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# Does the consumption of pasta, rice and groats affect the risk of cancer of women's reproductive organs and breast?

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**Objective:** To determine whether the consumption, together with the frequency and quantity of consumption of wholegrain pasta, rice and groats is related to the risk of reproductive and breast cancer among women. **Material and methods:** Food Frequency Questionnaire (FFQ) covering the 12 months prior to diagnosis was used. It consisted of questions evaluating the frequency of consumption of specific cereal products that may contribute to the development of or protect against malignant reproductive or breast tumours. **Results:** There were no significant differences between the groups in relation to the frequency of consumption of rice and pasta. Groats were consumed significantly more often by the ill women (women with gynaecologic malignancy) ( $p < 0.05$ ). However, the ill women consumed smaller quantities of groats, rice and pasta than the healthy women (control group). The healthy women consumed more cereal products and significantly more rice compared to the ill women ( $p < 0.05$ ). **Conclusions:** Age was the main factor impacting the incidence of breast and reproductive tract cancer, followed by the consumption of long-grain rice, aromatic rice, and BMI. A higher mean age and BMI was noted among the ill women. The consumption of long rice was higher among healthy women, while the consumption of aromatic rice was higher among women with cancer.

## Keywords

Pasta; Rice; Groats; Risk factors

## 1. Introduction

The consumption of wholegrain products, such as wholegrain groats, brown rice and pasta, is essential in the prevention of many infectious diseases, including cancers [1].

The main components of cereal grains and rice are carbohydrates, mainly in the form of starch, protein and fats. Cereal products and rice also contain bioactive compounds: dietary fibre, phytates, phenolic compounds, lignans, phytoestrogens (most of which have antioxidant properties), vi-

tamins (including B-group vitamins and vitamin E) and microelements such as iron, magnesium, selenium, copper, zinc and manganese.

The majority of nutrients and bioactive compounds are in the outer layer of grains and germ seeds, which is why minimally processed and wholegrain foods are recommended [2, 3]. Refining removes the bran and the germ seed, leaving only the endosperm. This process decreases the contents of dietary fibre, B-group vitamins, iron, magnesium, vitamin E, and other valuable nutrients [1].

The World Cancer Research Fund and the American Institute for Cancer Research emphasise the health-promoting effects of eating unprocessed cereal products with every meal, and the necessity to reduce the consumption of high-starch refined foods [4].

Studies have shown that whole grains are protective [5, 6], and a change of diet can significantly decrease the risk of cancer [4-7].

Considering their bioactive compounds and antioxidants, the protective role of whole grains in decreasing the risk of cancers has been extensively studied, e.g., the fibre [8-12]. Nevertheless, it is not yet clear whether the fibre itself or the synergistic effect of all the components of grains have the anti-cancer effect [13, 14].

It has been observed that a diet containing fibre and magnesium from whole grains is associated with a reduced risk of cancer, such as in colorectal cancer [15, 16]. It has been shown that the fibre in whole grains is fermented in the colon into short-chain fatty acids, such as butyrate, that have an anti-cancer effect [17]. The fibre in grains also has a beneficial impact on weight loss and thus reduces the risk of obesity-related cancers [13]. It has been proven that wholegrain products can reduce energy consumption as the fibre prolongs the sense of fullness, which leads to weight loss [17] and reduces central obesity [18, 19] associated with metabolic

disorders, such as insulin resistance and the resulting diabetes, while the weight loss and resulting increased insulin sensitivity can be significant in the prevention of cancers [20–24].

Some components of wholegrain cereal products (phytoestrogens, such as lignans and isoflavones) can also reduce the risk of sex-hormone related cancers. They modulate the concentration of sex hormones (decreased estrogen levels) and inhibit the development and progression of breast cancer [8]. Wholegrain products are also a source of strong antioxidants such as vitamin E, selenium, phenol acids, lignans and phytoestrogens, limiting oxidative damage and oxidative stress, and indirectly reducing the risk of cancer associated with these processes [16].

