Describing the dietary intake of breast cancer survivors participating in the EXPINKT™ programme. A pilot study.

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Abstract

Background: In 2015, 3292 New Zealand women were diagnosed with breast cancer. A breast cancer diagnosis tends to evoke lifestyle change and in particular dietary change. There is a substantial amount of research about the potential causes of breast cancer and dietary risk factors, but less on diet during breast cancer treatment and even less on what women are consuming post treatment completion. There can be lasting impacts from treatment including poor nutrient intake, unwanted weight change and undesirable weight changes. These affect nutritional status and possibly recurrence risk. To date, the guidelines for what breast cancer survivors should consume post treatment are based on limited, but suggestive evidence for reducing the risk of recurrence. There is a lack of research on dietary habits in women with breast cancer in this country. In order to potentially influence lifestyle changes, it is important that breast cancer survivors have their actual diet documented.

Objective: The aim of this thesis is to describe the diet in breast cancer survivors and compare it to recommendations and guidelines. This will guide further research in this area, here in New Zealand and potentially aid the production of specific national dietary recommendations for breast cancer survivors.

Design: This is a descriptive pilot study of women participating in the EXPINKT™ programme in Dunedin who completed breast cancer treatment at least six weeks prior. Participants received a questionnaire including a section on characteristics and a Food Frequency Questionnaire (FFQ), measuring dietary intake for the preceding three months.

Results: The questionnaire was returned by 35 women. Nutrient intakes derived from the FFQ were slightly higher than that of the New Zealand women population of the same age

group. The cohort did not meet the Ministry of Health recommendations for the food groups of vegetables, meat, poultry and seafood as well as breads and cereals. There were no meaningful differences for any nutrients between treatments, although of the women who received either chemotherapy or hormone therapy, nutrient intakes tended to be higher than those women who did not receive that treatment. There were meaningful differences for protein 22.8 g (95 % CI: 1.64, 43.9), riboflavin 0.88 mg (95 % CI: 0.11, 1.64), folate 162 µg (95 % CI: 22.4, 301), calcium 587 mg (95 % CI: 99.7, 1074), zinc 3.21 mg (95 % CI: 0.23, 6.20) and potassium 1153 mg (95 % CI: 85.7, 2220) in women that were diagnosed prior to 2013 as their confidence intervals did not cross zero. Education level and body mass index status had no association with nutrient intake, although a lack of tertiary education was associated with a lower intake of all food groups.

Conclusion: Dunedin breast cancer survivors who participate in the EXPINKT™ programme do not meet the Ministry of Health's food group recommendations for vegetables, meats and breads and cereals. To prevent the negative outcomes that may occur, there is a need for nutritional guidance in this population, particularly in New Zealand. Continued research is needed in order to determine what foods can reduce recurrence risk and what may increase it.

Preface

This thesis was completed as an extension of the EXPINKT™ programme and conducted in Dunedin at the University of Otago under joint supervision from Dr. Paula Skidmore from the Department of Human Nutrition and Dr. Lynnette Jones from the School of Physical Education, Sport & Exercise Sciences. Dr. Jill Hazsard completed the statistical analysis.

The current candidate was the primary researcher for this project and was responsible for the following:

- Preparing the information cover sheet for the questionnaire.
- Finalising the layout and inclusion of questions in the demographics questionnaire.
- Creating a question regarding chemotherapy and taste change to include at the end of the food frequency questionnaire.
- Printing and collating the questionnaire and the envelopes for their return.
- Collating the questionnaire results and entering the data into Microsoft Excel spreadsheets.
- Completing sections of statistical analysis: calculating participant means, mean intakes of food groups.
- Attending an EXPINKT™ focus group as part of a PhD project regarding nutritional information and breast cancer.
- Transcribing the recording of the aforementioned focus group.

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List of Abbreviations

Abbreviations	Definition
AICR	American Institute for Cancer Research
AMDR	Acceptable macronutrient distribution range
ANS	2008/09 New Zealand Adult Nutrition Survey
BC	Breast cancer
BMI	Body mass index
CI	Confidence interval
cm	Centimetre
e.g.	Example
FFQ	Food frequency questionnaire
g	Gram
g/kg	Gram per kilogram
HR	Hazard ratio
i.e.	That is
IQR	Interquartile range
kg	Kilogram
kg/m^2	Kilograms per metre squared
kJ	Kilojoule
kJ/d	Kilojoules per day
mg	Milligram
mg/d	Milligrams per day
MOH	Ministry of Health
MUFA	Monounsaturated fatty acid
n	Number
NZ	New Zealand

PUFA	Polyunsaturated fatty acid
SD	Standard deviation
SFA	Saturated fatty acid
µg	Microgram
UK	United Kingdom
US	United States of America
WCRF	World Cancer Research Fund

1. Introduction

Breast Cancer (BC) has been estimated to be responsible for 627,000 deaths worldwide in 2018 (1) and 641 deaths in New Zealand (NZ) in 2013, 633 of whom were women (2). Over 1.5 million people per year internationally are diagnosed with BC, with 3292 new cases diagnosed in NZ in 2015 (3). Almost half of those women were aged between 45 and 64 years (3).

There is ongoing research into BC and the factors that can increase or decrease the risk of developing the disease (4). Several lifestyle-related factors have been identified to decrease BC risk. These are vigorous physical activity, greater body fatness in young adulthood and lactation (5). Factors that have been found to increase risk of BC in postmenopausal women include consuming alcoholic drinks, greater body fatness throughout adulthood, greater weight gain throughout adulthood and factors leading to increased linear growth. Some dietary factors have been linked with decreasing the risk of development, these include non-starchy vegetables, carotenoids, dairy products and calcium (5).

While there is a deal of research investigating the role of diet in the prevention of cancer and BC, there is less information available discussing the role of diet in BC survivors or data describing their dietary intake post treatment. There is no reliable evidence for determining the best diet for BC survivors. Although, evidence indicates that a diet that intends to prevent primary cancer could also help with maintaining a disease free status (5).

There are currently several treatment options used in BC. These include surgery, chemotherapy, radiation therapy and hormonal therapy (6). There are significant side effects

associated with these treatments including weight gain, weight loss, change of taste perception, nausea and fatigue (7).

The term ‘BC survivor’ is defined in a number of ways throughout the literature. The internationally accepted definition is that someone from the day of diagnosis is a cancer survivor.

There is currently no data from NZ populations that describe the dietary intake of BC survivors. This thesis is purely exploratory and descriptive. It is outside the scope of this thesis to look at treatment types and types of BC themselves. This area of research is a minefield, and the overall aim of this thesis is to describe the diet in a group of BC survivors from Dunedin and the surrounding areas and compare it to recommendations and guidelines. This will guide further research in this area in NZ and potentially advise the creation of specific national dietary recommendations for BC survivors.

This literature review summarises the relevant evidence surrounding BC and dietary intake. The majority of research has focused on dietary exposures before BC diagnosis and during treatment. There has been little research undertaken on BC survivors i.e. post treatment and diet or nutrition, thus creating a gap in the literature.

2. Literature Review

2.1 Literature Review Search Methodology

The article databases Web of Science, Scopus, MEDLINE and Google Scholar were searched, including papers from a year range of 1977 to 2018. The reference lists of relevant articles were also searched. The search terms included a combination of "breast cancer", diet*, weight loss, treatment, food, cancer, "adult women", "cancer treatment", survivors, taste changes, nutrition*, recommendations, guidelines, review, impact, affect, intervention, malnutrition, intake, nutrient, micronutrient, nutrition, "food frequency questionnaire" and "Willet FFQ".

2.2 Dietary Assessment

2.2.1 Dietary Techniques

There are four main techniques commonly used to measure the dietary intake of individuals; 24-hour recalls, food records, diet histories, and Food Frequency Questionnaires (FFQ) (8). The **24-hour recall** method requires a trained interviewer to ask the subject to recall their exact food intake for the previous 24 hours or the preceding day. To gain a better understanding of the individual's habitual diet, this process can be repeated over several non-consecutive days throughout different seasons. The advantages to this assessment method are that it has a low respondent burden, the subjects do not need to be literate and they are not limited by a selection of food lists. However, the recall relies heavily on the individual's memory and their ability to describe portion size. It can also be costly due to the trained interviewer (8).

Food records can either be estimated or weighed. The subject is asked to record everything that they eat and drink, including the specific ingredients to recipes, over a set amount of time e.g. a week. Measuring cups and spoons are encouraged when completing an estimated record,

but measuring scales are used in the other. Details of how the food was prepared as well as the type and brand are also important and should be recorded. This method is regarded as the most precise dietary assessment technique and it does not rely on memory, any food can be recorded and portion size is documented. Although the disadvantages of this method are that it has a high respondent burden and requires motivated, literate and numerate respondents (8).

A **diet history** is a detailed interview of an individual with the aim of recording their usual food intake over a relatively long period of time. This method requires a trained interviewer, it can be labour intensive, there is a heavy reliance on the individual's memory and their ability to recognise portion size (8).

Food frequency questionnaires aim to measure an individual's habitual consumption of certain foods by listing a set list of food and drinks with a section that can be used to indicate how often that item is consumed and the portion size. The advantages of FFQs are that they are well suited to research populations, there is a low respondent burden, and they are more cost effective than other methods due to administration, data-entry and analysis. FFQs aim to capture a respondent's usual intake of certain foods, in order to rank the individuals according to their standard consumption of nutrients, foods or groups of foods (9). They tend to be used in case control or cohort studies to assess the association between dietary intake and the risk of disease. Semi quantitative FFQs incorporate information about usual portion sizes (8). As with all methods of dietary assessment, there are some limitations associated with the use of FFQs. They do not usually measure absolute levels of intake of nutrients and foods. A finite food list means it is unable to measure the absolute intake of all nutrients and the variability (e.g. the brands and preparation practices) of someone's diet in full and there are errors in participant estimations of frequency and serving sizes (9). FFQs are not always accurate in estimating quantitative parameters (mean and variance) of a population's usual intake (9).

Different FFQ's perform differently and unpredictably in different populations, despite sometimes producing reasonable averages. Therefore, nutrient intake results should generally only be deemed as approximations (9). This means that results of validation studies show that semi quantitative FFQs can give researchers a reliable and valid estimate of intake, although this tends to mostly be at the group, rather than individual, level.

One of the most widely used FFQs worldwide is the Willet FFQ. In 1980 Walter Willett developed a semi quantitative FFQ (10) which was then validated against diet records (10). The Willett FFQ has been adapted for use in many countries worldwide (11) and has been used in many published papers, such as the renowned Nurses Health Study and the Health Professional Cohort Study. It has also been used in other studies such as magnesium intake and insulin resistance (12), dietary intake in the transition to adulthood (13), diet quality and mortality in older adults (13), and vitamin C and hip fractures (Framingham Osteoporosis Study) (14), in countries such as Canada, the United States of America (US) and Australia. Previous research from the Nurses Health Study and the Health Professional Cohort Study have shown significant and reliable associations with specific foods and the burden of several diseases.

