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Impact of Nutrition Education on Nutritional Status, Tolerance and Response to Chemotherapy: Experience at Douala General Hospital, Cameroon, Central Africa

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Abstract: *Objective:* The overall aim of this study was to determine the impact of nutrition education on the tolerance and response to chemotherapy of cancer patients at Douala General Hospital. *Material and methods*: This was a 2-arm randomized comparative study done over a 5-months period from November 1, 2016 to March 31, 2017. A total of 107 patients with all cancers undergoing chemotherapy were randomized into 2 groups after obtaining their informed consent: the group that received nutrition education with each cycle of chemotherapy, and the group without nutrition education that received only the usual treatment. *Results*: The mean age was 46.6 ±15.3 years. The most common cancers were breast cancer (36.4%) and cervical cancer (19.4%). The incidence of undernutrition in our study population was 45.8%, of which 35.5% was moderate and 10.3% severe. Patients in the nutrition education group showed a marked improvement in their nutritional status after 3 cycles of chemotherapy, tolerated the treatment better and had a better response to it. Conversely, patients in the group without nutritional education showed a deterioration in their nutritional status, tolerated treatment less and also responded less to it. Moreover, in the

latter group, the risk of not responding to treatment was 19.6 times greater than in patients who received nutritional follow-up. *Conclusion*: Nutritional education had a significant impact on patients' nutritional status, tolerance and response to chemotherapy.

Keywords: Nutritional Education, Nutritional Status, Chemotherapy, Tolerance, Response

1. Introduction

Undernutrition is a frequent complication of cancer progression, linked to an imbalance between needs that are sometimes increased by the tumour, and intakes that are often reduced (by obstruction of the digestive tract, appetite disorders, etc.) [1]. Its overall prevalence in cancer varies from 40% to 80% [2]. Deterioration in the nutritional status of cancer patients increases morbi -mortality and therapeutic costs [3]; moreover, it diminishes the tolerance and efficacy of the various treatments, in this case chemotherapy, and thus modifies patients' quality of life. Despite its self-sufficiency in food, thanks to the development of the agricultural sector, Cameroon remains a poor country, with low purchasing power and a minimum monthly wage estimated at 55 euros (36,000 XAF). The recently introduced universal health coverage does not include cancer care [4, 5]. As a result, the initiation of a specific anti-cancer treatment, generally expensive, has consequences for the patient's basic social needs (clothing, food, etc.). Knowing what to eat at the lowest cost to cover basic nutritional needs and avoid undernutrition is therefore a daily challenge for most cancer patients and practitioners in Cameroon. Hence the interest of this study, whose aim was to assess the impact of nutritional education adapted to local socio-economic conditions on the tolerance and response to chemotherapy of cancer patients.

2. Patients and Methods

2.1. Type of Study

This was an unblinded 2-arm randomized comparative study conducted from November 1, 2016 to March 31, 2017 at the Douala General Hospital (DGH) chemotherapy day hospital.

2.2. Inclusion Criteria

We included in the study any consenting patient with an anatomopathological diagnosis of cancer, a WHO performance index less than or equal to 2 [6] and admitted to the HGD day hospital for their first cycle of chemotherapy.

2.3. Sampling

Patients fulfilling our inclusion criteria were selected after obtaining their informed consent, then randomised into two groups.

2.3.1. Sample Size

According to a study by Ravasco et al in Portugal in 2005 [7], the number of well-nourished patients rose from 59.45% to 83.78% following nutritional intervention. Nutritional education improved the nutritional status of 24.33% of patients. We determined the number of subjects needed to obtain a 24.33% (Δ= 0.24) difference in nutritional status between the two groups with a 10% risk of first order error, i. e., $\alpha = 0.1$ and $z_{1-\alpha} = 1.645$, and a 10% risk of second order error (β), i. e., $z\beta = -1.282$.

The formula was:

$$n = \left[\frac{\left\{Z_{1-\alpha}\sqrt{2\bar{\pi}(1-\bar{\pi})} - Z_{\beta}\sqrt{\pi_1(1-\pi_1)+\pi_2(1-\pi_2)}\right\}}{\Delta}\right]^2 ; \ \bar{\pi} = \frac{\pi_1+\pi_2}{2}$$

After numerical application, a minimum of 59 subjects had to be included in each group to meet the expectations of the study.

2.3.2. Randomization

We performed a simple randomization, which consisted of randomly selecting, for each included patient, a number between 0 and 1 using the "rand ()" function in Microsoft Excel 2013 software.

In order to obtain an equiprobable distribution, groups were assigned according to a probability *p* equal to ½. Patients with a score lower than *p were assigned to* the group without nutritional education (54 patients), and those with a score higher than *p* to the group with nutritional education (53 patients).

2.4. Procedure

2.4.1. Interview

Patients from both groups were interviewed at consultation every 3 weeks for 3 months prior to the start of each chemotherapy cycle. Patients were then examined and clinical findings recorded in the medical record. The data collection instrument was a form that collected the following information:

1. Socio-demographic characteristics
2. Clinical features: Type of cancer, WHO Performance Status (PS), Nutritional status (previous weight, current weight, percentage of weight loss, height, Body Mass Index, brachial circumference, ingestion measurement, nutritional assessment category or APG nutritional index);
3. Therapeutic characteristics: tolerance to chemotherapy (major toxicities), response to chemotherapy (complete response, partial response, stabilization, progression).

2.4.2. Intervention and Events of Interest

(i). Intervention

Our intervention consisted of personalized nutritional education and monthly follow-up. This intervention was carried out by the DGH dietetics service team and medical or

dietetics students previously trained and posted at the chemotherapy day hospital.

