture other sensory traits and expectations that may be relevant to food intake, and certainly does not help hospitals to identify how to improve food intake from patients' expectations or individual sensory ratings of the food. When used as the dependent variable, 10 items from the HFEQ were significantly associated this overall meal quality rating. Previous

studies have found that patient perceptions of food quality, which is highly associated with sensory meal traits, is significant to patients' perceptions of meal quality.[2–4,7,10–12,14,18,22,33] All sensory items, except aroma, were associated with this single item. Meal expectations of the importance of taste, food choice, easy to eat foods and easy to open packaging were also associated with the single item, and thus potential candidates for an abbreviated version of the HFEQ. Previous research confirms the relevance of food choice and accessibility to be important to patients.[8,27,30,82]

Further analyses to validate and shorten the HFEQ included logistic regression analysis, first using the PCA factors and next using individual items with the outcome of food intake. It was hypothesized that patient food expectations and ratings of meal sensory quality would be positively associated with total or less than total food consumption at a single meal. Only Factor 1 (meal ratings) was significantly associated with food intake. For every 1-point increase in Factor 1 score the odds of consuming 100% of the meal was 1.77 times higher than the odds of consuming less than 100% of the meal. This further highlights the importance of sensory meal traits in that they are most strongly associated with perceptions of overall meal quality and food intake. Further, it also demonstrates that questions that tap into meal perceptions beyond a single overall meal quality item are relevant to food intake. Although the sensory meal traits in Factor 1 could be the items used to create a shorter HFEQ, this approach would not include patients' expectations of hospital food or food-related traits, which were demonstrated to be relevant to patients' perceptions of meal quality in this thesis, as well as in previous research.[4,27,43,59–62] The cross validation analysis using all 22 questions from HFEQ with food intake as the outcome also reinforced the importance of food choice and meal taste for inclusion in an abbreviated HFEQ, as these were the only two items significantly associated. These predictive validation analyses helped to identify key components for an abbreviated tool, but were insufficient to decide on those items. Thus, the convergent construct validity discussed above with the single overall item of meal quality rating was used to define the HFEQ-sv; this includes 5 food expectations and 5

meal sensory ratings, as well as the single item on overall meal rating. This approach considers patients' expectations of food, and food-related traits in addition to sensory traits beyond food choice and meal taste, overcoming limitations of previous tools.[10,17,19,20] In Study 3, the predictive validity of the 22-item HFEQ and 11-item HFEQ-sv were confirmed when relevant patient and hospital characteristics were considered with the dependent variable of food intake.

Previous tools used to assess the meal experience or patient meal satisfaction were not validated against food intake.[10,17,20,28] In this thesis, both the full HFEQ and HFEQ-sv were validated against food intake. Additionally, previous tools did not comprehensively assess meal quality, as sensory traits such as meal aroma and texture were missing, and if expectations were assessed, this was typically a single item assessing if meals met patients' overall expectations.[10,17,20,28] The HFEQ is both more comprehensive and validated against food intake, making it more useful in practice than previous tools. While the HFEQ is quite comprehensive, however, lengthy, the HFEQ-sv also demonstrated good predictive validity with food intake (Study 3), therefore, either tool could be implemented in practice to gain an understanding of patients' expectations and meal ratings and how these subsequent ratings influence food intake. While the goal of foodservice is to serve foods patients enjoy and consume, previous tools are only able to assess meal sensory qualities, making it challenging to understand the subsequent effects of the meal experience. The HFEQ is superior in that it comprehensively assesses the construct of meal quality, and is able to predict food intake, making assessment of the goal of hospital foodservice possible with a single tool that is both valid and reliable.

7.2 What Impacts Patient Perceptions of Meal Quality?

The full HFEQ was used in 16 Ontario hospitals, which allowed for data collection of patients' expectations of food and food-related traits in addition to meal ratings. Diverse hospitals and patients participated in this study, therefore HFEQ results could be analyzed while considering the relevance of patient and hospital characteristics to ratings on the HFEQ. With respect to food expectations, our results from Study 1 demonstrated that the importance of food taste, local food provision, food choice and easy to open packaging and easy to eat foods were patient expectations significantly associated with the construct of overall meal quality. This is similar to previous studies which have found that food choice is important to patients as it gives them a sense of control, which is often lacking during hospital admission.[11,18,25,37,41] Further, patients will likely choose foods they prefer and find appealing which could lead to increased perceptions of meal quality. Patients in our study who rated meal choice as being "very important" had lower perceptions of meal quality compared to patients who rated this trait as "not important" (CI [1.148, 4.069]) or "neutral" (CI [1.198, 2.589]). This could be attributable to the limited number of patients who were able to choose their meal (37%), therefore, this expectation of having food choice was not met. Previous research has found that patients experience various mealtime challenges in hospital such as lacking eating assistance, inappropriate tray set up, challenges with chewing or swallowing and opening food packaging.[27,82] Patients who rated the importance of easy to open packages and easy to eat foods as "very important" generally had higher odds of a "very good" meal quality rating, therefore suggesting that accessibility needs were met for patients who identified these traits as being important. To check this assumption, bivariate analyses with the question on experience barriers at the meal with the MMIT were completed. Approximately 19% of patients experienced challenges opening packaging, and a chi-square testing the association between the importance of easy to open packaging found that significantly more patients who rated this trait as "very important" experienced challenges with

packaging at meals served ($\chi 2(4) = 48.27$, $p < .001$; standardized residual: +6.82). However, despite more patients who rated easy to open packaging as "very important" experienced more challenges, there was no significant difference in overall meal quality across patients who experienced this challenge ($\chi 2(4) = 1.86$, $p = .762$). This suggests that opening packages for these patients who experienced difficulties at that meal was not as relevant to their assessment of meal quality, as other aspects of the meal like sensory qualities. Efforts to further support meal accessibility has been suggested in the literature, and efforts to support accessibility through eating assistance or other interventions should be investigated as approximately 75% of patients in this present study rated easy to eat foods and easy to open packaging as either "important" or "very important." Food taste was significantly associated with overall meal quality perceptions, where patients who rated the importance of food taste as "very important" had higher odds of rating meal quality as "very good." Previous studies have identified that sensory traits, especially taste are drivers of meal quality, therefore it is not surprising that this trait was associated with meal quality, with higher levels of importance being associated with greater odds of a "very good" meal quality rating. Approximately 6.8% of patients indicated on the MMIT that they experienced the mealtime challenge of disliking the food served and patients who identified disliking food served as a mealtime challenge were less likely to rate overall meal quality as "very good" ($\chi 2(4) = 215.96$, $p < .001$; standardized residual: -4.58) and were significantly less likely to consume 100% of their meal (($\chi 2(1) = 48.28$, $p < .001$; standardized residual: -6.80). Disliking food therefore is a significant barrier to food intake and could potentially increase the risk of developing or worsening malnutrition. Although local food provision has previously been associated with serving foods that are fresh and with favourable sensory traits,[41,75] when the importance of local food provision was rated as "very important," patients were less likely to rate overall meal quality as "very good." This could perhaps be due to most hospitals spending 10% or less of their foodservice budget on local food, therefore, this expectation of local

food provision was likely not met for patients who perceived this trait to be important and thus had a negative effect on perceptions of overall meal quality.