A New Zealand (NZ) version of this FFQ (FOOD-FFQ) was developed and its reproducibility and relative validity assessed (15) where 132 adult participants completed the FFQ, an eight day weighed food record and blood tests. The results of the validation study show that a single administration of the FOOD-FFQ is sufficient to provide measures with a high level of reliability (15). Validity correlation coefficients ranged from 0.74 (alcohol), 0.65 (cholesterol), 0.58 (β - carotene), 0.56 (carbohydrate) and 0.56 (vitamin C) (15). This FFQ was revalidated in 2017 and showed similar levels of reproducibility and validity (16). The correlation coefficients ranged from 0.56 energy, 0.59 protein, 0.68 total fat, 0.69 saturated fat, 0.52

carbohydrate and 0.56 fibre. Results of Bland-Altman analyses showed that this FFQ actually provides estimates of intake for all micronutrients with high agreement for protein (99 %) and total fat (103 %), that are suitable for use at the individual level.

2.3 Breast Cancer and Nutrition

The links between diet and Breast Cancer (BC) incidence and recurrence have been researched for decades. Despite this there does not appear to be any definitive or reliable evidence for the optimal diet in BC survivors.

2.3.1 AICR/WCRF Recommendations

The American Institute for Cancer Research/World Cancer Research Fund (AICR/WCRF) is the leading group for cancer research and prevention globally. The Continuous Update Project (4) analyses the worldwide research on how diet, nutrition and physical activity affect cancer risk and survival. It informs guidelines and policies for cancer prevention and survival. The research conclusions are used to update the Cancer Prevention Recommendations (17).

The AICR/WCRF recommend that for preventing all types of cancer recurrence, people should follow as many of the cancer prevention recommendations (17) as possible. These are; be a healthy weight; be physically healthy; eat a diet that is rich in whole grains, vegetables, fruits and beans; limit consumption of red and processed meat; limit consumption of sugar-sweetened drinks, limit consumption of “fast foods” and other processed foods high in fat, starches or sugars; limit alcohol consumption; do not use supplements for cancer prevention; and for mothers, breastfeed your baby if you can. They also recommend avoiding smoking and other tobacco exposure as well as an excess of sun exposure.

There are currently minimal BC specific nutrition recommendations for preventing incidence and recurrence that are supported by strong evidence (5, 18). Most research regarding nutrition and BC shows limited, but suggestive, evidence for links between foods or nutrients and the risk of BC (5). The research for the risk of BC is influenced by menopausal status, i.e. premenopause and postmenopause (5). In terms of premenopausal BC, there is strong evidence that being overweight or obese between the ages of 18 and 30 probably decreases risk, whereas consuming alcoholic drinks probably increases risk (5). There is limited, but suggestive, evidence that consuming non-starchy vegetables, foods containing carotenoids, dairy products, and a diet high in calcium might decrease risk (5). The same is true for postmenopausal BC with the exception of dairy products as no link was mentioned (5). There has also been a substantial amount of research conducted into other types of foods and nutrients; however, the evidence is limited and inconclusive (5).

The AICR/WCRF also produces a report about diet, nutrition and physical activity regarding BC survivors (18). The latest publication was in 2014, but revised in 2018, and the findings for BC survival were presented by timeframe or by outcome, which was then further categorised by all-cause mortality, BC-mortality and second primary BC. All of these findings were too limited to justify making specific recommendations, as they were only suggestive and inconsistent associations. The nutrients identified that show suggestive evidence for survival were, fibre, saturated fatty acids and soy. Body fatness and physical activity were also included. The conclusions for these three dietary components are that a greater consumption of fibre both before and after diagnosis may lower the risk of women dying from BC. The higher the intake of fat and saturated fat before BC development may increase women's risk of dying following a diagnosis of BC. Lastly, women who have been diagnosed with BC and/or are in remission who have large intakes of soy may have a lower risk of dying from the disease. The evidence for fruits, vegetables and subsequent micronutrients continues

to be limited and contradictory. Although, this report recommends that after BC treatment, people should follow the Cancer Prevention Recommendations (17) mentioned above.

2.3.2 Breast Cancer and Dietary Change

Dietary changes are one of the most common lifestyle alterations made by BC survivors (19) and cancer survivors will pursue advice on how to best help their cancer treatment and prevent recurrence (20). Still, there is limited evidence from randomised controlled trials on diet and prognosis (5, 18).

Post diagnosis, During Treatment

A large number of BC patients improve their diet post diagnosis; however many BC survivors do not initiate or continue dietary changes after treatment (19-23). A United Kingdom multicenter study found that 30 – 48 % of people recently diagnosed with BC significantly altered their diet in a positive way. The changes reflected healthy eating guidelines, with reduced intakes of fat, red meat and simple sugars as well as an increased intake of fruits and vegetables (24). Some women increase their consumption of 'less healthy' foods because of the comfort found in them while going through the negativity and uncertainty of a BC diagnosis and its treatment (25).

Post Treatment

There have been only two large randomised controlled trials investigating whether dietary change after BC affects cancer endpoints and the findings varied (26, 27). Pierce *et al*. (27) reported that increasing fruit, vegetables and fibre in the diet and decreasing fat had no effect on BC events or mortality. Whereas Chlebowski *et al*. (26) found reducing fat in the diet led to positive effects on cancer endpoints. The extensive amount of observational research investigated and reported on by the AICR/WCRF is not robust enough to create sound

recommendations for BC survivors (18). Therefore it is not surprising that a larger proportion of women do not initiate dietary change. In a group of 7,443 BC survivors, only 33.9 % (95 % CI: 31.9, 36.0) of the women consumed the recommended more than five serves of fruits and vegetables per day (28). After adjustment for years of survival after BC, this value had minimal change. Thus concluding that BC survivors' adherence to lifestyle recommendations is low and that more efforts such as counselling and health education should be increased (28). These findings were similar to Blanchard *et al.* who found only 18.2 % of BC survivors were meeting '5 – A – Day', which was similar for the other types of cancer (29). Additionally, another epidemiological study (30) found that in BC survivors, 58 % made positive changes to their diet and or physical activity, with 44 % decreasing fat intake, 42 % increasing fibre and 43 % increasing fruit and vegetable intake. A more recent study conducted in Malaysian BC survivors post treatment (31), showed that the mean fibre and calcium intakes were low compared to the WCRF recommendations. The mean macronutrient distributions were 56 %, 15 % and 29 % for carbohydrate, protein and fat, respectively (31). Despite these changes, research does show that it is no more feasible that longer term cancer survivors will sustain a healthful diet, compared with non survivors of similar characteristics (19, 29, 32). In NZ there is limited research about what BC patients or survivors are doing in terms of their diet.

2.3.3 Breast Cancer Side Effects and the Impact on Nutrition

BC and its treatments can have countless negative impacts on the body. These include, but are not limited to, poor nutrient intake, unwanted weight change, undesirable taste changes, and fatigue. These effects can influence nutritional status, which can indirectly contribute to an increased risk of postoperative complications and mortality (33-35). Therefore, preventing and treating these side effects is vital.

Post Diagnosis, During Treatment

To minimise the impact of BC treatment and negative outcomes for a patient, interventions and lifestyle changes have been suggested. However, these are not necessarily implemented, particularly in NZ. One suggestion is a nutrition counselling session prior to treatment. A critical review (36) recommends that all BC patients should receive a nutritional assessment immediately after diagnosis. The review highlights several reasons why this would be a positive arrangement for patients. Studies found that BC patients are often found to have insufficient intakes of calcium, iron, phosphorus, magnesium, niacin, riboflavin, thiamine, vitamin B6, vitamin C and zinc, which weakens their nutritional status. Although dietary intake was measured via repeated 24 hour recalls in these studies and so underestimation due to memory bias (8) may have occurred. However in one study, up to nine recalls were performed to combat this. Nevertheless, these vitamins and minerals are abundant in fruit, legumes, and dark green and orange vegetables, which have been found to be scarce in BC patients' diets (36-38). The aforementioned nutrients, plus others can play an important role in aiding people going through treatment, as they have been linked with positive changes in anthropometric, metabolic, inflammation and DNA methylation markers (36, 39), therefore assessing nutritional status at baseline and throughout treatment is imperative. The review (36) recommends that the nutritional assessment should be part of their treatment routine and be simple, inexpensive, reliable and able to identify those who are at greater risk of nutritional imbalance.

Weight management is another way to prevent detrimental outcomes. The mechanism for weight gain after diagnosis is unclear (40). Although reduced metabolism due to rapid onset of menopause and a reduction in physical activity all attributed to chemotherapy have been considered (40). The imbalance of energy expenditure and energy intake during and post treatment has also been researched (40). Being overweight after diagnosis has negative

consequences for BC patients, as does being underweight. A U – shaped curve has been recognised in terms of mortality and weight change (41). Weight gain is common in women after BC diagnosis for both pre- and postmenopausal women (42). Due to a substantial amount of documented information surrounding this, oncologists now counsel newly diagnosed women to avoid weight gain (40). Despite this, weight gain is still common (43-45).

Evaluation of nutritional status in BC patients actively receiving treatment showed that obese patients have decreased BC specific survival (HR = 1.33, 95 % CI: 1.19, 1.50) and an increased risk of mortality (HR = 1.33, 95 % CI: 1.21, 1.47) when compared with non-obese women with BC (46). Proposed nutrition interventions for BC patients suggest limiting weight loss to between 5 % and 10 % of initial body weight using calorie restriction based on age and BMI, increasing dietary quality with nutrient dense foods and reducing the intake of simple sugars and added fats (7, 36, 40, 47-49). While there are risks when carrying too much weight, being underweight also has health risks. A US observational study (41) measured the effects of pre- and post-diagnosis BMI on mortality and found that women who lost 2.1 to 10.0 kg had 1.39 times greater mortality than women who stayed within 2 kg of their pre diagnosis weight (95 % CI: 1.04, 1.86). Women who had lost greater than 10 kg had 2.66 times greater mortality (95 % CI: 1.73, 4.07). There is an increased risk of complications due to malnutrition in BC patients who have lost > 10 % of their usual weight in less than six months (36), therefore a BMI range of 20 - 24.9 kg/m^2 is encouraged (40, 50).

One of the side effects of cancer treatment, specifically chemotherapy, is taste change (51). These changes can result in a decline in pleasure of eating (25) and therefore a decline in nutritional intake (52). Research has shown that a lower taste perception during chemotherapy in BC patients is associated with a lower energy intake, specifically protein and fat (53) and protein is vital throughout all stages of treatment, recovery and long-term survival (7). A

group of BC patients were questioned approximately one month after their last round of chemotherapy and again six months later. Their responses were compared to a group of women without BC (54). At the first point of questioning, 65 % of patients reported their taste perception as worse compared to before chemotherapy. Six months later, 76 % reported their taste as the same as before chemotherapy and 8 % reported better taste perception. The results from this study concur with others (55, 56) who reported that taste and smell perception is altered briefly after chemotherapy ceases, but has returned to normal six months later for most patients (54). Thus, BC patients post treatment are not as restricted by food taste and can have a greater dietary intake than when they are receiving treatment.

Another side effect of cancer treatment is fatigue (57). Diet quality has also been linked with fatigue levels in women with BC. Fatigue may limit BC survivors' ability to change their health behaviours; alternatively survivors who increase their fruit and vegetable intake reported less fatigue after doing so (30). When ranked into groups, a higher quality diet e.g. a greater intake of foods such as fruits and vegetables appeared to decrease the levels of fatigue in women with BC ($p_{\text{contrast}} = 0.003$), as well as behavioural and physical symptoms of fatigue (58). These secondary side effects of having BC begin to resolve once treatment ceases but can continue for some time, impacting intake and therefore nutritional status (7). They can be attenuated to some extent with nutrition.