The objective of this paper is to determine whether the consumption, together with the frequency and quantity of consumption of wholegrain pasta, rice and groats is related to the risk of reproductive and breast cancer among women.

## 2. Materials and methods

The study was carried out between 2011–2013 among 1032 patients of the Gynaecology and Obstetrics Clinical Hospital of the Karol Marcinkowski University of Medical Sciences in Poznań.

The analysis included healthy women (not diagnosed with malignant reproductive or breast tumours (group healthy,  $n = 683$ ), and women with malignant breast tumours, ovarian cancer, endometrial cancer and cervical cancer (group ill,  $n = 349$ ) based on histopathology of specimens taken during surgery, curettage or breast biopsy. When qualifying the healthy women for the study, a normal mammogram and/or breast ultrasound imaging, as well as a transvaginal ultrasound examination, were taken into consideration. Genetic determinants of reproductive cancer risk were excluded.

A Food Frequency Questionnaire (FFQ) covering the 12 months prior to diagnosis was used. It consisted of questions evaluating the frequency of consumption of specific cereal products that may contribute to the development of or protect against malignant reproductive or breast tumours.

The level of statistical significance was taken at  $p < 0.05$ . The study was approved by the Bioethics Committee of the Karol Marcinkowski University of Medical Sciences in Poznań (Approval no. 574/11).

## 3. Results

The ages of the women participating in the study are presented in Fig. 1. Most of the women were between 40–49 (28.29%), or 50–59 (28%) years of age, totalling 56.29% of the total respondents.

The results presented in Table 1 show no significant differences between the groups in relation to the frequency of consumption of pasta and rice. Groats were consumed significantly more often by ill women ( $p < 0.05$ ).

As far as the quantities are concerned, the healthy women consumed a higher amount of pasta, rice and groats, where

the consumption of rice was statistically significantly higher ( $p < 0.05$ ) (Table 2, Fig. 1).

Four significant disease predictors were recorded: age, BMI, consumption of long-grain rice and consumption of aromatic rice (Table 3).

Multiple coefficient of determination ( $R^2$ ) indicates an explanation for about 17% of the value of the dependent variable (occurrence of the disease). The entire model turned out to be statistically significant (Table 4).

Age was the main factor impacting the incidence of breast and reproductive cancer, followed by the consumption of long-grain rice, aromatic rice, and patient BMI (Fig. 2).

The data in Table 5 show a higher average age and BMI among ill women. The consumption of long rice was higher among healthy women, while the consumption of aromatic rice was higher among women with cancer.

## 4. Discussion

This study evaluated the diets of women with ovarian, breast, endometrial and cervical cancer. A Food Frequency Questionnaire adjusted to these studies was used. The main objective was to determine whether the consumption, frequency and quantity of consumption of wholegrain pasta, rice and groats is related to the risk of reproductive and breast cancer in women.

The studies showed that the women not diagnosed with reproductive tract or breast cancer had consumed more cereal products and rice than women with cancer. In the case of rice, this dependence was statistically significant. The ill women consumed groats more frequently, yet in smaller quantities compared to the healthy women, from which a conclusion can be drawn that it is the quantity, not the frequency of consumption of groats, rice and pasta that matters in the prevention of cancer diseases.

Many compounds with potential anti-cancer properties have been found in cereals and rice during *in vivo* tests involving the treatment of cancer cells line with a given substance. The results obtained in the research by Dziedzic K. *et al.* [25] in cancer prevention indicate a likely positive role of the biologically active ingredients present in buckwheat seeds, which include: quercetin, catechin, serine, proline, glycine, histidine and arginine, because the results obtained during *in vitro* tests indicate significant negative correlations between the growth of HT-29 cells and the levels of catechin, quercetin, serine, proline, glycine, histidine and arginine in buckwheat samples after digestion.