Each patient was seen individually at least 3 times during each chemotherapy cycle. The average interview lasted 45 minutes. This depended on the patient's level of understanding. The session was interactive, beginning with an introduction to the patient. It continued with the transmission of knowledge, focusing on specific points depending on what the patient had said during the first part of the interview. It ended with a series of bi-directional questions and answers. The second and third interviews, unlike the first, began with a reminder of the recommendations given during the previous interview.

The following points were covered during the education sessions:

1. How can I balance my diet during chemotherapy?
2. Which foods should I choose, and which should I cut back on?
3. How can I manage the side effects of chemotherapy?

Follow-up was also by telephone, using the "24-hour reminder". This was carried out twice throughout the study, at 1st and 3rd chemotherapy cycles. Each patient was asked to recall the number of meals and all food and drink consumed during the 24 hours preceding the interview. The information obtained was recorded on the patient's data collection sheet.

(ii). Follow-up of the Group Without Intervention

Patients in the group without personalized nutrition education benefited from the usual management of toxicities and nutritional complications by the medical team of the DGH chemotherapy day hospital.

(iii). Events of Interest

Three events of interest were defined for this study:

1. Patients' nutritional status between chemotherapy cycles. Nutritional status was measured by weight variation between cycles (% weight loss or gain) and the Subjective Global Assessment (SGA) nutritional index.
2. Chemotherapy tolerance was assessed by two main criteria: (i) patients' WHO Performance Status at the end of each chemotherapy cycle, and (ii) the proportion of toxicities occurring at the end of each chemotherapy cycle.
3. Therapeutic response was assessed after the 3rd cycle of chemotherapy or 1 month after the end of concurrent chemoradiation where applicable, using the RECIST 1.1 criteria developed by Eisenhauer et *al.* in 2009 for solid tumors [8].

2.5. Definitions of Operating Terms

Overall: The word "Overall" was used to designate the two groups of patients (intervention group and non-intervention group).

Anthropometric parameters

1. Weight: this was expressed in kilograms and measured on the same scales for all patients, placed on a horizontal surface. The patient stepped onto the scale after removing as many clothes and accessories as possible. Once on the scale, the patient was asked to look straight ahead, and the weight obtained was noted.
2. Height: this was expressed in meters and was measured using a measuring rod placed on a flat, solid surface, the same one being used for all patients. The patient had to take off his shoes and stand on it, and the measurement obtained was noted.

Percentage weight loss: this was obtained through calculation, using parameters such as current weight and usual weight resulting from the patient interview. The formula is as follows:

Percentage weight loss (%) = (Usual weight - Current weight) x 100/ Usual weight

Body Mass Index: this was calculated after obtaining weight and height, and was expressed in kg/m^2 using the following formula: BMI=Weight/Height^2.

Body mass index is a valuable tool for detecting undernutrition and its risk [9]. BMI normality limits have been set by the WHO at between 18.5 and 24.9 kg/m^2, with no distinction made between the sexes. For values below 18.5 kg/m^2 different grades of undernutrition are also proposed.

Branchial circumference: measured at mid-distance between the acromion and the olecranon, using a non-elastic 0.1 cm precision tape measure on a bare arm, without compressing the underlying tissues. All patients with a brachial circumference of less than 25cm in men and less than 20cm in women were considered malnourished.

1. *The nutritional index* estimated from the Subjective Global Assessment (SGA): assesses nutritional status on the basis of questioning (weight change, change in food intake, gastrointestinal symptoms that have persisted for more than two weeks, and functional capacity) and physical examination (subcutaneous fat loss, muscle atrophy) and classifies it into 3 levels:
2. Normal nutrition (A);
3. Moderate undernutrition (B);
4. Severe undernutrition (C). [10]

Measuring food consumption (ingestion):

Food consumption frequency: patients were asked about their weekly food consumption frequency, focusing on different food groups and the number of meals they ate each day.

Disease stage: based on the UICC TNM classification, three categories have been defined: (i) local (T_1, T_2, T_3 N_0); (ii) locoregional (T4 or involvement of at least one regional lymph node); (iii) generalized (presence of distant metastases).

Tolerance to chemotherapy: this was assessed based on two parameters: The performance index and the WHO toxicity grade classification [6, 11].

WHO toxicity grade classification: this was obtained from a clinical examination of the patient and his or her pre-therapy check-ups before each cycle of chemotherapy. The results obtained were recorded on the data collection form.

Response to chemotherapy

Response to chemotherapy was assessed according to

RECIST version 1.1 criteria as follows:

1. Complete response (CR): Disappearance of all lesions. In addition, all lymph nodes (target or non-target) must have reached a dimension < 10 mm in their smallest axis.
2. Partial response (PR): Reduction of at least 30% in the sum of target lesion diameters compared with the initial sum of diameters.
3. Progression (PD): Increase ≥ 20% in the sum of the diameters of target lesions compared with the smallest sum of diameters observed during the study. In addition to this relative increase of 20%, this sum must increase by at least 0.5 cm.
4. Stabilization (SD): Neither RP (or RC), nor PD.

This assessment was carried out mainly by the medical team at the DGH, who did not know to which group each patient belonged.

2.6. Ethical Considerations

The research protocol drafted for the realization of this study was submitted to the Institutional Ethics Committee for Human Health Research of the University of Douala and obtained the ethical clearance N° CEI-Udo/824/03/2017/T of March 09, 2017. This work also benefited from an Administrative Research Authorization from the Douala General Hospital, N° 068AR/MINSANTE/HGD/DM/02/17. An explanatory notice was applied to all participants who gave informed consent prior to inclusion in the study. The names of study participants were coded to preserve anonymity. The risk-benefit analysis of the study was in favour of the benefits.