All meal sensory ratings were significantly associated with overall meal quality, except for meal aroma and in Study 3, Factor 1 from the PCA on meal sensory ratings predicted food intake. A previous study found that food smell is associated with meal quality, however this was not observed in our study.[37] This could be due to meals having poor aroma upon delivery and thus other meal traits such as appearance or taste becoming more salient predictors of meal quality, or that other smells from the hospital environment could overbear the smell of the meal. When meal appearance, taste, texture, temperature and combination of food served were rated less than "very good," the odds of a "very good" overall meal quality decreased. Sensory traits and specifically food quality have demonstrated to be significant predictors of patients' perceptions of meal quality.[2,4,6,10,14,20,22,25–27,31,37–39] Some studies have suggested that certain sensory characteristics, such as meal temperature and texture are the most important sensory traits when predicting meal quality.[2,10] However, our results demonstrated that combination of food served followed by meal taste as these sensory traits had the highest Wald chi-square statistics, and therefore may be most relevant.

Food and food-related expectations were typically rated as either "very important" or "important" by participants in this study. Of all 16 food and food-related expectations assessed, expectations receiving the highest frequency of "very important" ratings included: taste (73.75%), freshness (70.45%), meeting dietary needs (69.54%), and temperature (67.45%). Expectations least frequently rated as "very important" included: receiving foods that were familiar (35.89%), locally sourced (36.47%) and culturally appropriate (25.57%). These three expectations were most frequently rated as "not important" by 4.39%, 11.38%, and 16.98% of patients, respectively. All food and food-

related traits had a median of 5 (i.e. “very important”) except for local food provision (median = 4, “important”), receiving familiar foods (median = 4, “important”) and cultural foods (median = 3, “neutral”). This indicates that patients have high expectations of food served and that even expectations that were less frequently rated as such were rated as “very important” by at least 25% of participating patients. Previous tools have been limited in their approach when assessing patients’ expectations in that expectations are not assessed, or if assessed, there is a single item assessing if a meal served met expectations. While food-related traits were also generally rated highly, some items such as the provision of culturally traditional and familiar foods had a higher standard deviation, suggesting more variability in how patients rated the importance of certain items. While previous studies using available tools have generally failed to comprehensively assess the importance of food and food-related traits to patients, results from this study suggest that food-related traits may be important to include, as it is expected that patients will want high sensory qualities of their hospital food. Greater variation observed in food-related traits, such as the importance of receiving preferred or familiar foods, will help hospitals with menu planning. Adding questions directly assessing how patients think the quality of served meals will be and also if this expectation was met could further provide insight if patients exhibit intuitional stereotyping[4,10] and also provide an understanding of if overarching expectations of hospital food matched their experience, which is a question considered by the MAT.[17]

Despite patients having high expectations for meals served in hospital, ratings of a single meal served were scored lower that patient expectations, as demonstrated in Table 5.1. The median for all meal ratings was 4 (i.e. "good") and mean scores were less than 4 (i.e. "good"). Approximately two-thirds or more of patients rated meal traits as "good" or "very good", with meal temperature, overall meal quality, meal taste and appearance most frequently rated as "good" or "very good" (69.59%, 67.70%, 67.08%, and 66.76%, respectively). On the other hand, 10.59% of patients rated meal traits as "poor" or "very poor." Meal texture, combination of food served, meal aroma and temperature were most frequently rated as "poor" or "very poor" (12.52%, 11.78%, 11.59% and 10.76%, respectively). Our results are similar to previous studies assessing patients' perceptions of and satisfaction with hospital food in that meal ratings were generally rated as "good."[17,22,58] Meal temperature was one item frequently rated as "very important," while also receiving a high frequency of "poor" or "very poor" ratings, suggesting that patients have varying experiences with meals served, which could be influenced by food, or other contextual factors such as patient and hospital characteristics, as discussed further below. The average HFEQ score (n = 22 items) was 90.60 (SD 10.83) while the HFEQ-sv score (n = 11 items) was 44.22 (SD 6.55). The minimum and maximum score of both the HFEQ and HFEQ-sv is 0-110 and 0-55, respectively, while range in HFEQ and HFEQ-sv scores were 51-110 and 22-55, respectively further highlighting that patients generally rated expectations and meal ratings highly. Ceiling effects have previously been observed in studies where food satisfaction or overall hospital satisfaction has been assessed, where the majority of patients

rated overall meal quality/satisfaction or meal traits highly (i.e. 80% or more of patients).[19,44,45,48] Higher ratings could be attributable to either self-interest or social desirability biases, to either protect patients against potential repercussions depending on their answers or a desire to respond favourably, especially if receiving assistance completing a questionnaire.[42] It is important to consider the potential effect of contextual and patient factors to better understand the various factors that influence food expectations and potentially food intake to best support recovery.

As meal quality perceptions are subjective, it is worthwhile to consider the effect of various patient characteristics on meal quality perceptions. In multivariable analyses, only age was significantly associated with the three measures of meal quality (i.e. overall meal quality rating, HFEQ and HFEQ-sv scores) and gender was only significantly associated with HFEQ and HFEQ-sv score. Age and gender are the patient characteristics that most strongly predict perceptions of meal quality, where older patients had significantly higher odds of rating overall meal quality as "very good" and scored significantly higher on HFEQ and HFEQ-sv than younger patients. This suggests that patients who are older generally rate meal experiences as better than younger counterparts, or that current practices are more favourably catered to older patients' preferences. With respect to gender, male patients scored significantly lower on HFEQ and HFEQ-sv, indicating that they had lower perceptions of meal quality than female patients, perhaps due to a bias in females rating satisfaction more favourably, which was observed in previous studies.[43,79,80] Strategies to improve perceptions of meal quality among younger and male patients are needed and could potentially include processes that facilitate preference accommodation. Additionally, as the HFEQ and HFEQ-sv consider more items in its score (n = 22, n = 11, respectively) than the single item meal quality rating, this could partly explain why gender was not associated with overall meal quality rating, while other meal ratings or expectations included in the overall HFEQ or HFEQ-sv scores varied by gender. This

highlights that the expectations and meal ratings contributing to a quality meal experience may vary across genders while the single overall meal quality rating does not. As other patient characteristics including diagnosis, education level, living situation, ethnicity and number of prescribed diet orders were not significantly associated with meal quality measures, this suggests that patients' perceptions of meal quality are dependent on factors such as sensory traits of a meal served, rather than individual patient characteristics. Therefore, results from this analysis demonstrate that perceptions of meal quality may not vary across different patient characteristics (beyond age and gender) but rather be dependent on food expectations, in which patients generally rated food and food-related attributes as being important, and on actual meal ratings. When considering ways of improving perceptions of meal quality, focusing on the quality and sensory traits of meals served will likely yield more favourable results. This finding is critical to the implementation of such a questionnaire that focuses on food expectations and meal ratings, as it can be implemented across various units and used among adult patient populations without concern that patient characteristics will skew results.

