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Keaver, L., & McLaughlin, C. (2024). A Latent Class Analysis of Nutrition Impact Symptoms in Cancer Survivors. *Dietetics*, *3*(4), 423-434. Advance online publication. https://doi.org/10.3390/dietetics3040031

Link to publication record in Ulster University Research Portal

Published in:
Dietetics

Publication Status:
Published online: 15/10/2024

DOI:
10.3390/dietetics3040031

Document Version
Publisher's PDF, also known as Version of record

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A Latent Class Analysis of Nutrition Impact Symptoms in Cancer Survivors

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Abstract: Those with a cancer diagnosis report experiencing a wide range of nutrition impact symptoms, the prevalence of which varies by study, group, and cancer type. We aimed to identify groups of cancer survivors with specific patterns of nutrition impact symptoms. Two hundred and twenty-nine individuals attending oncology day ward and outpatient clinics completed a series of questionnaires and physical measurements. A latent class analysis was performed to identify subgroups based on 13 nutrition impact symptoms taken from the Patient Generated Subjective Global Assessment short form. The identified classes were subsequently compared using analysis of variance and chi-square tests, by sociodemographic, clinical and nutritional variables, and by the Global Health Status (GHS) and five functioning scales determined using the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ-C30). Three latent subtypes were identified: (1) Fatigue (n = 58, 28%); (2) Low Symptom Burden (n = 146, 64%), and (3) High Symptom Burden (n = 25, 11%). Those in the High Symptom Burden group were more likely to be female, were currently receiving some form of treatment, were diagnosed ≥two years, and had consumed less food than usual in the last month compared to those in the Low Symptom Burden group. Those in the Fatigue group were less likely to have reported their food intake to be unchanged and more likely to be diagnosed ≥two years than those in the Low Symptom Burden group. The EORTC-QLQ-C30 functioning and GHS scores were all significantly different between the three nutrition impact symptoms classes ($p < 0.001$). This is the first study to examine heterogeneity of nutrition impact symptoms in Irish cancer survivors. The findings of this work will inform and allow for more individualised nutrition care. By tailoring interventions to these specific groups, we can enhance the precision of care, improve prognostic accuracy, and significantly elevate the quality of life of survivors. This work underscores the critical importance of symptom management in the continuum of cancer care, ensuring that every survivor receives comprehensive support tailored to their unique journey.

Keywords: latent class analysis; nutrition; oncology; nutrition impact symptoms

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Citation: Keaver, L.; McLaughlin, C. A Latent Class Analysis of Nutrition Impact Symptoms in Cancer Survivors. *Dietetics* **2024**, *3*, 423–434. https://doi.org/10.3390/dietetics3040031

Academic Editor: Andriana Kaliora

Received: 28 June 2024
Revised: 9 September 2024
Accepted: 9 October 2024
Published: 15 October 2024

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1. Introduction

Nutrition impact symptoms are a common side effect of cancer treatments. They refer to any impediment with the ability to compromise oral intake [1]. They include dysphagia, pain, sore and dry mouth, constipation, nausea and vomiting, diarrhoea, fatigue, dental problems, and sensory and taste alterations. These can be experienced throughout treatment as well as after the completion of treatment. Nutrition impact symptoms have been associated with poorer quality of life and performance status [2]. The majority of individuals (50–90%) experience at least one nutrition impact symptom [3,4] and even at 12 months post-treatment their prevalence has been reported at 46% [2]. On average,

individuals report ten unresolved symptoms [5]. The most common symptoms experienced include dry mouth [2,6], nausea [2,7], constipation [2], lack of appetite [6], taste and smell changes [8], and fatigue. However, it is clear that there is large inter-individual variability in symptom occurrence [9,10].

These symptoms have been shown to adversely affect dietary intake, body weight, and functional capacity [11] and therefore identification and treatment of these symptoms are imperative in the management of those with cancer. It is also important that an understanding of how these symptoms can co-occur is reached to allow healthcare providers to develop more targeted and effective interventions for a group of symptoms rather than focussing on an individual symptom [12].

The aim of this research was (1) to examine the heterogeneity of nutrition impact symptoms in Irish Cancer Survivors, using the 13 nutrition impact symptoms identified in the Patient Generated Subjective Global Assessment short form; (2) to determine whether these subgroups differed on select demographic and clinical characteristics; and (3) to determine if these subgroups differed on quality-of-life outcomes.

