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Organized Breast Cancer Screening in Diabetic Women: A Prospective Study Among 100,000 Women from the Grand-Est Region (France), from 2020 to 2022

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ABSTRACT

Objective: The risk of breast cancer in type 2 diabetic women is increased by 10–20%. Diabetic women have a higher risk of being diagnosed with advanced breast cancer and having complications with its treatments. In France, women aged between 50 and 74 years old are invited to undergo organized breast cancer screening (OBCS). The objective of this study was to evaluate OBCS participation in a large cohort of diabetic women.

Materials and Methods: Based on data from Social Security reimbursement databases, we studied OBCS participation rate of 50–74 years old diabetic women from the Grand-Est region (France) between 2020 and 2022, according to four age brackets and their geographical areas.

Results: In 2020, among the 99,302 diabetic women, 16,340 (16.45%) underwent OBCS versus 24% in the general population. In 2021, among the 100,390 diabetic women, 20,914 (20.83%) underwent OBCS, versus 29% in the general population. In 2022, among the 101,694 diabetic women, 18,576 (18.27%) underwent OBCS, versus 24% in the general population. OBCS participation in 50–54 years old and 70–74 years olds were significantly lower ($p<0.0001$ in 2020; $p<0.0001$ in 2021; $p<0.0037$ in 2022). There was a significant link between OBSC participation and geographical area ($p<0.0001$).

Conclusion: The OBCS participation rate in women with type 2 diabetes was significantly lower than the general population, and associated with age and area. These findings suggest a need to inform patients and health care professionals about the higher risk of breast cancer in diabetic women to improve OBCS rates with the proven associated health benefits.

Keywords: Breast cancer screenings; diabetic women; organized breast cancer scrennning; type 2 diabetes

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Key Points

- Breast cancer risk in women with type 2 diabetes is increased by 10–20%.
- Breast cancer mortality is higher in women with type 2 diabetes.
- Organized breast cancer screening participation rate in diabetic women is low.
- Lower participation is observed in women with type 2 diabetes aged 50–54 and 70–74.
- The analysis of barriers to screening participation must be encouraged.

Introduction

Breast cancer and type 2 diabetes are two major public health problems globally (1, 2). In 2021, 529 million people worldwide suffered from diabetes. Type 2 diabetes is the most common form, accounting for 96% of all cases (2). In 2020, 2.26 million women were diagnosed with breast cancer, and almost 685,000 died from it (1). As the prevalence of obesity continuously increases, so does the incidence of breast cancer and type 2 diabetes (1, 3, 4).

Type 2 diabetes and breast cancer share extrinsic risk factors, including post-menopausal overweight and obesity (5, 6), sedentary lifestyle, and

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lack of physical activity (7, 8). Type 2 diabetes is considered a risk factor for hormone-dependent breast cancer (9), because of diabetes-associated insulin resistance. The latter leads to hyperinsulinemia and activation of insulin signaling and growth factors implicated in the pathogenesis of breast cancer. Hyperinsulinemia, also decreases the production of sex hormone binding globulin, a key feature of hormonal breast cancer (10-13).

A diabetic woman has a 15% higher risk of breast cancer (14), which rises to 22% after adjusting for body mass index (14). At diagnosis, tumors in diabetic women are larger with more lymph node involvement, or even metastatic from the outset (15). It should also be highlighted that diabetic comorbidities, including heart disease or kidney disease, possibly contraindicate optimal breast cancer treatment (16). Anthracyclines, one of the main cytolytic drug groups used for breast cancer and Trastuzumab and Pertuzumab used for human epidermal growth factor receptor 2 overexpressed breast cancer, induce a high risk of cardiotoxicity in diabetic patients (17-19). Diabetic patients with heart failure do not receive adjuvant or neoadjuvant treatments as recommended (16). Lymphedema, which can occur after an axillary node clearance and is frequently associated with obesity, is more often observed in diabetic women, with a direct impact on women's lives (20). In the case of breast reconstruction after mastectomy, diabetic women are at greater risk of delayed wound-healing, infection and prosthesis removal (21, 22). They are also at greater risk of breast cancer mortality and all-cause mortality (16), even in the absence of delayed diagnosis (23).