Varying hospital characteristics were predictive of meal quality ratings, dependent on the meal quality measure used. A greater number of hospital characteristics were significantly associated with the HFEQ score, while fewer were associated with the HFEQ-sv and overall meal quality, respectively. This is not surprising as the HFEQ is more comprehensive in the number of items it includes in its score, followed by the HFEQ-sv and single item meal quality question ($n = 22$, $n = 11$, $n = 1$, respectively). A decrease in explained variance was observed across the three measures, where patient and hospital characteristics explained the most variance in HFEQ score (15%), followed by HFEQ-sv (11%) and overall meal quality rating (8%). Hospital size was significantly associated with overall meal quality and HFEQ score, where patients admitted to medium and larger hospitals had significantly higher odds of rating overall meal quality as "very good," and scored significantly higher on the HFEQ score, respectively. While a previous study conducted among Ontario hospitals

suggested that smaller hospitals may provide a more personal and customized meal experience,[18] this was not observed in our study. Average daily food costs per patient were highest in medium ($9.12), followed by small ($8.88) and large ($8.10) sized hospitals. While the differences in average daily food cost per patient were statistically significant (ps < .050; analysis not shown), these small differences in spending may not be clinically significant. However these small differences may partly explain the difference in quality observed between small and medium sized hospitals. Medium to large sized hospitals may have a larger overall foodservice budget or additional staff or higher skilled staff preparing and delivering meals, or may experience other efficiencies (for example food cost due to geography) which may result in more appealing sensory characteristics of the food and overall rating of meal quality, despite the lower food spending. Average daily food costs were only significantly associated with HFEQ-sv score, where hospitals with average daily food costs greater than $8.00 resulting in significantly higher HFEQ-sv scores. This is not surprising as budget has been a frequently cited constraint to serving high quality meals, and this result suggest that an increase in food spending can increase perceptions of meal quality.[18,21,75] Foodservice model was significantly associated with HFEQ score, where hot plated centrally/tray delivery with plate covers performed best, and the cold plated/rethermed centrally or on unit resulted in lower HFEQ score than the bulk delivery/centrally prepared/plated on unit from bulk steam cart system. While hot plated centrally/tray delivery with plate covers system performed best, this system was only used at one participating site (n = 76 patients), therefore, higher HFEQ score could be attributable to other site characteristics rather than this foodservice model itself. For example, this site had 75% of its food prepared in-house and spent more than $8/day on average food cost per patient, which could influence the types of foods purchased and how they are prepared. The bulk delivery/centrally prepared/plated on unit from bulk steam cart system resulted in the second highest HFEQ score. From our results, the bulk delivery/centrally prepared/plated on unit from bulk steam cart system would best improve patients'

perceptions of meal quality as it resulted in the third highest HFEQ score when compared to other models in multivariable analyses (Table 5.4) and was the model used at 3 sites, whereas the two models scoring higher in multivariable analyses were each only used at one site, removing any bias introduced from site specific processes and other site-specific factors. The room service model/centrally prepared/hot bedside delivery model was not significantly different on the HFEQ score as compared to the bulk delivery/centrally prepared/plated on unit from bulk steam cart, which is similar to previous studies which have suggested such models can increase meal quality, satisfaction and food intake.[83–86] The room service model was only present at one site making it challenging to decipher whether the effect on meal quality was truly due to the foodservice model, or a combination of other positive foodservice related characteristics at this site (e.g. 100% of food was prepared in-house at this site). The cold plated/rethermed centrally or on unit system was most commonly used in participating hospitals (57.59% of patients received meals prepared by this system), and had the lowest HFEQ score when compared to the bulk delivery/centrally prepared/plated on unit from bulk steam cart. Current systems in place at many sites are potentially contributing to lower perceptions of meal quality, perhaps due to the effect the retherm system may have on meals (e.g. meal texture may become crusty or hard if rethermed for longer periods of time).

While significant patient characteristics were relatively stable across multivariable analyses for the three meal quality measures, this was not the case for hospital characteristics. Significant hospital characteristics varied depending on the meal quality measure used as the dependent variable. While variations were observed in hospital characteristics significantly associated with meal quality, significant predictors should be considered as they could have downstream effects on the sensory traits and quality of meals served. For example, from qualitative data from this project, retherm systems were often described as negatively affecting meal texture and temperature, as certain dishes may become hard, or crunchy and stick to the plate, and temperature may not be well maintained

upon delivery. Sensory traits are therefore impacted from this process, which previously demonstrated to be highly associated with meal quality in Study 1. Therefore, hospital characteristics may potentially be influencing meal quality indirectly through such processes and should be included when modifying strategies and procedures to improve meal quality. Study 2 described patients' expectations and experiences of meals served in hospital, and also demonstrated that gender, age and some key hospital characteristics (e.g. hospital size, foodservice model, average daily food cost per patient) influence perceptions of meal quality. Increasing daily food costs per patient to greater than $8.00 demonstrated to be associated with a significant increase in meal quality perceptions (HFEQ-sv score) and could also potentially support food intake (effect non-significant). Increased food spending per patient is potentially one strategy to serve foods patient enjoy and perceive to be of high quality. Hospitals should consider foodservice models that provide patients with meal choice and allow for meals to be delivered closer to patients (e.g. bulk prepared, centrally prepared, and trolley delivered system) so that patients may see and experience sensory aspects of their meal prior to tray delivery (e.g. aroma from trolley cart) to improve patient perceptions of the meal and thus potentially support food intake.

7.3 The Importance of Measuring Patient Perceptions of Food and Meal Quality

Approximately 29% of patients consumed 50% or less of their meal, which was similar to a Canadian study investigating food intake in 18 hospitals.[13,29] For analyses (unless otherwise specified), food intake was dichotomized to reflect 100% intake or less than 100%, due to most patients consuming either 75% or 100% of their meal. Food and beverages that were frequently served included juice, tea/coffee, milk and fruit, which were consumed by approximately 60% of patients. Of patients with low food intake (i.e. ≤50%), fluid or soft texture foods were most frequently consumed (e.g. juice, tea/coffee, soup, pudding/Jell-O). This result is similar to other studies[39,91] and

suggests that these foods have more appealing sensory traits among patients experiencing low food intake, potentially due to symptoms such as nausea, low appetite and other eating challenges. As these patients experiencing low food intake have demonstrated a desire for, or at least a willingness to consume these fluid and soft foods, menu modifications could be adapted to provide several offerings of these particular foods. Perhaps these soft or fluid foods are easy to eat, comforting or have more desirable textures than other foods served. With respect to nutritional content, future analyses could investigate whether fortifying these commonly consumed items may support food intake among this group. Such an intervention could be relevant as oral nutritional supplements (ONS) are frequently prescribed to patients with low food intake; as noted in our sample, less than one-third of patients prescribed ONS consumed more than 50% of their meal. Menu modifications to serve foods that patients are willing to eat and further fortifying these foods to improve nutritional content are potential strategies to balance serving foods patients are willing to eat and meeting their nutritional needs.