In the research by Hole A.S. *et al.* [26] it was proved that the biologically active compounds (phenolic acids) are even more valuable in the process of cereal fermentation conducted with the presence of specific probiotic strains, and, at the same time, it improves their bioavailability in the body.

It is worth emphasizing that the greatest number of biologically active values are found in the outer layer of the grain and in the germ, much less in the endosperm. Therefore, in cancer prevention, it is important to eat unrefined and grain

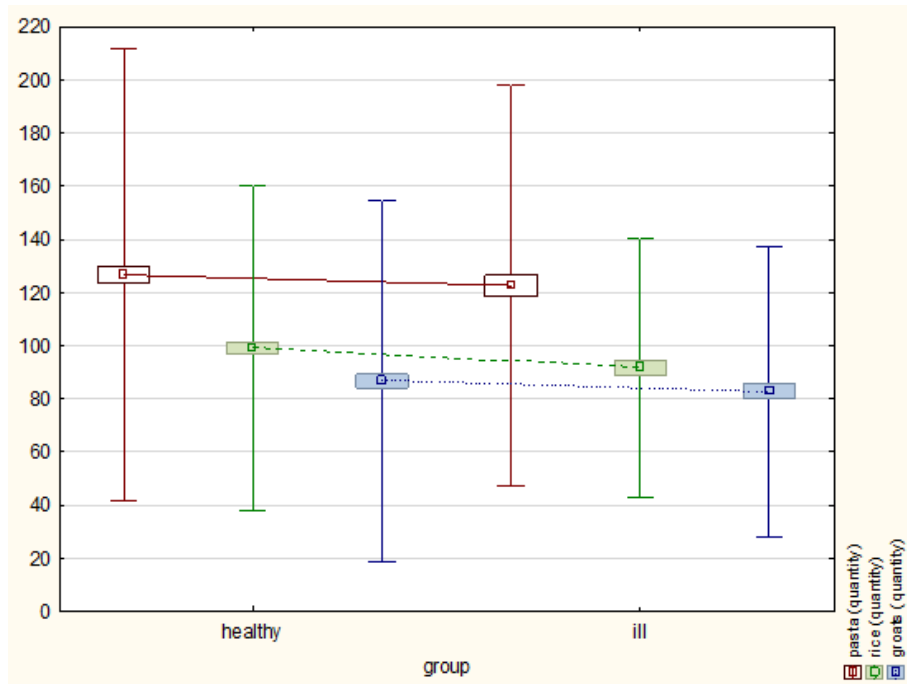


Fig. 1. Distribution of the average consumption quantity among ill and healthy women.