Women with diabetes are invited to participate in organized breast cancer screening (OBCS) in the same way as the general population (24). In France, since 2004, OBCS has been offered to asymptomatic 50–74-year-old women, once every two years. This screening consists of a free of charge mammogram, breasts and axilla clinical examination and breast ultrasound in selected cases. Eligible women receive an invitation from the French Regional Cancer Screening Coordination Centers, with a double-reading mammogram by two certified radiologists (25).

In France, individual breast cancer screening (IBCS) is also available. IBCS consists of an individualized prescription of breast imaging. IBCS is being offered to women with a personal history of breast cancer, a "high" or "very high" risk of breast cancer, or with symptoms of breast cancer. Women at "high" risk of breast cancer are those with: a personal history of breast cancer; abnormal image on last mammogram; existence of lobular neoplasia; existence of atypical epithelial hyperplasia; or high-dose thoracic irradiation. Women at "very high" risk of breast cancer have a hereditary form of breast cancer and presence of genetic mutations, notably *BRCA1* and *BRCA2* (25).

The French National Authority for Health specifies that "special attention" should be paid to breast cancer screening in diabetic patients due to their high risk of breast cancer (24). Despite this, diabetic women tend to participate less in OBCS than the general population. In 2022, in France, only 44.9% of women from the general population took part to OBCS (26). To the best of our knowledge, only two French studies have been conducted so far to assess OBCS participation of diabetic women. In 2008, Constantinou et al. (27) studied 2056 women, including 157 diabetic women. Diabetic women participated significantly less in OBCS [odds ratio: 0.55 (0.36–0.83)]. In 2018, Bernard (28) studied 5161 women, including 456 diabetic women. Only 16% of diabetic women had taken part in OBCS, compared to 52% of non-diabetic women. However, these two studies were biased, due to their small numbers of diabetic women and lack of IBCS evaluation.The aim of the present study was to evaluate participation in OBCS and IBCS among diabetic women within the Grand-Est region in France, from 2020 to 2022 in a prospective cohort. Our secondary objective was to assess differences in participation depending on geographical area and women's age.

Materials and Methods

This prospective, descriptive, epidemiological study investigated OBCS participation of type 2 diabetic women from the Grand-Est region in France for the years 2020, 2021, and 2022.

The medical department of the Grand-Est region provided us with aggregated statistical data extracted from the French Health Insurance reimbursement databases. These data were anonymous and protected by the following regulatory bodies: European Regulation RGPD n° 2016–679 of April 27, 2016; *Loi informatique et libertés* n° 2018–486 of June 20, 2018, and its Decree of application n° 2019- 536 of May 29, 2019, consolidating Ordinance n° 2018–1125 of December 2018 modifying the law of January 6, 1978. The agreement is attached in Appendix A (supplemental files). The approval of the Committee for the Protection of Individuals was not required.

Inclusion Criteria

The study period runs from January 1, 2020, to December 31, 2022. Women included in the study were those alive on January 1 of the year n+1 studied, as well as those eligible for OBCS according to French recommendations (asymptomatic 50–74-year-old women, without high risks of breast cancer as personal history of cancer of the breast, uterus and/or endometrium, atypical hyperplasia or benign proliferative disease, chest radiation before the age of 30, and a family history of breast and/or ovarian cancer among relatives) (25). They were between 50 and 74 years old and categorized into four age groups: 50–54, 55–64, 65–69 and 70–74 years old. They were beneficiaries of the French primary health insurance fund in one of the 10 areas of the Grand-Est region: Ardennes (08), Aube (10), Marne (51), Haute-Marne (52), Meurthe-et-Moselle (54), Meuse (55), Moselle (57), Bas-Rhin (67), Haut-Rhin (68), and Vosges (88).