At the bivariate level, gender was a significant driver of food intake, with males having significantly higher odds of consuming 100% of their meal than female patients. In Study 3, the only hospital characteristic associated with food intake was foodservice model, with patients receiving meals prepared by cold plated/rethermed centrally or on unit model having significantly lower odds of consuming 100% of their meal compared to the bulk delivery/centrally prepared/plated on unit from bulk steam cart model. When investigating perceptions of meal quality, the hot plated centrally/tray delivery with plate covers was associated with the highest HFEQ score (Study 2), however was associated with lower odds of 100% consumption (effect nonsignificant; Study 3). While choosing to prioritize perceptions of meal quality or food intake is challenging, food intake could be argued to be more relevant as it may predict subsequent patient outcomes and hospital associated costs.[7,9,27,31,38] This foodservice model was also used only at one hospital, making it

challenging to infer if this foodservice model is superior, or if other hospital characteristics are influencing foodservice processes related to the foodservice model. Retherm systems were significantly associated with a decrease in HFEQ score and lower odds of consuming 100% of the meal, when compared to the bulk system, therefore it could be argued that when choosing a superior foodservice model, our results demonstrated that the bulk model demonstrates the best trade-off between higher meal quality and highest food intake. Further, the bulk model was used by 3 sites, making it easier to interpret the observed effect being attributable to the foodservice model rather than other individual site characteristics.

As gender explained a large amount of the variance in food intake, multivariable analyses were stratified by gender to gain a better understanding of the various patient and hospital characteristics and measures of meal quality influencing food intake. The three measures of patient perceived meal quality were significantly associated with food intake in multivariable analyses when considering both male and female patients, where increases in HFEQ or HFEQ-sv score and overall quality rating of "very good" were significantly associated with increased odds of consuming 100% of the meal. No other patient characteristics were significantly associated with food intake for either males or females. This indicates that measures of meal quality, rather than these individual patient characteristics are significant drivers of food intake. However, this study did not include appetite and illness factors, as well as barriers to food intake, shown in prior work to be influential for food intake.[6,13] These variables were not included as the primary question was if the HFEQ was independently associated with food intake when considering key patient and hospital factors – that is, was patient perception of food and meal quality relevant? Barriers to food intake such as illness and poor appetite, would have likely captured much of the variance in food intake as previously noted,[13] limiting the ability to test this hypothesis. Meal quality, whether defined as a single item of overall meal quality or a score comprised of meal sensory ratings and expectations (i.e. HFEQ or HFEQ-sv

scores) are significant drivers of overall food intake in hospital and are more salient than the individual patient and hospital traits modeled. Future interventions should focus on improvements to meal quality to support food intake.

While meal quality was significantly associated with food intake, assessment of which of the three potential HFEQ meal quality measures (i.e. overall meal quality rating, HFEQ and HFEQ-sv scores) should be used to assess meal quality in future studies and practice was needed. Previous studies have relied on a single overall meal quality question,[10,17,28,64–67,87] however Study 1 and previous research have demonstrated that meal ratings and patients' expectations are relevant to assessing meal quality and should be considered. Therefore, both the scores of the HFEQ and HFEQ-sv were also considered to understand how expectations and meal ratings beyond a single item of overall meal quality rating are associated with food intake. For all models, the lowest AIC was observed when HFEQ score was considered, suggesting this measure of meal quality best fit the data in predicting food intake. However, for both male patient characteristics and hospital characteristics, the HFEQ score models explained the least variance in food intake; only in the female patient characteristics model was HFEQ score the best fitting model that explained the most variance. With respect to this discrepancy in best model fit and explained variance in food intake, the HFEQ-sv was the second best model fit for all patient and hospital characteristic models, and explained more variance in the male patient and hospital characteristic analyses. Regardless, the AIC for all models demonstrated that HFEQ and HFEQ-sv scores better fit the data than the overall meal quality rating alone, although overall meal quality rating explained more variance in food intake in both the male patient characteristics and hospital characteristic analyses. This could potentially be due to a decrease in sample size across the meal quality measures as a result of some missing data on the HFEQ-sv and HFEQ scores, which affected the number of cases with complete data. Results from this final analysis demonstrated that meal quality was the most salient predictor of food intake and not hospital or

selected patient characteristics when gender stratified. Further, the HFEQ-sv demonstrated a compromise between optimal model fit and explained variance, which highlights its utility in practice in that it is a shorter questionnaire that may be easier to administer and associated with food intake at a single meal. When all three meal quality measures were considered with gender stratified patient characteristics or hospital characteristics, less than 20% of the variance in food intake was explained. This suggests that despite the significant effect of the three measures of meal quality on food intake when considering patient and hospital characteristics, other variables that were not included in analyses could explain additional variance in food intake. For example, previous studies have found that mealtime challenges such as inability to reach food and requiring eating assistance, [6,27,82] in addition to symptoms affecting food intake (e.g. nausea)[6,15,63] and other barriers to food intake such as mealtime interruptions could explain the low variance explained in our models and should be considered in future analyses. The HFEQ-sv is recommended as a way to quantify patients' food expectations and meal ratings that will be predictive of patient food intake, which can help support the ultimate goal of hospital foodservice to serve foods that patients enjoy and will consume to support their recovery and wellbeing.[11]

7.4 Strengths and Limitations

To our knowledge, this is the most comprehensive and largest project assessing patients' expectations, meal experiences and food intake in Ontario hospitals. Data was collected from 16 diverse hospitals varying in location, size, and foodservice practices, and patients were recruited using a quota system to recruit a diverse patient sample (e.g. age, living arrangement, etc.). The Project Coordinator extensively trained hospital employees at each site on data collection procedures to reduce potential biases in data collection.

While this project has many methodological strengths, there are limitations to this work. Only one meal served was assessed, therefore how patients' meal experience change over time cannot be

determined. Mealtime challenges and symptoms such as nausea which may affect appetite were not considered in multivariable analyses, which could influence both the meal experience (Study 2) and food intake (Study 3). Specifically for Study 3, as patient factors like appetite are known to be large drivers of intake,[13] these were omitted to determine the independent effect of the meal quality measures. While a quota of a minimum of 75 patients per hospital was established, this was not always met by some sites due to challenges in recruitment, which could potentially affect analyses if characteristics were unique to these sites with fewer participants.

Some hospital characteristics (e.g. foodservice model) were unique to only one participating site, making it challenging to isolate and interpret the effect of some hospital covariates. Analyses did not consider mealtime challenges and other potential reasons for low food intake such as low appetite, which may partially explain why the explained variance in our food intake analyses was low. Similarly, only food intake of meals served was assessed and outside food provided by visitors was not considered, which could potentially explain low food intake among some patients. While we were able to discuss overall meal intake and proportion of specific items consumed, detailed nutrient analyses were not conducted, therefore nutrient composition of meals are unknown. Lastly, our analyses considered the number of diet orders patients were prescribed as a greater number of prescriptions could limit meal variety available to patients. However, specific diet orders were not considered due to complexity in the number of diet order combinations. Therefore, we can only comment on the effect of the number of diet orders prescribed and not specific prescriptions, which may be of interest to in future analyses.