2.7. Statistical Analysis

Data were entered using Epi InfoTM version 7.1.5.2 and analysed using R Studio Version 1.0.143 statistical software. Chi-square and Fisher tests were used for qualitative variables, and Student's t test for quantitative variables. The final significance level for statistical tests was set at 10% ($p < 0.1$). Results were presented using tables and graphs (constructed using Microsoft Office Excel® 2016).

3. Results

Between November 1er 2016 and March 31 2017, 243 patients were selected for the study. 112 were excluded and 131 were randomized: 62 patients in the nutrition education group and 69 in the non-nutrition education group. 9 patients were lost to follow-up in the nutrition education group and 15 in the non-education group. In all, 107 patients were included, 53 in the intervention group and 54 in the non-intervention group. (see Figure 1)

3.1. Sociodemographic, Anthropometric and Clinical Characteristics of Study Patients

Overall, the mean age of patients was 46.6 years (± 15.3), with a predominance of women (74.8%) and a sex ratio (M:F) of 0.34: 1. The majority of patients (44.9%) had a higher level of education, as shown in Table 1.

Overall, as in the patient groups, breast cancer was the most frequent (36.4%; n=39), followed by cervical cancer (19.6%; n=21) and cancers of the upper aerodigestive tract (16.8%; n=18). Table 2 shows the distribution of the two patient groups by cancer type.

In both groups (with and without intervention), the majority of patients (61.7%, n=66) were in the locoregional stage as shown in Table 3.

Figure 1 shows the distribution of the two patient groups according to the WHO performance index. Before the 1st cycle of chemotherapy, 81.5% of patients in the non-intervention group had a performance index below 2, compared with 50.9% in the intervention group.

3.2. Nutritional Status of Patients Before the 1st Chemotherapy Cycle

Before the first cycle of chemotherapy, 58 patients (54.2%) overall had a normal nutritional status, 38 (35.5%) were moderately undernourished and 11 (10.3%) were severely undernourished. Thirty patients (56.6%) were undernourished at the start of chemotherapy in the intervention group, compared with 19 (35.2%) in the non-intervention group, as shown in Table 4.

In terms of dietary habits, 18.5% of patients reported eating vegetables at least 5 times a week, 20.6% milk and dairy products and 25.2% fruit. Table 5 shows the distribution of the two groups of patients according to the frequency of weekly consumption of different foods.

3.3. Therapeutic Features

Overall, as in each group, platinum-based protocols were the most frequently administered at the chemotherapy day hospital (43%, N=46). Concerning the rhythm of chemotherapy, 83% (44) of patients in the intervention group and 75.9% (N=41) in the non-intervention group received chemotherapy every three weeks (rhythm D1=D21). Whereas 17% (N=9) of the intervention group and 24.1% (N=24) of the non-intervention group received chemotherapy on a fortnightly or weekly basis. (see Table 6)

Sixty-four patients (59.8%) were receiving or had received another specific treatment (29.0% surgery and 30.8% radiotherapy).

3.4. Impact of Intervention on Nutritional Habits

Table 7 compares the number of daily meals (based on a 24h recall) at 1st cycle with that at 3rd cycle of chemotherapy in each intervention group. In both groups, there was a significant difference between the number of meals per day at 1st cycle and at 3rd cycle. In the nutrition education group, the frequency of daily meals had increased by the third cycle in a large proportion of patients (90.6% of patients were eating at least 3 meals a day at 3rd cycle versus 24.5% at 1st cycle). Conversely, in the group that did not receive nutrition education, the frequency of daily meals decreased in the third cycle in a large proportion of patients (only 11.1% of patients were eating at least 3 meals a day in the 3rd cycle, compared

with 55.6% in the 1st cycle).

In terms of food groups, patients in the intervention group consumed more vegetables (88.7% vs. 45.3% in 1st cycle; $p < 0.001$), more dairy products (94.3% vs. 9.4% in 1st cycle; $p < 0.001$) and more fruit (92.5% vs. 17.0% in 1st cycle; < 0.001) in the 3rd cycle. In the group that did not receive nutrition education, patients consumed fewer vegetables (16.7% vs. 57.4% at 1st cycle; $p < 0.001$), fewer dairy products (3.7% vs. 42.6% at 1st cycle; $p < 0.001$) and less fruit (5.6% vs. 55.6% at 1st cycle; $p < 0.001$) at 3rd cycle.

3.5. Impact of Nutrition Education on Patients' Nutritional Status, Tolerance and Response to Chemotherapy

Figures 3 and 4 compare the nutritional status of patients in the 2 groups at the 2nd and 3rd chemotherapy cycles respectively. At the 2nd chemotherapy cycle, only 3.8% of patients in the nutrition education group were undernourished, compared with 94.4% of patients in the non-education group ($p<0.001$). In the group without nutritional education, the proportion of undernourished patients was significantly higher than that observed in the 2rd chemotherapy cycle (38.9% moderate undernutrition in the 3rd cycle versus 18.5% in the second cycle; $p<0.001$).

We compared the WHO performance status in the two groups, as shown in figure 5; at 3rd cycle, 96.2% of patients in the nutrition education group had a performance status below 2, compared with 14.8% in the non-nutrition education group, with a statistically significant difference.

At the end of the 1st cycle of chemotherapy, there was no significant difference between the onset of toxicities in the 2 groups. At 3rd cycle, with the exception of constipation, hematological, gastrointestinal and dermatological toxicities were higher in the group without nutritional education than in the group with nutritional education (see figure 6).