The population of diabetic women was elected according to one of the following inclusive criteria: having a long-term illness of type 2 diabetes (LTI 8 E11), having undergone at least three antidiabetic treatments (Anatomical Therapeutic Chemical A10A or A10 B) that year, or having been hospitalized during the current year for a cause related to type 2 diabetes or one of its complications according to the French Information Systems Medicalization Program (Table 1).

Exclusion Criteria

The exclusion criteria were recognition of long-term illness for breast cancer (LTI D05), breast carcinoma *in situ* (LTI D05), or hospitalization during the year with a breast cancer-related French Information Systems Medicalization Program code (Table 1).

Patients with type 1 diabetes were excluded.

Mammography execution was evaluated. A mammogram was considered performed if a mammography procedure was reimbursed under the Common Classification of Medical Procedures (CCMP) during the studied year. In France, there are three CCMP codes: QEQK001 for bilateral mammography, QEQK005 for unilateral

Table 1. Inclusion and exclusion criteria for type 2 diabetic population

Inclusion criteria for type 2 diabetic population		
One of three criteria		
LTI	**Drug tracers**	**Hospitalization ICD code**
LTI Type 2 diabetes active in year n: - E11	At least three deliveries in year n of oral antidiabetics or insulin. ATC codes used: - A10A: Insulins and analogues - A10B: Blood glucose-lowering drugs other than insulins.	FISMP: Beneficiaries hospitalized in MSOD or FRD for diabetes in year n (PD, RD or SAD in MSOD; PME or EC in FRD) FISMP (diabetes) : - E11 Non-insulin-dependent diabetes mellitus FISMP (diabetes complications): - G59.0 Diabetic mononeuritis - G63.2 Diabetic polyneuritis - G73.0 Myasthenic syndrome during endocrine disease - G99.0 Autonomic nervous system neuropathy during endocrine and metabolic diseases - H28.0 Diabetic cataract - H36.0 Diabetic retinopathy - I79.2 Peripheral angiopathy in diseases classified elsewhere - L97 Lower limb ulcer, not elsewhere classified - M14.2 Diabetic arthropathy - M14.6 Nervous arthropathy - N08.3 Glomerulopathy in diabetes mellitus.
Exclusion criteria for type 2 diabetic population		
One of three criteria		
LTI	**Drug tracers**	**Hospitalization ICD code**
LTI Breast cancer active in n: - C50 or - D05	None	FISMP: women hospitalized for breast cancer in MSOD or FRD during year n (PD, RD or SAD in MSO; PME or EC in SSR) - C50 - D05

LTI: Long-term illness; ATC: Anatomical therapeutic chemical classification; ICD: International Classification of Diseases; FISMP: French Information Systems Medicalization Program; MSOD: Medicine, surgery or obstetrics department; FRD: Follow-up and rehabilitation department; PD: Principal diagnosis; RD: Related diagnosis; SAD: Significant associated diagnosis; PME: Principal morbid event; EC: Etiological condition

mammography, and QEQK004 for mammography performed in OBCS programs. Mammograms with CCMP codes QEQK001 and QEQK005 are prescribed for IBCS or follow-up of breast-pathology. All the Social Security data tables are given in Appendix B (supplemental files).

Results

Study Population

For the 2020–2021 and 2021–2022 periods, 102,138 and 104,266 diabetic women were eligible for OBCS respectively. For the 2020–2021 and 2021–2022 periods, there were 815,251 and 882,445 women in the general population.

In 2020, 2021 and 2022, 99,302, 100,390 and 101,694 diabetic women were eligible for OBCS respectively. In 2020, 2021 and 2022, there were 796,223, 815,251 and 882,445 women in the general population.