7.5 Conclusion and Implications

The Hospital Food Experience Questionnaire (HFEQ) demonstrated good internal reliability, and convergent validity with meal quality. The shortened 11 item HFEQ (HFEQ-sv) was statistically derived and includes some items from the original three subscales of the HFEQ and five factors

identified in PCA. Both the HFEQ and HFEQ-sv demonstrated predictive validity with patient food intake. It is recommended that either the HFEQ or HFEQ-sv be used in future research as well as in practice to support improved foodservice operations and food quality in hospital.

Approximately 67.70% of patients rated overall meal quality as either "good" or "very good." Few patient characteristics predicted meal quality ratings, but hospital foodservice factors were important. Based on this analysis, providing food that is hot and closer to the patient (e.g. bulk delivery) appears to be the best option for not only improving food intake but also patient perceptions of meal quality. Sensory ratings of the meal are key to improving ratings of HFEQ and HFEQ-sv and are consistent with high expectations for appearance, smell, temperature and taste of hospital food. Hospitals also need to invest in food being healthy, fresh, and having sufficient variety, as these are important food expectations. Easy to eat foods such as beverages and soup, especially for low consumers need to be emphasized in menu planning. Less relevant were food being local, familiar and based on cultural preferences. Despite lower ratings on the importance of culturally appropriate foods, hospitals where a high proportion of patients have a unique food culture, should continue to provide food that meets these patients' needs.

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Appendix A

HFEQ

Patient Hospital Food Experience Questionnaire

We would like your opinion on hospital food. First, we would like you to tell us about your expectations for hospital food and meals in general. Then, we would you like you to rate the meal you have just received and eaten and provide recommendations for improving the food.

Part 1: Hospital food/meals

We would like you to think about hospital food in general, and rate the level of IMPORTANCE (1= low 5= very important) to you, as a patient, of each of the following.

As a patient, how important is it that hospital food …

	Not important				Very important
…Looks good	1	2	3	4	5
…Smells good	1	2	3	4	5
…Tastes good	1	2	3	4	5
…Is healthy	1	2	3	4	5
…Is fresh	1	2	3	4	5
…Is local	1	2	3	4	5

As a patient, how important is it that a hospital …

	Not important				Very important
…Offers foods that meets your dietary needs	1	2	3	4	5
…Offers food that you are used to eating	1	2	3	4	5
…Offers foods traditional to your culture	1	2	3	4	5
…Offers food that you like to eat	1	2	3	4	5
…Offers a variety of food	1	2	3	4	5
…Serves food at the right temperature	1	2	3	4	5
…Allows you to choose your food	1	2	3	4	5
…Provides you with enough to eat	1	2	3	4	5
…Provides food in packages that are easy to open	1	2	3	4	5
Provides food that is easy to chew, swallow, or eat on your own	1	2	3	4	5

Part 2: This meal

Please rate the following characteristics of the food and drinks at this meal (1 = very poor, 5= very good).

	Very Poor	Poor	OK	Good	Very Good
The look of the food/drink	1	2	3	4	5
The smell of the food/drink	1	2	3	4	5
The taste of the food/drink	1	2	3	4	5
The texture of the food/drink	1	2	3	4	5
The temperature of the food/drink	1	2	3	4	5
The combination of food on the plate	1	2	3	4	5
The overall quality of the food at this meal	1	2	3	4	5

1. In comparison with other meals you have had at this hospital as a patient, the overall quality of this meal was (select one):

____Worse ____Better ____ Similar

___ This was my first meal Please explain:

2. At this meal, you were served (select one):

____Too little to eat ___Enough to eat ____Too much to eat

If you selected “too little to eat” or “too much to eat”, please explain

Part 3: Comments about hospital foods

3. During your stay, have you had food/drinks brought in by family or friends?

____Yes ____No

If yes, describe the food/drink and why it was brought in.

4. What could be done to improve the food in this hospital?

5. What food would you like to see offered?

6. Is there anything else you would like to tell us about the food at this hospital?

Appendix B

Demographic Questionnaire

Putting More Nutrition on the Tray

Patient Demographics

Site #: _____Date:_____ RA Initials: _____

1. Age: _____

2. Admission Diagnoses: _____

3. Date of admission to unit:_____

4. Day of admission when this assessment is completed (e.g. 1, 2…): _____

5. Meal used to complete this assessment: _____

6. Diet order/supplements (including medpass): _____

3. Highest level of education?

- ☐ Some primary school
- ☐ Graduated primary school (e.g. grade 8)
- ☐ Some high school (e.g. 9 through 12)
- ☐ Graduated high school
- ☐ Some post secondary education (e.g. college, university)
- ☐ Graduated post secondary
- ☐ Post graduate (MSc, PhD) study or degree
- ☐ Other (e.g. trade training with no post---secondary component): specify

☐ Does not know

☐ Prefers not to say

4. Living situation in the community?

☐ live alone

☐ live with spouse

☐ live with spouse & other family

☐ live with other family/friends

☐ live in retirement or long term care residence where meals provided

☐ other, Specify:_____

5. Do you consider yourself to be . . . (check all that apply)

☐ White
☐ Chinese
☐ First Nation
☐ Inuit
☐ Métis
☐ Indigenous/Aboriginal (not included elsewhere)
☐ South Asian (East Indian, Pakistani, Sri Lankan, etc.)
☐ Black
☐ Filipino
☐ Latin American
☐ Southeast Asian (Vietnamese, Cambodian, Malaysian, Laotian, etc.)
☐ Arab
☐ West Asian (Iranian, Afghan, etc.)
☐ Korean
☐ Japanese
☐ Other

Appendix C

My Meal Intake Tool

MY MEAL INTAKE

Participant ID: _____

Room #:_____Date: _____

This form helps us understand how you are eating. Please complete this form after you have finished **this meal**. If you need help, let us know.

1. List all drinks on your tray; this includes juice, tea/coffee, milk, drink supplements, etc.
2. Place an 'X' in the circle to indicate how much you consumed of each beverage
3. For the food on your tray, place an 'X' in the circle to indicate how much you ate overall; this includes the main dish, side dishes, soup, bread, dessert
4. List any food or beverages you are saving to eat at a later time
5. **Turn the page over** and answer the remaining questions

What meal is this? ☐ Breakfast ☐ Lunch ☐ Supper

What and how much did you drink?	0% I drank none	25%	50%	75%	100% I drank all
Example: Milk	○	○	X	○	○
	○	○	○	○	○
	○	○	○	○	○
	○	○	○	○	○
	○	○	○	○	○

How much of all the food on your tray did you eat?	0% I ate none	25%	50%	75%	100% I ate all
	○	○	○	○	○

Please list any items (food or beverages) being saved for later: _____

_____

Please turn over →

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Canadian Malnutrition Task Force™ | le Groupe de travail canadien sur la malnutrition™

Advancing Nutrition Care in Canada /Améliorer les soins nutritionnels au Canada

How was your appetite at this meal?

❑ Very good/Good

❑ Less than usual

Why was your appetite less than usual?

❑ I was not interested in eating

❑ I had nausea/vomiting

❑ I was tired

❑ I had pain

❑ I ate other foods and was not hungry

❑ No specific reason

❑ Other: _____

_____

_____

Did you have any challenges at this meal?

