



RAISONS DE SANTE 356 – LAUSANNE

Unisanté – Centre universitaire de médecine générale et santé publique  
Secteur Maladies Chroniques – Groupe Epidémiologie du cancer  
(GEPIC)

# Breast cancer screening programmes in Switzerland, 2019-2021

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### Étude financée par :

Fédération Swiss Cancer Screening (SCS)

### Citation suggérée :

Braendle K, Zwahlen M, Bulliard J-L. Breast cancer screening programs in Switzerland, 2019-2021. Lausanne, Unisanté – Centre universitaire de médecine générale et santé publique, 2024 (Raisons de santé 356).

<https://doi.org/10.16908/issn.1660-7104/356>

### Remerciements :

Dr. César Wong Alcazar, responsable du groupe de travail Monitoring de SCS, pour ses précieuses remarques et sa disponibilité.

### Relecture et contrôle de l'édition :

Aurélien Baud

### Date d'édition :

Mai 2024

# Table of contents

<b>Summary</b> .....	<b>6</b>
<b>1 Introduction</b> .....	<b>7</b>
1.1 Methods	7
<b>2 Breast cancer screening in Switzerland, ages 50-69</b> .....	<b>9</b>
2.1 Development of organized breast cancer screening	9
2.2 Screening activity	11
2.3 Coverage and participation	11
2.4 Performance of mammography screening	16
2.4.1 Prevalent screening	16
2.4.2 Incident screening	19
<b>3 Performance of mammography screening in specific age groups</b> .....	<b>22</b>
3.1 Prevalent screening in women aged 50 and 51 years	22
3.2 Mammography screening in women aged 70-74 years	24
<b>4 Possible harms for women participating in mammography screening (ages 50-74)</b>	<b>27</b>
<b>5 Appendix</b> .....	<b>29</b>
5.1 Annual results of all Swiss regional breast cancer screening programmes, 2019-21	29
5.2 Results of regional programmes, 2019-2021	31
5.3 Supplementary figures	35

## List of Tables

Table 1	Activity, coverage and participation rates in Swiss regional programmes (ages 50-69) by triennial periods, 2010-2021	13
Table 2	Performance of prevalent screening of Swiss regional programmes, (ages 50-69) by triennial periods, 2010-2021	17
Table 3	Performance of incident screening of Swiss regional programmes (ages 50-69) by triennial periods, 2010-2021	19
Table 4	Performance of prevalent screening in Swiss regional programmes (ages 50-51) by triennial periods, 2010-2021	23
Table 5	Invitations, participation and performance in Swiss regional programmes (ages 70-74) for all screening examinations 2016-2021	26

## Appendix

Table S1	Activity, coverage and participation rates of Swiss breast cancer screening programmes, ages 50-69 (all screening rounds)	29
Table S2	Performance of Swiss breast cancer screening programmes, ages 50-69 (all screening rounds)	30
Table S3	Activity, coverage and participation rates by screening programmes, ages 50-69 (all screening rounds), 2019-2021	31
Table S4	Performance of screening by programme, ages 50-69, all screening rounds, 2019-2021	32
Table S5	Performance of prevalent screening by programme, ages 50-69, 2019-2021	33
Table S6	Performance of incident screening by programme, ages 50-69, 2019-2021	34

## List of Figures

Figure 1	National coverage rate of women aged 50-69 years by regional breast cancer screening programmes, 2010-2023*	10
Figure 2	Geographical coverage of women aged 50-69 years by Swiss regional breast cancer screening programmes (year of start implementation)	10
Figure 3	Annual participation: (a) all-rounds and first round participation, (b) age-specific participation rates, 2010-2021 by year (all programmes, ages 50-69)	14
Figure 4	Annual reattendance (ages 50-69), with and without the influence of the BE programme	15
Figure 5	Trend in prognostic indicators of detected cancers by type of screening round	21
Figure 6	Annual referral, false-positive and breast cancer detection rates (per 1000 screens) 2010-2021, prevalent screening, ages 50-51 years	24
Figure 7	Geographical coverage of women aged 70-74 years by Swiss regional breast cancer screening programmes (year of start implementation)	25
Figure 8	National coverage of target population (women aged 70-74 years) by regional breast cancer screening programmes, 2014- 2023*	25
Figure 9	Probabilities of false-positive (FP) result and probability of true-positive result (screen-detected cancer) by screening round and age	28

## Appendix

Figure S1:	Contribution of each programme to the total number of invitations and mammographies, 2019-2021	35
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## Summary

This sixth national monitoring report mandated by Swiss Cancer Screening presents the results of organized mammography screening for the years 2010-2021 with focus on 2019-2021. The report covers all 10 regional programmes in 14 cantons. The analyses are based on more than 3 million anonymized records. This report mainly focuses on the outcomes of screening in women aged 50-69. Results for first-time attending women aged 50-51 and women aged 70-74 in programmes that systematically invite this older age group are also presented.

In 2023, 60% of women in Switzerland aged 50-69 and 44% of those aged 70-74 were covered by organized mammography screening. The increase in geographical coverage by public programmes is slow and population coverage remains comparatively low for a European country. Participation has steadily increased over time since the beginning of monitoring (2010-2012) and reached 47% for general participation and 41% for first-round participation in 2019-2021. It varied little across age groups. The range in general participation between programmes (36-60%) slightly narrowed over time. Reattendance rate remained around 82%. The COVID-19 pandemic likely had only a punctual impact on screening activity and participation.

Quality of screening differed largely between first and subsequent screening. In 2019-2021, the referral rate for prevalent (first) screening exceeded the acceptable level of the European Guidelines (98.5 vs 70 per 1000 screens recommended) whereas the acceptable standard was largely met for incident (subsequent) screening (31 vs 50 per 1000). Prevalent referral rates varied nearly three-fold across programmes with only one programme (BE) satisfying the recommended threshold. This upward trend corroborated results from the previous national monitoring and from longstanding programmes in Europe. Consequently, risk of false-positive results was high, and the positive predictive value (PPV) of mammography screening further decreased to 7.4%. In contrast, performance in incident screening was satisfying, more homogenous across programmes and stable over time. The PPV was 16.2%, more than twice that observed for prevalent screens. This value was particularly high in women aged 70-74 (25.9%) due to their higher breast cancer risk and detection rate (8.9 per 1000 screens). Out of 1000 first-time screened women, 90 experienced a false-positive result (31 in subsequent screens) and 19 an invasive investigation without a cancer diagnosis (4 in subsequent screens). Screening-related risks were highest for first-time participants aged under 52 and lowest for women aged 70-74 years. The increasing discrepancy in quality indicators for prevalent and subsequent screening, performed by the same pool of radiologists in the programmes, warrants further investigation into the medical approach for younger, first-time screened women.

The profile of screen-detected cancers was stable over time and globally met the recommended levels. If, as expected, prognostic profile was more favourable for cancers detected in incident than in prevalent rounds, this difference reduced over time.

# 1 Introduction

This sixth national monitoring report covers the results of organised mammography screening in Switzerland from 2010 to 2021, with a focus on the period 2019-2021. In Switzerland, breast cancer screening is organized and carried out per canton or region and is being implemented gradually from 1999. Data from all 10 Swiss programmes with at least one full year of operation are included.

The report presents the results aggregated at the national level for the 3-year period 2019-2021 in comparison with the triennial periods 2010-2012, 2013-2015 and 2016-2018. The triennial approach is based on larger numbers and leads to more stable results than annual results. National results regarding activity, coverage and performance are presented for women aged 50-69 in Section 2. The section 3 of the report is dedicated to specific age groups: Women aged 50-51 who attend screening for the first time and women aged 70 to 74 years in the 7 programmes that have extended the upper age limit of their systematic invitation to 74 years. Section 4 presents potential risks for women of different age groups participating in organised mammography screening in Switzerland. The Appendix provides annual national results and outcomes by programme and type of screening round for 2019-2021.

## 1.1 Methods

Data were extracted from the common database used by all regional programmes. This report includes roughly 3'100'000 records of all women invited for, or who requested, a screening examination between 2010 and 2021; were aged between 50 and 74 years at time of invitation; were living in the recruitment area of a regional programme; did not have prior breast cancer<sup>a</sup>; were not seriously ill; and did not have a breast prostheses.

### Why a national report?

A national monitoring gives the opportunity to assess the performance of all regional programmes at the same moment and in a uniform way. Predefined outcome and quality indicators are identically calculated, contributing to the harmonisation of quality assurance and the uniform evaluation of the process and outcomes of the screening programmes.

All variables were checked for completeness and consistency. Synchronous events, such as a referral for multiple suspect findings or a multiple breast cancer diagnosis were counted as one event per woman's screening round. In case of multiple breast cancers, the tumour of highest stage was considered. Indicators were calculated for regional programmes and the national total according to the Monitoring concept of Swiss Cancer Screening<sup>b</sup> which is mainly based on the

<sup>a</sup> Epidemiological criterion applied in order to abide to the population addressed by EU quality indicators. In accordance with Swiss norms, the programmes reinvite women with prior breast cancer.

<sup>b</sup> Swiss Cancer Screening. National monitoring of organized mammography screening programmes in Switzerland; Concept and methodology. Bern: Swiss Cancer Screening, version 1.0, 13.05.2020.

European Guidelines for Quality Assurance<sup>c,d</sup>. All indicators were independently double-checked and the results compared with the standards recommended by the European Guidelines.

Data are pooled, resulting in a larger impact of programmes covering a large population. Since performance is heterogeneous across programmes, the range of performance (on a programme-level) is presented alongside national results.

As specified in the Monitoring Concept, new programmes are considered in the Swiss monitoring once they are active for a full calendar year. Thus, 7 programmes contributed data for the period 2010-2012, 7 to 10 (BE as of 2013, BS as of 2014 and TI as of 2015) programmes for the period 2013-2015, 2016-2018 and 2019-2021 (SO as of 2020 as part of BE-SO).

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<sup>c</sup> Perry N, Broeders M, de Wolf C, Törnberg S, Holland R, von Karsa L and Puthaar E (eds.). European Guidelines for Quality Assurance in breast cancer screening and diagnosis. Fourth Edition. Luxembourg: Office for Official Publications of the European Communities, 2006.

<sup>d</sup> Janusch-Roi A, Neamțiu L, Dimitrova N, Ulutürk A, García Escribano M, Sardanelli F, et al. European Commission Initiative on Breast Cancer—Manual for Breast Cancer Services—European Quality Assurance Scheme for Breast Cancer Services Luxembourg: Publications Office of the European Union; 2021.