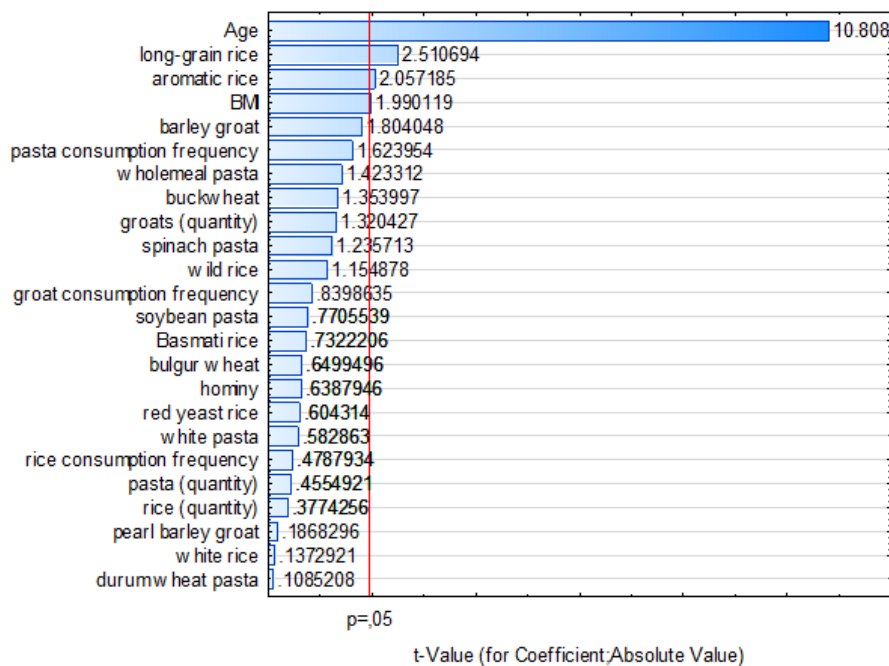


Fig. 2. Petro graph with *t*-value coefficients (df=1007).

products as little processed as possible. In the research by Qureshi *et al.* [27], it was proven that the highest antioxidant activity of the examined cereal products was found in the fractions with a short pearling time and it gradually decreased as more and more endosperm was activated.

Our studies also confirmed that the breast and reproductive tract cancer predictors were BMI and age, as well as the consumption of long-grain and aromatic rice.

Therefore, the fibre in cereal products, particularly in wholegrain foods such as coarse-grained groats, wholegrain pasta and unrefined rice, probably play a key role in the prevention of breast and reproductive tract cancer.

Meta-analysis by Xu *et al.* [28] aimed at proving the beneficial impact of fibre on a reduced risk of ovarian cancer. The scientists stated that fibre rich foods should be promoted, as a greater consumption of dietary fibre is associated with a re-

**Table 1. The frequency of consumption of the products by ill and healthy women.**

Consumed product	Group	Healthy		Ill		
		frequency	number	%	number	%
Pasta		never	11	1.6	5	1.4
		seldom	73	10.7	36	10.3
		once every two weeks	127	18.6	48	13.8
		once a week	341	49.9	184	52.7
		a few times a week	127	18.6	74	21.2
		every day	4	0.6	2	0.6
Rice		never	7	1.0	5	1.4
		seldom	97	14.2	58	16.6
		once every two weeks	190	27.8	70	20.1
		once a week	296	43.3	163	46.7
		a few times a week	91	13.3	53	15.2
		every day	2	0.3	0	0.0
Groats		never	59	8.6	30	8.6
		seldom	227	33.2	95	27.2
		once every two weeks	167	24.5	65	18.6
		once a week	185	27.1	132	37.8
		a few times a week	39	5.7	27	7.7
		every day	6	0.9	0	0.0
Total			683	100.0	349	100.0

**Table 2. Comparison of the quantities consumed by healthy and ill women.**

Product	Group	N	Mean [g]/day	SD	Confidence		Min.	Max.	Median
					-95.0%	+95.0%			
Pasta	healthy	683	126.60	85.172	120.20	133.00	0.0	800.0	100.0
	ill	349	122.58	75.447	114.64	130.52	0.0	500.0	100.0
	Total	1032	125.24	81.997	120.23	130.25	0.0	800.0	100.0
Rice	healthy	683	99.14	60.981	94.55	103.72	0.0	500.0	100.0
	ill	349	91.62	48.725	86.49	96.75	0.0	400.0	100.0
	Total	1032	96.59	57.218	93.10	100.09	0.0	500.0	100.0
Groats	healthy	683	86.61	68.018	81.50	91.72	0.0	1000.0	100.0
	ill	349	82.79	54.628	77.04	88.54	0.0	500.0	100.0
	Total	1032	85.32	63.804	81.42	89.22	0.0	1000.0	100.0

duced risk of ovarian cancer [28]. There have also been attempts to prove the beneficial role of fibre in relation to breast cancer [29, 30]. Nevertheless, insufficient studies have been devoted to the links between the various types of dietary fibre and the risk of breast and reproductive cancer to be able to determine which type of fibre (soluble or insoluble) from which products and at what minimum daily quantity has a protective function in this respect [28–30]. Therefore, future studies should continue examining the link between the consumption of fibre from various products, not only grains and rice, but also vegetables, fruit and pulses, and the risk of ovarian cancer. Intervention studies in this area are also necessary.