❑ I needed help to sit up to eat

❑ I needed help opening food packages

❑ I needed help to eat and/or drink

❑ I did not like the food

❑ I had problems chewing/swallowing

❑ I was not allowed to eat because I am having a test today

❑ I did not get what I had ordered (if selective menu)

❑ The environment was not appetizing

❑ Other: _____

_____

❑ I had no challenges

Other comments to share with us about your food intake: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Who completed this form? ❑ Patient ❑ Family/Friend/Volunteer ❑ Staff

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Canadian Nutrition Society / Société canadienne de nutrition

Canadian Malnutrition Task Force / le Groupe de travail canadien sur la malnutrition

Advancing Nutrition Care in Canada /Améliorer les soins nutritionnels au Canada

Appendix D

Site Survey

Putting More Nutrition on the Tray
Site Survey

To be completed by the Site Champions in consultation with various departments as required.

This survey provides background information on the hospital.

Site: _____

- What is the total number of active beds of the hospital?
  _____
- Where is your hospital located? (i.e. Local Health Integration Unit)
  _____
- Type of hospital (ex. Community, teaching, mixed facility (rehab, AC and LtC)? _____

Does this hospital have longer stay beds: Yes_____ No_____

Describe (e.g. # ALC, rehab beds): _____

- Complete the chart below, describing the units/wards involved in the study (where participants will be recruited from). N/A if not applicable to specific unit.

Unit/Ward	# of beds	Funding provided for a bed on this unit	Average length of Stay	Foodservice delivery system/model e.g. non-select tray, bulk etc.	Who delivers meals	Type of Bulk foods on Unit (e.g. Biscuits, cheese and crackers)	Snack delivery process (e.g. with meal, separate delivery)

- Staff Complement with respect to food production & delivery

  What is the Full Time Equivalent (FTE) of food service supervisors, diet technicians, chefs/cooks, dietary staff, food porters/meal delivery staff, health care aides and any other allied health personnel participating in food production and delivery of meals involved in this study? (provide number of hours that equal 1 FTE, e.g. 1950 hours). Report FTEs separately for each staff classification as well as their pay scale. What is their current role in nutrition/food/mealtime care? (i.e. assemble meal, check meal ticket, delivery meal)
  Note: cleaning staff, ward clerk and other staff not directly involved in food production or delivery do not need to be included.

Staffing Classification	Total FTE for hospital	Role in nutrition/food/ mealtime care

- What percentage of the hospital food budget is spent on procurement of local food (e.g. food harvested or produced in Ontario)? _____

- Are food services provided by a contract company? Yes___ No____
  Name of company_____

- What proportion of the food provided in this hospital is produced/cooked in hospital vs. being outsourced (complete product except for thawing/reheating)? % should add up to 100%.
  ____% In-House ____% Outsourced

  What proportion of **main plate** items is prepared on-site:
  ____ traditional cooking created from ingredients, including some preparation of ingredients
  ____ pre-prepared (e.g. partially assembled or prepared such as peeled potatoes; use of mixes for gravy, puddings, jello)
  ____ ready made with no further preparation other than cooking/re-therming and plating

  What proportion of **side dishes** (soup, salad, desserts etc.)
  ____ traditional cooking created from ingredients, including some preparation of ingredients
  ____ pre-prepared (e.g. partially assembled or prepared such as peeled potatoes; use of mixes for gravy, puddings, jello)
  ____ ready made with no further preparation other than cooking/re-therming and plating

- Does the Foodservice Department provide in-between meal nourishments to specific patients (i.e. Designated for specific patient) within the hospital?
  Yes _____ No _____

  Please describe: _____

- What was the actual 2017 fiscal year spend for commercial Oral Nutritional Supplements (ONS)?
  _____

- Does the hospital provide “in-house” (i.e. made by the hospital) oral nutrition supplements such as milkshakes, gelled shakes, supplemented soups or food items? If yes, please provide a list of products provided

  _____
  _____
  _____
  _____
  _____
  _____

- What is the average food cost per day?

  _____

Appendix E

Ordinal Logistic Regression Assessing the Importance of Food Expectations and Overall Meal Quality Rating

		Odds Ratio Estimates		
Comparison of Trait Score		**Meal Quality Rating Point Estimate [a]**	**95% Wald CI**	
…Looks good	"Not important" [b]	0.64	0.298	1.365
	"Less important" [b]	0.54	0.285	1.033
Wald $\chi 2$ (4) = 6.91	**"Neutral" [b]**	**0.64**	**0.436**	**0.941**
p = .141	"Important" [b]	0.77	0.547	1.076
…Smells good	"Not important" [b]	1.31	0.576	2.956
	"Less important" [b]	1.05	0.455	2.415
Wald $\chi 2$ (4) = 1.72	"Neutral" [b]	0.85	0.548	1.316
p = .788	"Important" [b]	1.07	0.772	1.476
…Tastes good	**"Not important" [b]**	**0.05**	**0.005**	**0.497**
	"Less important" [b]	**0.18**	**0.045**	**0.701**
Wald $\chi 2$ (4) = 15.02	**"Neutral" [b]**	**0.54**	**0.309**	**0.953**
p = .005	"Important" [b]	0.73	0.525	1.027
…Is healthy	**"Not important" [b]**	**0.33**	**0.121**	**0.895**
	"Less important" [b]	0.58	0.200	1.670
Wald $\chi 2$ (4) = 7.31	"Neutral" [b]	0.72	0.465	1.105
p = .121	"Important" [b]	0.81	0.592	1.103
…Is fresh	"Not important" [b]	2.16	0.432	10.782
	"Less important" [b]	2.30	0.775	6.846
Wald $\chi 2$ (4) = 3.32	"Neutral" [b]	1.27	0.762	2.120
p = .505	"Important" [b]	1.09	0.785	1.524
…Is local	"Not important" [b]	1.00	0.644	1.542
	"Less important" [b]	1.10	0.677	1.784
	"Neutral" [b]	0.89	0.641	1.238

Wald $\chi 2$ (4) = 0.92 p = .922	"Important" [b]	0.97	0.707	1.322

Note: this is for subscale 1 of the Hospital Food Experience Questionnaire (n = 6). Question stems for all items on this subscale "As a patient, how important is it that hospital food …" All expectations were assessed using a 5-point Likert scale anchored by "Not important" (1) and "Very important" (5).

[a] Meal Quality was rated on a 5-point Likert scale anchored by "Very poor" (1) and "Very good" (5). Modelling the odds of a "Very good" meal quality rating.

[b] vs. "Very important" (5)

Bolded values indicate statistical significance.