Participation in OBCS

- By Period

During the two-year 2020–2021 period, among the 102,138 diabetic women, 37,625 (36.84%) underwent OBCS versus 419,626 women (51%) from the general population. During the two-year 2021–2022 period, among the 104,266 diabetic women, 40,160 (38.52%) underwent OBCS versus 438,522 (50%) from the general population.

- By Year

In 2020, among the 99,302 diabetic women, 16,340 (16.45%) underwent OBCS versus 189,264 women (24%) from the general population. In 2021, among the 100,390 diabetic women, 20,914

(20.83%) underwent OBCS versus 237,481 women (29%) from the general population. In 2022,

among the 101,694 diabetic women, 18,576 (18.27%) underwent OBCS versus 209,654 women (24%) from the general population (Table 2).

- By Age Group of the Diabetic Population

In 2020, the diabetic age group with the lowest attendance was the 50–54-year-old group (Table 3), with 1,476 of 9,636 women (15.32%) having undergone OBCS. In 2021 and 2022, the diabetic group with the lowest attendance was the 70–74-year-old group, with 5,742 women of 28,658 (20.04%) having undergone OBCS in 2021, and 5,233 women of 29,630 (17.66%) in 2022.

In 2020, 2021, and 2022, the diabetic age group with the highest OBCS attendance was the 65–69-year-old group, with rates of 17.20%, 21.55% and 18.78%, respectively. The association between OBCS attendance and age was significant in 2020, 2021, and 2022 ($p<0.0001$, $p<0.0001$, and $p<0.0037$, respectively).

- By Area

In 2020, 2021, and 2022, the area with the highest OBCS attendance rates among diabetic women was Bas-Rhin (67), with 18.51%, 24.26% and 22.28%, respectively, and the area with the lowest OBCS attendance rates among diabetic women was Moselle (57), with 14.74%, 16.67% and 14.54%, respectively. The relationship between OBCS participation and area was significant in 2020, 2021, and 2022 ($p<0.0001$, $p<0.0001$ and $p<0.0001$, respectively) (Table 3).

- By Age Group and Area

The area the least represented in OBCS by diabetic women, all ages combined, was Meuse (55), and the most represented was Bas-Rhin (67) (Tables 4, 5, and 6), the relationship between age, area, and OBCS participation was significant in 2020, 2021, and 2022 (p = 0.0003, p = 0.0002, and p = 0.001, respectively).

- Individual Breast Cancer Screening

In 2020, 2021, and 2022, only 4% of diabetic women underwent an IBCS versus 8% of the general population (Table 2).

Discussion and Conclusion

This was the first large-scale French epidemiological study to evaluate OBCS participation rates of women with type 2 diabetes. As demonstrated, there was low-rate OBCS participation compared to non-diabetic peers, which was significantly related to area and age of diabetic women. These observations clearly corroborate the findings of Constantinou et al. (27) and Bernard (28). Several foreign studies draw the same conclusions (29-32), highlighting the fact that this low participation rate persisted despite the Pink October/Breast Cancer Awareness Month screening campaigns and ever-growing breast cancer awareness among women (33, 34).

Furthermore, only 4% of diabetic women resorted to IBCS, despite an estimated 10% of French breast cancer screenings being individual screenings (35). Not only did diabetic women make less use of OBCS than the general population, but they also made less use of IBCS. Since diabetic women are at greater risk of developing breast cancer, it may be thought that this patient group were undergoing IBCS-based follow-up within the two-year OBCS interval, but this was not the case.

This study displays several strengths, which deserve to be emphasized. First, our data originate from the French Health Insurance reimbursement databases, thus ensuring data reliability. Secondly, as the Grand-Est region is heavily affected by type 2 diabetes, we can extrapolate our results to other regions.