With regard to therapeutic response, the proportion of patients who responded to chemotherapy was higher in the group of patients who received nutritional follow-up (96.2% versus 25.9% in patients who did not receive nutritional follow-up), as shown in figure 7. The risk of having a stable or progressing disease at the end of chemotherapy in patients who did not receive specific nutritional follow-up during chemotherapy was 19.6 times greater than in patients who did receive nutritional follow-up.

4. Discussion

4.1. Frequency of Undernutrition

The incidence of undernutrition in our study population was 45.8%, with 35.5% moderate and 10.3% severe according to the SGA. These results are similar to those found by Wu et al in China in 2009, who found a frequency of undernutrition of 48.2% of patients after assessment according to the SGA [12]. However, the frequency of undernutrition found in our series is higher than those found by Ravasco et al in Portugal in 2005 and Pressoir et al in France in 2010 (40.5% and 30.9%) [1, 7]. These variations in frequency may be due to differences between the cancer sites found in the studies, the stages of these cancers, the treatments received by patients, and also the tool used to assess undernutrition.

4.2. Impact of Nutrition Education on Patients' Nutritional Status

Cytostatic-based therapies do not differentiate between diseased and healthy cells [13]. Chemotherapy is therefore a risk factor for undernutrition, and significantly influences nutritional status [13]. But nutritional intervention, started as early as possible, can lead to a reduction or improvement in nutritional status, quality of life, performance index, strength and physical activity, as well as increased treatment tolerance and better outcomes [14].

In terms of nutritional status, in the group with nutritional education, moderate and severe undernutrition fell from 67.9% in the 1st cycle to 3.8% in the 2nd cycle, then to 1.9% in the 3rd cycle. On the other hand, in the group without nutritional intervention, moderate and severe undernutrition fell from 53.7% at 1st cycle to 24.1% at 2nd cycle, then to 40.8% at 3rd cycle. This result is all the more important given that, at the start of chemotherapy, patients in the nutrition education group were more undernourished than those in the non-education group ($p=0.06$). The result thus obtained is similar to that of Ravasco et al in Portugal in 2005, who demonstrated that the nutritional status of patients who had received nutritional advice was significantly improved compared with that of patients who had just received the usual treatment ($p<0.001$) [7]. Our result is also in agreement with Isenring's 2004 study in England, in which patients who had received nutritional education had maintained or had a small weight loss in contrast to patients who had only received the usual treatment [15]. The main reasons why our approach was effective would be: the message was objective, practical, simple, and reinforced by boards. In addition, the message was culturally sensitive; each topic was treated according to the patient's level of understanding; goals and strategies were proposed and discussed with the patient to optimize adherence to the recommendations.

4.3. Impact of Nutrition Education on Tolerance and Response to Chemotherapy

At 1st cycle, among patients in the nutrition intervention group, 50.9% had a performance status below 2 and were therefore able to work, whereas in the group without nutrition education, we had around 81.5% of patients able to work ($p= 0.002$). This trend was reversed at the 2nd chemotherapy cycle, when 88.7% of patients were in the nutrition education group versus 38.9% in the non-nutrition education group, and even more so at the end of the 3rd cycle, when 96.2% were in the nutrition education group versus 14.8% in the non-nutrition education group ($p<0.001$). This result corroborates that of Bauer et al in 2005, who demonstrated in their series an improvement in the performance index in patients admitted for chemotherapy and receiving dietary advice [16]. Xavier Hébuterne has also highlighted this improvement in prognosis associated with active dietary management during radiotherapy and chemotherapy [17].

The involuntary reduction in food intake that is an indirect consequence of the disease is a fact of life for most patients. However, combined with the onset of adverse effects during chemotherapy, this reduction in food intake precipitates the onset of undernutrition [18].

At the end of the 1st cycle of chemotherapy, there was no significant difference between the onset of systemic toxicities in the 2 groups. This could be explained by the fact that short-term nutrition education had no significant impact on chemotherapy tolerance. On the other hand, at 2rd and 3rd cycles of chemotherapy, the occurrence of systemic toxicities was significantly lower in the nutrition education group than in the group without nutrition education. These results are all the more important in the case of gastrointestinal toxicity, as this constitutes a real barrier to the nutrition of patients undergoing chemotherapy [19]. As long ago as 1992, Nayel et al. reported that nutritional intervention carried out earlier could lead to improved treatment tolerance and better results [20]. We can therefore see the impact of continuous nutritional monitoring on chemotherapy tolerance in cancer patients at Douala General Hospital.

Response to chemotherapy treatment can be influenced by nutritional status, which in turn influences patients' performance index and quality of life [20].

After the 3rd chemotherapy session, treatment response was assessed. In the nutrition education group, 96.2% of patients were responders versus only 25.9% in the non-nutrition education group ($p<0.001$). What's more, in the group without nutrition education, the risk of being non-responders to treatment was 19.6 times greater than in patients who received nutrition follow-up. This large relative risk would demonstrate the need for optimal nutritional intervention in cancer patients, and is in line with the assertion by Chappuis et al that optimal nutritional management aims to improve tolerance and response to treatment [18].

4.4. Validity and Limitations of Our Study

In our study, selection bias was inferably limited, since the main inclusion criterion was having an indication for chemotherapy. As an investigator, we therefore had no real influence on the decision to include participants.

Allocating patients to the 2 groups by randomization enabled us to ensure balanced numbers in each group, as well as equalizing the distribution of all third factors in the study population, despite the relatively small number of subjects in our sample. We were thus able to prevent the occurrence of confounding bias.

The absence of blinding in our study could lead to a bias in the measurement of our events of interest. Indeed, we might have been tempted to carry out a more active search in patients without nutrition education than in patients with nutrition education. But this bias was limited by a clear and standardized definition of the different measures (weight for nutritional status, WHO toxicity grades for side effects, WHO score for performance level and RECIST classification for response to chemotherapy). However, the use of biological criteria would have been more objective for measuring response to chemotherapy.