## 2 Breast cancer screening in Switzerland, ages 50-69

### 2.1 Development of organized breast cancer screening

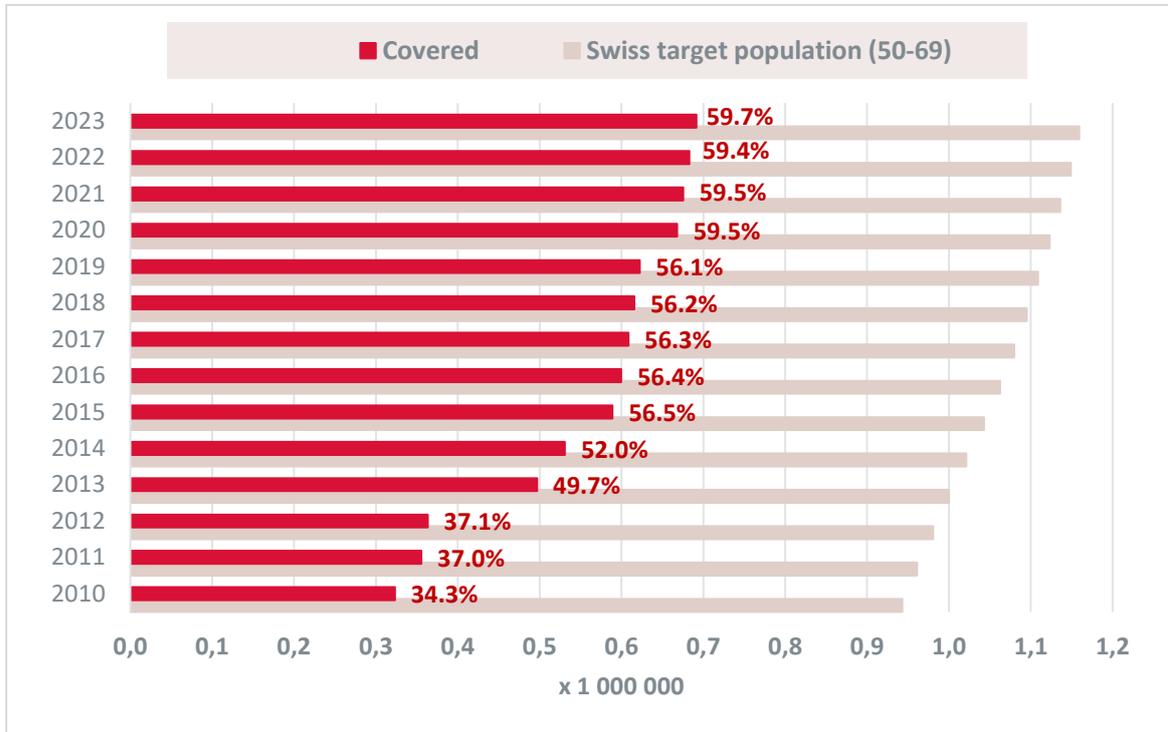
In 2023, 1.12 million women aged between 50 and 69 years lived in Switzerland. The proportion of women who lived in a canton covered by a screening programme, and therefore are targeted for organized breast cancer screening, increased from 34% in 2010 to nearly 60% in 2023 (Figure 1). The largest increase in population coverage occurred in 2013 when the programme in the Canton of Bern, the second most populated Swiss canton, started. The last marked increase in coverage was observed with the start of the SO programme in 2020 (+3.4%), while the new programme in AI (2023) accounts for a tiny increase of 0.3%. In 2023, Swiss population coverage by screening programmes is higher for colorectal than for breast cancer<sup>e</sup>, even though organized colorectal cancer screening only started in 2015.

By 2010, French-speaking Switzerland (VD, VS, GE, FR and the region BEJUNE, which includes the French-speaking part of the Canton of Bern [BE] and the Cantons of Jura [JU] and Neuchâtel [NE]) was fully covered by organized programmes for years, but there was no joint monitoring. In 2010, the first two programmes in the German-speaking part of Switzerland were implemented in the Cantons of St.Gallen (SG) and Thurgau (TG), followed by Graubünden (GR) in 2011, the German-speaking part of the Canton of Bern (BE) in 2013, the Canton of Basel-Stadt (BS) in 2014, Ticino (TI) in 2015, Solothurn (SO) in 2020, and Innerrhoden (AI) in 2023 (Figure 2). Mammography screening in the Cantons of SG and GR, as well as in BE and SO, is currently delivered by a single organisation. These two entities are considered as two programmes (SG-GR and BE-SO) for the national monitoring.

The integration of new programmes leads to differences across years in the age distribution of invited and screened women, and in the distribution of initial (prevalent) and subsequent (incident) screening examinations. Both age and the screening round have an impact on the outcomes of breast cancer screening. Comparison of outcomes between different calendar years or time periods for a changing set of programmes with varying duration of functioning and therefore varying proportions of prevalent (initial) screening exams must be interpreted with caution (see Section 3.1).

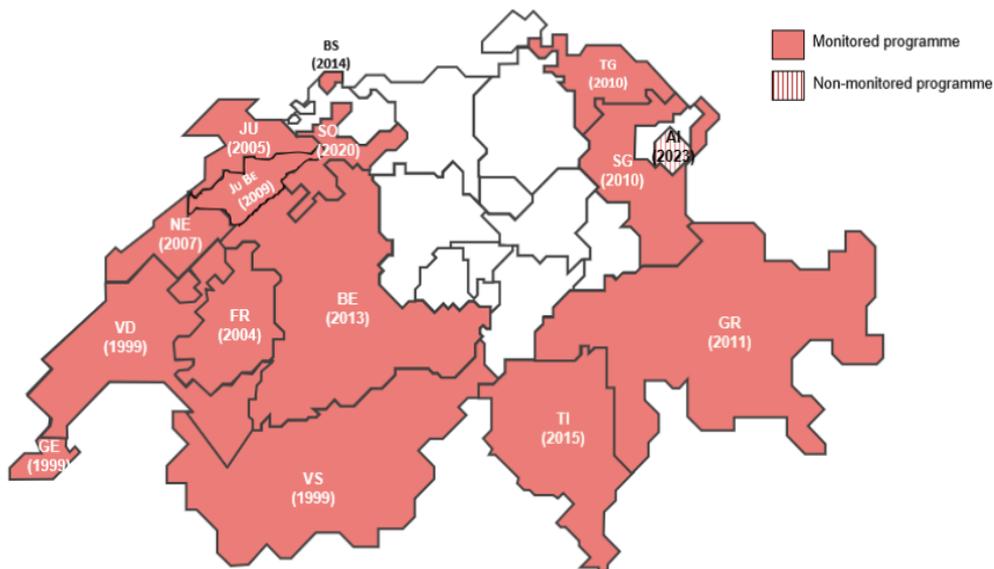
<sup>e</sup> Brändle K, Bulliard JL. Premier bilan du programme vaudois de dépistage du cancer colorectal. Rev Med Suisse. 2022;18(803):2108-11

**Figure 1** National coverage rate of women aged 50-69 years by regional breast cancer screening programmes, 2010-2023\*



Source target population: Federal Statistical Office

**Figure 2** Geographical coverage of women aged 50-69 years by Swiss regional breast cancer screening programmes (year of start implementation)



## 2.2 Screening activity

Between 2019 and 2021, some 842'000 invitations (around 281'000 per year) have been sent by the 10 regional programmes. During this period, an average of 135'000 annual screening examinations have been performed, for a total of 405'000 mammographies (Table 1). Compared to the period 2016-2018, the number of invitations and screening examinations increased by 9% and 8%, respectively. This increase in activity slowed down compared to earlier time periods. The suspension of activity for several weeks in 2020 due to COVID-19 had a temporary effect on the number of mammographies (-10'000 in comparison with 2019) and likely on the coverage by invitation, without an observable impact on participation. The effect on reattendance is difficult to estimate.

The numbers of invitations and screening examinations vary widely across programmes. The mean annual number of invitations was more than four-fold in the largest programme (BE-SO) compared to the smallest one (BS). For the period 2019-2021, the two programmes in VD (17.7%) and BE-SO (16.5%) contributed each to about 1/6 of all screening examinations, whereas the two smallest ones (TG and BS) contributed to 5% or less of all mammographies (Supplementary Figure 1 in the Appendix).

## 2.3 Coverage and participation

The mean annual number of women in the target population was 655'279 for the period 2019-2021 (Table 1). A total of 2615 women (0.4%) were found to be ineligible for screening<sup>f</sup> and were therefore excluded.

Invitations are sent out every two years, resulting in a target number of 327'639 invitations per year. With an annual mean of 280'843 invitations sent, coverage by invitation was 85.6% for 2019-2021 (Table 1). As for the period 2016-2018, coverage rate by invitation was heavily impacted by the low coverage in the BE programme in the aftermath of the suspension of screening activity between November 2017 and September 2018. Coverage rate by invitation remained under 60% until 2020 in the BE programme. Coverage rate by invitation without the BE programme was 92.5% for the

2019-2021 period, which is comparable to the result of 2016-2018 (93.5%).

### Coverage rate

The coverage rate gives the proportion of targeted women who has been invited (*coverage by invitation*) or screened (*coverage by participation*) in a defined time period.

Ideally, the latter should include screening mammographies performed outside of organised programmes, but no reliable data are available on this so-called opportunistic screening in Switzerland.

The *coverage rate by invitation* measures the equal access to mammography screening for all entitled women.

<sup>f</sup> According to the epidemiological criteria applied, c.f. Methods, section 1.1.

The effect of the COVID-19 pandemic is difficult to estimate with the concomitant start of invitations in the canton of SO in 2020. Six programmes maintained their coverage by invitation stable in 2020, while it dropped by 5-10% compared to 2019 in others (VD, BJN, BE-SO, SG-GR).

The coverage by invitation rate is never precisely 100%. The target population determined at the beginning of a calendar year is continuously altered by migration into and out of the catchment area of a programme. Furthermore, some women opt out of a programme or become ineligible for some other reason in subsequent screening rounds, resulting in fewer invited women. Some 405'000 women invited between 2019 and 2021 (around 135'000 per year on average) were screened within one year resulting in a participation rate of 47.3% (Table 1). Compared to earlier periods, participation was highest in 2019-2021. In comparison with 2016-2018, participation rates decreased only in two long-standing programmes (VD and VS, -3-4%), while it increased in most programmes (GE, SG-GR, BE, BS, and TI). Participation rates in 2019-2021 ranged from 36.4% (BS) to 60.4% (BJN) (Table S3 in the Appendix).