However, our study has limitations as well. First, the general population also included diabetic women, which does not enable reliable comparisons of the two populations. Moreover, unlike the diabetic population, the general population did not exclude women that did not rely on organized screening, owing to their high and very high breast-cancer-related risk factors. However, our data were superimposed onto the French participation rates according to French public health data. In 2020, the OBCS participation turned out to be very low, owing to the COVID-19 pandemic-related closure of the French Regional Cancer Screening Coordination Centers and radiology practices. It is also important to point out that type 2 diabetic patients were particularly affected by the COVID-19 pandemic, which is a factor limiting their participation in OBCS, in addition to the closure of screening centers from March to May 2020. Away from the pandemic, participation rates are on the rise, but remain below the European target of 70%: in 2022, the OBCS participation rate was 44.8%, and in 2023, 48.2% (26).

In the present study, disparities between age and area were observed, and it is thus possible for us to draw a parallel between our data and the barriers to OBCS participation already described, including socio-economic and socio-demographic factors, along with factors relating to women's health status and their medical follow-up (36-38). Indeed, women within the extreme age range groups, including 50–54 and 70–74-year-olds, displayed lower participation, as previously reported by several other authors (15, 20). Prior to age 50, over 30% of women had already undergone IBCS (39). Once these women reached the

Table 2. OBCS and IBCS by year (2020, 2021 and 2022) in the general and diabetic populations

	2020		2021		2022	
	General population	Diabetic population	General population	Diabetic population	General population	Diabetic population
	n = 796,223	n = 99,302	n = 815,251	n = 100,390	n = 882,445	n = 101,694
OBCS only	189,264 (24%)	16,340 (16.45%)	237,481 (29%)	20,914 (20.83%)	209,654 (24%)	18,576 (18.27%)
IBCS only	60,913 (8%)	3,697 (4%)	63,593 (8%)	3,889 (4%)	66,172 (7%)	4,027 (4%)

OBCS: Organized breast cancer screening; IBCS: Individual breast cancer screening eligible age for OBCS, they possibly kept on undergoing IBCS at the expense of OBCS. After the age of 74, women tend to lose interest in gynecological follow-ups. Moreover, the end of OBCS at 74 years old may be misperceived by women and their doctors as the absence of breast cancer risk (40). All this could similarly be perceived prior to the age of 74 years, resulting in a OBCS participation drop among 70–74-year-old women.

Table 3. Baseline characteristics of diabetic women

	2020		2021		2022	
	Diabetic population *n* = 99,302		Diabetic population *n* = 100,390		Diabetic population *n* = 101,694	
OBCS participation	No	Yes	No	Yes	No	Yes
	n = 82,962 (83.55%)	*n* = 16,340 (16.45%)	*n* = 79,476 (79.16%)	*n* = 20,914 (20.83%)	*n* = 83,118 (81.73%)	*n* = 18,576 (18.27%)
Age						
50–54	8,160 (84.68%)	1,476 (15.32%)	7,879 (79.83%)	1,991 (20.17%)	8,208 (81.25%)	1,894 (18.75%)
55–64	29,698 (83.71%)	5,780 (16.29%)	27,986 (78.87%)	7,497 (21.13%)	29,182 (81.74%)	6,517 (18.26%)
65–69	21,721 (82.80%)	4,513 (17.20%)	20,695 (78.45%)	5,684 (21.55%)	21,331 (81.22%)	4,932 (18.78%)
70–74	23,383 (83.65%)	4,571 (16.35%)	22,916 (79.96%)	5,742 (20.04%)	24,397 (82.34%)	5,233 (17.66%)
	$p<0.0001$	$p<0.001$	$p<0.0001$	$p<0.0001$	$p<0.0037$	$p<0.0037$
Areas						
Ardennes 08	5,016 (84.77%)	901 (15.23%)	4,744 (79.93%)	1,191 (20.07%)	5,012 (84.08%)	949 (15.92%)
Aube 10	4,377 (82.03%)	959 (17.97%)	4,277 (78.19%)	1,193 (21.81%)	4,501 (81.93%)	993 (18.07%)
Marne 51	8,435 (82.52%)	1,787 (17.48%)	7,857 (76.50%)	2,414 (23.50%)	8,470 (81.25%)	1,955 (18.75%)
Haute-Marne 52	2,819 (83.80%)	545 (16.20%)	2,586 (77.52%)	750 (22.48%)	2,752 (82.27%)	593 (17.73%)
Meurthe-et-Moselle 54	10,137 (84.33%)	1,884 (15.67%)	9,825 (81.16%)	2,280 (18.84%)	10,186 (83.55%)	2,006 (16.45%)
Meuse 55	2,751 (84.28%)	513 (15.72%)	2,684 (80.65%)	644 (19.35%)	2,689 (81.21%)	622 (18.79%)
Moselle 57	16,619 (85.26%)	2,874 (14.74%)	16,316 (83.33%)	3,263 (16.67%)	16,949 (85.46%)	2,884 (14.54%)
Bas-Rhin 67	16,035 (85.26%)	3,643 (18.51%)	15,183 (75.74%)	4,862 (24.26%)	15,943 (77.72%)	4,571 (22.28%)
Haut-Rhin 68	11,432 (83.63%)	2,238 (16.37%)	10,922 (78.14%)	3,056 (21.86%)	11,362 (80.13%)	2,818 (19.87%)
Vosges 88	5,341 (84.28%)	996 (15.72%)	5,082 (80.12%)	1,261 (19.88%)	5,254 (81.60%)	1,185 (18.40%)
	$p<0.0001$	$p<0.0001$	$p<0.0001$	$p<0.0001$	$p<0.0001$	$p<0.0001$