2. Materials and Methods

Individuals over the age of 18 and with a cancer diagnosis who were attending the oncology day ward and outpatient department in Sligo University Hospital between September 2019 and March 2020 were recruited and completed a series of questionnaires and undertook handgrip dynamometry and anthropometric measurements. All participants provided written consent before enrolment and ethical approval was granted by the Research and Education Foundation Ethics Committee at Sligo University Hospital (No. 762).

2.1. Questionnaires

Participants completed a demographic questionnaire which collected information on gender, age, cancer type, year diagnosed, treatment received, recent weight loss, living situation, education status, and employment status. They also completed the Patient Generated Subjective Global Assessment short form (PG-SGA SF) [13]. This validated questionnaire is broken into four different sections: weight history, food intake, nutrition impact symptoms, and functional status. Information on the prevalence of 13 different nutrition impact symptoms was taken from this questionnaire. The questions can be viewed at the following link: PG-SGA© | Pt-Global. The EORTC QLQ-C30 [14] was used to determine quality of life. It includes Global Health Status (GHS), five functional scales, and nine symptom scales. This work focusses on the GHS and functional scales (physical functioning; role functioning; social functioning; emotional functioning; and cognitive functioning). Higher scores for GHS indicate a higher quality of life while higher scores for the functional scales characterise healthy functioning. The scales are scored from 0 to 100.

2.2. Anthropometry and Handgrip Strength

Weight and height were recorded by an oncology nurse with weight being measured with a Seca column weighing scale to the nearest 0.1 kg and height being measured using a Seca portable stadiometer to the nearest cm. Body Mass Index (BMI) was calculated using the formula weight/height2 (ref). BMI was classified as per WHO guidelines [15]: <18.5 kg/m^2 = underweight, >18.5 kg/m^2 and <25 kg/m^2 = healthy weight, $\geq$25 kg/m^2 and <30 kg/m^2 = overweight, and $\geq$30 kg/m^2 = obese.

Isometric handgrip strength was measured using a spring-loaded handgrip dynamometer (Takei 5001 Hand Grip Dynamometer-Grip A, Takei Scientific Instruments Co., Ltd., Tokyo, Japan). Three measures were recorded, and values reached were recorded to the nearest 0.5 kg. The highest value of the three tests was used for analysis [16,17].

2.3. Proposed Analytical Plan

For the analysis, we undertook a three-stage approach to the research. Firstly, we adopted Latent Class Analysis (LCA) as the main statistical approach in order to explore the number of possible hidden or latent typologies in the data. Using the binary observed indicators, it is expected that it will identify possible typologies [18,19] and for this reason LCA is seen as a "person-centred" statistical process [19]. For each with the latent class indicated, we defined a conditional model using each of the thirteen binary indicators; and furthermore, six separate models were estimated using Mplus 6.11 [20] using the robust maximum likelihood [21]. Also, in order to avoid solutions based on local maxima, 100 random sets of start value were used alongside 20 final stage optimisations. Model fit was assessed using several information theory-based fit statistics: Akaike Information Criterion (AIC) [22], Bayesian Information Criterion (BIC: Schwarz 1978), and the sample-size-adjusted BIC (ssaBIC) [23]. The model that produces the lowest values on each of these is the best fitting model. Additionally, the Lo–Mendell–Rubin adjusted Likelihood Ratio Test (LMR-LRT) [24] has also been employed to assist in class enumeration, where a non-significant value suggests that a lower class should be considered. Nylund et al. (2007) have identified the benefits of the LMR-LRT over the BIC in aiding decision making over the number of classes to accept [25].

Once the best fitting model was identified, at the second stage, one-way analysis of variance (one-way ANOVAs) was used to examine the association between class membership and the normally distributed variable, age. Kruskal–Wallis tests were used to examine the relationship between class membership and the non-normally distributed variables: BMI and handgrip strength. Crosstabulations with associated chi-squares were used to test for relationships between class membership and gender; age range; education; employment; living situation; BMI classification; time since diagnosis; cancer type; treatment status; treatment type; recent weight loss; and changes in food intake.

