Breast cancer screening programmes in Switzerland, 2010-2018

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In 2020, 6 in 10 women aged 50-69 years and 4 in 10 aged 70-74 years had access to a free-of-charge mammography screening within one of the 11 organized programmes in Switzerland.

The outcomes of 10 programmes monitored over the years 2010-2018 show a slight improvement in quality of mammography performance over time, which is largely in line with the indicator values recommended by the European Guidelines. However, a substantial heterogeneity of performance subsists across programmes, in particular in the first screening round.

The participation rate in organised screening reaches 46% in 2016-2018, showing a remarkable increase after having decreased to 42% between 2013 and 2015, due to the start of a large programme with a relatively low participation. The participation in longer running programmes is rather stable, whereas the participation in most German-speaking cantons has increased. The participation of 70-74 years old women strongly increased from 32% in 2016 to 46% in 2018. Screening outcomes in this age group were similar to those in women aged 50-69.

Summary

This fifth national monitoring report for *Swiss Cancer Screening* presents the results of organised mammography screening in Switzerland for the years 2010-2018, subdivided into three triennial periods, 2010-2012, 2013-2015 and 2016- 2018, respectively.

The number of regional programmes increased from 7 in 2010 to 10 in 2018, and to 11 in 2020 (canton of Solothurn/SO), currently covering the geographical area of 13 cantons. In 2018, 56.2% of women aged between 50 and 69 years in Switzerland lived in an area covered by a breast cancer screening programme, nearly a doubling of coverage since 2010. The results in this monitoring report are based on available data from 7 programmes (Vaud/VD, Valais/VS, Geneva/GE, Fribourg/FR, BEJUNE (German-speaking part of Bern, Jura/JU and Neuchâtel/NE), St.Gallen-Graubünden/SG-GR, Thurgau/TG) for the period 2010-2012, 9 programmes (including Bern/BE and Basel-Stadt/BS) for the period 2013-2015 and 10 programmes (including Ticino/TI) for the period 2016-2018.

The outcomes of this report are based on anonymized records extracted from the database common to all screening programmes. Performance indicators were calculated in a standardised way according to the Concept and Methodology of Monitoring adopted by Swiss Cancer Screening. Programmes contributed to this report from their first whole calendar year of screening activity. The main focus of this report lays on the outcomes of organised mammography screening in 50-69 years old women between 2016 and 2018; in an additional Section some results are presented for women aged 70-74 years who were systematically invited by 6 programmes during the period 2016-18.

The *coverage by invitation rate* decreased from more than 90% before 2016 to 85% in 2016-2018 as a consequence of the suspension of screening activity in the large Bern programme for nearly a full year. After a decrease from 47% in 2010-2012 to 42% in 2013-2015, the *participation rate* increased to 46% in the most recent period 2016-2018. This increase is observed in all age groups in most programmes. The *first round participation rate* showed a similar evolution as the overall participation rate. With 40% in 2016-2018, it was higher than in the preceding two triennial periods. The *reattendance rate* of previously screened women was 81% in the most recent period. This rate was lower than before due to the relatively low reattendance in the new programmes; in the long standing programmes, reattendance remained at a stable high level.

In 2016-2018, *prevalent screening* resulted in a *recall rate* of 80.3 per 1000 screens. As in the two preceding periods, this recall rate was higher than recommended by the European Guidelines (acceptable level: <70 per 1000). As a consequence, *false-positive rates* were relatively high (73.7 per 1000 in 2016-2018) and the *positive predictive value of mammography screening* rather low (8.4%), irrespective of the sufficient *breast cancer detection rate* (6.5 per 1000). Most proportions of tumour distribution were in line with those recommended by the European Guidelines. There was a very large variation between programmes in prevalent screening outcomes.

The outcomes of *incident screening* show a rather stable evolution across the three time periods. The *recall rate* was 31.9 per 1000 screens in 2016-2018, which is close to the desirable level of the European Guidelines and slightly lower than in 2010-2012 and 2013-2015. As this did not lead to a lower *breast cancer detection rate* compared to 2013-2015 (4.7 per 1000 in both periods), the *positive predictive value of mammography screening* (15.1%) slightly increased. The proportions of tumour distribution were close to or fully in line with the desirable values recommended by the European Guidelines. The variation in results across regional programmes was much less pronounced than in prevalent screening.

The results of screening for women aged 70-74 years who are invited systematically by 6 programmes were close to those of incident screening for women aged 50-69 between 2016 and 2018. There was a strong increase in participation of women aged 70-74 years from 32% in 2016 to 46% in 2018.

The most important consequences for screened women, e.g. the likelihood to be recalled and to get a false- or true-positive screening result, differed substantially between younger and older women. Screened women aged 50-51 years who were invited for the first time got a false-positive result 3 times more frequently than older women, whereas screened women above age 70 had the highest likelihood to be diagnosed with breast cancer.