**Table 1 Activity, coverage and participation rates in Swiss regional programmes (ages 50-69) by triennial periods, 2010-2021**

Activity statistics	2019-2021		2016-2018		2013-2015		2010-2012		
	Annual mean (all prog.)	range (per prog.) <sup>b</sup>	Annual mean (all prog.)	range (per prog.)	Annual mean (all prog.)	range (per prog.)	Annual mean (all prog.)	range (per prog.)	
Target population (prog. in monitoring)	<b>655 279</b>	24 509 / 161 507	608 005	24 198 / 132 371	473 483	23 756 - 88 985	319 399	20 204 / 83 760	
Invitations (incl. self-referrals)	<b>280 843</b>	11 933 / 52 433	258 661	11 441 / 43 980	233 458	14 253 - 45 466-	145 392	11 045 / 37 984	
Mammographies	<b>134 969</b>	4 481 / 23 843	124 724	3 971 / 23 060	97 762	3 777 - 20 937-	70 065	4 087 / 20 426	
Coverage and participation rates						min - max**		min / max**	
Invitations (eligible women)	<b>279 971</b>	11 919 / 52 291	257 643	11 413 / 43 853	231 927	14 181 - 45 079-	144 500	10 900 / 37 801	
Mammographies (within 1 year)	<b>132 340</b>	4 334 / 22 603	118 271	3 611 / 22 253	98 244	4 177 - 21 105-	67 927	4 111 / 19 305	
Coverage rate by invitation <sup>a</sup>	<b>85.6%</b>	64.8% / 103.0%	84.9%	54.3% / 103.7%	98.3%	94.3% - 119.8%	90.7%	74.4% / 108.7%	
Participation rate <sup>a</sup>	<b>47.3%</b>	36.4% / 60.4%	45.9%	31.6% / 59.9%	42.4%	25.7% - 59.9%	47.0%	31.4% / 59.7%	
1st round participation rate <sup>a</sup>	<b>41.3%</b>	31.9% / 51.2%	39.8%	28.6% / 52.6%	32.6%	25.8% - 52.6%	38.3%	27.8% / 52.9%	
Reattendance <sup>a</sup>	<b>77.0%</b>	44.8% / 87.6%	80.6%	64.6% / 88.1%	83.6%	73.1% - 89.0%	85.7%	74.4% / 89.2%	

<sup>a</sup> based on eligible population per year<sup>b</sup> annual mean (min – max) per single programme

An increase was also observed for first round participation rate, resulting in the highest rate observed in any monitoring to date (41.3% in 2019-2021 vs 39.8% in 2016-2018 and lower rates in earlier periods). This result is of importance since first round participation is predictive of future trends in participation. However, rather than being a general tendency, first-round participation increased strongly in three programmes, TI (+9.8%), BE (+8.5%) and BS (+5.4%), while it decreased in all programmes in French-speaking Switzerland. The largest decrease was observed for the VS programme (-4.1%), followed by VD (-3.4%).

**Participation rate (within one year following the invitation)**

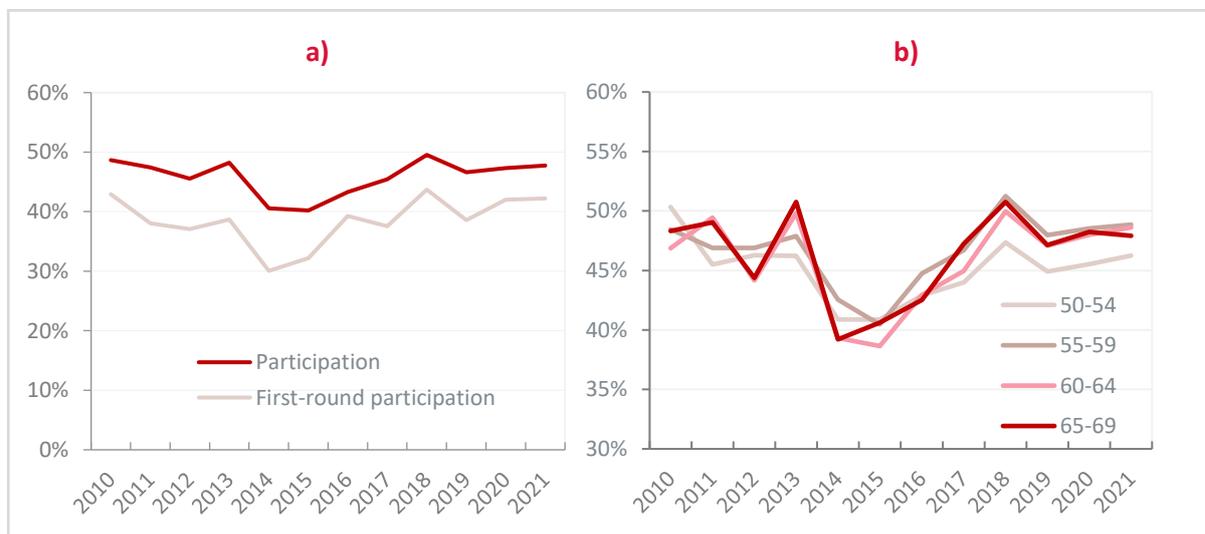
The participation rate within one year measures the proportion of eligible women that attended the programme within one year after having been invited to screening. The screening examination can take place in another year than the year in which the woman has been invited.

The participation rate within one year must not be confused with the activity index specified in the annual reports of regional programmes. This index reports the number of performed screening examinations divided by the number of invitations sent out within the same calendar year. For this reason, the activity index can substantially differ from the participation rate.

Figure 3a shows the annual participation rates (all rounds and first round participation) between 2010 and 2021. Participation decreased after the start of two new programmes (BE, 2013; BS, 2014), but thereafter recovered. After a decrease in 2019, participation slightly increased in 2020 and 2021.

Figure 3b presents age-specific participation rates for 2010-2021 by year. Overall, participation varied little with age, except for a slightly lower participation rate of women aged under 55 since 2018 (difference of 1.5-2% compared to older women). All age groups showed a similar decreasing trend from a higher level of participation in 2010 and 2013 to a lowest level around 40% in 2014-2015, followed by an increase up to and including 2021. These trends were similar, but less pronounced in the youngest age group.

**Figure 3 Annual participation: (a) all-rounds and first round participation, (b) age-specific participation rates, 2010-2021 by year (all programmes, ages 50-69)**



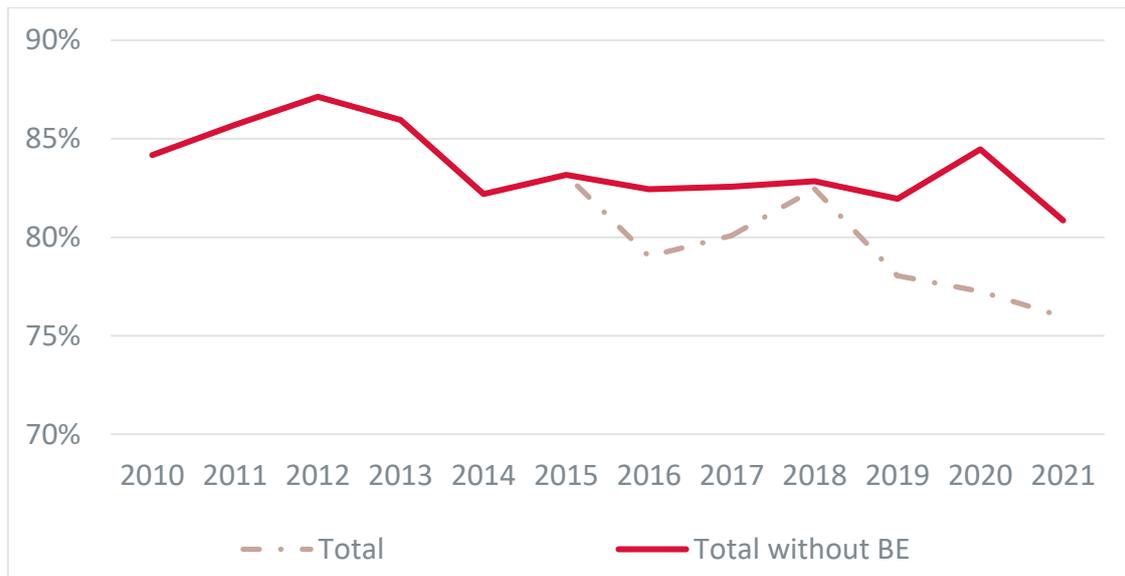
Reattendance rate, a measure of compliance of those screened in the previous round, was lower between 2019 and 2021 than in all previous time periods (77.0%). This is mainly due to the lower reattendance in the BE programme after the suspension of screening. Reattendance rate without the BE programme (82.3%) was in line with results for earlier time periods (Table 1, Figure 4). Reattendance lowered in four programmes, while it remained stable or slightly increased in the other programmes. Reattendance rate diminished in 2021 in all programmes (except for BE). A contribution of the COVID-19 pandemic to this drop cannot be excluded.

Reattendance was 3-5% higher in the Latin parts (programmes BJN, FR, GE, VD, VS, TI) than in the German-speaking parts of Switzerland (programmes BS, SG-GR, TG, BE) when disregarding BE (data not shown) The evolution is similar in both regions since 2015.

**Reattendance rate**

The reattendance rate measures the proportion of women that participates in the current screening round who also participated in the previous screening round within the last three years.

**Figure 4 Annual reattendance (ages 50-69), with and without the influence of the BE programme**



## 2.4 Performance of mammography screening

### 2.4.1 Prevalent screening

A prevalent screening examination is the first mammography of a woman within a programme. As the risk of breast cancer strongly increases with age, a prevalent screening round will result in a lower detection rate when the proportion of younger women screened increases. This occurs when comparing prevalent screens over time or across programmes of highly different durations. Therefore, while this section includes all age groups, prevalent screening in women aged 50-51 years will be separately analysed in section 3.1.

Of almost 405'000 screening examinations performed between 2019 and 2021, 99'370 (24.6%) were prevalent (initial) screens. On average, there were 33'000 initially screened women per year during 2019-2021 (Table 2). This period is the first in the monitored timespan with a decrease in both the number and the proportion of initial screens, dropping from roughly one third to one quarter of all mammographies.

Some 3300 initially screened women were referred for a diagnostic assessment each year, which corresponds to a referral rate of 98.5 per 1000 prevalent screens. This rate is nearly 20% higher than the already high rate in the period 2016-2018 (80.3 per 1000). It exceeds by 40% the acceptable level of 70 per 1000 recommended by the European Guidelines. Only one programme (BE) had a referral rate within the recommended range. The referral rate of the other nine programmes showed a large heterogeneity, ranging from 82.4 (TI) to 181.2 (BS) per 1000.

#### Prevalent and incident screening

When screening a population for the first time, one expects to find many asymptomatic cancers (cancers in a preclinical phase). A perfect screening test would theoretically detect all these prevalent cancers. For this reason, a first screening test is also called prevalent screening. Prevalent screening leads to comparatively high referral and breast cancer detection rates. The positive predictive value of the mammography is however lower than in incident screens because of the lack of opportunity to compare the current mammogram with previous ones, which results in higher false-positive rates.

In subsequent screening rounds, less asymptomatic cancers will be detected because many have already been found during the prevalent round. Subsequent screening mainly detects cancers that have become preclinically detectable since the previous round, the so called incident cases. Therefore, subsequent screening is also called incident screening.

In the first two years of a mammography screening programme, only prevalent screening examinations are performed within the total age range of targeted women. In an older programme, the vast majority of screens are incident screens. The prevalent screens are mainly performed among younger women who reach 50 years of age and newly belong to the target population.

Because results differ greatly between prevalent and incident screens, they are presented separately. This is particularly relevant when the distribution of prevalent and incident screens shows large variations across time periods.