During follow-up, 15 patients were lost to follow-up in the non-intervention group and 9 in the intervention group. These patients were not taken into account in our analyses, which could have an impact on measuring the effectiveness of our intervention in the event that their exit from follow-up was linked to their nutritional status. In this case, there could be an underestimation of the frequency of undernutrition in the group concerned. In our study, we believe that this proportion of dropouts could be explained by a lack of financial means, given the cost of drugs and hospitalization in the chemotherapy department. Indeed, as Brami et al pointed out in a study on the problem of the cost of new therapies in oncology in Morocco, despite their effectiveness, cancer therapies pose a major problem of cost, making them inaccessible to the majority of patients in developing countries [21]. On the other hand, the fact that there were more drop-outs in the group without nutritional education than in the group with intervention could be the result of this lack of nutritional intervention.

5. Conclusion

The frequency of undernutrition in the chemotherapy day hospital is 45.8% according to the *SGA*. Nutritional education improved the nutritional status of patients in the intervention group, from 67.9% undernutrition at 1st cycle to 1.9% at 3rd cycle of chemotherapy. Conversely, patients in the non-education group saw very little improvement in their nutritional status. In fact, undernutrition fell from 53.7% at 1st cycle to just 40.8% at 3rd cycle.

Nutritional education had positively and significantly influence patients' tolerance of chemotherapy, response to treatment. WHO performance status was below 2 in 96.2% of patients in the intervention group, versus 14.8% in the non-intervention group. The frequency of occurrence of hematological, digestive and skin toxicities ranged from 0 to 20.8% in the intervention group, versus 46.6% to 92.6% in the non-intervention group. Response rates to chemotherapy after 3 cycles were significantly higher in the intervention group, at 96.2% versus 25.9% in the non-intervention group.

Table 1. *Socio-demographic characteristics of the study population.*

Variables	Total workforce (N=107)	Nutrition education group (N1=53)	Group without nutritional education (N2=54)	P value
Age (years)				
Average (Standard deviation)	46,6 (± 15,3)	47,0 (± 15,0)	46,4 (±15,7)	0,83
Gender, n (%)				
Female	80 (74,8)	39 (73,6)	41 (75,9)	0,95

Variables	Total workforce (N=107)	Nutrition education group (N1=53)	Group without nutritional education (N2=54)	P value
Male	27 (25,2)	14 (26,4)	13 (24,1)	
Level of education n (%)				
No	4 (3,7)	2 (3,8)	2 (3,7)	
Primary	12 (11,2)	8 (15,1)	4 (7,4)	
Secondary	43 (40,2)	19 (35,8)	24 (44,4)	
Superior	48 (44,9)	24 (45,3)	24 (44,4)	

N: total workforce (N1 +N2) n: understaffing %: percentage

Table 2. *Distribution of the two groups of patients by cancer type.*

	Overall (N=107)	Nutrition education group (N1=53)	Group without nutritional education (N2=54)	P value
Type of cancer, n (%)				
Breast cancer	39 (36,4)	16 (30,2)	23 (42,6)	
Cervical cancer	21 (19,6)	11 (20,8)	10 (18,5)	
Head and Neck cancer	18 (16,8)	9 (17,0)	9 (16,7)	0,76
Digestive cancer	12 (11,2)	7 (13,2)	5 (9,3)	
Other cancers	17 (15.9)	10 (18,9)	7 (13,0)	

N: total number of employees (N1 +N2)

Table 3. *Population distribution by disease stage.*

Cancer stage	Overall (N=107)	Nutrition education group (N=53)	Group without nutritional education (N=54)	P value
	N (%)	N (%)	N (%)	
Local	17 (15,9)	6 (11,3)	11 (20,3)	
Locoregional	66 (61,7)	34 (64,1)	32 (59,3)	0,43
Generalized	24 (22,4)	13 (24,5)	11 (20,4)	

N: headcount; n: understaffed; %: percentage.

Table 4. *Distribution of the two groups of patients according to nutritional status before the 1er chemotherapy cycle.*

Nutritional status at start of chemotherapy, n (%)	Overall (N=107)	Nutrition education group (N=53)	Group without nutritional education (N=54)	P value
Normal	58 (54,2)	23 (43,4)	35 (64,8)	
Moderate undernutrition	38 (35,5)	22 (41,5)	16 (29,6)	0,06
Severe undernutrition	11 (10,3)	8 (15,1)	3 (5,6)	

Table 5 *Distribution of the two groups of patients according to the frequency of weekly consumption of different foods.*

	N (%)	Nutrition education group (N1 =53)	Group without nutritional education (N2=54)	P value
Starches and cereals, n (%)				
< 5 times	1 (0,9)	0 (0,0)	1 (1,9)	1,00
5 times or more	106 (99,1)	53 (100,0)	53 (98,1)	
VPO and legumes, n (%)				
< 5 times	25 (23,4)	12 (22,6)	13 (24,1)	1,00
5 times or more	82 (76,6)	41 (77,4)	41 (75,9)	
Vegetables, n (%)				
< 5 times	87 (81,3)	46 (86,8)	41 (75,9)	0,23
5 times or more	20 (18,5)	7 (13,2)	13 (24,1)	
Milk and dairy products, n (%)				
< 5 times	85 (79,4)	45 (84,9)	40 (74,1)	0,25
5 times or more	22 (20,6)	8 (15,1)	14 (25,9)	
Fruit, n (%)				
< 5 times	80 (74,8)	39 (73,6)	41 (75,9)	0,96
5 times or more	27 (25,2)	14 (26,4)	13 (24,1)	
Oils and fats, n (%)				
< 5 times	5 (4,7)	4 (7,5)	1 (1,9)	0,20
5 times or more	102 (95,3)	49 (92,5)	53 (98,1)	

VPO: meat, poultry, fish, eggs; N: total number of employees (N1+N2); n: under-staffing; %: percentage.