Appendix F

Ordinal Logistic Regression Assessing the Importance of Food-Related Expectations and Overall Meal Quality Rating

		Odds Ratio Estimates		
Comparison of Trait Score		**Meal Quality Rating Point Estimate [a]**	**95% Wald CI**	
…offers foods that meet your dietary needs Wald $\chi 2$ (4) = 4.87 p = .301	"Not important" [b]	0.66	0.277	1.557
	"Less important" [b]	2.22	0.786	6.283
	"Neutral" [b]	1.18	0.701	1.973
	"Important" [b]	0.87	0.636	1.179
…offers foods that you are used to eating Wald $\chi 2$ (4) = 5.07 p = .280	"Not important" [b]	0.57	0.286	1.128
	"Less important" [b]	0.68	0.356	1.311
	"Neutral" [b]	0.74	0.515	1.062
	"Important" [b]	0.76	0.559	1.043
… offers foods traditional to your culture Wald $\chi 2$ (4) = 4.08 p = .396	"Not important" [b]	1.29	0.858	1.937
	"Less important" [b]	0.94	0.612	1.445
	"Neutral" [b]	0.94	0.649	1.357
	"Important" [b]	1.19	0.828	1.709
… offers foods you like to eat Wald $\chi 2$ (4) = 0.54 p = .970	"Not important" [b]	0.95	0.347	2.616
	"Less important" [b]	1.00	0.444	2.256
	"Neutral" [b]	1.01	0.671	1.533

	"Important" [b]	1.12	0.811	1.535
… offers a variety of food Wald $\chi 2$ (4) = 2.81 p = 0.591	"Not important" [b]	1.11	0.339	3.622
	"Less important" [b]	1.15	0.413	3.198
	"Neutral" [b]	0.75	0.476	1.186
	"Important" [b]	0.82	0.601	1.109
… serves food at the right temperature Wald $\chi 2$ (4) = 0.39 p = .984	"Not important" [b]	1.16	0.300	4.497
	"Less important" [b]	1.12	0.331	3.793
	"Neutral" [b]	1.09	0.651	1.828
	"Important" [b]	0.95	0.694	1.294
… Allows you to choose your food **Wald $\chi 2$ (4) = 12.41** **p = .015**	**"Not important" [b]**	**2.16**	**1.148**	**4.069**
	"Less important" [b]	1.17	0.570	2.405
	"Neutral" [b]	**1.76**	**1.198**	**2.589**
	"Important" [b]	1.26	0.929	1.704
… Provides you with a sufficient amount Wald $\chi 2$ (4) = 6.96 p = .138	"Not important" [b]	0.92	0.303	2.786
	"Less important" [b]	**0.32**	**0.126**	**0.816**
	"Neutral" [b]	0.85	0.527	1.359
	"Important" [b]	0.79	0.585	1.076
… Provides food in packages that are easy to open **Wald $\chi 2$ (4) = 12.17** **p = .016**	**"Not important" [b]**	**0.36**	**0.179**	**0.734**
	"Less important" [b]	0.89	0.480	1.632
	"Neutral" [b]	**0.61**	**0.402**	**0.919**
	"Important" [b]	0.96	0.677	1.347

… Provides food that is easy to chew, swallow, or eat on your own **Wald $\chi 2$ (4) = 13.01** **p = .011**	**"Not important"** [b]	2.02	0.887	4.581
	"Less important" [b]	0.49	0.227	1.057
	"Neutral" [b]	**0.56**	**0.348**	**0.888**
	"Important" [b]	0.86	0.602	1.214

Note: this is for subscale 2 of the Hospital Food Experience Questionnaire (n = 10). Question stems for all items on this subscale [b] Question stem: "As a patient, how important is it that a hospital …"

All expectations were assessed using a 5-point Likert scale anchored by "Not important" (1) and "Very important" (5).

[a] Meal Quality was rated on a 5-point Likert scale anchored by "Very poor" (1) and "Very good" (5). Modelling the odds of a "Very good" meal quality rating.

[b] vs. "Very important" (5)

Bolded values indicate statistical significance.

Appendix G

Ordinal Logistic Regression Assessing Meal Ratings and Overall Meal Quality Rating

		Odds Ratio Estimates		
Comparison of Trait Score		**Meal Quality Rating Point Estimate [a]**	**95% Wald Confidence Limits**	
Meal look	**"Very poor" [b]**	**0.14**	**0.048**	**0.422**
Wald χ2 (4) = 42.16	**"Poor" [b]**	**0.13**	**0.056**	**0.280**
p < .001	**"Neutral" [b]**	**0.21**	**0.128**	**0.354**
	"Good" [b]	**0.40**	**0.264**	**0.614**
Meal smell	"Very poor" [b]	0.60	0.234	1.554
	"Poor" [b]	0.66	0.319	1.371
Wald χ2 (4) = 3.12	"Neutral" [b]	0.74	0.449	1.217
p = .538	"Good" [b]	0.68	0.429	1.073
Meal taste	**"Very poor" [b]**	**0.01**	**0.003**	**0.026**
Wald χ2 (4) = 100.89	**"Poor" [b]**	**0.04**	**0.017**	**0.083**
p < .001	**"Neutral" [b]**	**0.11**	**0.065**	**0.200**
	"Good" [b]	**0.44**	**0.283**	**0.680**
Meal texture	**"Very poor" [b]**	**0.10**	**0.036**	**0.252**
Wald χ2 (4) = 32.78	**"Poor" [b]**	**0.23**	**0.114**	**0.472**
p < .001	**"Neutral" [b]**	**0.52**	**0.310**	**0.874**
	"Good" [b]	0.92	0.587	1.454
Meal temperature	**"Very poor" [b]**	**0.39**	**0.177**	**0.862**
Wald χ2 (4) = 15.10	**"Poor" [b]**	**0.39**	**0.213**	**0.709**
p = .005	**"Neutral" [b]**	**0.48**	**0.305**	**0.758**

	"Good" [b]	**0.57**	**0.388**	**0.837**
Combination of food served **Wald $\chi 2$ (4) = 117.74** **p < .001**	**"Very poor" [b]**	**0.02**	**0.006**	**0.048**
	"Poor" [b]	**0.04**	**0.021**	**0.079**
	"Neutral" [b]	**0.11**	**0.064**	**0.174**
	"Good" [b]	**0.31**	**0.202**	**0.461**

Note: this is for subscale 3 of the Hospital Food Experience Questionnaire (n = 6). Ratings of a single meal served. All ratings were assessed using a 5-point Likert scale anchored by "Very poor" (1) and "Very good" (5).

[a] Meal Quality was rated on a 5-point Likert scale anchored by "Very poor" (1) and "Very good" (5). Modelling the odds of a "Very good" meal quality rating.

[b] vs. "Very Good" (5)

Bolded values indicate statistical significance.