OBCS: Organized breast cancer screening

Table 4. Organized breast cancer screening in diabetic women in 2020 by age and area

Areas	Age				
	50–54	55–64	65–69	70–74	Total
Ardennes 08	67 (4.54%)	301 (5.21%)	261 (5.78%)	272 (5.95%)	901
Aube 10	99 (6.71%)	293 (5.07%)	287 (6.36%)	280 (6.13%)	959
Marne 51	195 (13.21%)	637 (11.02%)	469 (10.39%)	486 (10.63%)	1,797
Haute-Marne 52	40 (2.71%)	189 (3.27%)	147 (3.26%)	169 (3.70%)	545
Meurthe-et-Moselle 54	161 (10.91%)	656 (11.35%)	511 (11.32%)	556 (12.16%)	1,884
Meuse 55	50 (3.39%)	175 (3.03%)	128 (2.84%)	160 (3.50%)	513
Moselle 57	247 (16.73%)	1,066 (18.44%)	760 (16.84%)	801 (17.52%)	2874
Bas-Rhin 67	334 (22.63%)	1,277 (22.09%)	1,030 (22.82%)	1,002 (21.92%)	3643
Haut-Rhin 68	205 (13.89%)	854 (14.78%)	599 (13.27%)	580 (12.69%)	2238
Vosges 88	78 (5.28%)	332 (5.74%)	321 (7.11%)	265 (5.80%)	996
Total	1,476	5,780	4,513	4,571	1,6340

Table 5. Organized breast cancer screening in diabetic women in 2021 by age and area

Areas	Age				
	50–54	55–64	65–69	70–74	Total
Ardennes 08	107 (5.37%)	401 (5.35%)	342 (6.02%)	341 (5.94%)	1,191
Aube 10	113 (5.68%)	402 (5.36%)	307 (5.40%)	371 (6.46%)	1,193
Marne 51	232 (11.65%)	869 (11.59%)	631 (11.10%)	682 (11.88%)	2,414
Haute-Marne 52	72 (3.62%)	267 (3.56%)	197 (3.47%)	214 (3.73%)	750
Meurthe-et-Moselle 54	218 (10.95%)	795 (10.60%)	621 (10.93%)	646 (11.25%)	2,280
Meuse 55	56 (2.81%)	209 (2.79%)	177 (3.11%)	202 (3.52%)	644
Moselle 57	268 (13.46%)	1,194 (15.93%)	897 (15.78%)	904 (15.74%)	3,263
Bas-Rhin 67	499 (25.06%)	1,824 (24.33%)	1,294 (22.77%)	1,245 (21.68%)	4,862
Haut-Rhin 68	303 (15.22%)	1,135 (15.14%)	859 (15.11%)	759 (13.22%)	3,056
Vosges 88	123 (6.18%)	401 (5.35%)	359 (6.32%)	378 (6.58%)	1,261
Total	1,991	7,497	5,684	5,742	20,914