Differences in the mean Health Related Quality of Life (HRQL) scores between identified nutrition impact symptom classes were determined with ANCOVA, correcting for gender and age. Post hoc analyses were conducted using Bonferroni correction for multiple testing. All data analysis was conducted using IBM SPSS (Statistical Package for Social Sciences, Chicago, IL, USA) version 26 for Windows. All tests were two-sided and significant if $p < 0.05$.

3. Results

Two hundred and twenty-nine individuals were recruited. Individuals had a mean age of 63.5 (±12.0) years; the majority were female (n = 138, 61.1%), diagnosed less than five years (n = 167, 73.9%), and currently receiving treatment (n = 159, 70.4%). The main treatment type being received was chemotherapy (n = 129, 81.1% of those receiving treatment), followed by hormonal therapy (n = 19, 11.9% of those receiving treatment). The most common diagnosis was breast cancer (n = 58, 25.7%), followed by colorectal (n = 32, 13.8%), haematological (n = 28, 11.1%), lung (n = 12, 5.2%), and upper gastrointestinal/liver (n = 10, 4.3%).

3.1. Descriptive Trends in Indicators

Figure 1 presents the symptom breakdown for each of the indicators to be included in the LCA. The number of nutrition impact symptoms (NISs) experienced ranged from 0 to 11. The descriptive analysis indicated that the most commonly experienced symptoms were fatigue (27.1%) and taste changes (20.5%).

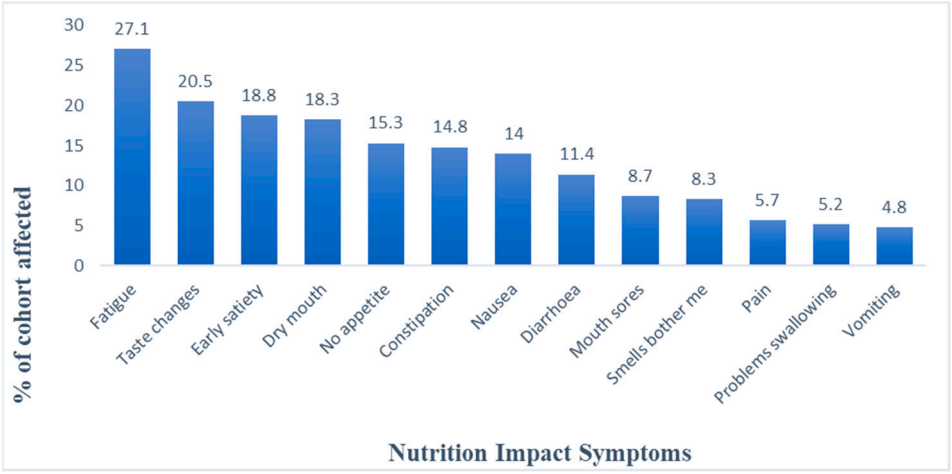

Figure 1. Nutrition impact symptoms experienced by the cohort.

3.2. Fit Indices and Latent Class Analyses

To explore the possible number of user symptom typologies, five conditional models were tested. However, model testing would cease at the fifth model or once a model failed to reach statistical significance. The fit indices of each of the models are displayed in Table 1. As the fourth-class model failed to research statistical significance, no further models were tested. The third class model was therefore considered the best fitting model. Though the AIC is near similar for the third and fourth class models, both the BIC and ssaBIC increased across class four, supporting the third class classified users compared to the BIC and ssaBIC values for the fourth class. In sum, not only do the LMR-LRT support the third-class model but it is preferred due to parsimony.

Table 1. Latent class fit indices for two to five class solutions.

Classes	LL	Par	AIC	BIC	ssaBIC	PB-LRT	*p*
1	−1111.921	13	2249.842	2294.480	2253.279		
2	−890.959	27	1835.918	1928.628	1843.056	441.924	0.000
3	**−860.126**	**41**	**1802.251**	**1943.034**	**1813.090**	**61.666**	**0.000**
4	−843.937	55	1797.874	1986.729	1812.414	32.377	0.200

Note: LL = Log Likelihood; Par = Parameters; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; ssaBIC = sample size-adjusted Bayesian Information Criterion; PB-LRT = Parametric Bootstrapped Likelihood Ratio Test. Best fitting LCA model in bold.