Appendix H

Ordinal Logistic Regression Testing the Hospital Food Experience Questionnaire with Overall Meal Quality Rating

		Odds Ratio Estimates		
Comparison of Trait Score		**Meal Quality Rating Point Estimate [a]**	**95% Wald CI**	
… Looks good [b] Wald $\chi 2$ (4) = 4.89 p = .299	"Not important" [c]	0.67	0.227	1.989
	"Less important" [c]	0.45	0.192	1.029
	"Neutral" [c]	0.66	0.398	1.094
	"Important" [c]	0.74	0.472	1.175
… Smells good [b] Wald $\chi 2$ (4) = .0.36 p = .986	"Not important" [c]	0.80	0.257	2.480
	"Less important" [c]	1.12	0.334	3.715
	"Neutral" [c]	1.01	0.561	1.828
	"Important" [c]	1.08	0.698	1.664
… Tastes good [b] Wald $\chi 2$ (4) = 3.79 p = .436	"Not important" [c]	0.05	0.001	2.315
	"Less important" [c]	1.42	0.163	12.367
	"Neutral" [c]	0.72	0.340	1.533
	"Important" [c]	0.80	0.502	1.274
… Is healthy [b] Wald $\chi 2$ (4) = 4.04 p = 0.400	"Not important" [c]	0.43	0.112	1.619
	"Less important" [c]	0.32	0.079	1.258
	"Neutral" [c]	0.91	0.493	1.669
	"Important" [c]	0.88	0.581	1.325

… Is fresh [b] Wald $\chi 2$ (4) = 7.85 p = .097	"Not important" [c]	4.85	0.419	55.982
	"Less important" [c]	**5.63**	**1.421**	**22.289**
	"Neutral" [c]	0.99	0.489	2.006
	"Important" [c]	1.04	0.672	1.619
… Is local [b] **Wald $\chi 2$ (4) = 12.81** **p = .012**	**"Not important" [c]**	**1.98**	**1.066**	**3.675**
	"Less important" [c]	**2.35**	**1.217**	**4.548**
	"Neutral" [c]	**1.89**	**1.197**	**2.971**
	"Important" [c]	**1.84**	**1.204**	**2.814**
… offers foods that meet your dietary needs [d] Wald $\chi 2$ (4) = 7.15 p = .128	"Not important" [c]	0.67	0.196	2.280
	"Less important" [c]	2.63	0.717	9.615
	"Neutral" [c]	**2.29**	**1.076**	**4.863**
	"Important" [c]	1.20	0.798	1.800
…offers foods that you are used to eating [d] Wald $\chi 2$ (4) = 8.61 p = .072	"Not important" [c]	0.44	0.180	1.064
	"Less important" [c]	1.10	0.465	2.598
	"Neutral" [c]	1.33	0.828	2.145
	"Important" [c]	1.44	0.959	2.170
… offers foods traditional to your culture [d] Wald $\chi 2$ (4) = 2.34 p = .673	"Not important" [c]	0.80	0.466	1.369
	"Less important" [c]	0.67	0.383	1.168
	"Neutral" [c]	0.90	0.558	1.457
	"Important" [c]	0.93	0.581	1.503

… offers foods you like to eat [d] Wald $\chi 2$ (4) = 5.77 p = .217	"Not important" [c]	4.20	0.981	17.953
	"Less important" [c]	1.39	0.461	4.210
	"Neutral" [c]	1.64	0.939	2.862
	"Important" [c]	1.22	0.805	1.846
… offers a variety of food [d] Wald $\chi 2$ (4) = 5.54 p = .236	"Not important" [c]	1.45	0.279	7.553
	"Less important" [c]	0.72	0.181	2.823
	"Neutral" [c]	0.71	0.389	1.277
	"Important" [c]	**0.63**	**0.419**	**0.946**
… serves food at the right temperature [d] Wald $\chi 2$ (4) = 6.58 p = .160	"Not important" [c]	3.91	0.222	68.962
	"Less important" [c]	1.13	0.198	6.479
	"Neutral" [c]	**2.39**	**1.171**	**4.876**
	"Important" [c]	1.30	0.861	1.973
… Allows you to choose your food [d] Wald $\chi 2$ (4) = 4.14 p = .387	"Not important" [c]	2.17	0.912	5.171
	"Less important" [c]	0.93	0.351	2.466
	"Neutral" [c]	1.34	0.813	2.218
	"Important" [c]	1.10	0.742	1.636
… Provides you with a sufficient amount [d] Wald $\chi 2$ (4) = 4.38 p = .357	"Not important" [c]	1.20	0.271	5.338
	"Less important" [c]	0.29	0.076	1.121
	"Neutral" [c]	0.66	0.347	1.239
	"Important" [c]	0.88	0.593	1.301

… Provides food in packages that are easy to open [d] Wald $\chi2$ (4) = 2.00 p = .735	"Not important" [c]	0.81	0.317	2.079
	"Less important" [c]	1.15	0.506	2.592
	"Neutral" [c]	0.79	0.458	1.377
	"Important" [c]	1.15	0.735	1.809
… Provides food that is easy to chew, swallow, or eat on your own [d] Wald $\chi2$ (4) = .731 p = .120	"Not important" [c]	1.73	0.581	5.152
	"Less important" [c]	1.14	0.398	3.268
	"Neutral" [c]	0.55	0.300	1.007
	"Important" [c]	0.67	0.424	1.061
Meal look [e] **Wald $\chi2$ (4) = 36.87** **p < .001**	**"Very poor" [f]**	**0.11**	**0.032**	**0.375**
	"Poor" [f]	**0.14**	**0.058**	**0.355**
	"Neutral" [f]	**0.20**	**0.112**	**0.343**
	"Good" [f]	**0.39**	**0.242**	**0.613**
Meal smell [e] Wald $\chi2$ (4) = 3.72 p = .445	"Very poor" [f]	0.72	0.241	2.130
	"Poor" [f]	0.60	0.268	1.344
	"Neutral" [f]	0.64	0.369	1.109
	"Good" [f]	0.63	0.380	1.028
Meal taste [e] **Wald $\chi2$ (4) = 96.21** **p < .001**	**"Very poor" [f]**	**0.01**	**0.002**	**0.020**
	"Poor" [f]	**0.03**	**0.013**	**0.073**
	"Neutral" [f]	**0.10**	**0.054**	**0.187**
	"Good" [f]	**0.45**	**0.279**	**0.726**
Meal texture [e] **Wald $\chi2$ (4) = 27.38** **p < .001**	**"Very poor" [f]**	**0.11**	**0.038**	**0.309**
	"Poor" [f]	**0.20**	**0.092**	**0.429**
	"Neutral" [f]	**0.44**	**0.252**	**0.775**
	"Good" [f]	0.84	0.515	1.371
Meal temperature [e] **Wald $\chi2$ (4) = 17.64**	**"Very poor" [f]**	**0.30**	**0.124**	**0.704**
	"Poor" [f]	**0.36**	**0.185**	**0.697**
	"Neutral" [f]	**0.43**	**0.260**	**0.707**

p = .001	**"Good" [f]**	**0.48**	**0.313**	**0.734**
Combination of food served [e]	**"Very poor" [f]**	**0.01**	**0.003**	**0.027**
	"Poor" [f]	**0.04**	**0.019**	**0.080**
Wald $\chi 2$ (4) = 107.87	**"Neutral" [f]**	**0.10**	**0.058**	**0.175**
p < .001	**"Good" [f]**	**0.29**	**0.185**	**0.459**

Note: this is for the entire Hospital Food Experience Questionnaire (n = 22).

[a] Meal Quality was rated on a 5-point Likert scale anchored by "Very poor" (1) and "Very good" (5). Modelling the odds of a "Very good" meal quality rating.

[b] Question stem: "As a patient, how important is it that hospital food …"

[c] vs. "Very important" (5)

[d] Question stem: "As a patient, how important is it that a hospital …"

[e] Ratings of a single meal served

[f] vs. "Very good" (5)

Bolded values indicate statistical significance.