2.3.4 Individualised Nutrition Treatment Plans

In NZ there are no individualised nutrition treatment plans for BC patients. Several studies have shown positive outcomes for BC and cancer patients that have had individualised treatment plans regarding nutrition and exercise (59-61). The information given to BC patients should be delivered when they are most amenable (19). When surveyed, 52 % of BC

survivors would have liked to received information about health related programmes at the time of diagnosis or soon after (20).

Post Diagnosis

Creating individualised dietary plans or interventions for BC patients are considered to be 'state of the art' (36, 62). However, they are only effective if the target population is willing to adhere to them. The United States Oncology Nursing Society proposed an evidence based nutrition intervention programme for cancer patients, which was also supported by the United States National Cancer Institute (36, 63). They recommended individualised nutritional therapy as the most effective measure for cancer patients. A dietitian would be part of the team, who would work with the patient and their families and also be included in the multidisciplinary team (36). In addition, some Australian BC patients voiced their desire to see a dietitian after diagnosis (25). They also would have liked to received diet management during treatment as well as the option of discussing dietary concerns.

Post Treatment

There have been several constructive and effective outcomes stemming from individualised treatment plans surrounding exercise and nutrition for BC patients post treatment. A randomised controlled trial (64) of 90 overweight/obese women 3 - 18 months post BC treatment found that individualised dietary advice and exercise sessions resulted in significant changes in blood biomarkers and perceived quality of life. Central adiposity also reduced, as a decrease in weight circumference of 3.32 cm was observed in favour of the intervention group (95 % CI: -1.53, -5.11; $p < 0.001$). Central adiposity is associated with a number of metabolic disorders such as elevated leptin concentration (65). These disorders are connected with postmenopausal cancer risk (66, 67) and poorer survival in early stage BC patients (68). The intervention group also had a significantly greater reduction in total fat (-9.1 g, 95 % CI: -1.4,

-16.7) and saturated fat (-4.1 g, 95 % CI: -1.2, -7.0) intake than in the control group, which meets recommendations by the AICR/WCRF (17). Thus implying that individualised support potentially can positively influence health outcomes and therefore the long-term prognosis in these patients (64). Rock *et al.* (69) also found that, overweight and obese BC survivors lost significantly more weight at six, twelve and eighteen months if they were in the intervention group that received more intensive weight loss support. The support began with weekly group sessions then fortnightly then monthly, plus reinforcing phone calls and/or email and individually tailored newsletters. All with the aim of reducing energy intake relative to expenditure and undertaking at least 60 minutes exercise per day (69).

Conversely, an Australian study (70) that assessed the feasibility, acceptability and outcomes of 53 BC survivors participating in a funded lifestyle programme had mixed findings. In addition to other lifestyle support, women received ten personalised phone calls across six months, where physical activity, nutrition and weight management were discussed. Daily fruit and vegetable intakes showed no significant change from baseline, with no change in the consumption of takeaway meals per week. However, a low adherence was reported, as only 62 % of the original cohort completed the programme.

2.3.5 Breast Cancer, Diets and Micronutrients for Nutritional Therapy

There has been extensive research published on specific foods and their properties for aiding and benefiting people undergoing cancer treatment. Cancer diagnosis is a key period for nutritional changes.

<u>Post Diagnosis</u>

In a recent review (71) of the role of dietary polyphenolics on BC recurrence, a recommended intake of at least five servings of fruits and vegetables per day and particularly those high in

flavonols such as onions, broccoli, apples and citrus for early diagnosed BC patients was suggested.

Cancer risk may increase with the consumption of meat, particularly red meat and processed meats (4). Women diagnosed with BC with a high intake (more than 44 times per year) of grilled/barbecued and smoked meat prior to diagnosis, had a 23 % increased risk (95 % CI: 1.03, 1.46, $p_{trend} = 0.02$) of all-cause mortality compared to a low intake (0 - 43 times per year) (72). There was no significance in BC specific mortality for those who changed their high intake of smoked meat pre diagnosis to a low intake post diagnosis (HR = 1.71, 95 % CI: 1.00, 2.92). Post diagnosis changes of the intake of grilled/barbecued poultry or fish were not associated with BC specific mortality.

<u>During Treatment</u>

The AICR recommends a diet rich in vegetables and fruit (17). An increase in fruit and vegetables is associated with better cancer outcomes and improved results in inflammatory response, tumour progression and hormonal biomarkers of recurrence risk in BC patients (39). During chemotherapy, dietary intake has been found to decrease over the course of treatment and even reaching an inadequate intake (38). In particular, intakes of fruit, orange and green vegetables and legumes have been found to significantly decrease over the treatment course. Collectively, fruits and vegetables are associated with a moderate reduction in the risk of BC (73); however, there is still only minimal evidence in this area. These foods are abundant in vitamins, minerals and antioxidants, which have several health benefitting properties. One fruit serving of 150 g and a vegetable serving of 75 g at 5 - 9 servings per day would supply a satisfactory amount of antioxidants and fibre in the diet (7, 40, 74-76). Preferably, vegetables should be mostly rich in β - carotene and vitamins A, E and C (77). These vitamins have been linked with positive changes in anthropometric, metabolic, inflammation and DNA

methylation markers (39). Vitamin B6, magnesium, riboflavin, thiamine, zinc and niacin have anti-inflammatory properties, which have the potential to decrease the risk of adverse health outcomes in cancer patients by helping the anti-inflammatory cytokine profile (78). Garlic (79, 80) and vegetables (81, 82) from the cruciferous family have a greater antiproliferative and antioxidant activity in BC cells, therefore they have been recommended in the diets of BC patients for therapeutic nutritional intervention (83). They have also been found to contain bioactive compounds that have shown chemopreventive activities in all stages of BC carcinogenesis (84).

Protein plays an important role in a cancer patient. An intake of 1.2 - 1.5 g/kg per day is said to prevent sarcopenic obesity as it maintains fat free mass (85, 86). It is suggested that the adequate sources of protein consumed are fish, poultry, turkey and pork tenderloin as they have a low fat content (87) and that meat, eggs and low fat dairy should make up only a small amount of protein sources in the diet (1 - 2 times/week each) due to their potential heightened risk increase of developing BC (88).

Post Treatment

The research conducted about BC survivors' diet and its impact on several outcome measures, shows positive associations when 'healthier' diets are followed. A recent systematic review (89) looked at seven studies that had measured the dietary intake of BC survivors and mortality. Two found that a prudent/healthy diet was significantly associated with a reduced risk of all-cause mortality (90, 91) and two found that a Western/unhealthy diet was significantly associated with an increased risk of all-cause mortality (90, 92). These findings support the AICR/WCRF recommendations for cancer survivors to reduce intakes of fast foods, processed foods, red meat and sugar sweetened drinks and increase consumption of vegetables, fruit, and wholegrains (5). Regarding BC recurrence, (90, 91), a prudent diet did

not reduce the risk of recurrence (HR = 0.71, 95 % CI: 0.48, 1.06) (91) and neither did a healthier diet (HR = 0.95, 95 % CI: 0.63, 1.43) (90), although neither of these findings were significant. One of the seven was able to make a connection with BC and diet when the cancer was analysed by subgroup. The overall diet quality of women who had estrogen receptor positive tumours (HR = 0.55, 95 % CI: 0.38, 0.79, p_{trend} = 0.0009) was more strongly associated with all-cause mortality than women who had estrogen receptor negative tumours (HR = 1.14, 95 % CI: 0.58, 2.23, p_{trend} = 0.811). This suggests the effects of diet quality may differ by tumour subtype, although there was no statistically significant interaction (p = 0.449) (93).

2.4 Conclusion

Currently, there is insufficient evidence to create robust nutritional guidelines for BC survivors. This may be a potential reason why BC patients and survivors do not tend to follow a 'healthy diet'. There are several ways that cancer treatment can impact nutritional status and a number of proposed ways to alleviate or prevent the problem. Individualised treatment plans with a focus on nutrition are considered the cutting edge technique in order to do this; however they have not been implemented in NZ. There have been ample studies around the world investigating the effect that diets, foods and micronutrients have on BC patients and BC survivors, with a large focus on fruits and vegetables. However, minimal research has been done on this population in NZ. The findings from these studies tend to have mixed results and are sometimes inconclusive. In order to make NZ specific guidelines and/or recommendations for survivors, there is a requirement to determine what the population is currently, actually doing.

3. Objective Statement

To date, there is no research on the dietary intake of Breast Cancer (BC) survivors who have completed treatment in New Zealand. This information is vital if nutritional support is to be provided to survivors, as it will provide an insight as to what these women are currently doing. Therefore this study will:

1. Describe the macronutrient and micronutrient intakes of physically active BC survivors in Dunedin, New Zealand who are at least three months post treatment ceasing and compare to intakes of New Zealand adults.
2. Describe the food group intakes of physically active BC survivors in Dunedin, New Zealand who are at least three months post treatment ceasing and compare to New Zealand recommendations.
3. Determine whether BC treatment type has an association with macronutrient, micronutrient and food group intake.
4. Determine whether time since diagnosis has an association with macronutrient, micronutrient and food group intake.
5. Determine whether body mass index or tertiary education status is associated with macronutrient, micronutrient and food group intake.

4. Methods

4.1 Study Design

The specific aim of this observational pilot study was to describe the dietary takes of Breast Cancer (BC) survivors attending the Exercise Training Beyond Breast Cancer (EXPINKT™) programme, who were at least six weeks post treatment. Participants completed a demographic questionnaire and a validated semi quantitative Food Frequency Questionnaire (FFQ) that gathers information on their food and nutrient intake over the previous three months.

4.2 EXPINKT™

The EXPINKT™ programme provides personalised exercise opportunities that use a combination of resistance and aerobic training. It was developed in 2009 by Dr. Lynnette Jones and is based at the Otago University School of Physical Education, Sport and Exercise Sciences. The aims of the programme are to improve physical function, strength, cardiovascular health and quality of life.

Clients are referred to the EXPINKT™ programme by their Medical or Radiation Oncologist, Radiation Therapist, or Breast Surgeon. They attend two, 40 - 45 minute sessions per week. The first year of their training is one-on-one with a specialised trainer and after this they are encouraged to participate in the group-based exercise classes.

4.3 Ethical Approval

Ethical approval was obtained from the University of Otago Human Ethics Committee (H18/057) (**Appendix A**). This approval covered the EXPINKT™ programme's EFFECT study as well as this specific sub-study.

4.4 FFQ Sub-Study

This research was carried out as a sub study of the EXPINKT™ programme. A convenience sample of women from the EXPINKT™ programme were used in this study.

4.4.1 Participants

Participants from the EXPINKT™ programme, who had completed active treatment at least six weeks prior, were invited to participate in this sub-study. Participants were provided with an envelope containing an information sheet, which outlined the purpose of the study, what was required of the participants and what would happen with their information supplied, a short demographics questionnaire and a copy of the FFQ (**Appendix B**). Participants were provided with a stamped, addressed envelope to return the questionnaire to the investigators.

4.4.2 Demographic Data

The demographic questionnaire collected information on age, highest education level attained, relationship status, height, weight, working arrangement, income, smoking status, health conditions, BC diagnosis time and stage and BC treatment.