Table 2 contains descriptive information on the three classes along with associated probabilities. The lower the probability presented, the less of an issue it is for that particular latent class group; conversely, the higher the probability, the more likely it is to be an issue for those in the group. From the table, the second class was the largest (64%, n = 146) and it was clear that this group was associated with a very low probability of experiencing symptoms. Scores ranged from 0.00 to 0.04 on indicators; thus, this group was labelled "Low Symptom Burden" based on having little probability of experiencing symptoms. The next largest was the first class (25%, n = 58) of the sample. The only indicator to have higher probability was fatigue (0.56) and all other indicators were below 0.50. Based on this, class 1 was labelled "Fatigue" as this indicated a higher probability of membership. Lastly, class 3 was the smallest group that emerged from the data (11.0%, n = 25) and all the indicators except for "problems swallowing", "pain", "vomiting", and "diarrhoea" were reported above the cut-off point. Examining the probability values, these users were termed the "High Symptom Burden" group. A graph was also developed to aid the interpretation of the probabilities and how the three classes distinguish from each other across each of the symptom indicators (Figure 2).

Table 2. Descriptive information regarding the three classes that arose from LCA.

	Fatigue	Low Symptom Burden	High Symptom Burden
	1	**2**	**3**
No appetite	0.19	0.04	**0.67**
Nausea	0.26	0.00	**0.59**
Constipation	0.21	0.03	**0.61**
Mouth sores	0.07	0.01	**0.56**
Taste changes	0.38	0.03	**0.74**
Problems swallowing	0.08	0.00	0.28
Pain	0.04	0.01	0.37
Vomiting	0.09	0.00	0.21
Diarrhoea	0.16	0.03	0.48
Dry mouth	0.32	0.01	**0.80**
Smells bother me	0.08	0.00	**0.54**
Early satiety	0.34	0.00	**0.84**
Fatigue	**0.56**	0.03	**0.87**
Percentage	25%	64%	11%
N	58	146	25

Note: Probabilities over 0.50 bolded.

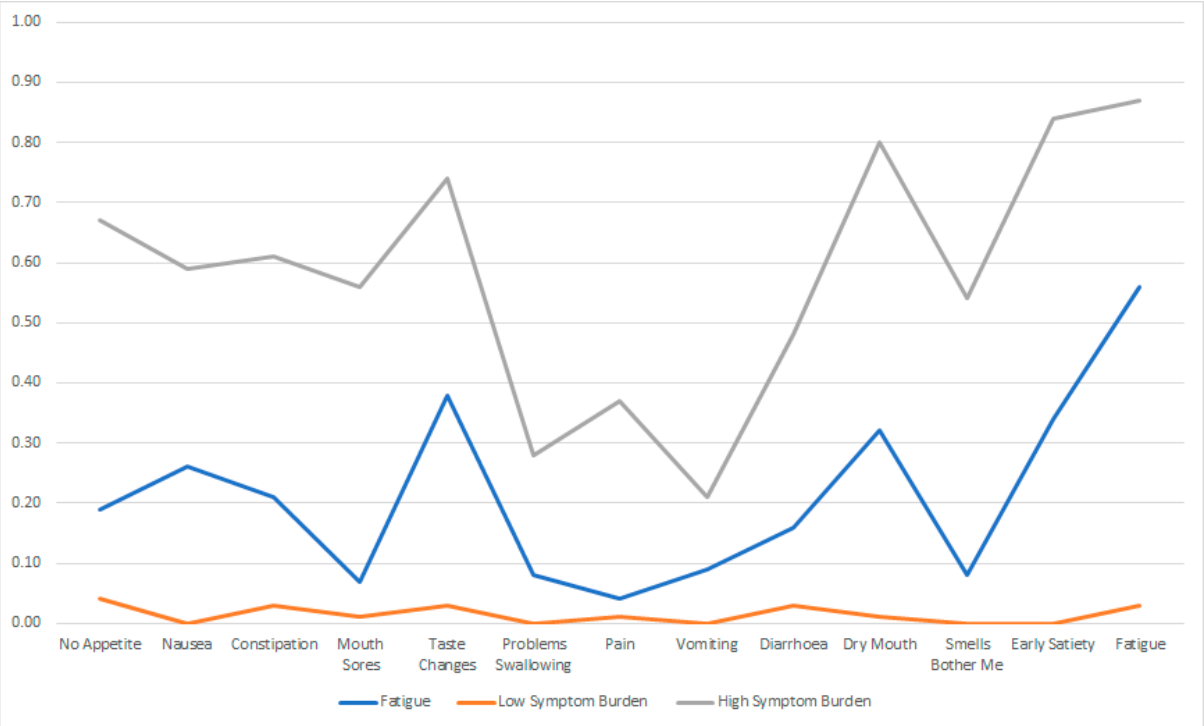

Figure 2. Probability of symptom occurrence for each of the latent classes for the 13 nutrition impact symptoms.