The referral rates in the period 2019-2021 lead to false-positive results in nearly one of 10 initially screened women. While referral rate increased in all programmes, it was particularly marked (25-50%) in four programmes (BJN, BS, FR, VS). This trend appears however to have reversed in the last

1-2 years in some programmes (FR, SG-GR, VD, VS), but referral rates remained higher than during the 2016-2018 period. However, while the recall rates exceed the thresholds stipulated by European guidelines, the results of most Swiss programmes lie within the average of programmes of other European countries

**Table 2 Performance of prevalent screening of Swiss regional programmes, (ages 50-69) by triennial periods, 2010-2021**

	Annual mean (total)				Range (programme) <sup>c</sup>		EU GL
	2019- 2021	2016- 2018	2013- 2015	2010- 2012	2019-2021		
<b>Screening tests performed</b>							
<b>Prevalent (first) mammographies</b>	<b>33 123</b>	38 074	35 427	24 664	1 313 - 9 127		
Proportion of prevalent mammographies	<b>24.6%</b>	30.5%	38.5%	39.4%	16.7% - 41.3%		
<b>Referrals</b>							
<b>Referrals</b>	<b>3 263</b>	3 056	2 578	2 148	148 - 613		
<b>Referral rate (/1000 screens)</b>	<b>98.5</b>	80.3	72.8	87.1	66.9 - 181.2		<70 (<50)
Completeness follow-up referrals	<b>98.6%</b>	97.4%	99.2%	99.8%	97.5% - 99.9%		
<b>False-positive rate (/1000 screens)</b>	<b>91.3</b>	73.7	66.6	80.0	59.8 - 173.6		
<b>Breast cancer detection rate (/1000 screens)</b>	<b>7.2</b>	6.5	6.2	7.1	5.3 - 9.7		NA
<b>Positive predictive value (PPV adjusted)<sup>a</sup></b>	<b>7.4%</b>	8.4%	8.5%	8.2%	4.3% - 11.1%		
<b>Rate of invasive investigations (/1000 screens)<sup>b</sup></b>	<b>24.7</b>	19.7	26.5	23.8	18.8 - 31.8		
<b>Screen-detected breast cancers</b>							
<b>Screen-detected breast cancers (N)</b>	<b>239</b>	249	218	175	10 - 65		
<i>Tumour behaviour determined</i>	<b>99.7%</b>	98.9%	95.3%	100.0%	97.9% - 100.0%		
<b>Ductal carcinoma in situ (DCIS)</b>	<b>19.5%</b>	19.6%	21.3%	19.6%	12.6% - 26.2%		10% (10-20%)
<b>Invasive breast cancers (N)</b>	<b>192</b>	197	161	141	8 - 49		
- invasive node-negative cancers	<b>84.0%</b>	80.4%	77.7%	80.1%	65.7% - 94.5%		NA (>70%)
- invasive cancers ≤10mm (T1a+T1b)	<b>32.9%</b>	32.3%	30.8%	29.6%	17.1% - 43.5%		NA (>25%)
- invasive cancers <15mm	<b>49.0%</b>	49.7%	47.9%	40.3%	31.4% - 58.7%		50% (>50%)
<b>Early stage breast cancers (stage 0+I)</b>	<b>70.6%</b>	69.7%	66.2%	64.2%	52.1% - 82.6%		NA (>70%)
<b>Advanced stage breast cancers (stage II+)</b>	<b>28.2%</b>	26.8%	26.5%	32.4%	16.4% - 43.8%		NA (<30%)
Stage undetermined	<b>1.3%</b>	3.5%	7.3%	3.4%	0.0% - 10.0%		

<sup>a</sup> based on known follow-up only

<sup>b</sup> Data for SG-GR and BE discarded as deemed incomplete or unreliable (number of screen-detected cancers exceeded the number of invasive investigations).

<sup>c</sup> Annual mean (min – max) per single programme

Eur. GL: European guidelines – Acceptable level (desirable level)

NA: not applicable.

An average of 239 breast cancers were detected per year in women attending organized screening for the first time between 2019 and 2021 (total: 717 screen-detected cancers), resulting in a detection rate of 7.2 per 1000 screens. Compared to the period 2016-2018, the false-positive rate increased from 73.7 to 91.3 per 1000 screens and the positive predictive value decreased from 8.4% to 7.4%. In other words, one in about 7 referred women was diagnosed with a breast cancer. At the programme level, the detection rate ranged from 5.3 (GE) to 9.7 (TG) per 1000, the positive predictive value from 4.3% (BS) to 11.1% (TI), and the false-positive rate from 59.8 (BE) to 173.6 (BS) per 1000 screens. However, the low number of detected cancers in prevalent screening for some programmes renders the results very sensitive to small changes (Table S5Table S6, Appendix).

The radiological quality of prevalent screening decreased further in 2019-2021. Compared to the previous periods, the false-positive rate substantially increased, which led to a markedly lower positive predictive value of mammography. However, caution is required when interpreting differences in the outcomes of prevalent screening across time. Comparison over time is hampered by the fact that the age distribution of initially screened women differs between the periods. Indeed, the proportion of women aged 50-51 years in prevalent screening has constantly increased over the periods, from 37% before 2016 to 43% in 2016-2018 and to 51% in 2019-2021. Further, possible previous opportunistic screening means that some prevalent screening examinations indeed were incident screening examinations. By limiting the comparison of prevalent screening outcomes to women aged 50 and 51 years, the impact of age distribution on the results can be excluded (see Section 3.1). However, the influence of opportunistic screening remains and data to account for this are not available.

Prognostic characteristics of screen-detected breast cancers mostly fulfilled the recommendations of the European Guidelines. However, not all characteristics were fully determined, which can slightly affect the proportions of tumour sizes or stages (less than 10% missing values overall). At single programmes' level, the numbers of screen-detected cancers were sometimes too small to allow a reasonable interpretation.

Data on non-invasive and invasive assessment procedures were available and deemed reliable for 8 of the 10 programmes (exceptions: SG-GR, BE). The analysis from 8 programmes showed that 25 out of 1000 women experienced invasive<sup>9</sup> investigations upon their first participation. With the 2019-2021 detection rate, this means that 17 out of 1000 women who did not have a cancer (false-positive result) underwent an invasive assessment. The ratio of invasive investigations per screen-detected cancer was 3.4 for the period 2019-21.

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<sup>9</sup> In recent periods, the procedures have become minimally invasive.

## 2.4.2 Incident screening

On average, some 102'000 incident mammographies were performed annually by organized programmes between 2019 and 2021 (Table 3), for a total of 305'315 screening examinations.

**Table 3** Performance of incident screening of Swiss regional programmes (ages 50-69) by triennial periods, 2010-2021

	Annual mean (total)				Range (programme) <sup>d</sup>	EU GL
	2019- 2021	2016- 2018	2013- 2015	2010- 2012	2019-2021	
<b>Screening tests performed</b>						
Incident (subsequent) mammographies	101 772	86 650	62 334	45 400	3 167 - 18 744	
Subsequent screens within 22-26 months	50.8%	65.4%	67.1%	68.9%	20.4% - 69.2%	
<b>Referrals</b>						
Referrals	3 155	2 766	2 072	1 554	125 - 592	
Referral rate (/1000 screens)	31.0	31.9	33.2	34.2	21.4 - 45.6	<50 (<30)
Completeness follow-up referrals	99.2%	98.7%	99.3%	99.8%	98.2% - 99.9%	
False-positive rate (/1000 screens)	26.0	27.2	28.5	29.1	15.8 - 40.3	
Breast cancer detection rate (/1000 screens)	5.0	4.8	4.7	5.1	4.1 - 5.8	(>)1.5 * IR
Positive predictive value (PPV adjusted) <sup>a</sup>	16.2%	15.1%	14.2%	15.0%	11.8% - 26.4%	
Rate of invasive investigations (/1000 screens) <sup>b</sup>	8.7	8.6	8.8	9.5	7.2 - 10.0	
<b>Screen-detected breast cancers</b>						
Screen-detected breast cancers (N)	507	412	293	233	18 - 90	
Tumour behaviour determined	99.9%	99.1%	99.8%	100.0%	99.3% - 100.0%	
Ductal carcinoma in situ (DCIS)	17.5%	16.5%	18.1%	17.2%	12.0% - 27.3%	10% (10-20%)
Invasive breast cancers (N)	418	340	239	193	13 - 72	
- invasive node-negative cancers	83.4%	80.4%	77.7%	82.0%	75.2% - 92.3%	(>)75%
- invasive cancers ≤10mm (T1a+T1b)	32.9%	36.4%	34.3%	34.0%	26.2% - 46.4%	≥25% (>30%)
- invasive cancers <15mm	54.4%	55.3%	55.7%	55.3%	47.5% - 71.2%	50% (>50%)
Early stage breast cancers (stage 0+I)	72.9%	72.3%	71.8%	74.4%	63.2% - 80.9%	75% (>75%)
Advanced stage breast cancers (stage II+)	24.1%	25.3%	26.3%	25.0%	15.7% - 29.8%	25% (<25%)
Stage undetermined	2.9%	2.4%	1.9%	0.6%	0.0% - 12.7%	

<sup>a</sup> based on known follow-up only

<sup>b</sup> Data for SG-GR and BE discarded as deemed incomplete or unreliable (number of screen-detected cancers exceeded the number of invasive investigations).

<sup>c</sup> Incident screens BS 2016 and TI 2016-17 excluded

<sup>d</sup> Annual mean (min – max) per single programme

Eur. GL: European guidelines - Acceptable level (desirable level)

IR: (underlying) breast cancer incidence rate

Half of the subsequent mammographies occurred 22 to 26 months after the previous screen (Table 3), a substantially lower proportion than in previous periods (65.4% in 2016-2018 and nearly 70% before 2016). The COVID-19 pandemic appears the most likely explanation for this decrease (45% in 2020, 50% in 2021). Timely screening examinations around every two years are considered to be most favourable for a breast cancer mortality reduction. About 9500 subsequently screened women were referred for a diagnostic assessment (3155 per year on average), resulting in 1,522 diagnosed breast cancers (507 per year). The referral rate of 31.0 per 1000 incident screens nearly met the desirable level recommended by the European Guidelines (<30). All programmes reached the minimal requirement of less than 50 referrals per 1000 incident screens. The breast cancer detection rate was 5.0 per 1000 screens and the false-positive rate 26.0 per 1000 screens. The referral rate constantly diminished over the monitored periods with 2019-2021 showing the lowest rate. Together with the slightly increased breast cancer detection rate, PPV increased to 16.2% (vs 15.1% in 2016-2018).

The variation in performance between programmes was much less pronounced in incident than in prevalent screens. There were no extreme outliers. However, two programmes (FR and BJN) registered referral rates over 40 per 1000 incident screens for cancer detection rates only slightly higher than the national average. Consequently, their PPV was lower than the national average (around 12%). Five programmes (GE, TG, SG-GR, BE, TI) attained the recommended, desirable threshold of below 30 per 1000 for their referral rate (and as low as 21.4 for BE) (Table S66, Appendix).