4.4.3 Food Frequency Questionnaire

The FFQ gives values for energy, 35 nutrients, as well as for the five food groups for which there are national guidelines for intake in New Zealand (NZ) (94). Weighed records are the

gold standard, (8, 9) but when designing a research study a pragmatic approach must be taken i.e. the dietary assessment method used must not only give reasonable results, but it should be one that participants would also undertake. In this case, after discussion with project staff and participants and based on previous research experience, an FFQ was deemed to be the only method that would work in this study. This was because although a small sample size, we did not have the time or resources to conduct 35, 24-hour recalls as they can take between 30-45 minutes (9) and well trained interviewers are required (9). The participants were used to answering questionnaires and by giving them the option of completing the questionnaire themselves in their own time was deemed less intrusive than a 24-hour recall. Recalls also have errors in measurement due to a number of reasons related to knowledge, memory and the interview situation (9). Also, a validated FFQ was already available for use in this population. The dietary information was collected using a 60 item validated FFQ, (see the next section for more details) which was designed to take about 15 to 20 minutes to complete.

Development of FFQ

The FFQ used in this research was developed in 2009 (95, 96) for use in adults and was based on the Willet FFQ (10). It measured dietary intake over the preceding year. Foods that were not commonly consumed in NZ that were listed in the Willet FFQ were removed and foods that are commonly consumed, but were not included in the Willet FFQ were added. The names of some foods or brands that are not recognised in NZ were changed as well, e.g. "sweet peppers" was altered to "capsicum". Foods consumed on a weekly basis by more than 10 % of the population in the 1997 New Zealand National Nutrition Survey (97) were included. If items were not found in two Dunedin supermarkets they were removed. Food items were also grouped together if the nutrient contents were comparable (e.g. apples and pears), if they had the same main constituent (e.g. processed meats) or if they shared seasonality (e.g. stone fruit).

The Willet FFQ used nine frequency options, which was reduced to seven by combining the 4 - 5 times per day and 6 or more times per day into 4 - 6 per day. The amount of supplementary questions was decreased from 24 to five. They covered dietary supplement use, intake of other foods not in the questionnaire, consumption of milk and fat spreads and a summary of intake from each food group.

Pretesting

The FFQ was pretested in a two hour focus group in August 2009 which consisted of seven female and male Dunedin residents aged 30 - 59. They discussed (a) the participants' initial reactions and overall impressions; (b) the example page; (c) any foods not included; (d) serving sizes; (e) helpful features; (f) any difficulties. Their feedback assisted modifications to the FFQ.

FFQ Validation

The FFQ was first validated in 2012 in a population of 132 males and females aged 30 - 39 years. The participants completed the FFQ twice, an eight day weighed food record and provided a blood sample. The results from the study showed that the reliability coefficients ranged from 0.47 for calcium to 0.83 for alcohol with most values placing between 0.60 and 0.80. In terms of the validity coefficients for energy adjusted data, alcohol was the highest (0.74) followed by cholesterol (0.65) and β - carotene (0.58). The lowest nutrients were zinc (0.24) and calcium (0.28). The mean percentage agreement for all energy adjusted nutrients was 77.9 % and gross misclassification was 4.5 %. There was almost perfect mean percentage agreement (i.e. close to 100 with 95 % confidence intervals including 100) for energy and most macronutrients both before and after adjustment. The Bland-Altman analyses showed wide limits of agreement for all micronutrients, however high agreement was demonstrated for most macronutrients (99 % for protein, 103 % for total fat). The energy adjusted

coefficients were 0.34 for β - carotene and 0.33 for vitamin C when compared with biomarkers. The validation proved that the FFQ can administer highly repeatable measurements and has good validity in ranking individuals intake.

In 2017, the FFQ was validated again for an intake of the preceding three months. It was validated in 65 participants aged 18 - 70 years. They too completed the FFQ twice and a seven day weighed diet record. This FFQ established good test-retest reliability with Spearman correlation coefficients ranging from 0.51 to 0.69, and gross misclassification tertile no greater than 9.2 %. The Spearman correlations ranged from 0.44 for carbohydrate to 0.58 for total fat and monounsaturated fat demonstrating that the validity of the FFQ was acceptable. The highest rate of gross misclassification between the FFQ and seven day weighed diet record was 12.5 % for carbohydrate.

4.4.4 Data Entry

FFQ data was entered into Microsoft Excel spreadsheet (Microsoft Corporation 2010). The spreadsheet calculated the participants' daily average intake of energy, 35 nutrients and the five food groups (94).

4.5 Statistical Analysis

All statistical analyses were done using Stata 15.1 (StataCorp, College Station, Texas). Mean differences between groups (treatment type, time since diagnosis, BMI status and tertiary education status) were determined along with 95 % confidence intervals.

5. Results

5.1 Participant Characteristics

A total of 35 out of the 50 participants from the EXPINKT^{TM} programme who received a questionnaire, returned their questionnaire by the cutoff date and were therefore included in this pilot study; a 70 % response rate. Participant characteristics are presented in **Table 5.1** - ages ranged from 42 to 74 years. Most participants (45 %) had a Body Mass Index (BMI) in the normal weight range (BMI = 18.0 - 24.9 kg/m^2), while almost a third were classified as obese (BMI $\geq$ 30.0 kg/m^2). The majority of women (74 %) received their cancer diagnosis between 2013 and 2018, while the remaining were diagnosed from 2008 to 2012. Only three women did not receive radiotherapy. However, 60 % received both chemotherapy and hormone therapy. Over 50 % of the participants had a tertiary education. Only five of the women were still experiencing taste changes as a result of chemotherapy (data not shown) and the affected foods listed were, rice, water, apples, root vegetables, salads, lettuce, sweet foods, tea, coffee, cereal, alcohol, broccoli, lemons and ginger. Fourteen women experienced weight fluctuation in the last twelve months and there was no consistency in this between women. Some women first gained several kilograms and then lost some, whereas other women were the opposite (data not shown). The net weight gained and lost ranged from a gain of 12 kg to a loss of 6 kg. In terms of other health concerns, six women reported having high blood pressure, and another six reported high cholesterol. Only one participant had diabetes and another had cardiovascular disease; no participants reported suffering from a heart attack or stroke.

Table 5.1: Participant characteristics

	Women (n = 35)
Age, mean (range)	61 (42 – 74)
Tertiary Educated, n	19
BMI kg/m^2, mean	27.0
Employment, n	
Full time	9
Part time	9
Retired	13
Volunteer	2
Home duties	2
Annual household income over $50,000	15
Time of diagnosis, n	
2008 - 2012	9
2013 - 2018	26
Stage at diagnosis, n	
I	11
II	9
III	5
IV	0
Do not know/no answer	10
Type of treatment, n	
Surgery	33
Chemotherapy	21
Radiotherapy	32
Hormone therapy	21
Treatment Regime, n	
S + C + R + H	15
S + C + R	3
S + C + H	2

S + R + H	3
C + R + H	1
S + R	9
H	1
0	1
Current smokers, n	2

n = number of participants; kg/m^2 = weight in kilograms divided by height in metres squared; S = surgery; C = chemotherapy; R = radiotherapy; H = hormone therapy.

Table 5.2: Mean, standard deviation, median and interquartile range for nutrient intakes from current study and mean intake of the 2008/2009 New Zealand Adult Nutrition Survey of selected age groups

	Mean intake per day (SD)	Median (IQR)	ANS 08/09 Women 31 – 50 years Mean Intake[a]	ANS 08/09 Women 51 – 70 Mean Intake[a]
Total energy (kJ)	9396 (2530)	9380 (8109, 10416)	7921	7205
Carbohydrate (g)	253 (70.6)	255 (199, 287)	213	197
Protein (g)	97.6 (28.3)	96.9 (76.5, 113)	79.0	71.0
Total fat (g)	87.6 (31.8)	82.4 (68.4, 97.9)	74.0	66.0
SFA (g)	35.3 (16.5)	33.1 (27.2, 39.8)	29.2	24.6
MUFA (g)	30.9 (10.4)	29.7 (24.8, 36.2)	26.8	24.8
PUFA (g)	13.6 (4.19)	13.3 (10.6, 16.4)	10.5	10.3
Sugars (g)	132 (40.2)	124 (102, 159)	98.0	95.0
Carbohydrate (% TE)	45.4 (6.41)	45.7 (41.4, 48.6)	45.5	46.2
Protein (% TE)	17.4 (2.75)	17.2 (15.8, 19.1)	17.0	16.7
Fat (% TE)	34.6 (5.09)	34.3 (32.0, 37.2)	34.5	34.1
SFA (% TE)	14.2	-	13.6	12.6
MUFA (% TE)	12.3	-	12.4	12.7
PUFA (% TE)	5.46	-	5.0	5.3
Fibre (g)	31.7 (8.42)	30.5 (25.3, 36.7)	18.1	18.7

Vitamin A (µg)	1386 (764)	1172 (787, 1623)	780	893
Vitamin C (mg)	151 (73.0)	128 (105, 185)	101	108
Vitamin B6 (µg)	2.16 (0.61)	2.07 (1.69, 2.61)	1.8	1.5
Vitamin B12 (µg)	4.34 (2.15)	4.16 (3.26, 5.97)	3.7	3.5
Niacin (mg)	41.5 (10.0)	39.4 (34.1, 48.9)	32.6	28.3
Riboflavin (mg)	2.40 (1.02)	2.27 (1.72, 2.69)	1.8	1.7
Thiamine (mg)	2.19 (1.92)	1.52 (1.14, 2.12)	1.2	1.2
Folate (µg)	569 (189)	530 (418, 703)	-	-
Calcium (mg)	1149 (663)	992 (799, 1284)	847	775
Iron (mg)	15.1 (3.91)	14.5 (12.1, 17.5)	10.4	10.2
Magnesium (mg)	437 (110)	423 (372, 508)	-	-
Zinc (mg)	12.8 (4.00)	12.8 (9.93, 15.1)	10.0	9.1
Selenium (µg)	55.6 (19.7)	58.0 (38.5, 70.7)	54.2	56.9
Potassium (mg)	4695 (1431)	4317 (3733, 5587)	2869	2878

SD = standard deviation; IQR = interquartile range; ANS = Adult Nutrition Survey; kJ = kilojoule; g = gram; SFA = saturated fat; MUFA = monounsaturated fat; PUFA = polyunsaturated fat; TE = total energy; µg = microgram; mg = milligram.

[a]Obtained from 2008/09 New Zealand Adult Nutrition Survey, where dietary information was derived from one 24 - hour diet recall from 746 and 517 New Zealand women aged 31 - 50 and 51 - 70 years respectively (University of Otago and Ministry of Health 2011).

Table 5.3: Median and interquartile range for food group intake and comparison to New Zealand Ministry of Health Guidelines[a]

Food Groups	Median	IQR	NZ Guidelines[a]
Fruit (per day)	2	(1 – 3)	≥ 2
Vegetable (per day)	2	(2 – 3)	3 +
Meat and Poultry (per week)	4	(3 – 6)	≥ 7[b]
Seafood (per week)	1	(1 – 2)	
Breads and cereals (per day)	1	(1 - 2)	6 +

IQR = interquartile range; NZ = New Zealand.

[a]Obtained from Eating and Activity Guidelines for New Zealand Adults (Ministry of Health 2015).

[b]Meat, poultry and seafood combined total a recommendation of ≥ 7 servings per week.