3.3. Differences in Characteristics among the Latent Classes

Table 3 summarises the differences in demographic, clinical, and nutrition-related characteristics among the three latent classes. Those in the High Symptom Burden group were significantly more likely to be female, to be currently receiving treatment, and to have a lower handgrip strength than those in the Low Symptom Burden group. Those in the High Symptom Burden Group were more likely to have reported consuming less food in the previous month compared to the Low Symptom Burden Group and the Fatigue Group. Those in the High Symptom Burden Group and the Fatigue Group were less likely to have reported their food intake to be unchanged in the last month and more likely to have been diagnosed ≥2 years ago than those in the Low Symptom Burden group. There were no

significant differences found based on cancer type. Cancer stage was not recorded. Those who were currently receiving treatment were more likely to be in the fatigue group than the low symptom burden group, similar findings for found for those who specifically received chemotherapy. No significant differences were found for those who received radiation therapy or hormonal therapy. Those not currently receiving treatment were more likely to be in the Low Symptom Burden group than the High Symptom Burden group.

Table 3. Differences in demographic, clinical, and nutrition-related characteristics among the three latent classes.

	Fatigue (1) n = 58 (25%)	**Low Symptom Burden (2) n = 146 (64%)**	**High Symptom Burden (3) n = 25 (11%)**	**Significance**
Age (mean ± SD)	63.66 (10.94)	63.17 (12.45)	63.54 (11.88)	NS (p = 0.69)
Age (years), n (%)				
<65	30 (51.7)	72 (50.3)	13 (52.0)	NS (p =0.98)
≥65	28 (48.3)	71 (49.7)	12 (48.0)	
Gender, n (%)				X^2 = 8.05
				p = 0.05
Males	20 (34.5)	64 (44.8)	4 (16.0)	1 < 3
Females	38 (65.5)	79 (55.2)	21 (84.0)	2 < 3
Education, n (%)				
<Third level	39 (68.4)	108 (76.6)	14 (56.0)	NS (p = 0.08)
≥Third level	18 (31.6)	33 (23.4)	11 (44.0)	
Employment, n (%) *				
Not working	43 (75.4)	87 (60.8)	18 (72.0)	NS (p = 0.11)
Working	14 (24.6)	56 (39.2)	7 (28.0)	
Living situation, n (%)				
Alone	7 (12.3)	38 (27.0)	5 (20.0)	NS (p = 0.08)
Family/Others	50 (87.7)	103 (73.0)	20 (80.0)	
BMI, median (IQR)	25.41 (5.12)	27.21 (6.53)	25.97 (6.88)	NS (p = 0.16)
BMI category, n (%)				
<25 kg/m^2	26 (44.8)	66 (46.1)	12 (48.0)	NS (p = 0.35)
25–29.99 kg/m^2	23 (39.7)	40 (28.0)	9 (36.0)	
≥30 kg/m^2	9 (15.5)	37 (25.9)	4 (16.0)	
Time since diagnosis, n (%)				X^2 = 10.16
				p = 0.01
<2 years	16 (27.6)	73 (51.4)	9 (36.0)	1 < 3
≥2 years	42 (72.4)	69 (48.6)	16 (56.4)	2 < 3 1 > 2
Currently receiving treatment, n (%)				X^2 = 8.08
Yes	49 (84.5)	92 (64.3)	18 (72.0)	p = 0.02
No	9 (15.5)	51 (35.7)	7 (28.0)	1 > 2 2 > 3
Experienced weight loss in last six months, n (%)				X^2 = 8.56 p = 0.01
Yes	28 (48.3)	45 (31.5)	14 (56.0)	No significant
No	30 (51.7)	98 (68.5)	11 (44.0)	contrasts
Food intake (last month), n (%)				X^2 = 28.610
Unchanged	22 (37.9)	102 (71.3)	10 (41.7)	p = 0.00
Consuming more	16 (27.6)	17 (11.9)	2 (8.3)	1, 3 < 2, 3 > 1, 1, 2 > 3
Consuming less	20 (34.5)	24 (16.8)	12 (50.0)	1, 2 < 3
Handgrip strength, median (IQR)	25.0 (8.4)	28.2 (11.3)	21.7 (8.1)	F(2) = 4.8, p = 0.01 1 < 2 NS 2 > 1 NS 3 < 2 p = 0.02