Table 6. Organized breast cancer screening in diabetic women in 2022 by age and area

Areas	Age				
	50–54	55–64	65–69	70–74	Total
Ardennes 08	86 (4.54%)	340 (5.22%)	273 (5.54%)	250 (4.78%)	949
Aube 10	104 (5.49%)	294 (4.51%)	278 (5.64%)	317 (6.06%)	993
Marne 51	237 (12.51%)	703 (10.79%)	465 (9.43%)	550 (10.51%)	1,955
Haute-Marne 52	66 (3.48%)	190 (2.92%)	161 (3.26%)	176 (3.36%)	593
Meurthe-et-Moselle 54	165 (8.71%)	722 (11.08%)	530 (10.75%)	589 (11.26%)	2,006
Meuse 55	54 (2.85%)	235 (3.61%)	159 (3.22%)	174 (3.33%)	622
Moselle 57	283 (14.94%)	1,026 (15.74%)	747 (15.15%)	828 (15.82%)	2,884
Bas-Rhin 67	497 (26.24%)	1,593 (24.44%)	1,223 (24.80%)	1,258 (24.04%)	4,571
Haut-Rhin 68	292 (15.42%)	1,030 (15.80%)	748 (15.17%)	748 (26.54%)	2,818
Vosges 88	110 (5.81%)	384 (5.89%)	348 (7.06%)	343 (6.55%)	1,185
Total	1,894	6,517	4,932	5,233	18,576

In Aube, Marne, Bas-Rhin, and Haut-Rhin, participation rates were low but exceeding regional averages. In Ardennes, Meurthe-et-Moselle, and Moselle, participation rates were below regional averages. Several factors could account for these either better or poorer rates of OBCS attendance. As previously mentioned, women's socio-economic status is considered a major barrier to OBCS participation. Compared with the general population, women with type 2 diabetes displayed lower socio-economic and socio-educational levels (41-46). According to the French National Institute of Statistics and Economic Studies monetary poverty rates, most areas with low OBCS participation rates likewise displayed high monetary poverty rates (47). A link between OBCS participation and professional activity was thus observed, given that half of the Grand-Est region's inhabitants performed more than 20% of their jobs in agriculture and industry. These sectors are deemed more affected by low socio-economic status. The Grand-Est region comprises both rural and urban areas. There is a well-known link between residence place and OBCS. In 2018, almost 40% of the French population lived in rural areas (48), where access to services was more difficult, which could account for women living there participating less in OBCS than women living in urban areas (49). This could be explained by either distance from radiology services (50), density of general practitioners, or both. Areas with low OBCS participation rates tend to be mostly rural, with few accredited radiology services and low medical density. We can also see a link between the high turnout in Marne and Bas-Rhin regions along with the presence of medical schools and university hospitals. Meurthe-et-Moselle area, despite its socio-economic advantages, numerous radiology services and general practitioners, and presence of a medical faculty, displayed low rates of OBCS participation. In their study evaluating IBCS, Quintin et al. (39) showed that Meurthe-et-Moselle had a high rate of IBCS. This could explain why OBCS participation rate in this area was lower, despite the advantages mentioned above.