5.2 Nutrient and Food Group Intakes

Table 5.2 shows mean and median energy and nutrient intakes from the current study and comparative values from women participants aged 31 to 70 years from 2008/2009 New Zealand Adult Nutrition Survey (ANS) (98). This study compared results to the ANS despite dietary assessment differences, to have some kind of comparative dietary intake of women of the same age group. Also, it shows that this FFQ has produced reasonable intakes when compared to the general population's intake. Nutrient intakes obtained from the Food Frequency Questionnaire (FFQ) used in the current study were slightly higher than those seen in the ANS (98). Mean energy intake from the FFQ was 9396 kJ/d, higher than 7921 kJ/d, and 7205 kJ/d reported by ANS participants of 31 - 50 years and 51 - 70 years respectively. Calcium intake from the EXPINKT™ participants was substantially greater than those women from the ANS. Saturated fat comprised 14 % of total energy, MUFA 12 % and PUFA 5 %. Reported breads and cereals intake per day was one serving (**Table 5.3**). This low intake prompted investigation of the individual relevant category questions from the FFQ. The average intake at this level was found to be three serves per day. Of the study population 43 % met the Ministry of Health (MOH) vegetable recommendations, 60 % met the fruit, 40 % met the meat and seafood recommendation and 0 % met the breads and cereals.

5.2.1 Average Nutrient and Food Group Intake by Subgroup

The mean difference in energy intake for participants who had chemotherapy compared to those who did not have chemotherapy was 996 kJ (95 % CI: -772, 2764) and the difference for those who had hormone therapy compared to those who did not was 789 kJ (95 % CI: -991, 2570).

Table 5.4: Mean and 95 % confidence interval for nutrient intake by breast cancer treatment

	Chemotherapy (n = 21) versus no chemotherapy (n = 14)[a]	Hormone therapy (n = 14) versus no hormone therapy (n = 21)[b]
	Mean (95 % CI)	Mean (95 % CI)
Energy (kJ)	996 (-772, 2764)	789 (-991, 2570)
Carbohydrate (g)	35.8 (-12.8, 84.5)	30.8 (-18.3, 79.9)
Protein (g)	12.8 (-6.83, 32.5)	12.6 (-7.10, 32.3)
Fat (g)	7.46 (-15.0, 30.0)	4.17 (-18.4, 26.8)
SFA (g)	5.58 (-6.01, 17.2)	1.73 (-10.0, 13.5)
MUFA (g)	0.75 (-6.66, 8.17)	0.52 (-6.90, 7.94)
PUFA (g)	0.24 (-2.74, 3.22)	1.00 (-1.96, 3.96)
Sugars (g)	12.2 (-16.1, 40.5)	21.7 (-5.86, 49.4)
Carbohydrate (% TE)	0.82 (-3.74, 5.38)	0.67 (-3.89, 5.23)
Protein (% TE)	0.87 (-1.07, 2.80)	1.12 (-0.80, 3.03)
Fat (% TE)	-0.65 (-4.27, 2.97)	- 0.74 (-4.36, 2.88)
Fibre (g)	2.34 (-3.60 – 8.28)	2.87 (-3.04, 8.78)
Vitamin A (µg)	328 (-204, 859)	-50.8 (-595, 493)
Vitamin C (mg)	16.2 (-35.5, 67.9)	3.8 (-48.1, 55.8)
Vitamin B6 (µg)	0.32 (-0.10, 0.74)	0.25 (-0.17, 0.67)
Vitamin B12 (µg)	0.82 (-0.68, 2.33)	0.75 (-0.76, 2.26)

Niacin (mg)	3.61 (-3.40, 10.6)	3.52 (-3.50, 10.5)
Riboflavin (mg)	0.59 (-0.11, 1.30)	0.52 (-0.19, 1.22)
Thiamine (mg)	0.46 (-0.90, 1.82)	0.81 (-0.54, 2.15)
Folate (µg)	71.8 (-60.1, 204)	115 (-13.4, 243)
Calcium (mg)	396 (-54.0, 848)	369 (-85.2, 823)
Iron (mg)	0.50 (-2.28, 3.28)	1.22 (-1.53, 3.98)
Magnesium (mg)	41.9 (-35.8, 119)	43.4 (-33.2, 120)
Zinc (mg)	1.74 (-1.05, 4.52)	1.88 (-0.89, 4.65)
Selenium (µg)	3.68 (-10.3, 17.7)	0.94 (-13.1, 15.0)
Potassium (mg)	810 (-168, 1788)	605 (-392, 1602)

n = number of participants; CI = confidence interval; kJ = kilojoule; g = gram; SFA = saturated fat; MUFA = monounsaturated fat; PUFA = polyunsaturated fat; TE = total energy; µg = microgram; mg = milligram.

[a]Women who underwent chemotherapy have intakes represented as positive compared to those who did not undergo chemotherapy.

[b]Women who underwent hormone therapy have intakes represented as positive compared to those who did not undergo hormone therapy.

Table 5.5: Mean and 95 % confidence interval for food group intake by breast cancer treatment

	Chemotherapy (n = 21) versus no chemotherapy (n = 14)[a]	Hormone therapy (n = 14) versus no hormone therapy (n = 21)[b]
	Mean (95 % CI)	Mean (95 % CI)
Fruit (per day)	0.00 (-0.69, 0.69)	0.00 (-0.69, 0.69)
Vegetables (per day)	0.87 (-0.18, 1.92)	0.39 (-0.69, 1.48)
Meat and poultry (per week)	-0.89 (-2.85, 1.08)	-1.01 (-2.97, 0.95)
Fish and seafood (per week)	0.21 (-0.59, 1.02)	0.10 (-0.71, 0.90)
Breads (per day)	0.36 (-0.28, 1.00)	0.00 (-0.65, 0.65)

n = number of participants; CI = confidence interval.

[a]Women who underwent chemotherapy have intakes represented as positive compared to those who did not undergo chemotherapy.

[b]Women who underwent hormone therapy have intakes represented as positive compared to those who did not undergo hormone therapy.

There were no meaningful differences for any nutrients between treatments. In groups of participants who underwent either chemotherapy or hormone therapy, nearly all of their nutrient intakes were greater than participants who did not receive either treatment (**Table 5.4**). Differences between Breast Cancer (BC) diagnosis groups are highlighted in **Table 5.6**. Higher values were in favour of protein, riboflavin, folate, calcium, zinc and potassium and these nutrients confidence intervals did not cross zero. Calcium intake was significantly higher in the cohort of participants who were diagnosed earlier at 587 mg/d (95 % CI: 99,7, 1074). As **Table 5.7** shows, those with an earlier diagnosis consumed 0.75 pieces more fruit (95 % CI: 0.02, 1.48) than the later diagnosis group. There were no meaningful differences between nutrients and BMI or education level (**Table 5.8**). However, lack of a tertiary education was associated with a lower intake of all food groups (**Table 5.9**).

Table 5.6: Mean and 95 % confidence interval for nutrient intake by time since diagnosis

	Diagnosed prior 2013 (n = 9) versus diagnosed 2013 and after (n = 26)[a]
	Mean (95 % CI)
Energy (kJ)	1267 (-703, 3238)
Carbohydrate (g)	45.7 (-8.26, 99.7)
Protein (g)	22.8 (1.64, 43.9)
Fat (g)	8.04 (-17.2, 33.3)
SFA (g)	6.04 (-6.96, 19.1)
MUFA (g)	0.93 (-7.38, 9.25)
PUFA (g)	-0.47 (-3.80, 2.87)
Sugars (g)	19.1 (-12.3, 50.5)
Carbohydrate (% TE)	1.40 (-3.70, 6.50)
Protein (% TE)	1.86 (-0.24, 3.95)
Fat (% TE)	-1.29 (-5.33, 2.75)
Fibre (g)	5.73 (-0.68, 12.1)
Vitamin A (µg)	455 (-134, 1043)
Vitamin C (mg)	38.6 (-18.1, 95.2)
Vitamin B6 (µg)	0.40 (-0.07, 0.86)
Vitamin B12 (µg)	1.40 (-0.25, 3.04)

Niacin (mg)	6.65 (-0.98, 14.3)
Riboflavin (mg)	0.88 (0.11, 1.64)
Thiamine (mg)	0.25 (-1.28, 1.78)
Folate (µg)	162 (22.4, 301)
Calcium (mg)	587 (99.7, 1074)
Iron (mg)	1.89 (-1.17, 4.94)
Magnesium (mg)	73.1 (-10.6, 157)
Zinc (mg)	3.21 (0.23, 6.20)
Selenium (µg)	8.91 (-6.50, 24.3)
Potassium (mg)	1153 (85.7, 2220)

n = number of participants; CI = confidence interval; kJ = kilojoule; g = gram; SFA = saturated fat; MUFA = monounsaturated fat; PUFA = polyunsaturated fat; TE = total energy; µg = microgram; mg = milligram.

[a]Women who were diagnosed prior to 2013 have intakes represented as positive compared to those who were diagnosed after 2013.

Table 5.7: Mean and 95 % confidence interval for food group intake by time since diagnosis

	Diagnosed prior 2013 (n = 9) versus diagnosed 2013 and after (n = 26)[a]
	Mean (95 % CI)
Fruit (per day)	0.75 (0.02, 1.48)
Vegetables (per day)	0.30 (-0.93, 1.52)
Meat and Poultry (per week)	-0.37 (-2.60, 1.86)
Fish and seafood (per week)	0.33 (-0.56, 1.23)
Breads and cereals (per day)	0.45 (-0.27, 1.16)

n = number of participants; CI = confidence interval.

[a]Women who were diagnosed prior to 2013 have intakes represented as positive compared to those who were diagnosed after 2013.

Table 5.8: Mean and 95 % confidence interval for nutrient intake by body mass index and tertiary education status

	BMI < 25 kg/m^2 (n = 16) versus BMI ≥ 25 kg/m^2 (n = 18)[a]	No tertiary education (n = 16) versus tertiary educated (n = 19)[b]
	Mean (95 % CI)	Mean (95 % CI)
Energy (kJ)	203 (-1591, 1998)	-55.6 (-1827, 1718)
Carbohydrate (g)	5.17 (-45.3, 55.6)	-0.68 (-50.1, 48.8)
Protein (g)	1.88 (-18.4, 22.1)	-11.8 (-31.2, 7.56)
Fat (g)	5.90 (-16.6, 28.4)	3.81 (-18.4, 26.0)
SFA (g)	0.63 (-11.2, 12.5)	-1.46 (-13.0, 10.1)
MUFA (g)	3.00 (-4.25, 10.3)	2.01 (-5.25, 9.28)
PUFA (g)	1.47 (-1.40, 4.33)	2.04 (-0.81, 4.88)
Sugars (g)	5.07 (-23.9, 34.0)	-0.97 (-29.2, 27.2)
Carbohydrate (% TE)	-0.34 (-4.95, 4.26)	-0.49 (-5.98, 4.00)
Protein (% TE)	0.67 (-1.29, 2.63)	-2.06 (-3.84, -0.28)
Fat (% TE)	1.53 (-2.09, 5.15)	2.53 (-0.93, 5.98)
Fibre (g)	-0.13 (-6.17, 5.90)	1.65 (-4.22, 7.51)
Vitamin A (µg)	149 (-393, 692)	85.6 (-449, 620)
Vitamin C (mg)	-11.7 (-63.4, 39.9)	3.14 (-48.0, 54.3)
Vitamin B6 (µg)	0.20 (-0.23, 0.63)	-0.19 (-0.61, 0.24)
Vitamin B12 (µg)	0.82 (-0.70, 2.34)	-1.35 (-2.78, 0.84)

Niacin (mg)	3.45 (-3.56, 10.5)	-3.49 (-10.4, 3.41)
Riboflavin (mg)	-0.30 (-1.03, 0.44)	-0.40 (-1.11, 0.31)
Thiamine (mg)	-0.34 (-1.72, 1.04)	-0.97 (-2.28, 0.33)
Folate (µg)	-38.4 (-174, 96.8)	63.4 (-66.7, 194)
Calcium (mg)	-332 (-795, 131)	-188 (-648, 272)
Iron (mg)	0.77 (-2.04, 3.57)	-1.34 (-4.04, 1.36)
Magnesium (mg)	-12.8 (-90.8, 65.2)	21.4 (-55.1, 97.8)
Zinc (mg)	-0.04 (-2.89, 2.81)	-1.43 (-4.19, 1.33)
Selenium (µg)	16.3 (3.57, 29.08)	-8.07 (-21.6, 5.43)
Potassium (mg)	-191 (-1206, 824)	-71.7 (-1074, 931)

BMI = body mass index; kg/m^2 = weight in kilograms divided by height in metres squared; n = number of participants; CI = confidence interval; kJ = kilojoule; g = gram; SFA = saturated fat; MUFA = monounsaturated fat; PUFA = polyunsaturated fat; TE = total energy; µg = microgram; mg = milligram.