This fifth national monitoring report for *Swiss Cancer Screening* covers the results of organised mammography screening in Switzerland over the 9 years from 2010 to 2018. Because data from the programme of the cantons of Basel-City and Ticino are included for the first time in this fifth monitoring report, national outcomes as of 2015 are not fully comparable with those of previous reports.

This report presents the national results for the 3-year period 2016-2018 in comparison with the two previous triennial periods 2010-2012 and 2013-2015. This approach leads to more stable results as they are based on larger numbers than those based on annual data. For the first time, a section of this report is dedicated to the screening results of women aged 70 to 74 years in the 6 Swiss programmes who have extended the upper age limit of their systematic invitation to 74 years.

Methods

Data were extracted from the common database used by all regional programmes. Records of all women who had received an invitation letter for a screening examination or had requested a screening examination between 2010 and 2018, were aged between 50 and 74 years at the moment of invitation, were living in the recruitment area of a regional programme, did not have a prior breast cancer, were not seriously ill, and did not have a breast prosthesis were included in this monitoring report (women with breast prostheses are excluded from this report although this is not an exclusion criterion for all programmes).

Why a national report?

A national monitoring gives the opportunity to assess at the same moment and in a uniform way the performance of Swiss regional programmes. Predefined outcome and quality indicators are identically calculated. This contributes 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 recall for multiple suspect findings or a multiple breast cancer diagnosis were counted as one event per woman's screening round and per woman, respectively. In case of multiple breast cancers, the tumour with the highest stage was considered. Indicators were calculated for regional programmes and the national total according to the Monitoring concept of Swiss Cancer Screening[1] which is mainly based on the European Guidelines for Quality Assurance[2]. All indicators were independently double-checked and their values compared with the standards recommended by the European Guidelines.

[1] 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.

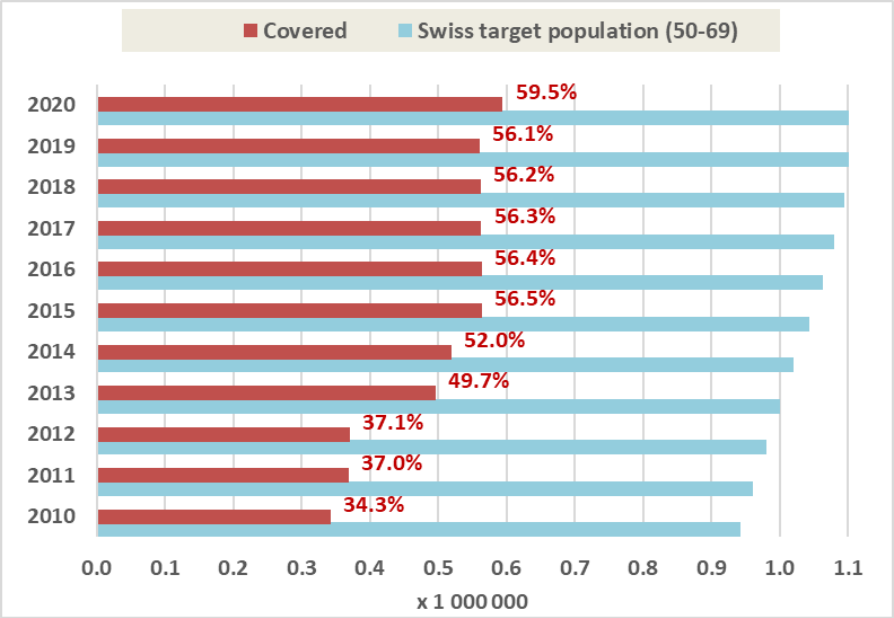
[2] Perry N, Broeders M, de Wolf C, Törnberg S, Holland R, von Karsa L and Puthaar E (eds.). European Guidelines for Quality Assurance in breast cancer screening and diagnosis. Fourth Edition. Luxembourg: Office for Official Publications of the European Communities, 2006.

Breast cancer screening in Switzerland, ages 50-69

In 2010, 943 thousand women aged 50-69 years lived in Switzerland; this number increased to 1.12 million in 2020. The proportion of women who lived in a canton covered by a screening programme and therefore are "targeted" for breast cancer screening increased from 34% in 2010 to nearly 60% in 2020 (Figure 1). The largest increase in population coverage occurred in 2013 with the start of the programme in the Canton of Bern, the second most populated Swiss canton.

Figure 1

National coverage of target population (women aged 50-69 years) by regional breast cancer screening programmes, 2010-2020 (*source target population: Federal Office of Statistics*)



In Switzerland, breast cancer screening is organized and carried out per canton or region. By 2010, programmes were fully implemented for years in all French-speaking Cantons of Vaud (VD), Valais (VS), Geneva (GE), Fribourg (FR) and the region *BEJUNE* (this programme covers the French-speaking part of the Canton of Bern [BE] and the Cantons of Jura [JU] and Neuchâtel [NE]) 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 the Canton of Graubünden (GR) in 2011, the German-speaking part of the Canton of Bern (BE) in 2013, the half Canton of Basel-Stadt (BS) in 2014, and the Canton of Ticino (TI) in 2015 (Figure 2). Mammography screening in the Cantons of St.Gallen and Graubünden is delivered by the same organisation and considered as one programme (SG-GR) for the national monitoring. In 2020, a new programme was launched in the canton of Solothurn (SO).