The rate of invasive investigation amounted to 8.7 for 1000 incident screens in 2019-2021. With a breast cancer detection rate of 5.0 per 1000, four out of 1000 incident screens resulted in invasive investigations with a false-positive result. The ratio of invasive investigations per detected breast cancer was 1.8 for the period 2019-2021. Among women with a positive mammography result, 18.1% underwent invasive investigations and 80.8% had only non-invasive diagnostic investigations. The type of investigation was unknown in 1.1% of cases.

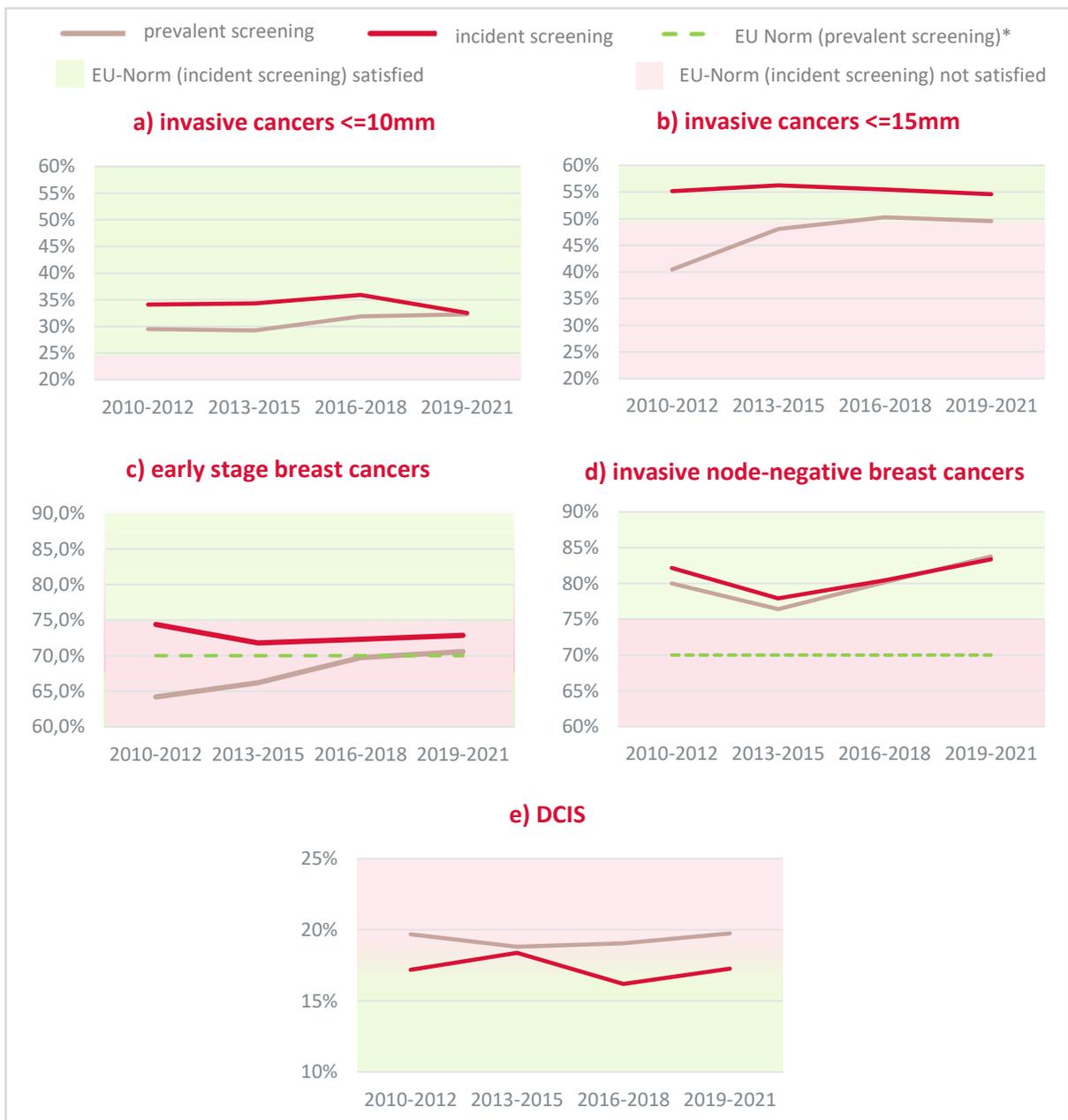
Of 1522 breast cancers detected in incident screening between 2019 and 2021, 17.5% were ductal carcinoma in situ (DCIS), 72.9 % were early stage and 24.1% advanced stage cancers (Table 3). Of the invasive cancers, 83.4% were lymph node-negative, 32.9% smaller or equal to 10 mm in size and 54.4% smaller than 15 mm.

The performance Indicators for breast cancers detected by incident screening met the desirable levels recommended by the European Guidelines, except for the proportion of early-stage cancers which consistently remained marginally below the threshold of 75%. Three programmes (TG, BE and TI) met this threshold. In the FR, GE and VS programmes, less than 70% of cancers detected in incident screening were early stage. Performance did not differ substantially from the values observed in previous periods. Staging was known for more than 95% of cancers in 8 programmes. (Table S6, Appendix).

The prognostic profile of screen-detected cancers showed minor variations over time (Figure 5). The proportion of early stage breast cancers has been relatively stable since the first monitoring period (2010-12; Figure 5c); that of node-negative cancers has constantly increased after a dip in 2013-15 (Figure 5d). The proportion of DCIS has constantly been near the 20% threshold in incident

screening (Figure 5e). As expected, clinical profiles were more favourable for cancers detected in incident screening round than upon first participation. However, apart for DCIS, all indicators of early detection showed a reduced difference between prevalent and incident screening over time (Figure 5). This may suggest that the share of women having an opportunistic mammography before age 50 might have increased and their first participation is not a true prevalent screen.

**Figure 5** Trend in prognostic indicators of detected cancers by type of screening round



\*if different from threshold for incident screening

## 3 Performance of mammography screening in specific age groups

### 3.1 Prevalent screening in women aged 50 and 51 years

The interpretation of results of prevalent screening in all targeted women (ages 50-69) is difficult since the age distribution at first screening is heterogenous due to new programmes starting at different years. Every new regional programme starts with a first round of invitations of all women aged 50-69 (or 50-74) in its catchment area. Over the next invitation rounds, the majority of first invited women will be 50 years old; the small proportion of older women with a first invitation are those who have immigrated into the catchment area of the programme after age 50.

As the vast majority of prevalently screened women are under age 52, limiting analyses of prevalent screening results to these ages improves comparability across programmes. These “newcomers” are of special interest because some of their screen-related harms differ from older women. Programmes should consider providing this specific information to younger women when inviting them for the first time.

The annual number of prevalent (first) mammographies in women aged 50-51 almost reached 17'000 on average for the period 2019-2021 (50'331 in total). This number remained stable in comparison with 2016-2018 (16'300 annual screenings, 49'011 in total) (Table 4). The referral rate increased steadily from around 90 per 1000 screens up to 2015 and 100 per 1000 screens in 2016-2018 to 110 per 1000 in 2019-2021. This trend corroborated the general increase in referral rate observed in prevalent screening for almost all programmes in the recent years. While breast cancer detection rate continued to marginally increase (5.8 per 1000 in 2019-2021, 5.7 per 1000 in 2016-2018, 5.4 per 1000 in 2013-2015 and 5.3 per 1000 in 2010-2012), positive predictive of mammography decreased (5.3% in 2019-2021), and the false-positive rate increased to 105 per 1000 screens (vs 94.6 per 1000 in 2016-2018 and about 84 per 1000 in the preceding triennial periods). Out of 1000 first screened women under 52 years, 25 underwent invasive investigations; and 19 of them did not have cancer.

The proportion of ductal carcinoma in situ (DCIS) of 21.8% was lower than in all previous triennial periods. Although these proportions exceeded the recommended value (for ages 50-69), proportions of 20-25% in younger women have been observed internationally in mammography screening programmes. Other indicators of tumour prognosis met the recommended values of the European Guidelines.

The increasing discrepancy in quality indicators between prevalent and subsequent screening, performed by the same pool of radiologists altogether and the persisting large differences across programmes warrant further investigation into the approach to mammography screening for younger, first-time screened women.

**Table 4 Performance of prevalent screening in Swiss regional programmes (ages 50-51) by triennial periods, 2010-2021**

	Annual mean (total)				Eur. GL
	2019-2021	2016-2018	2013-2015	2010-2012	
<b>Screening tests performed</b>					
Prevalent (first) mammographies	16 777	16 337	39 242	27 789	
<b>Referrals</b>					
Referrals	1 859	1 637	1 165	831	
Referral rate (/ 1000 screens)	110.8	100.2	89.1	89.7	<70 (<50)
Completeness follow-up referrals	98.6%	97.7%	99.1%	99.8%	
False-positive rate (/1000 screens)	105.0	94.6	83.6	84.3	
Breast cancer detection rate (/1000 screens)	5.8	5.7	5.4	5.3	NA
Positive predictive value (PPV adjusted) <sup>a</sup>	5.3%	5.9%	6.1%	6.0%	
Rate of invasive investigations (/1000 screens) <sup>b</sup>	24.8	22.8	24.5	24.3	
<b>Screen-detected breast cancers</b>					
Screen-detected breast cancers (N)	98	94	71	49	
Tumour behaviour determined	100.0%	98.2%	99.1%	100.0%	
Ductal carcinoma in situ (DCIS)	21.8%	24.9%	22.5%	26.4%	10% (10-20%)
Invasive breast cancers (N)	77	69	54	36	
- invasive node-negative cancers	84.8%	78.6%	77.3%	80.7%	NA (>70%)
- invasive cancers <=10mm (T1a+T1b)	38.3%	31.1%	31.3%	33.9%	NA (>25%)
- invasive cancers <15mm	54.3%	51.0%	50.3%	45.0%	50% (>50%)
Early stage breast cancers (stage 0+I)	73.8%	68.7%	67.6%	70.3%	NA (>70%)
Advanced stage breast cancers (stage II+)	25.5%	27.0%	27.2%	28.4%	NA (<30%)
Stage undetermined	0.7%	4.3%	5.2%	1.4%	