Refined forms of (aromatic and long-grain) rice are characterised by a lower content of fibre and higher glycaemic load, typical for the Western diet with a high glycaemic index (GI) and glycaemic load (GL).

Previous studies have shown a relationship between the development of various cancers and the consumption of specific kinds of carbohydrates increasing postprandial blood glucose. It has been proven that the factors related to glucose and insulin metabolism play an important role in the development of cancers, and diets reducing tissue sensitivity to insulin and the secretion of this hormone can be associated with a risk of cancers. A high glycaemic load may be linked to an increased risk of reproductive and breast cancer, yet the relationship between the risk of breast cancer and the GL and GI of the diet still needs confirmation [31, 32].

The carcinogenesis process can also be related to inflammation in the body, which in turn can be generated by an incorrect diet. In a case-control study conducted by Stasiewicz *et al.*, which was carried out with 420 female patients aged 40 to 79 years, it was proven that a higher odds ratio (OR) of breast cancer was associated with a higher score obtained on

**Table 3. Univariate significance tests for the variable disease (sigma-restricted parametrisation; effective hypothesis decomposition).**

Effect	SS	Degrees	MS	F	p
Intercept	5.670	1	5.670	29.808	<0.0001
Age	22.225	1	22.225	116.828	<0.0001
BMI	0.753	1	0.753	3.961	0.047
Pasta consumption frequency	0.502	1	0.502	2.637	0.105
Wholemeal pasta	0.385	1	0.385	2.026	0.155
White pasta	0.065	1	0.065	0.340	0.560
Soybean pasta	0.113	1	0.113	0.594	0.441
Spinach pasta	0.290	1	0.290	1.527	0.217
Durum wheat pasta	0.002	1	0.002	0.012	0.914
Pasta quantity	0.039	1	0.039	0.207	0.649
Rice consumption frequency	0.044	1	0.044	0.229	0.632
Basmati rice	0.102	1	0.102	0.536	0.464
Red yeast rice	0.069	1	0.069	0.365	0.546
Long-grain rice	1.199	1	1.199	6.304	0.012
Wild rice	0.254	1	0.254	1.334	0.248
Aromatic rice	0.805	1	0.805	4.232	0.040
White rice	0.004	1	0.004	0.019	0.891
Rice amount	0.027	1	0.027	0.142	0.706
Groat consumption frequency	0.134	1	0.134	0.705	0.401
Buckwheat	0.349	1	0.349	1.833	0.176
Barley groat	0.619	1	0.619	3.255	0.072
Bulgur wheat	0.080	1	0.080	0.422	0.516
Hominy	0.078	1	0.078	0.408	0.523
Pearl barley groat	0.007	1	0.007	0.035	0.852
Groat quantity	0.332	1	0.332	1.744	0.187
Error	191.567	1007	0.190		

**Table 4. Test of the SS Whole Model vs. SS Residual (sums) disease.**

Dependent variable	Multiple R	Multiple R <sup>2</sup>	Adjusted R <sup>2</sup>	SS model	df model	MS model	SS residue	df residue	MS residue	F	p
Disease	0.413	0.171	0.151	39.408	24	1.642	191.567	1.007	0.190	8.631	0.000

the basis of the FFQ questionnaire (Food Frequency Questionnaire), which in turn was associated with a higher ‘pro-inflammatory profile’ of the female patients’ diet (related, *inter alia*, to the consumption of high glycaemic index products). On the other hand, the lower OR was associated with adherence to the pro-health diet profile, which was associated with higher consumption of low-processed plant products, including cereals [33].