[a]Women who have a BMI < 25 kg/m^2 have intakes represented as positive compared to those who have a BMI ≥ 25 kg/m^2.

[b]Women who have a tertiary education have intakes represented as positive compared to those who have no tertiary education.

Table 5.9: Mean and 95 % confidence interval for food group intake by body mass index status and tertiary education status

	BMI < 25 kg/m^2 (n = 16) versus BMI ≥ 25 kg/m^2 (n = 18)[a]	No tertiary education (n = 16) versus tertiary educated (n = 19)[b]
	Mean (95 % CI)	Mean (95 % CI)
Fruit (per day)	-0.35(-1.04, 0.33)	-0.23 (-0.91, 0.44)
Vegetables (per day)	0.50 (-0.60, 1.59)	-0.12 (-1.20, 0.95)
Meat and poultry (per week)	1.51 (-0.43, 3.44)	-1.41 (-3.30, 0.48)
Fish and seafood (per week)	0.75 (-0.02, 1.51)	-0.59 (-1.35, 0.18)
Breads and cereals (per day)	-0.03 (-0.69, 0.63)	-0.40 (-1.02, 0.22)

BMI = body mass index; kg/m^2 = weight in kilograms divided by height in metres squared; n = number of participants; CI = confidence interval.

[a]Women who have a BMI < 25 kg/m^2 have intakes represented as positive compared to those who have a BMI ≥ 25 kg/m^2.

[b]Women who have a tertiary education have intakes represented as positive compared to those who have no tertiary education.

6. Discussion

The results of this study show that the mean carbohydrate, protein and fat percentage of total energy intake in Breast Cancer (BC) survivors fall just within the New Zealand (NZ) Acceptable Macronutrient Distribution Ranges (AMDR) of 45 – 65 %, 15 – 25 % and 20 – 35 % respectively (99). These results are comparable to other BC survivors. In a study in Canada, (100) these proportions were found to be 52 %, 18 %, and 29 % and in Malaysia, (31) 56 %, 15 % and 29 % respectively, although these countries used estimated three day food diaries to measure intake. Conversely, in the current study the mean percentage of saturated fat that contributes to total energy is over the < 10 % Ministry of Health (MOH) recommendations (94). This is well above Canada's reported intake of 8.9 % (100) and Malaysia's of 5.4 % (31).

Compared to the 2008/09 Adult Nutrition Survey (ANS) (98), nearly all nutrient intakes appeared to be greater in the current study. However, the ANS used 24-hour recall to measure dietary intake, so it may be that the difference is due to methods used to assess diet, rather than there being a true difference in intake (8, 9). However, a recent small qualitative study in the United States of America (US) (101), noted that cancer survivors' diets reflect that of the general US adult population day to day diet, which is abundant with high fat, sugar and sodium containing foods (102). While this study also reported that some participants said their cancer diagnosis led to healthful dietary changes, an equal number of participants had chosen to 'let go' of 'dietary restrictions' that they had lived by which had not guaranteed them free from cancer.

Whether participants were meeting national recommendations for the breads and cereals food group was measured in two ways. It was initially measured using a supplementary question at the end of the questionnaire and when the results of this were found to be unexpectedly low,

consumption was calculated from the relevant food item frequency questions within the main body of the Food Frequency Questionnaire (FFQ). The two mean answers for this food group were one serving and three, respectively. The supplementary question used here was one used in the ANS (98), and during cognitive pre-testing it was shown that participants understood the meaning of the question (103). However, it may be the case, but we cannot say for certain, that participants in this study did not understand exactly what foods belong to the breads and cereals category. Therefore, it is possible that participants did not include all servings in their answer. It is also possible that over-reporting also occurred for the individual 'cereal-containing foods' questions. Whichever measure is used, intake of breads and cereals in this study is below national recommendations (94). This food group is responsible for providing energy so that the body can perform everyday activities and maintain metabolism (94, 104). Inadequate breads and cereals i.e. low carbohydrate intake could contribute to fatigue (105, 106), which can be a problem for cancer patients and survivors (30). This food group also has high fibre containing foods (94). Fibre is extensively researched by the AICR/WCRF for its potential in decreasing risk of all-cause mortality of BC survivors (18). The evidence was consistent but limited in showing an inverse association between fibre containing foods and all-cause mortality at 12 months after diagnosis (18). These low intakes highlight the need for nutritional treatment plans for BC survivors.

In the current study, median fruit intake only just meets recommendations (94) and median vegetable intake is lower than recommended (94). The Women's Healthy Eating and Living Study (27) was a prospective cohort study of BC survivors. The intervention group received nutrition advice about increasing fruits and vegetables in their diet. A greater intake was weakly associated with reduced mortality ($p = 0.02$).

Women who are undergoing BC treatment have been shown to have inadequate diets due to their low intakes of fruit, legumes and dark green and orange vegetables. Thereby resulting in an inadequate intake of several micronutrients (38, 107). Dunedin women participating in the EXPINKT™ programme five years ago who were undergoing chemotherapy had their dietary intake measured using four day weighed food diaries, at three time points, before and twice during chemotherapy (108). Their macronutrient ranges contributing to total energy tended to fall only just within the NZ AMDRs (99). Carbohydrate at the three time points were 45.2 % to 47.1 % to 44.7 %, protein went from 15.8 %, to 14.6 % to 16.9 % and total fat 35.6 %, to 37.0 % to 36.4 %. Average total fat was above the recommendation of 20 – 35 % (99) during the entire study period. Saturated fat intake ranged 12.4 to 124.6 g/d. These intakes are similar to the current study's population where a different assessment method has been used and the women are post treatment.

Results of previous research on diet quality of cancer survivors and BC survivors is contrasting. Cancer survivors have significantly lower healthy eating scores than people without cancer (32) and in general, a poor dietary intake compared to people without cancer (29, 109). Specifically inadequate intakes of total energy, protein and fat (110-113) as well as several nutrients that are often found in animal food sources such as vitamin A, B vitamins and phosphorus (114). BC survivors have been found to have low protein intake as well as a poor intake for a number of micronutrients and minerals when compared to people who have never been diagnosed with cancer (114). This differs from the current study where protein intake was within recommendations, albeit at the lower end of the AMDR (99). Zhang *et al.* proposed that BC survivors have the best diet quality among other major cancer types (32). They have been shown to increase their fruit and vegetable significantly more so than cancer free women (115, 116) and to decrease total and saturated fat consumption after their diagnosis (116). BC survivors' have also been reported to increase the number of diet

recommendations met after their diagnosis and surpass those met by cancer free women significantly (116).

A review (117) of the combined effects of dietary intake and exercise on BC survivors did not find evidence to support a decreased risk of cancer recurrence, despite the overall positive influence of changes in these lifestyle components.

It is difficult to identify an 'average' duration for BC treatment as each case differs (6). Individuals are typically considered to be 'cancer free' if there has been no recurrence or metastases diagnosed in the five-year period following diagnosis (118-120). While treatments are effective, the late and long-term side effects of cancer treatment are known to include weight gain, (42) fatigue, cognitive limitations, depression and anxiety (57). There is seldom mention of an impact on nutritional intake or status.

Various measures are encouraged to offset the adverse side effects of treatment; however, post-treatment benefits of nutrition and diet are often ignored. Despite this, cancer patients diagnosed over five years prior to assessment have been found to meet more nutrition recommendations than those diagnosed two to four years prior (101). Those diagnosed earlier were also found to have healthier eating index scores (101). Fruits and vegetables are consumed more so in women diagnosed with BC earlier (116). However, no significant differences in cancer survivors' health behaviours were reported when categorised by time since diagnosis in a US study (121). Women in the current study diagnosed with BC more than five years ago tended to have greater intakes of almost all nutrients compared to those diagnosed within five years, with meaningfully greater intakes of protein, riboflavin, folate, calcium, zinc and potassium. These nutrients are abundant in animal products such as meat, dairy and eggs and some vegetables (94, 99). The difference in protein intake is 22.8 g, which

is approximately, two sausages, a piece of fish, 2/3 cup of chicken, four eggs, 1 ½ cups lentils and 300 g tofu. The difference between the two groups may be because women are more relaxed about their diet several years after diagnosis. Therefore they may consume as much of whatever foods they prefer as they no longer want to live within diet restrictions, much like the cancer survivors reported by Klassen *et al.* (101). Perhaps by this time, women know what their body needs in order to function the way they like and so consume what they like, or maybe they are trying to meet a self-determined pre diagnosis weight; however, these are all just theories. There are theories that health behaviour changes may not relate to the entire cancer survivor population or that they may only be temporary (122). Guidance for nutritional intake after treatment could potentially prevent these significant differences.

The differences within nearly all of the 'time since diagnosis' nutrients are greater than 10 % of the mean intake for the cohort. This is a large difference and if the sample size had been greater it is likely it would have been a significant difference.

There is a great deal of research and evidence that nutritional intake is altered during cancer treatment. However, research on post-treatment changes is limited. A large number of BC patients undergoing chemotherapy (37) consumed less than the recommended amount for a number of micronutrients and the majority of women fell into the category of "diet requires modification". Most side effects of treatment that impact eating, tend to disappear after treatment ceases (123). For women who had recently finished chemotherapy treatment, no significant differences were found in diet quality compared to those who had not (124). To our knowledge only one study has compared nutrient intake by treatment type of chemotherapy, radiation therapy and hormonal therapy and found no significant difference across a range of nutrients (31).

Most nutrient intakes were not affected by BMI status in this study. Obese women with BC have poorer survival compared to those who are non-obese (46). BC patients who consume a more Western diet have significantly higher BMI's (90). In women recently having completed BC treatment, better diet quality scores were strongly associated with lower inflammatory blood markers; however, the correlation was attenuated following adjustment for BMI (124). This indicates that BMI may indirectly be related to the benefits of a healthy diet and subsequent anti-inflammatory properties (125).

Although the current study found no significant differences in nutrient intake by educational status, other studies observed an effect. In both cancer survivors (32) and BC survivors (126) who had received some tertiary education, they had significantly higher 'healthy' diet measures than those who did not.

The current study has a number of strengths. This is the first study conducted in New Zealand to measure the dietary intake of BC survivors. The FFQ used in this study was based on the renowned Willet FFQ (10) and developed for and validated in Dunedin adults in 2017 (16). It shows good reliability and validity for all nutrients, and has been shown to give accurate information at the individual level for macronutrients (16).