<sup>a</sup> based on known follow-up only

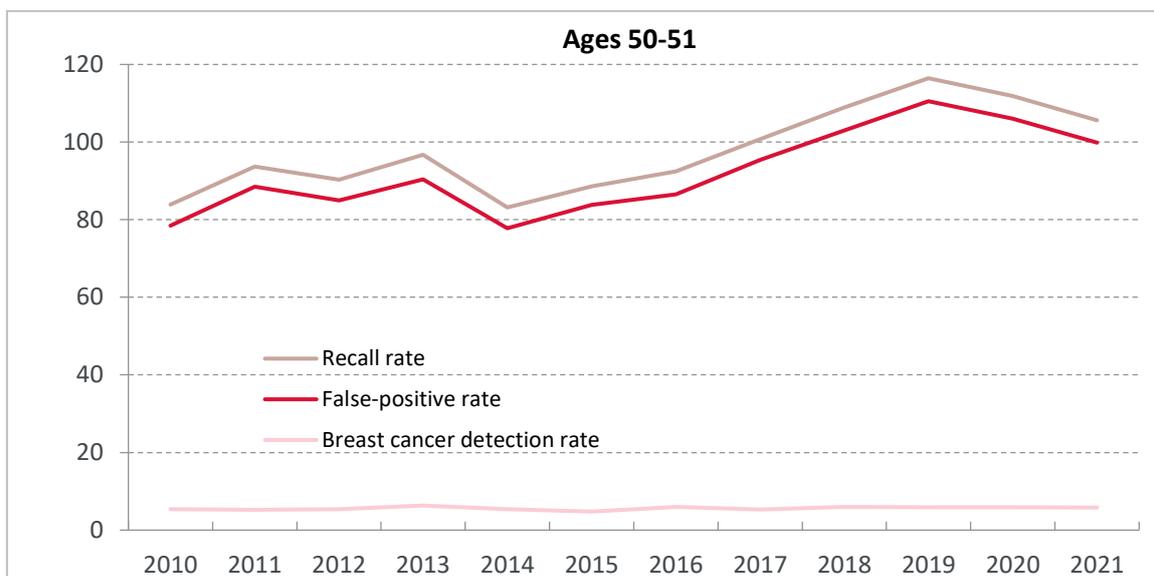
<sup>b</sup> Data for SG-GR and BE discarded as deemed incomplete or unreliable (number of screen-detected cancers exceeded the number of invasive investigations).

Eur. GL: European guidelines - Acceptable level (desirable level)

NA: not applicable.

Figure 6 presents the annual trends of referral, false-positive and breast cancer detection rates for women aged 50-51 years. Referral rates and false-positive rates followed a parallel trend. Cancer detection rate slightly increased over time. The higher likelihood for young women to be referred following a prevalent screening examination and to have a false-positive result in comparison with older women was likely due to the denser tissue of younger breasts. This makes the interpretation of mammographic findings more difficult, especially as no previous mammograms are available for comparison. The risk of a referral and of a false-positive result will be markedly lower for these women in their following (incident) screening rounds.

**Figure 6** Annual referral, false-positive and breast cancer detection rates (per 1000 screens) 2010-2021, prevalent screening, ages 50-51 years



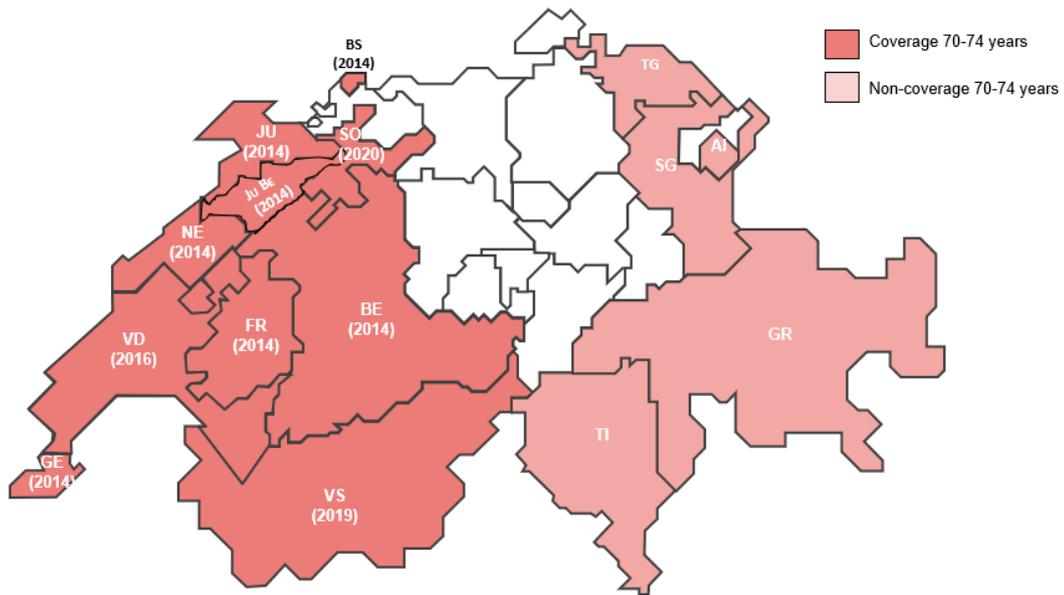
## 3.2 Mammography screening in women aged 70-74 years

Since clear scientific evidence supports a mortality benefit to recommend mammography screening up to age 75, several programmes abroad have gradually extended the upper age limit of their target population from 69 to 74 years<sup>h</sup>. Swiss regional programmes already accepted self-referred women aged 70 and over for screening before 2010. In 2014, five programmes (GE, FR, BEJUNE, BE, BS) started to systematically invite this age group, followed by VD and TG in 2016, VS in 2019 and SO in 2020 (Figure 7). Because of the likely selection bias in self-referred women, results in this section are limited to programmes with a systematic invitation policy for women aged 70-74.

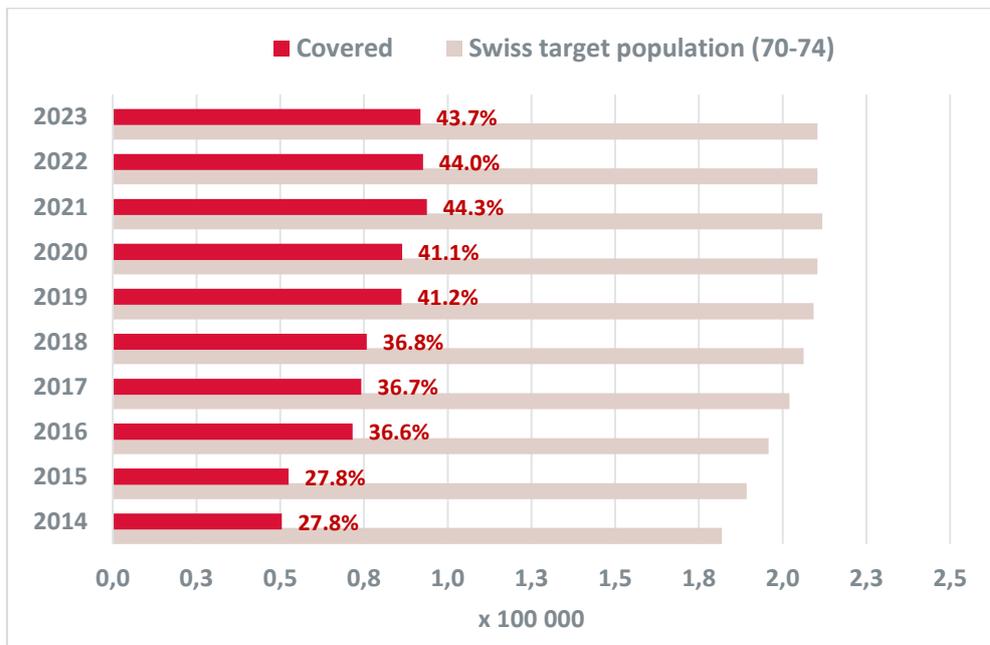
In 2014, slightly more than a quarter of the female Swiss population aged 70-74 years was covered by a screening programme that systematically invited them (Figure 8). The coverage rate increased to around 44% in the recent years (2021-2023).

<sup>h</sup> Lauby-Secretan B, Scocciati C, Loomis D, et al. Breast-cancer screening: viewpoint of the IARC working group. *N Engl J Med* 2015; 372: 2353-8

**Figure 7** Geographical coverage of women aged 70-74 years by Swiss regional breast cancer screening programmes (year of start implementation)



**Figure 8** National coverage of women aged 70-74 years by regional breast cancer screening programmes, 2014- 2023\*



\* Source target population: Federal Statistical Office

Table 5 shows the outcomes of systematic mammography screening for women aged 70 to 74 years by triennial periods, combining prevalent and incident screens. Between 2019 and 2021, 44.2% of the 98'000 invited women aged 70-74 participated. Participation rate increased compared to 2016-2018 (38.2%). Only 6.7% of the 44'245 screening mammographies performed during 2019-2021 were prevalent examinations. This proportion decreased from 12.5% in 2016-2018. Referral rate was 36.0, false-positive rate 26.7 and breast cancer detection rate 9.4 per 1000 screens, resulting in a positive predictive value of mammography screening of 26.3%. Of the 414 detected cancers, 14.7% were ductal carcinoma in situ (DCIS).

Other indicators of tumour prognostic for the period 2019-2021 were comparable with those observed for incident screens in women aged 50-69 (Table 5).

**Table 5** Invitations, participation and performance in Swiss regional programmes (ages 70-74) for all screening examinations 2016-2021

	2019-2021	2016-2018
<b>Invitations and participation</b>		
Invitations	98 032	79 448
Participation rate <sup>a</sup>	44.2%	38.2%
<b>Screening tests performed</b>		
All (prevalent and incident) mammographies	44 245	31 643
Prevalent screens (%)	6.7%	12.5%
<b>Referrals</b>		
Referrals	1 595	1 185
Referral rate (per 1000 screens)	36.0	37.4
Completeness follow-up referrals	98.9%	98.0%
False-positive rate (per 1000 screens)	26.7	28.4
Breast cancer detection rate (per 1000 screens)	9.4	9.1
Positive predictive value (PPV adjusted) <sup>b</sup>	26.3%	24.7%
Rate of invasive investigations (per 1000 screens) <sup>c</sup>	13.0	13.1
<b>Screen-detected breast cancers</b>		
Screen-detected breast cancers (N)	414	287
Ductal carcinoma in situ (DCIS)	14.7%	13.2%
Invasive breast cancers (N)	353	245
- invasive node-negative cancers	85.0%	84.5%
- invasive cancers <=10mm (T1a+T1b)	36.8%	38.8%
- invasive cancers <15mm	56.4%	59.6%
Early-stage breast cancers (stage 0+I)	73.9%	74.2%

<sup>a</sup> based on eligible population per year

<sup>b</sup> based on known follow-up only

<sup>c</sup> Data for SG-GR and BE discarded as deemed incomplete or unreliable (number of screen-detected cancers exceeded the number of invasive investigations).