Table 6. *Distribution of the two groups of patients according to chemotherapy protocols.*

Chemotherapy protocols, n (%)	Overall N=107 (%)	Nutritional education group N1=53 (%)	Group without nutrition education N2=54 (%)	P value
Cisplatin	46 (43,0)	25 (47,2)	21 (38,9)	
2-molecule protocol	23 (21,5)	9 (17,0)	14 (25,9)	0,67
Protocol based on 3 or more molecules	21 (19,6)	10 (18,9)	11 (20,4)	
Single molecule protocol	17 (15,9)	9 (17,0)	(14,8)	

N= total workforce (N1+N2)

Table 7. *Distribution of the population in each group according to the number of meals per day (based on a 24h recall) at 1st and 3rd cycles of chemotherapy.*

	Chemotherapy cycle		P value
Group	1st Cycle	3rd Cycle	
Nutrition education group (N=53)			
1 to 2 meals, n (%)	40 (75,5)	5 (9,4)	< 0,001
≥ 3 meals, n (%)	13 (24,5)	48 (90,6)	
Group without nutritional education (N=54)			
1 to 2 meals, n (%)	24 (44,4)	48 (88,9)	< 0,001
≥ 3 meals, n (%)	30 (55,6)	6 (11,1)	

N: headcount; n: understaffed; %: percentage.

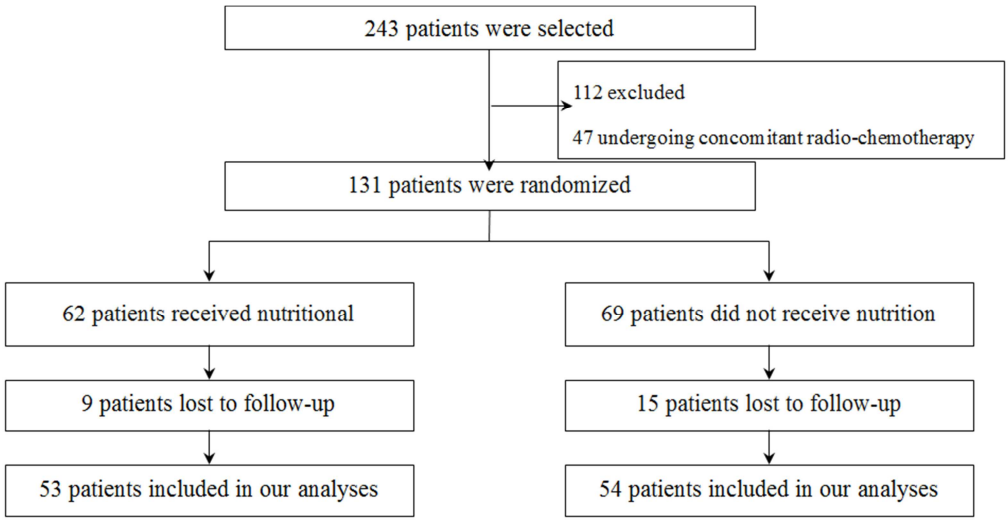


Figure 1. *Flowchart.*

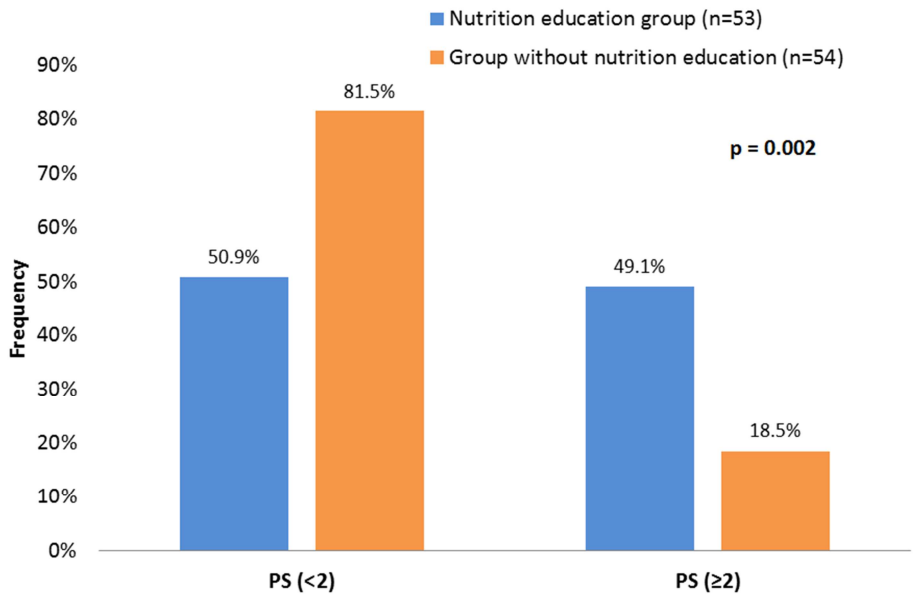


Figure 2. *Distribution of 2 groups of patients according to WHO Performance Staus (PS) before 1st cycle of chemotherapy.*