This study has several limitations. This was an observational study in a convenience sample. It is likely that the sample size was too small to see significant differences between the subgroups. It is hard to evaluate the power of the study, as there are not any other studies that can be used to estimate the power needed. The cohort of women in this study may also be more likely to consume a healthier diet due to the exercise and wellbeing part of the programme that they were recruited from (127, 128). This may limit the generalisability of the results. Despite being asked to fill out the questionnaire of their actual intake, social

desirability bias may have occurred whereby some participants may have exaggerated their intakes of some foods and under reported the amount of others, potentially skewing results. Although the questionnaire was anonymous so participants may have felt less inclined to do so. The use of an FFQ to measure dietary intake may have led to over-estimation of dietary intake, a key problem with FFQs (8, 9). Albeit, this FFQ has been shown to provide accurate levels of energy and nutrients in the general population (15, 16). Ideally it would have been best to use a weighed diet record as they are considered the 'gold standard' for measuring dietary intake, despite still having limitations (8, 9). However, a FFQ was chosen to reduce burden for the participant.

6.1 Conclusion

This study is the first NZ study to measure dietary intake in BC survivors. The results generated are designed to serve as a pilot to direct further studies in this country with a larger sample size and with the use of diet records. They are therefore exploratory in nature. There appears to be a worldwide lack of nutritional guidance and input for patients undergoing BC treatment and those who have finished treatment. The results of this study show the low dietary intakes of BC survivors in the Dunedin EXPINKT™ population compared to the MOH and the American Institute Cancer Research/World Cancer Research Fund recommendations. Survivors should have nutritional guidance at this stage of their cancer journey due to the problems that can arise concurrently with treatment and impact their nutritional status, which can have negative ramifications. Studies have documented the desire of nutrition input at this time from survivors. This area would benefit from further research in NZ, perhaps of the dietary changes endured from diagnosis to treatment ceasing, and the years after. Intervention studies of what women can do after treatment in relation to their nutrition, for the purpose of creating specific national guidelines and reducing recurrence risk is another possible research avenue.

7. Application to Practice

Women who have completed treatment for Breast Cancer (BC) should be consuming a diet that will be of benefit to their health and this study has exposed the potential heightened risk of inadequacies. This highlights where the role of a dietitian would be of great help. There is a lot of dietary information easily available to the public, and therefore BC survivors, that is often misguided and can lack scientific evidence. This in turn can create a greater need for dietitians.

Dietary changes are one of the most common lifestyle alterations made by BC survivors and this is a stage when patients are most ready to learn (19). Guidance by a dietitian for these changes would be ideal. BC and its treatments can have multiple negative impacts on the body, which may include poor dietary intake and weight change. These can weaken the patient's nutritional status and indirectly affect postoperative complications and mortality (33-35). Therefore, a nutritional assessment after diagnosis and after treatment by a dietitian could increase the patient's chance of developing positive habits, behaviours and outcomes.

Studies have shown that BC patients and cancer patients in general would have liked more dietetic input during their treatment (20, 25). The current study has shown what these women are consuming after treatment, which better equips dietitians about where to help and how to best target interventions in a clinical or public health setting.

The results of this thesis reinforce the need for dietetic care of cancer patients. Maintaining nutritional status in this population could in turn decrease pressure on the health care system in the long term by reducing hospital admissions and reducing the risk of recurrence. Therefore, New Zealand should have national nutrition guidelines that are accessible and

available and cancer patients should be provided dietetic service throughout their treatment and cancer journey.

8. References

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9. Appendices

Appendix A: Form sent for ethics approval as extension of the EFFECT study

Information Sheet for Participants
Food Frequency Questionnaire

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you and we thank you for considering our request.

What is the aim of the project?

The American Cancer Society recommends that after cancer treatment, patients consume a diet that helps maintenance of a healthy weight. This diet should be low in alcohol, high in fruit and vegetables and low in saturated fat. Recent research suggests that a higher intake of vegetables, in particular, may have a helpful effect on recurrence or survival for breast cancer. However, some of the treatments for different types of breast cancer can lead to changes affecting the ability of patients to accept and/or digest certain foods. There are currently no data from New Zealand populations that describe the dietary intake of breast cancer survivors. Therefore we would like to, describe the dietary takes of those participants from the Exercise Training Beyond Breast Cancer (EXPINKT) programme, who are at least 6 weeks post treatment.

In order to do this, we have developed a questionnaire about the frequency of how often you consume different types of foods. The questionnaire will take approximately 15 – 20 minutes to complete. Questionnaires will be de-identified, meaning that the obtained information will not lead to the identification of specific individuals.

What types of participants are being sought?

We are looking for current participants of the EXPINKT program, who are willing to complete a questionnaire about their dietary intake over the last 3 months.

Participation in this study is voluntary and there will be no financial compensation for participation.

What will participants be asked to do?

Should you ask to agree to take part in this project, you'll be invited to take a questionnaire home from the gym to complete and return by mail by Dr Jones in a stamped, addressed envelope. Completing the questionnaire will take approximately 15-20 minutes.

The questionnaire will ask you about the frequency of how often you have consumed specific foods over the last 3 months and the brands of some foods.

Please be aware that you may decide not to take part in the project without any disadvantage to yourself.

What will be made of the information collected?

Answers to the questionnaire will be analysed to see if there are any patterns in the nutrient intake among participants.

Data will be de-identified, e.g. you will not be individually identifiable and your responses will never be linked to overall outcomes.

The data collected will be securely stored in such a way that only the research team will be able to gain access to it. Data obtained as a result of the research will be retained for **10 years** in secure storage, after which it will be destroyed.
The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve your anonymity. Regardless of whether you choose to participate, please let us know if you would like a summary of the findings. To receive a summary, contact Dr. Lynnette Jones

Can Participants change their mind and withdraw from the project?

Upon completion of the questionnaire, there is no more opportunity to correct the questionnaire. You may withdraw from participation in the project at any time, and without any disadvantage to yourself, until the final data analysis has been conducted.

What if any participants have any questions?

If you have any questions about our project, either now or in the future, please feel free to contact:

Dr Lynnette Jones
School of Physical Education, Sport and Exercise Sciences
Email: lynnette.jones@otago.ac.nz
Phone: 479 8962

*This study has been approved by the University of Otago Human Ethics Committee (Health, **H18/057). If you** have any concerns about the ethical conduct of the research you may **contact the Committee through** the Human Ethics Committee Administrator (phone +64 3 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.*

Appendix B: Entire questionnaire including information sheet, participant characteristics and food frequency questionnaire

Information Sheet for Participants
Food Frequency Questionnaire

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you and we thank you for considering our request.

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The questionnaire will ask you about the frequency of how often you have consumed specific foods over the last 3 months and the brands of some foods.
Please be aware that you may decide not to take part in the project without any disadvantage to yourself.

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Answers to the questionnaire will be analysed to see if there are any patterns in the nutrient intake among participants.

Data will be de-identified, e.g. you will not be individually identifiable and your responses will never be linked to overall outcomes.

The data collected will be securely stored in such a way that only the research team will be able to gain access to it. Data obtained as a result of the research will be retained for **10 years** in secure storage, after which it will be destroyed.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve your anonymity.

Regardless of whether you choose to participate, please let us know if you would like a summary of the findings. To receive a summary, contact Dr. Lynnette Jones

Can Participants change their mind and withdraw from the project?

Upon completion of the questionnaire, there is no more opportunity to correct the questionnaire. You may withdraw from participation in the project at any time, and without any disadvantage to yourself, until the final data analysis has been conducted.

What if any participants have any questions?
If you have any questions about our project, either now or in the future, please feel free to contact:

Dr Lynnette Jones
School of Physical Education, Sport and Exercise Sciences
Email: lynnette.jones@otago.ac.nz
Phone: 479 8962

Please make sure that you put a tick in every line of the food frequency questionnaire and complete every page. Thank you

*This study has been approved by the University of Otago Human Ethics Committee (Health, **H18/057). If you** have any concerns about the ethical conduct of the research you may **contact the Committee through** the Human Ethics Committee Administrator (phone +64 3 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.*

1. What is your age? _____

2. What is your highest education qualification?

☐ None
☐ Secondary School (e.g. NZ School Certificate, NCEA, NZ Sixth Form Certificate, NZ University Bursary/Scholarship)
☐ Bachelor's Degree
☐ Masters
☐ PhD
☐ MD/MB ChB
☐ Other *(please specify)* _____

3. Are you…

☐ Single/Never Married
☐ Married
☐ Divorced
☐ Separated
☐ Defacto/Living together
☐ Widowed

4. How tall are you? _____ (cm) *(tick this box if you are unsure/don't want to answer)* ☐

5. How much do you weigh? _____ (kg) *(tick this box if you are unsure/don't want to answer)* ☐

6. Has your weight fluctuated in the last 12 months?

☐ No
☐ Yes, I lost weight *(how much)* _____ (kg)
☐ Yes, I gained weight *(how much)* _____ (kg)
☐ I'm unsure/don't want to answer this question

7. What is your <u>main</u> work arrangement?

☐ Employed/Self employed – full-time
☐ Employed/Self employed – part-time
☐ Employed/Self employed – casual
☐ Full – time home duties
☐ Unpaid work in a family business or farm
☐ Student
☐ Unemployed or looking for work
☐ Retired
☐ Permanently ill/unable to work
☐ Unpaid voluntary worker
☐ Other (please specify) _____

8. Could you provide us with an estimate of your total household income (before tax)?

☐ Zero income ☐ $1 - $5,000 ☐ $5,001 - $10,000 ☐ $10,001 - $15,000

☐ $15,001 - $20,000 ☐ $20,001 - $25,000 ☐ $25,001 - $30,000 ☐ $30,001 - $35,000

☐ $35,001 - $40,000 ☐ $40,001 - $50,000 ☐ $50,001 - $60,000 ☐ $60,001 - $70,000

☐ $70,001 - $100,000 ☐ $100,001 - $150,000 ☐ $150,001 or more

☐ I would rather not answer this question

9. When were you diagnosed with breast cancer? *(approximately)*

_____ *(month)* _____ *(year)*

10. What cancer stage did you have at diagnosis?

☐ I ☐ III

☐ II ☐ IV ☐ Don't know

11. Have you previously been diagnosed with any other cancer than breast cancer?

☐ Yes ☐ No

12. What treatment(s) have you had (tick all that apply) for breast cancer?

☐ Surgery
☐ Chemotherapy
☐ Radiotherapy
☐ Hormone treatment
☐ Don't know
☐ Other (please specify) -

_____

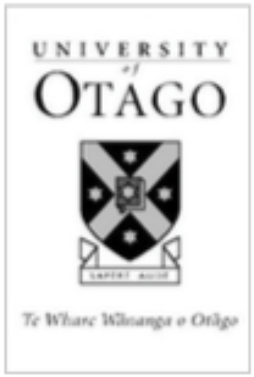
13. Do you currently smoke?

☐ Yes
☐ Quit within the last 2 years
☐ Quit over two years ago
☐ Never

14. Have you had, or do you have any of the following conditions? (tick all that apply)

☐ High blood pressure ☐ High blood glucose ☐ High cholesterol
☐ Diabetes ☐ Heart attack ☐ Stroke
☐ Emphysema ☐ Chronic bronchitis ☐ Arthritis/degeneration
☐ Thyroid condition ☐ Peripheral vascular disease ☐ Angina (chest pain)
☐ Cardiovascular disease ☐ Osteoporosis ☐ Asthma
☐ Inflammatory condition

☐ Other _____



Food Questionnaire

Different eating patterns have an effect on people's health. To help us understand these eating patterns we would like you to think about all the foods you have had over the past **three months** and answer the following questions about the foods you usually eat.