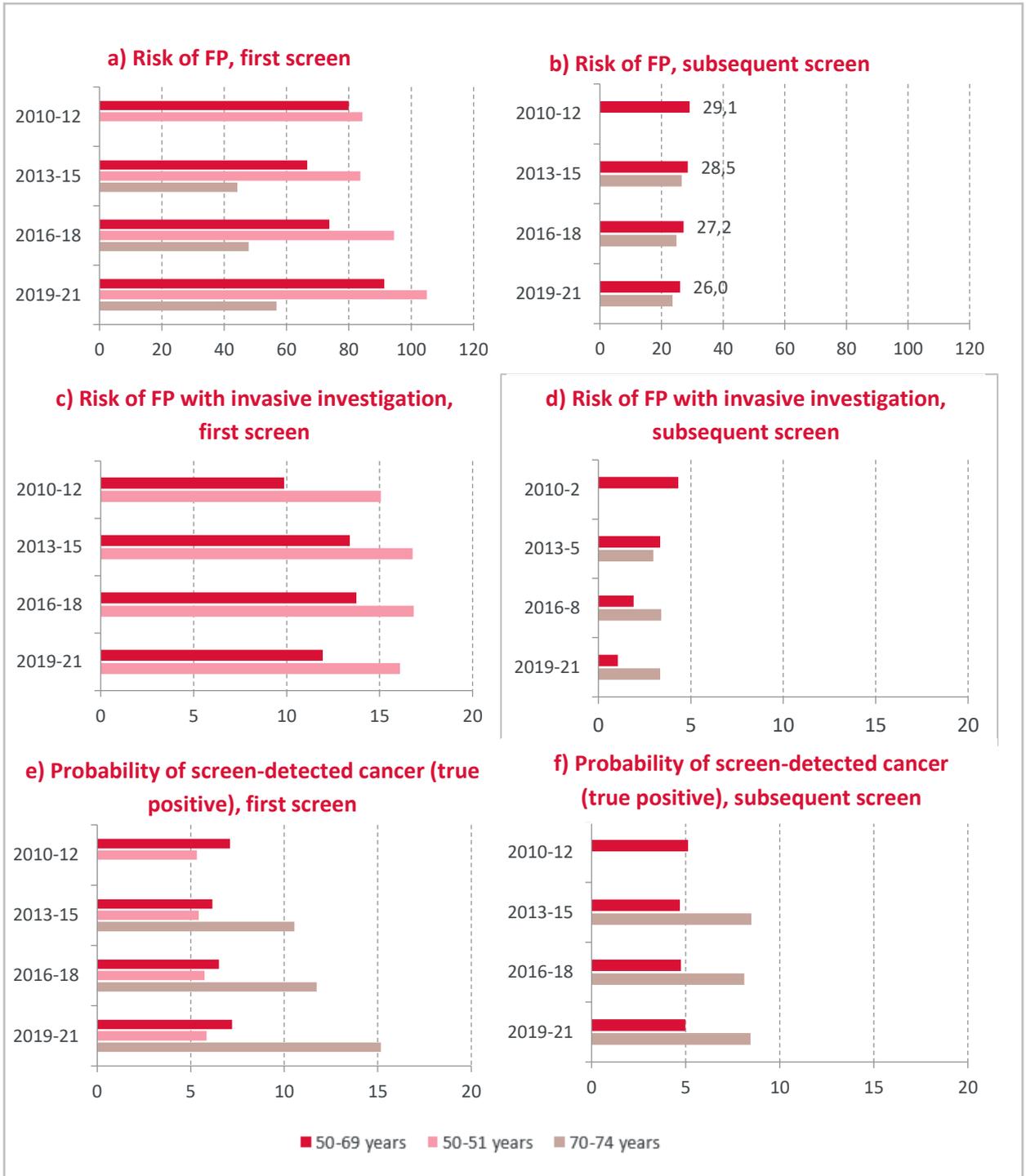
## 4 Possible harms for women participating in mammography screening (ages 50-74)

Women should be informed about the potential benefits and unwanted consequences of mammography screening before they decide about their participation. The probabilities of being referred for diagnostic assessment, being diagnosed with a breast cancer (true-positive result) or having a false-positive result (suspicion of cancer discarded after further investigation) per 1000 screens at different ages are presented in Figure 9 by type of screening round. The available data did not include any information on the risk of interval cancer.

In general, the estimated risks differed greatly between younger and older women. The risk-benefit balance appeared most favourable for women aged 70-74, since they experienced the highest breast cancer detection rate and the lowest risk of false-positive results. Their number of false-positive results per screen-detected cancer was 3. Older women had however a higher risk of a false-positive result with an invasive investigation than women aged 50-69. This difference increased over time due to the decreased risk of a false-positive result with an invasive investigation for women aged 50-69 from roughly 4 per 1000 screens in 2010-2012 to 1 per 1000 in 2019-2021 (Figure 9d).

Women aged 50-51 upon their first participation were more likely than older women to experience a false-positive result and less likely to have a screen-detected cancer. They also were at substantially higher risk of undergoing invasive investigation with a false-positive result (16 per 1000 screens). There were 18 false-positive results per screen-detected cancer in 2019-2021 for women aged 50-51 years. For women aged 50-69 years, this ratio was 13 false-positive results per screen-detected cancer in their first participation and 5 false-positive results per screen-detected cancer in subsequent participations.

**Figure 9 Risks of false-positive (FP) and true-positive result (screen-detected cancer) by screening round and age**



## 5 Appendix

### 5.1 Annual results of all Swiss regional breast cancer screening programmes, 2019-21

**Table S1** Activity, coverage and participation rates of Swiss breast cancer screening programmes, ages 50-69 (all screening rounds)

	2019	2020	2021
<b>Activity statistics</b>			
Target population	622 420	667 995	675 421
Invitations (incl. self-referrals)	264 020	268 640	309 868
Mammographies	130 080	120 443	154 385
<b>Coverage and participation rates</b>			
Mammographies (within 1 year)	122 589	126 802	147 629
Coverage rate by invitation <sup>a</sup>	84.6%	80.3%	91.6%
Participation rate <sup>a</sup>	46.6%	47.3%	47.8%
1st round participation rate <sup>a</sup>	38.6%	42.0%	42.2%
<i>Proportion 1st round attendees</i>	22.8%	23.4%	27.1%
Reattendance <sup>a</sup>	77.2%	76.6%	72.9%
<b>Screening tests performed</b>			
Mammographies	130 080	120 443	154 385
Proportion of prevalent (first) mammographies	22.8%	23.4%	27.1%
Proportion of incident (subsequent) mammographies	77.2%	76.6%	72.9%
Proportion subsequent within 22-26 months	56.5%	45.4%	50.0%

**Table S2 Performance of Swiss breast cancer screening programmes, ages 50-69 (all screening rounds)**

	2019	2020	2021
<b>Referrals</b>			
Referrals	6 370	5 552	7 331
Referral rate (/1000 screens)	49.0	46.2	47.5
Completeness follow-up referrals	98.5%	99.3%	99.0%
False-positive rate (/1000 screens)	43.7	40.5	41.9
Breast cancer detection rate (/1000 screens)	5.3	5.7	5.6
Positive predictive value (PPV adjusted <sup>a</sup> )	11.0%	12.4%	12.0%
Rate of invasive investigations (/ 1000 screens) <sup>b</sup>	12.2	11.5	12.7
<b>Screen-detected breast cancers</b>			
Screen-detected breast cancers	688	682	869
Tumour behaviour determined	100.0%	99.7%	99.9%
Ductal carcinoma in-situ (DCIS)	18.6%	18.2%	17.7%
Invasive breast cancers	81.4%	81.8%	82.3%
- invasive node-negative cancers	85.0%	84.4%	81.9%
- invasive cancers ≤ 10 mm (T1a+T1b)	34.6%	32.2%	32.1%
- invasive cancers < 15 mm	54.8%	51.6%	52.0%
Early stage breast cancers (stage 0+I)	73.8%	72.6%	70.5%
Advanced stage breast cancers (stage II+)	25.0%	25.4%	25.9%
Stage undetermined	1.2%	2.0%	3.6%

<sup>a</sup> based on known follow-up only

<sup>b</sup> Data for SG-GR and BE discarded as deemed incomplete or unreliable (number of screen-detected cancers exceeded the number of invasive investigations).

## 5.2 Results of regional programmes, 2019-2021

**Table S3 Activity, coverage and participation rates by screening programmes, ages 50-69 (all screening rounds), 2019-2021**

	CH	VD	VS	GE	FR	BEJUNE	TG	SG-GR	BE-SO <sup>b</sup>	BS	TI
<b>Activity statistics</b>											
Target population	<b>1 965 836</b>	291 538	141 575	182 504	120 652	118 820	115 524	285 965	484 520	73 526	151 212
Invitations (incl. self-referrals)	<b>842 528</b>	145 318	64 983	87 048	58 136	56 749	51 761	107 394	157 299	35 799	78 041
Mammographies	<b>404 685</b>	71 528	34 613	36 290	32 845	34 956	20 350	53 200	66 768	13 442	40 916
<b>Coverage and participation rates</b>											
Mammographies (within 1 year)	<b>397 020</b>	67 808	33 656	34 527	32 913	34 150	20 366	52 897	67 227	13 003	40 473
Coverage rate by invitation <sup>a</sup>	<b>85.6%</b>	99.5%	91.7%	95.1%	96.3%	95.3%	89.2%	75.1%	64.8%	97.3%	103.0%
Participation rate <sup>a</sup>	<b>47.3%</b>	46.8%	51.9%	39.9%	56.7%	60.4%	39.6%	49.3%	42.9%	36.4%	52.1%
1st round participation rate <sup>a</sup>	<b>41.3%</b>	42.8%	43.6%	35.3%	50.0%	51.2%	31.9%	41.3%	39.1%	34.0%	48.9%
Proportion 1st round attendees <sup>a</sup>	<b>24.6%</b>	21.4%	18.5%	25.1%	19.6%	16.7%	21.4%	21.2%	41.3%	29.3%	22.8%
Reattendance <sup>a</sup>	<b>77.0%</b>	82.1%	85.2%	77.4%	86.0%	87.6%	76.5%	81.7%	44.8%	75.6%	82.9%