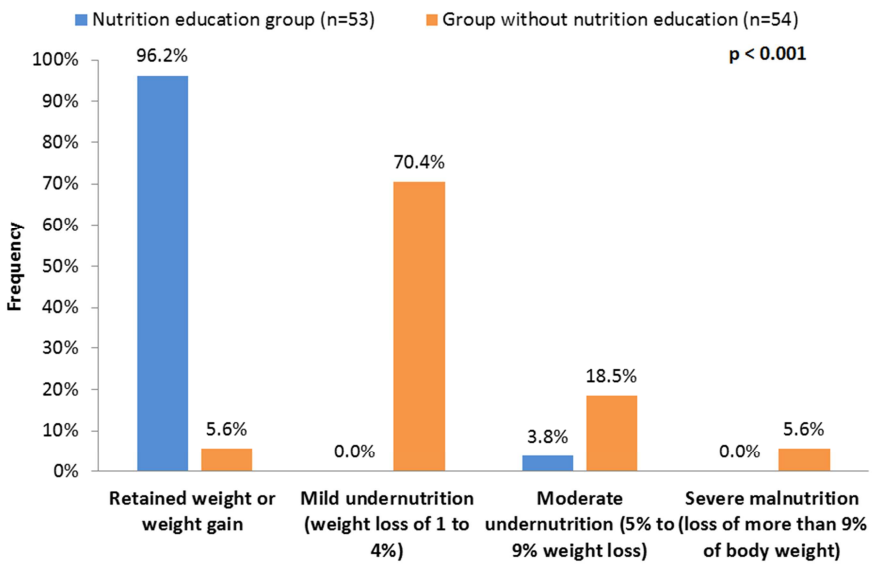


Figure 3. *Distribution of 2 groups of population according to nutritional status (weight change) at the 2nd cycle of chemotherapy.*

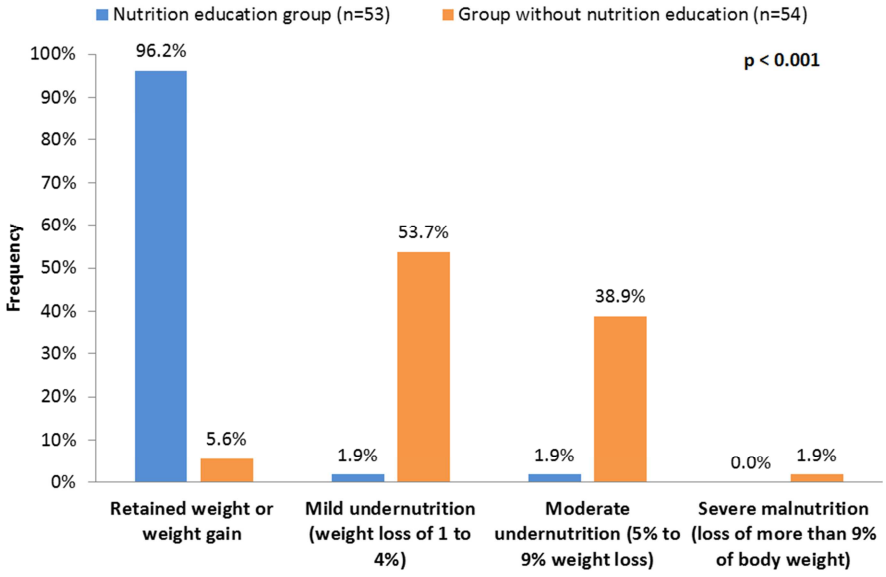


Figure 4. *Distribution of 2 groups of population according to nutritional status (weight change) at the 3rd cycle of chemotherapy.*

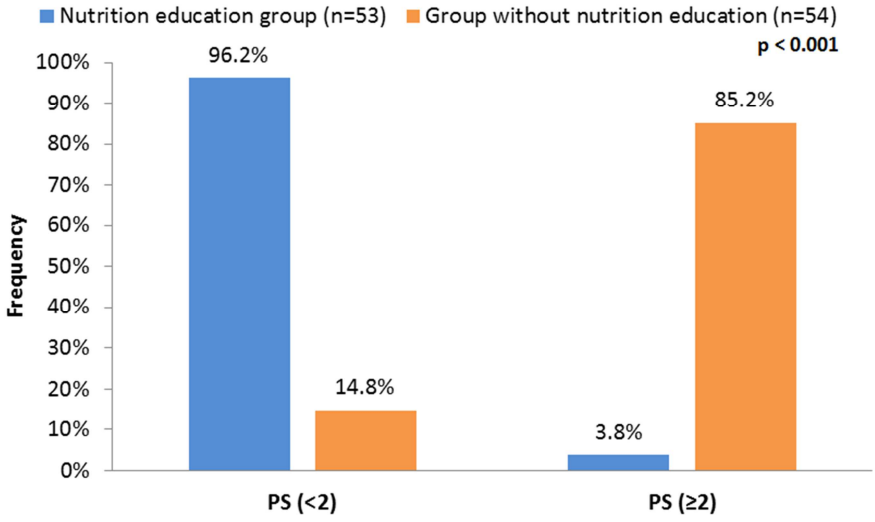


Figure 5. *Distribution of 2 groups of population according to the WHO performance Status at 3rd cycle of chemotherapy.*