Scientific reports testify to the role of wholegrain products in the aetiology of various cancers [28], such as reproductive tract and breast cancer [32, 34]. Although there are only a few scientific publications in this area and a lot of doubts arising from discrepancy between the results of studies, the American Institute for Cancer Research and American Cancer Society recommend the consumption of wholegrain foods for the prevention of cancer [4, 35]. Therefore, patients should be encouraged to consume wholegrain products, with preventive actions aimed at changing eating behaviours undertaken, as these products prevent metabolic diseases and cancer. Research by Demuth *et al.* [36] indicate that prophylactic measures against cancer are necessary, both in women diag-

nosed with breast cancer and after completed treatment. The study designed to assess the diet and eating habits of Polish women over 50 years of age undergoing breast cancer treatment showed that the eating habits and respondents’ preferences regarding compliance with the ‘healthy’ and ‘unhealthy dietary index’ (which were determined on the basis of the FFQ questionnaire) were unsatisfactory [36].

## 5. Strengths and Limitations

One of the strengths of our studies is the large sample size.

When it comes to limitations, a significant age discrepancy between the respondents (Table 5) and the short observation period are a concern. In addition, the study design introduces recall bias since the subjects recently diagnosed with cancer were asked to recall their diet for the previous 12 months.

It would be necessary to evaluate whether the observation of a few years of diet allows to draw similar and statistically significant dependencies.

Future studies should pay more attention to the homogeneity of groups. Apart from similarities related to socio-

**Table 5. Mean age and BMI results.**

Variable	Group	N	Mean age	SD	Confidene		Min.	Max.	Median
					-95.0%	+95.0%			
Age	healthy	683	46.7	10.484	45.89	47.47	22.0	84.0	45.0
	ill	349	55.8	11.160	54.58	56.93	21.0	82.0	57.0
	Total	1032	49.7	11.540	49.04	50.45	21.0	84.0	49.0
BMI	healthy	683	25.1	4.536	24.75	25.43	16.5	45.0	24.6
	ill	349	27.1	5.751	26.45	27.66	15.9	58.1	26.2
	Total	1032	25.8	5.063	25.45	26.06	15.9	58.1	24.9

demographic factors, i.e., the level of education, financial situation, source of income and place of residence, groups should be homogenous in terms of age fertility and BMI.

This would allow for accurate evaluation and exclusion of limitations typical for epidemiological studies, associated with differentiation of compared groups, which has an impact on the results of studies.

Further studies confirming the relationship between diet and the development of reproductive tract and breast cancer seem particularly important for at-risk women.

Intervention studies would be valuable to determine what type, quantity and frequency of consumption of cereal products, including wholegrain products, reduce the risk of these kinds of cancer.

## 6. Conclusions

(1) There were small differences between the groups in relation to the frequency of the consumption of rice and pasta (Table 1), yet they were not statistically significant (Table 2). (2) Groats were consumed significantly more often by women with cancer (ill women) ( $p = 0.014$ ) (Table 2). (3) The ill women consumed smaller quantities of groats, rice and pasta than the healthy women (Table 3). This difference was statistically significant only in relation to rice ( $p = 0.045$ ) (Table 4). (4) The important cancer predictors were age, patient BMI, as well as the consumption of long-grain and aromatic rice (Table 5), age being the most significant factor impacting the incidence of cancer (Fig. 2). Patients with cancer had a higher BMI. The consumption of long rice was higher among healthy women, while the consumption of aromatic rice was higher among women with cancer. (5) Multiple coefficient of determination indicates an explanation for 17% of the value of the dependent variable (occurrence of breast and reproductive tract cancer) ( $R^2 = 0.171$ ,  $p < 0.0001$ ) (Table 4).

## Author contributions

KPR substantial contributions to the conception and design of the study; KPR, MM acquisition of the data, or analysis and interpretation of the data; KPR, PM, GJB and MM drafting the article or substantively revising it; KPR, PM, GJB and MM the final approval of the version to be published.

## Ethics approval and consent to participate

The study was approved by the Bioethics Committee of the Karol Marcinkowski University of Medical Sciences in Poznań (Approval no. 574/11).

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## Conflict of interest

The authors declare no conflict of interest.

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