Abbreviations: IQR, Interquartile Range; NS, Not Significant; SD, Standard Deviation; * Working: full time, part time, homemaker, and self-employed were included in this category; Not working: retired, unemployed, and those on sick leave were included in this category.

3.4. Differences in Functioning and Global Health Status (GHS) between the Identified Classes

The EORTC-QLQ-C30 functioning and GHS scores were all significantly different between the three nutrition impact symptoms classes ($p < 0.001$) (Table 4). Survivors in the Low Symptom Burden Group scored the highest on all functioning and GHS subscales and those in the High Symptom Burden Group scored the lowest (Figure 3). Post hoc Bonferroni tests were significant for all GHS and functioning subscales, with the exception of that between Fatigue and the Low Symptom Burden Group for emotional functioning ($p = 0.33$), cognitive functioning ($p = 0.95$), and social functioning ($p = 0.33$) and that between Fatigue and the High Symptom Burden Group for role functioning ($p = 0.16$) (Table 5).

Table 4. Differences in Global Health Status and functional scales by nutrition impact classes.

Variables		M	SD	DF	F	Sig
Global Health Status	Fatigue	62.86	21.65	2	15.4	0.00
	Low Symptom Burden	71.38	18.70	222		
	High Symptom Burden	48.66	21.87			
Physical functioning	Fatigue	75.66	21.29	2	16.5	0.00
	Low Symptom Burden	83.81	17.58	221		
	High Symptom Burden	61.33	19.72			
Role functioning	Fatigue	68.42	30.16	2	10.8	0.00
	Low Symptom Burden	81.47	26.84	222		
	High Symptom Burden	55.99	32.59			
Emotional functioning	Fatigue	79.87	21.43	2	11.0	0.00
	Low Symptom Burden	84.63	20.29	218		
	High Symptom Burden	62.84	25.89			
Cognitive functioning	Fatigue	81.87	19.99	2	8.2	0.00
	Low Symptom Burden	82.98	22.25	222		
	High Symptom Burden	63.33	28.87			
Social functioning	Fatigue	71.05	27.19	2	7.8	0.00
	Low Symptom Burden	77.15	26.52	222		
	High Symptom Burden	53.99	33.08			