<sup>a</sup> based on eligible population per year

<sup>b</sup> Intercantonal programme BE-SO from 2020

**Table S4 Performance of screening by programme, ages 50-69, all screening rounds, 2019-2021**

	CH	VD	VS	GE	FR	BEJUNE	TG	SG-GR	BE <sup>c</sup>	BS	TI
<b>Screening tests performed</b>											
Prevalent (first) mammographies	404 685	71 528	34 613	36 290	32 845	34 956	20 350	53 200	66 545	13 442	40 916
<b>Referrals</b>											
Referrals	19 253	3 617	1 691	1 650	2 059	1 912	894	2 005	2 672	1 088	1 665
Referral rate (/1000 screens)	47.6	50.6	48.9	45.5	62.7	54.7	43.9	37.7	40.2	80.9	40.7
Completeness follow-up referrals	98.9%	98.4%	99.5%	97.9%	99.3%	99.0%	98.3%	99.9%	99.3%	98.3%	98.7%
False-positive rate (/1000 screens)	42.0	45.3	43.7	40.5	56.8	49.1	37.5	33.2	33.9	74.6	34.9
Breast cancer detection rate (/1000 screens)	5.5	5.3	5.2	5.0	5.9	5.6	6.4	4.5	6.2	6.3	5.8
Positive predictive value (PPV adjusted <sup>a</sup> )	11.8%	10.7%	10.7%	11.2%	9.5%	10.4%	14.9%	11.9%	15.6%	7.9%	14.4%
Rate of invasive investigations (/1000 screens) <sup>b</sup>	11.6	14.4	10.8	10.1	10.7	12.8	13.4	N/A	N/A	15.2	10.1
<b>Screen-detected breast cancers</b>											
Screen-detected breast cancers	2239	380	180	181	195	197	131	239	415	85	236
Ductal carcinoma in-situ (DCIS)	18.1%	17.4%	12.2%	15.5%	15.4%	19.3%	25.2%	18.4%	20.5%	25.9%	16.1%
Invasive breast cancers (N)	1830	314	157	152	165	159	98	195	329	63	198
- invasive node-negative cancers	83.6%	83.1%	86.0%	73.0%	77.6%	79.9%	87.8%	79.5%	93.3%	82.5%	84.8%
- invasive cancers ≤ 10 mm (T1a+T1b)	32.9%	31.5%	31.8%	29.6%	33.3%	34.0%	30.6%	30.3%	31.9%	30.2%	43.4%
- invasive cancers < 15 mm	52.7%	48.7%	47.8%	44.1%	52.7%	54.1%	55.1%	52.8%	54.7%	47.6%	65.7%
Early stage breast cancers (stage 0+I)	71.8%	71.3%	65.6%	60.2%	66.2%	69.5%	75.6%	70.7%	81.2%	71.8%	78.8%
Advanced stage breast cancers (stage II+)	25.4%	26.8%	27.8%	32.0%	31.8%	28.9%	22.1%	28.5%	18.3%	27.1%	19.1%
Stage undetermined	2.8%	1.8%	6.7%	7.7%	2.1%	1.5%	2.3%	0.8%	0.5%	1.2%	2.1%

N/A = data not available

<sup>a</sup> based on known follow-up only<sup>b</sup> Data for SG-GR and BE discarded as deemed incomplete or unreliable (number of screen-detected cancers exceeded the number of invasive investigations).<sup>c</sup> Intercantonal programme BE-SO from 2020

Table S5 Performance of prevalent screening by programme, ages 50-69, 2019-2021

	CH	VD	VS	GE	FR	BEJUNE	TG	SG-GR	BE <sup>c</sup>	BS	TI
<b>Screening tests performed</b>											
Prevalent (first) mammographies	99 370	15 297	6 408	9 104	6 448	5 846	4 345	11 288	27 382	3 940	9 312
<b>Referrals</b>											
Referrals	9 789	1 840	737	865	854	702	443	1 034	1 833	714	767
Referral rate (/1000 screens)	98.5	120.3	115.0	95.0	132.4	120.1	102.0	91.6	66.9	181.2	82.4
Completeness follow-up referrals	98.6%	97.9%	99.3%	97.5%	99.1%	98.1%	98.4%	99.9%	99.3%	97.8%	98.3%
False-positive rate (/1000 screens)	91.4	113.2	109.1	89.7	124.2	112.0	92.3	85.6	59.9	173.9	73.3
Breast cancer detection rate (/1000 screens)	7.2	7.1	5.9	5.3	8.2	8.0	9.7	6.0	7.1	7.4	9.0
Positive predictive value (PPV adjusted <sup>a</sup> )	7.4%	6.0%	5.2%	5.7%	6.3%	6.8%	9.6%	6.6%	10.7%	4.2%	11.1%
Rate of invasive investigations (/1000 screens) <sup>b</sup>	24.7	31.9	20.3	18.8	20.9	26.5	28.5	N/A	N/A	31.0	19.2
<b>Screen-detected breast cancers</b>											
Screen-detected breast cancers	717	111	38	48	54	47	42	68	195	30	84
Ductal carcinoma in-situ (DCIS)	19.5%	12.6%	13.2%	25.0%	14.8%	17.0%	26.2%	23.5%	24.6%	23.3%	13.1%
Invasive breast cancers (N)	567	95	33	35	46	39	31	52	146	23	73
- invasive node-negative cancers	83.8%	82.1%	93.9%	65.7%	67.4%	71.8%	93.5%	82.7%	94.5%	82.6%	83.6%
- invasive cancers ≤ 10 mm (T1a+T1b)	32.3%	25.3%	27.3%	17.1%	43.5%	33.3%	25.8%	34.6%	39.0%	26.1%	38.4%
- invasive cancers < 15 mm	49.6%	43.2%	45.5%	31.4%	58.7%	53.8%	32.3%	44.2%	56.2%	47.8%	56.2%
Early stage breast cancers (stage 0+I)	70.6	69.4%	65.8%	52.1%	63.0%	59.6%	64.3%	67.6%	82.6%	66.7%	75.0%
Advanced stage breast cancers (stage II+)	28.2%	29.7%	28.9%	43.8%	37.0%	40.4%	35.7%	32.4%	16.4%	30.0%	23.8%
Stage undetermined	1.3%	0.9%	5.3%	4.2%	0.0%	0.0%	0.0%	0.0%	1.0%	3.3%	1.2%

N/A = data not available

<sup>a</sup> based on known follow-up only<sup>b</sup> Data for SG-GR and BE discarded as deemed incomplete or unreliable (number of screen-detected cancers exceeded the number of invasive investigations).<sup>c</sup> Intercantonal programme BE-SO from 2020

Table S6 Performance of incident screening by programme, ages 50-69, 2019-2021

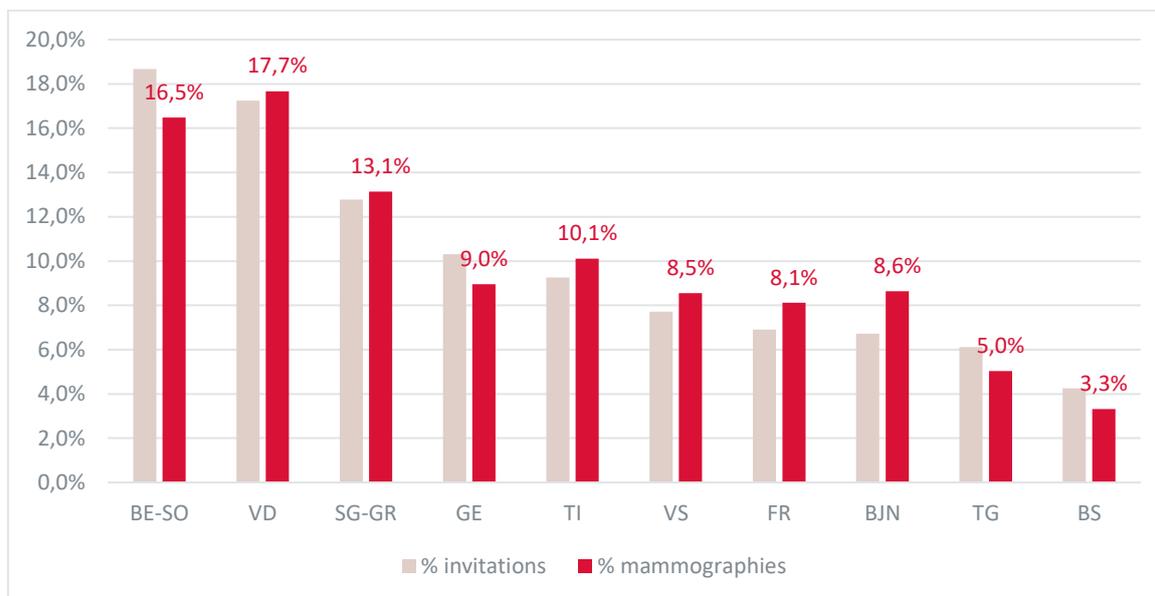
	CH	VD	VS	GE	FR	BEJUNE	TG	SG-GR	BE	BS	TI
<b>Screening tests performed</b>											
Incident (subsequent) mammographies	305 336	56 231	28 205	27 186	26 397	29 110	16 005	41 912	39 184	9 502	31 604
<b>Referrals</b>											
Referrals	9 465	1 777	954	785	1 205	1 210	451	971	840	374	898
Referral rate (/1000 screens)	31.0	31.6	33.8	28.9	45.6	41.6	28.2	23.2	21.4	39.4	28.4
Completeness follow-up referrals	99.2%	98.9%	99.7%	98.3%	99.5%	99.5%	98.2%	99.9%	99.3%	99.5%	99.1%
False-positive rate (/1000 screens)	26.0	26.8	28.8	24.0	40.3	36.4	22.6	19.1	15.8	33.6	23.6
Breast cancer detection rate (/1000 screens)	5.0	4.8	5.0	4.9	5.3	5.2	5.6	4.1	5.6	5.8	4.8
Positive predictive value (PPV adjusted <sup>a</sup> )	16.2%	15.4%	14.9%	17.2%	11.8%	12.5%	20.1%	17.6%	26.4%	14.8%	17.1%
Rate of invasive investigations (/1000 screens) <sup>b</sup>	8.7	10.2	8.7	7.2	8.2	10.0	9.2	N/A	N/A	8.7	7.5
<b>Screen-detected breast cancers</b>											
Screen-detected breast cancers	1 522	269	142	133	141	150	89	171	220	55	152
Ductal carcinoma in-situ (DCIS)	17.4%	19.3%	12.0%	12.0%	15.6%	20.0%	24.7%	16.4%	16.8%	25.5%	17.8%
Invasive breast cancers (N)	1 255	217	124	117	119	120	67	143	183	40	125
- invasive node-negative cancers	83.4%	83.4%	83.9%	75.2%	81.5%	82.5%	85.1%	78.3%	92.3%	82.5%	85.6%
- invasive cancers ≤ 10 mm (T1a+T1b)	32.9%	34.6%	33.1%	33.3%	29.4%	34.2%	32.8%	28.7%	26.2%	32.5%	46.4%
- invasive cancers < 15 mm	54.4%	51.6%	48.4%	47.9%	50.4%	54.2%	65.7%	55.9%	53.6%	47.5%	71.2%
Early stage breast cancers (stage 0-I)	72.9%	72.1%	65.5%	63.2%	67.4%	72.7%	80.9%	71.9%	80.0%	74.5%	80.9%
Advanced stage breast cancers (stage II+)	24.2%	25.7%	27.5%	27.8%	29.8%	25.3%	15.7%	26.9%	20.0%	25.5%	16.4%
Stage undetermined	2.9%	2.2%	7.0%	9.0%	2.8%	2.0%	3.4%	1.2%	0.0%	0.0%	2.6%

N/A = data not available

<sup>a</sup> based on known follow-up only<sup>b</sup> Data for SG-GR and BE discarded as deemed incomplete or unreliable (number of screen-detected cancers exceeded the number of invasive investigations).

## 5.3 Supplementary figures

Figure S1: Contribution of each programme to the total number of invitations and mammographies, 2019-2021



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