There were other factors linked to type 2 diabetes that could explain why diabetic women participated less in OBCS. In 2005, Lipscombe et al. (29) showed that low OBCS participation persisted after adjusting for age, comorbidities, income, and residence place, suggesting that type 2 diabetes *per se* could represent a barrier to OBCS participation, which was recently verified by Chan et al. (51). Type 2 diabetes is a complex disease, requiring time-consuming management and therapeutic education (52, 53), leading health professionals to prioritize diabetes management over cancer prevention (54). We could anticipate that the number of annual consultations would correlate with better screening follow-up, which actually was not the case (29). For health professionals, it is crucial to find enough time to properly explain the benefits of breast cancer screening to their patients, whilst listening to their fears and preconceptions (55). Diabetic women often display a poor self-image (56), over 80% of them being overweight or obese (57), both known to be barriers to OBCS participation (27, 58-60). These two patient populations could actually fear being stigmatized on account of their weight (61). Performing a logistic regression analysis on the diabetic population of the Grand- Est region may identify factors associated with non-participation in OBCS.

Our prospects for improving screening attendance are as follows. Informing patients and physicians of the increased breast cancer risk in diabetic women could help raise awareness of OBCS (62). Cardiovascular mortality was previously the leading mortality cause in type 2 diabetes patients, which is no longer the case because of prevention measures. Today, the leading mortality cause in diabetic patients is cancer (63, 64). Collier et al. (65) demonstrated that 28% of deaths among diabetic patients were caused by cancer, versus 24% by cardiovascular causes. In 2023, an English study carried out by Ashley et al. (66) investigated the knowledge and understanding of increased complication risk among diabetics. In both the general and diabetic populations, no one cited breast cancer as a type 2 diabetes complication, whereas microvascular and macrovascular complications were widely cited. Next, these authors analyzed 25 websites for healthcare professionals and for the public, with only three of them mentioning breast cancer risk as a potential complication (diabetes.co.uk, diabetes.org.uk, niddk.nih.gov), whereas the American Diabetes Association did not consider diabetes as a risk for breast cancer on its website.

One key to improving screening participation would be to increase awareness of the increased breast cancer risk among diabetic women and healthcare professionals, in our opinion. Education, information, and prevention all resulted in a reduction of macrovascular and microvascular complications. To maximize awareness, we wish to set up a campaign with posters being distributed to general practitioners. Along with raising awareness among diabetic patients, this would also raise awareness among the people surrounding them. It has been proven that if women were surrounded by family and friends, the latter would likely encourage them to more actively participate in OBCS (67-69).

In conclusion, participation in breast cancer screening by diabetic women was poorer than among their non-diabetic peers, a finding of concern given their increased risk of developing breast cancer. It is important to understand the barriers to OBCS participation, particularly those associated with type 2 diabetes. Informed patients and healthcare professionals will be one step towards further improving breast screening attendance among women with type 2 diabetes.

Ethics

Ethics Committee Approval: Date were anonymous and protected by the following regulatory bodies: European Regulation RGPD n° 2016-679 of April 27, 2016; Loi informatique et libertés n° 2018-486 of June 20, 2018, and its Decree of application n° 2019-536 of May 29, 2019, consolidating Ordinance n° 2018-1125 of December 2018 modifying the law of January 6, 1978. The approval of the Committee for the Protection of Individuals was not required.

Informed Consent: Date were anonymous and protected by the following regulatory bodies: European Regulation RGPD n° 2016-679 of April 27, 2016; Loi informatique et libertés n° 2018-486 of June 20, 2018, and its Decree of application n° 2019-536 of May 29, 2019, consolidating Ordinance n° 2018-1125 of December 2018 modifying the law of January 6, 1978. The approval of the Committee for the Protection of Individuals was not required.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.P., E.F., O.P.; Concept: M.P., E.F., O.P., C.M.; Design: M.P., E.F., O.B.; Analysis or Interpretation: M.P., E.F., T.O., O.P., C.M.; Literature Search: M.P., C.M.; Writing: M.P., E.F., O.P., C.M.

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