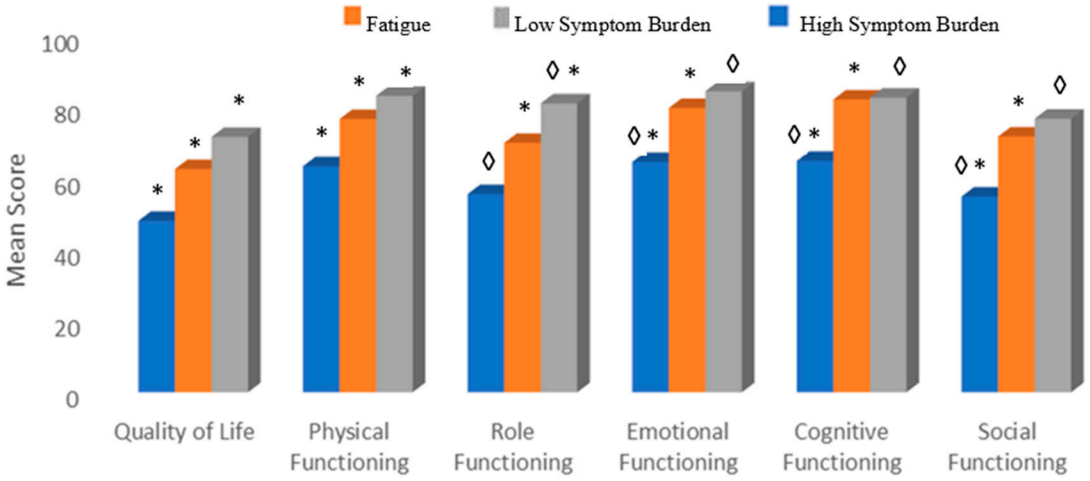

Figure 3. EORTC functioning and HRQL subscale scores according to the latent classes of cancer-related nutrition impact symptoms. Significant differences have been indicated with an *; e.g., for quality of life, there are significant differences between the Fatigue and Low Symptom Burden classes, between the Fatigue and High Symptom Burden classes, and between the Low and High Symptom Burden classes. Where there was a significant difference between some but not all classes, an additional symbol ◊ has been used; e.g., for cognitive function there are significant differences between the Fatigue class and the High Symptom Burden class (illustrated with an *) and between the Low Symptom Burden class and High Symptom Burden class (illustrated with an ◊), but not between the Fatigue class and Low Symptom Burden class.

Table 5. Post hoc comparisons between nutrition impact symptom classes.

Variable	Class A	Class B	Mean Difference (A)-(B)	Sig
Global Health Status	Fatigue	Low Symptom Burden	−8.5 *	0.02
		High Symptom Burden	14.2 *	0.01
	Low Symptom Burden	Fatigue	8.5 *	0.02
		High Symptom Burden	22.7 *	0.00
Physical functioning	Fatigue	Low Symptom Burden	−8.1 *	0.02
		High Symptom Burden	14.3 *	0.00
	Low Symptom Burden	Fatigue	8.2 *	0.02
		High Symptom Burden	22.5 *	0.00
Role functioning	Fatigue	Low Symptom Burden	−13.1 *	0.01
		High Symptom Burden	12.4	0.16
	Low Symptom Burden	Fatigue	13.1 *	0.01
		High Symptom Burden	25.5 *	0.00
Emotional functioning	Fatigue	Low Symptom Burden	−4.8	0.33
		High Symptom Burden	17.0 *	0.00
	Low Symptom Burden	Fatigue	4.8	0.33
		High Symptom Burden	21.8 *	0.00
Cognitive functioning	Fatigue	Low Symptom Burden	−1.1	0.95
		High Symptom Burden	18.5 *	0.00
	Low Symptom Burden	Fatigue	1.1	0.95
		High Symptom Burden	19.7 *	0.00
Social functioning	Fatigue	Low Symptom Burden	−6.1	0.33
		High Symptom Burden	17.1 *	0.03
	Low Symptom Burden	Fatigue	6.1	0.33
		High Symptom Burden	23.2 *	0.00

* statistically significant.

4. Discussion

This research aimed to identify groups of cancer survivors with specific patterns of nutrition impact symptoms. Three latent subtypes were identified: (1) Fatigue (n = 58, 28%); (2) Low Symptom Burden (n = 146, 64%); and (3) High Symptom Burden (n = 25, 11%). The EORTC-QLQ-C30 functioning and GHS scores were all significantly different between the three nutrition impact symptoms classes ($p < 0.001$).

It is difficult to directly compare our results to those of previous studies given the methodological differences in terms of study setting, cancer types, demographic factors, and the statistical methods used [10,26–28], but two of the groups we identified, the High Symptom Burden and Low Symptom Burden groups, are in general agreement with those of prior works. Those in the High Symptom Burden group were more likely to be female, which is consistent with other LCA studies [10,18,29,30].

The High Symptom Burden group scored the lowest on all functioning and GHS scales, which is consistent with previous reports [9,10,31]. Those in the Low Symptom Burden group scored the highest on all functioning and GHS scales. Compared with the Low Burden class, the differences in QOL subscale and total scores for the other two latent classes represent not only statistically significant but clinically meaningful decrements in QOL [32,33]. This highlights a relationship between nutrition impact symptoms and quality of life, although given the cross-sectional nature of this work it cannot be determined in which direction this relationship lies.

This study is the first to identify a group of cancer survivors who report moderate levels of fatigue but low levels of other symptoms (Table 2). Those in the Fatigue group were more likely to have received their diagnosis more than two years ago compared to

those in the Low Symptom Burden group. Fatigue remains a pervasive issue in cancer survivorship, with studies indicating that a significant proportion of survivors feel fatigued, even years after active treatment has been completed [34,35]. As the number of long-term cancer survivors increase [36], it is important that we understand the persistent or late effects of treatment. Cancer-related fatigue significantly impacts survivors' quality of life, daily functioning, and overall well-being [37]. This can lead to decreased physical activity and social engagement, exacerbating feelings of isolation and depression, which are already prevalent in this population [38].