This food questionnaire measures how often, **on average**, you have eaten a specified amount of food over the past three months.

Instructions:

Tick the circle which best tells **how often** you usually eat the given foods.

Answer each question as best as you can. Estimate if you are not sure. A guess is better than no answer!

When you are finished the questionnaire please check every page to see if you have missed any questions. Please complete the questionnaire using a blue or black pen.

If you have any queries regarding this questionnaire please contact:

Thank-you for filling in this questionnaire carefully!

FFQ three month
Sep 15

Example 1:

	Serving size	Never or less than once per month	1-3 per month	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-6 per day
Apples / Pears	**1**	○	○	○	✓	○	○	○	○

When asked how often I eat 'Apples / pears' I usually have 2 apples and 1 pear every week. The serving size is one piece of fruit. Therefore I have 3 servings per week and should tick the "2-4 per week" circle.

Example 2:

	Serving size	Never or less than once per month	1-3 per month	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-6 per day
Pizza / Hamburgers	**2 slices, 1 medium burger**	○	○	✓	○	○	○	○	○

When asked how often I eat 'Pizza/Hamburgers' I never eat hamburgers but I have pizza twice a month. I usually will eat 4 slices each time I have pizza. So I have 8 slices (4 servings) a month, as the serving size is 2 slices. So I will tick the "1 per week" circle.

Firstly, please answer the following brief questions:

Have you taken **dietary supplements** over the last three months?

Yes ◯ No ◯

How many teaspoons of **sugar** do you add to your beverages or food each day?

_____teaspoons

If you eat cold breakfast cereals, what brand and type of **cold breakfast cereal** do you usually eat? (eg. Kellogg's Special K)

_____

If you use table spread, what brand and type of **spread** do you usually use? (e.g. Anchor butter, MeadowLea spread)

_____

What type of **oil** do you usually use? (e.g. vegetable, sunflower, olive)

_____

Now, please tick the circle that best tells how often you eat the following foods:

	Serving size	Never or less than once per month	1-3 per month	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-6 per day
DAIRY FOODS									
Milk (include milk in hot drinks, cereals, creamed soups etc) eg. Cow, Soy	**1 cup/ 250mL**	◯	◯	◯	◯	◯	◯	◯	◯
Ice cream	**1 cup**	◯	◯	◯	◯	◯	◯	◯	◯
Yoghurt	**1 pottle (150g)**	◯	◯	◯	◯	◯	◯	◯	◯
Low fat cheese e.g. cottage, ricotta, low fat cheddar	**¼ cup**	◯	◯	◯	◯	◯	◯	◯	◯
Cheese e.g. Cheddar, Edam, Tasty, Mozzarella, Brie, Camembert	**¼ cup**	◯	◯	◯	◯	◯	◯	◯	◯
Cream based dairy e.g. Cream, Sour cream, Cream cheese	**¼ cup**	◯	◯	◯	◯	◯	◯	◯	◯

Please check that you have put a tick (✔) on EVERY line

	Serving size	Never or less than once per month	1-3 per month	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-6 per day
FRUITS									
Bananas	**1**	◯	◯	◯	◯	◯	◯	◯	◯
Apples/Pears	**1**	◯	◯	◯	◯	◯	◯	◯	◯
Citrus fruit: Oranges, Mandarins, Grapefruit, Lemons	**1**	◯	◯	◯	◯	◯	◯	◯	◯
Stone fruit e.g. Apricots, Plums, Nectarines, Peaches	**1**	◯	◯	◯	◯	◯	◯	◯	◯
Berries fresh, frozen or canned e.g. Strawberries, Blueberries	**½ cup**	◯	◯	◯	◯	◯	◯	◯	◯
Dried fruit e.g. Raisins, Sultanas, Prunes	**1 Tbsp**	◯	◯	◯	◯	◯	◯	◯	◯
Other fruit e.g. Kiwifruit, Grapes, Feijoa, Pineapple, Mango, Rhubarb, Tamarillos, Guava, Pawpaw, Melon	**1 serving**	◯	◯	◯	◯	◯	◯	◯	◯
VEGETABLES									
Tomatoes (fresh, canned), tomato based sauce	**1 small/ ½ cup**	◯	◯	◯	◯	◯	◯	◯	◯
Beans or legumes e.g. Green beans, Runner beans, Baked beans, Lentils, Chickpeas	**½ cup**	◯	◯	◯	◯	◯	◯	◯	◯
Salad Greens e.g. Lettuce, Cucumber, Celery, Rocket	**½ cup**	◯	◯	◯	◯	◯	◯	◯	◯
Other Greens: Broccoli, Cauliflower, Spinach, Silverbeet, Cabbage, Brussel Sprouts, Bok choy, Chinese cabbage, Watercress, Puha	**½ cup**	◯	◯	◯	◯	◯	◯	◯	◯

Please check that you have put a tick (✔) on EVERY line

	Serving size	Never or less than once per month	1-3 per month	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-6 per day
Onion, Leeks	½ cup	○	○	○	○	○	○	○	○
Potatoes, Kumara, Pumpkin	½ cup	○	○	○	○	○	○	○	○
Other Root Vegetables e.g. Carrot, Beetroot, Parsnip, Turnips, Yams	½ cup	○	○	○	○	○	○	○	○
Other Vegetables e.g. Corn Mushrooms, Asparagus, Courgette, Eggplant, Capsicum, peas, coleslaw	½ cup	○	○	○	○	○	○	○	○
EGGS, MEAT, ETC									
Eggs	1	○	○	○	○	○	○	○	○
Sausages, Hotdogs	1	○	○	○	○	○	○	○	○
Salami, Ham, Luncheon, Bacon or other processed meat	½ cup	○	○	○	○	○	○	○	○
Beef, Pork or Lamb e.g. mince, roast, steak, stew, casserole, lasagne, frozen dinners, etc	½ cup	○	○	○	○	○	○	○	○
Meat pie, 2 Sausage rolls	1 serving	○	○	○	○	○	○	○	○
Chicken and other poultry	½ cup	○	○	○	○	○	○	○	○
Tuna, Salmon, Sardines, Mackerel	½ cup	○	○	○	○	○	○	○	○
Fried fish, Battered fish, Breaded fish, Fish fingers	1 serving	○	○	○	○	○	○	○	○
Other Fish and Seafood e.g. Cod, Sole, Hoki, Gurnard, Shrimp, Mussels, Oysters, Crayfish	½ cup	○	○	○	○	○	○	○	○

Please check that you have put a tick (✔) on EVERY line

	Serving size	Never or less than once per month	1-3 per month	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-6 per day
BREADS, CEREALS, STARCHES									
High Fibre Cereals e.g. Porridge, Muesli, Bran Flakes, All Bran	**¾ cup**	○	○	○	○	○	○	○	○
Other Cold Breakfast Cereal eg. Light 'n' Tasty, Special K, Weetbix	**¾ cup**	○	○	○	○	○	○	○	○
White Bread including Sliced, Tortillas, Pita etc	**2 slices/ 1 roll**	○	○	○	○	○	○	○	○
Wholemeal or mulitgrain Bread including Sliced, Tortillas, Pita etc	**2 slices/ 1 roll**	○	○	○	○	○	○	○	○
Crackers, Crispbread e.g. Vitawheat, Cruskits	**2 crackers**	○	○	○	○	○	○	○	○
Pancakes, Waffles, Sweet Buns, Scones	**1 serving**	○	○	○	○	○	○	○	○
Brown Rice/ Wholemeal Pasta	**1 cup**	○	○	○	○	○	○	○	○
White rice/ Couscous	**1 cup**	○	○	○	○	○	○	○	○
Other Pasta e.g. Spaghetti, Spirals, Instant noodles, Tinned	**1 cup**	○	○	○	○	○	○	○	○
FASTFOODS									
Hot chips/French fries	**1 cup**	○	○	○	○	○	○	○	○
Potato Chips/Crisps or Corn chips	**1 cup**	○	○	○	○	○	○	○	○
Pizza/Hamburgers	**2 slices, 1 medium burger**	○	○	○	○	○	○	○	○
International Takeaway e.g. Chinese, Thai, Turkish, Indian, Japanese etc	**1 serving**	○	○	○	○	○	○	○	○

Please check that you have put a tick (✔) on EVERY line

	Serving size	Never or less than once per month	1-3 per month	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-6 per day
BEVERAGES									
Low-calorie drink, e.g. Diet Coke, Coke Zero, Sprite Zero	**1 cup**	○	○	○	○	○	○	○	○
Sweet drinks e.g. Sprite, Coke, Fruit juice, Raro, Cordial	**1 cup**	○	○	○	○	○	○	○	○
Alcoholic Beverages e.g. Beer, Wine, Spirits	**1 standard drink**	○	○	○	○	○	○	○	○
Water: Bottled, Sparkling, or Tap	**1 cup**	○	○	○	○	○	○	○	○
Tea/Coffee	**1 cup**	○	○	○	○	○	○	○	○
SWEETS, BAKED GOODS, MISCELLANEOUS									
Chocolate/Chocolate bars	**5 squares (25g)**	○	○	○	○	○	○	○	○
Sweets, Lollies	**Small handful**	○	○	○	○	○	○	○	○
Biscuits	**2**	○	○	○	○	○	○	○	○
Cake, Brownie, Slice, Croissant, Pie, Danish, Brioche, Milk Pudding, Muesli bars	**1 serving**	○	○	○	○	○	○	○	○
Jam, Preserves, Syrup, Honey	**1 Tbsp**	○	○	○	○	○	○	○	○
Nuts (include Peanut butter), seeds	**1/8 cup**	○	○	○	○	○	○	○	○
Oils e.g. Vegetable oil, Olive oil, Mayonnaise, Salad dressing, include frying	**1 Tbsp**	○	○	○	○	○	○	○	○
Fats e.g. Butter or Margarine, used as spreads or in cooking, excluding baking	**1 teaspoon**	○	○	○	○	○	○	○	○
Iodized salt, at table and in cooking	**1 pinch**	○	○	○	○	○	○	○	○

Please check that you have put a tick (✔) on EVERY line

Are there any **OTHER** foods which you have eaten more than once a week in the past three months?

Food	Usual Serving Size	Times eaten per week

What type of milk do you usually have either as a drink or added to drinks, cereals, creamed soups, etc? (Tick the one you have most often)

- ◯ I do not drink/use milk
- ◯ Full cream or farmhouse
- ◯ Standard or homogenised (blue top)
- ◯ Semi trim (light blue top)
- ◯ Trim (green top)
- ◯ Soy milk (regular)
- ◯ Soy milk (light)
- ◯ Other milk (please specify) _____

How many servings do you have the following **per day?**

	Serving Size	**Times per day**
Fruit	1 medium fruit / 2 small	
Vegetables	½ cup	
Breads, cereals, pasta, rice	2 slices / ½ cup	

How many servings do you have of the following **per week?**

	Serving Size	**Times per week**
Meat, poultry	½ cup cooked	
Fish, seafood	½ cup cooked	

If you have had chemotherapy treatment, are there any foods that you used to be able to eat that you can no longer have because of taste changes? (*please tick* ✔)

Yes ◯ No ◯

If yes, please list these foods:

Please make sure you have put a tick in every line and completed every page.

Thank you for your time!