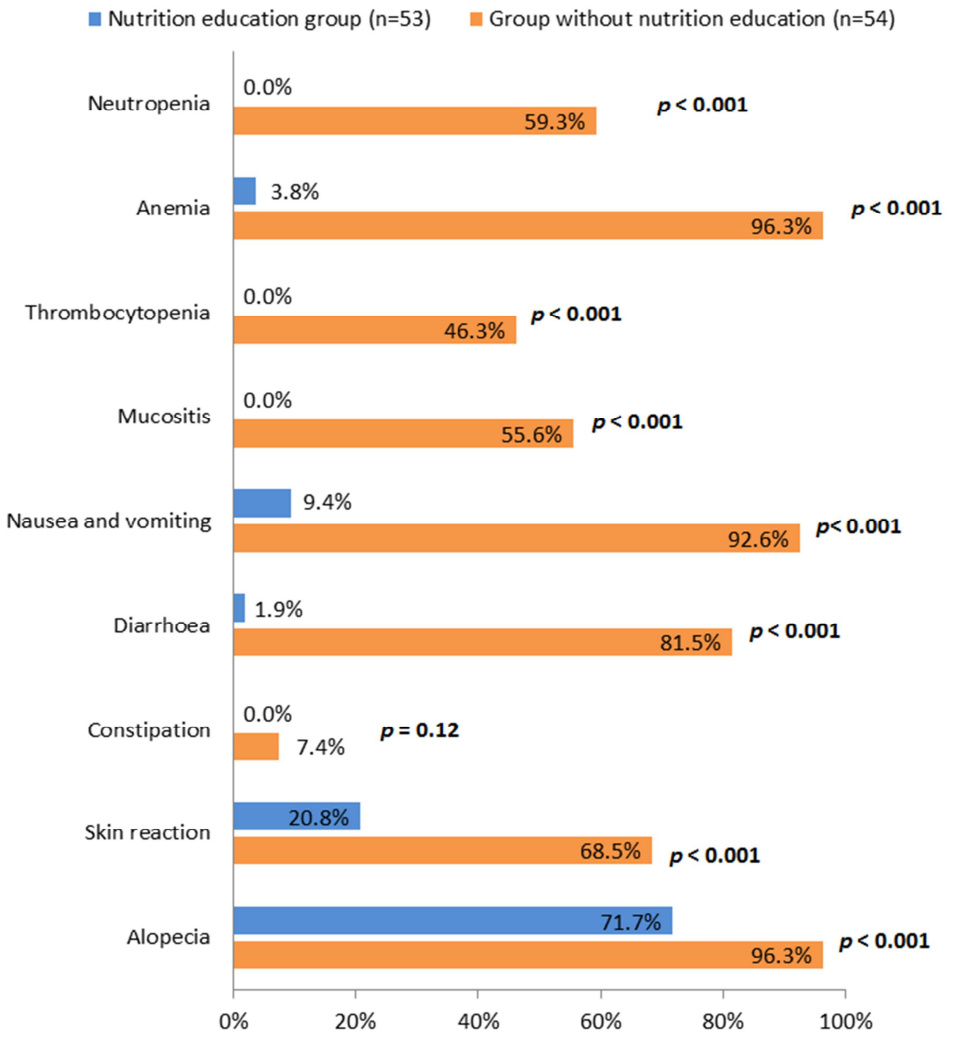
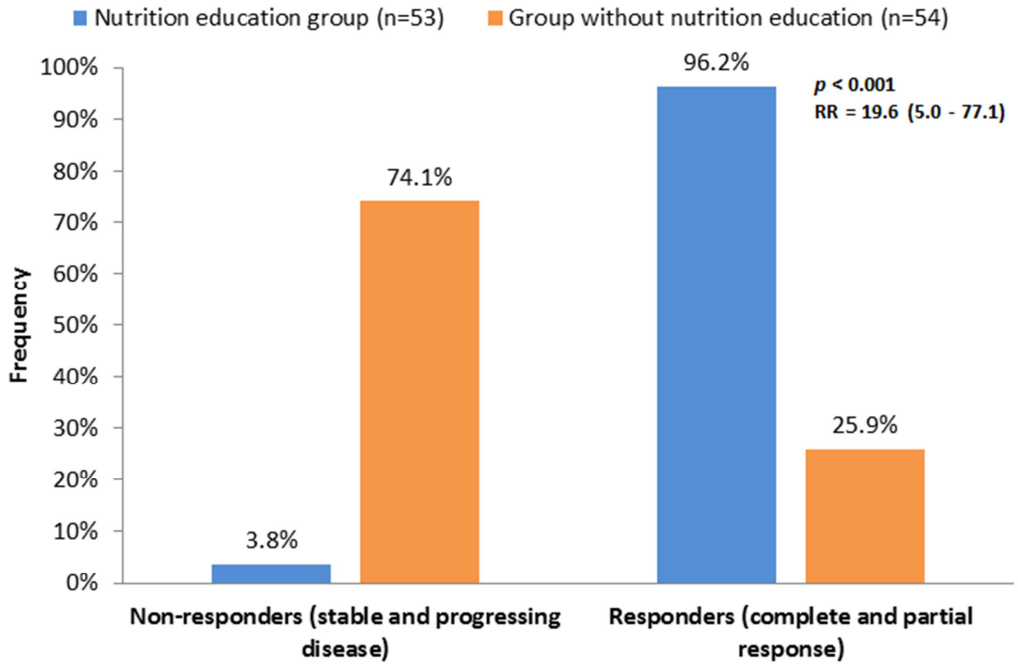


Figure 6. *Distribution of 2 groups of population according to the occurrence of toxicities at the 3rd cycle of chemotherapy.*



N: number *p*: p value RR: relative risk

Figure 7. *Distribution of 2groups of the population according to chemotherapy response.*

Conflict of Interest

The corresponding author declares that he is working alongside Laboratoire ROCHE as part of its ACCESS CANCER programme in Cameroon. However, Laboratoire ROCHE is neither closely nor remotely involved in the conception, writing or financing of this research work, which is part of the author's academic scientific research activities. As such, it has no influence on the publication of these results.

The other authors have no conflicts of interest to declare. This study did not receive any dedicated financial support.

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