While the Low Symptom Burden group experienced very low levels for each symptom, in both the High Symptom Burden group and the Fatigue group, fatigue and taste changes were the most common symptoms experienced. Although the probability of occurrence in the total sample was 27.1% and 20.5%, respectively, the probability ranged from 3% to 87% in the symptom groups. Early satiety was also commonly seen (0–84%). Clinicians therefore should assess these three symptoms routinely to ensure that patients are treated appropriately on a routine basis.

To our knowledge, this is the first study investigating nutrition impact symptom profiles among cancer survivors with various cancers, using a patient-centred statistical approach. The diversity of our population regarding cancer sites and stages reflects everyday practise. Our study has several limitations. It is based on the nutrition impact symptoms included in the PG-SGA short form and thus may not have incorporated all nutrition impact symptoms that can be experienced. While the inclusion of patients with various tumour sites and stages increases the general applicability of our results, the numbers of patients with each tumour site were too small for subgroup analyses. In addition, we cannot discuss causal relationships as the study was cross-sectional in nature, nor could we explore group membership over time.

Our findings have important clinical implications including personalised advice and management, improved prognostic accuracy, and improvements in quality of life. The identification of three symptoms groups may help clinicians differentiate patients based on the level of nutritional risk, allowing for more personalised plans to be developed based on the specific needs and challenges of each group. It could also assist in optimising medication use, ensuring more effective management of experienced symptoms while reducing unnecessary treatments and potential side effects. Recognising specific symptom patterns could lead to earlier and more specific interventions. For example, if individuals were identified as being in or likely to be in the Fatigue group at an early point in their treatment, then advice on how to manage this, such as preparing meals when they feel they have energy and freezing them for later use, obtaining help with shopping and food preparation, and eating foods that require little preparation and can be snacked on frequently, could assist in ensuring individuals have the knowledge to consume a nutritious diet even when experiencing fatigue.

Addressing symptom clusters rather than individual symptoms could provide more comprehensive relief to patients, significantly enhancing their quality of life. Different symptom groups are likely to come with unique psychological and social challenges and tailored support services could be provided to patients and their families, addressing specific emotional and social needs more effectively if these symptom clusters are better understood. Finally, better understanding symptom groups could allow for stratification within clinical trials, leading to more reliable and generalisable results.

Future research could longitudinally explore the outcomes for each group, allowing more accurate predictive models for patient prognosis to be developed. It could also focus on longitudinal analysis to determine any changes in group membership.

We found no current studies which developed and evaluated the usefulness of interventions targeted at symptom cluster groups. It would be interesting to determine if treatment of and improvement in one symptom could indirectly improve another symptom in the cluster. It will also be important to determine which interventions are clinically feasible and effective.

Current strategies that healthcare professionals could adapt based on the findings of this work include the following: (1) educating patients and caregivers about common symptom groups to assist in better recognition and reporting of symptoms, leading to timely nutrition intervention and support; and (2) exploring how healthcare resources can be allocated more efficiently by understanding which of the symptom groups require more intensive care and support.

5. Conclusions

This is the first study to examine the heterogeneity of nutrition impact symptoms in Irish cancer survivors. This nuanced understanding enables healthcare professionals to develop personalised treatment and management strategies that address the unique needs of each symptom cluster. By tailoring interventions to these specific groups, we can enhance the precision of care, improve prognostic accuracy, and significantly elevate the quality of life for survivors. Furthermore, this categorisation facilitates more targeted research, leading to better resource allocation and optimised clinical trials. This work underscores the critical importance of symptom management in the continuum of cancer care, ensuring that every survivor receives comprehensive support tailored to their unique journey.

Author Contributions: Conceptualization, L.K. and C.M.; methodology, L.K. and C.M.; software, C.M.; formal analysis, L.K. and C.M.; investigation, L.K.; data curation, L.K.; writing—original draft preparation, L.K.; writing—review and editing, L.K. and C.M.; project administration, L.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki, and approved by the Research and Education Foundation Ethics Committee at Sligo University Hospital (No. 762).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are available on request.

Acknowledgments: We would like to thank all those who took part in this piece of research.

Conflicts of Interest: The authors declare no conflicts of interest.

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