As specified in the Monitoring Concept, new programmes were considered in the Swiss monitoring from the first whole calendar year during which they were active. Thus, 5 to 7 (TG and SG-GR as of 2011) programmes contributed to the Swiss monitoring for the period 2010-2012, 7 to 9 (BE as of 2014 and BS as of 2015) programmes for the period 2013-2015 and 10 (TI as of 2016) programmes for 2016-2018. This means that new programmes contributed to the national monitoring in each triennial time period. The integration of new programmes leads to differences across years in the age distribution of invited and screened women, and in that of initial (prevalent) and subsequent (incident) screening examinations. Both age and the kind of screening examination have an impact on the outcomes of breast cancer screening. In a non-steady-state situation of screening, as it was the case in Switzerland during 2010-2018, the comparison of outcomes between different calendar years or time periods must therefore be interpreted with caution (see Section *Prevalent screening in women aged 50 and 51 years*).

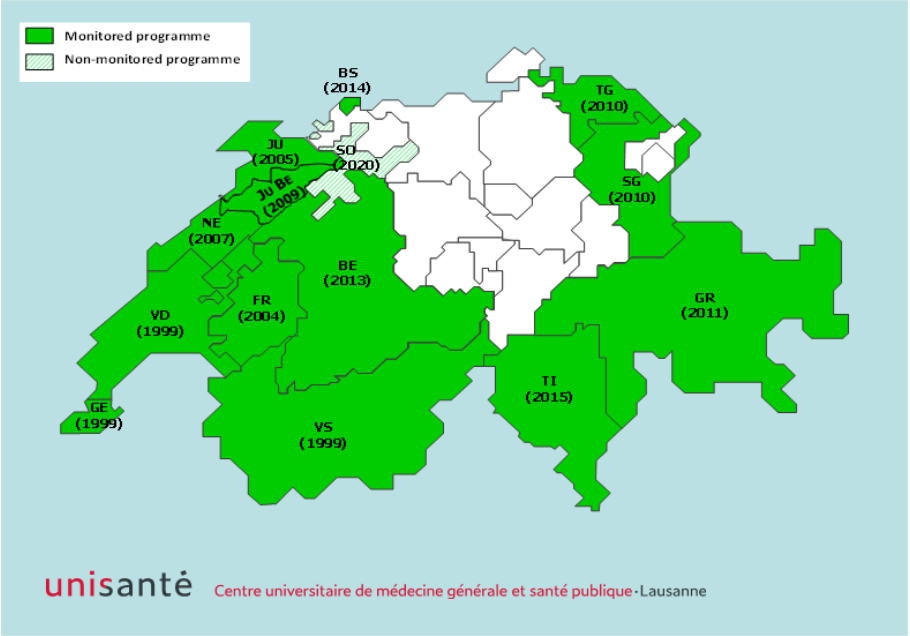


Figure 2

Geographical coverage in Switzerland of women aged 50-69 years by regional breast cancer screening programmes (year of start implementation) from (before) 2010 to 2018 (dark green) and after 2018 (light green)

Screening activity, ages 50-69 (Table 1)

Between 2016 and 2018, 777 thousand women have been invited for a mammography by one of the 10 regional programmes. During this period, 374,222 screening examinations have been performed (Table 1, *Activity statistics*). Compared to the period 2013-2015, the number of invitations increased by 11% and the number of screening examinations by 28%. This discrepant increase between invitations and screening examinations is explained by the relatively low number of examinations performed in the first years of the new programmes Bern and Basel-City between 2013 and 2016.

The numbers of invitations and of screening examinations differ widely across programmes. Between 2016 and 2018, the largest programme (VD) invited approximately four times more women and performed six times more screening examinations than the smallest one (BS).

Over a longer time period, the same women could be invited and screened several times, which means that numbers of invited or screened women are not equal to the numbers of different individuals. For instance, in a 3-year time period, many women will be invited and/or screened twice. Thus, the number of "women invited" indicates the number of invitations sent out and the number of "women screened" the number of screening mammographies performed. There is, however, one exception: by definition, a woman can have only one first invitation and only one first (prevalent) screening examination. The number of prevalently screened women indicates how many different women have ever been involved in the screening programme.

The activity statistics do not provide a participation rate because the reported invitations and screening examinations in the same calendar year are not necessarily linked to each other. Some women will attend only in the year following their invitation. A screening mammography at the beginning of 2016 (and falling in the period 2016-2018) may thus be the result of an invitation in 2015 (period 2013-2015). Some women invited in 2018 will participate in 2019, *i.e.* beyond the period covered by this report.

Coverage and participation rates (Table 1)

Among the 1.82 million women targeted in 2016-2018, 3,046 (0.17%) appeared to be ineligible for screening and were therefore excluded. As women are invited every second year, only about half of the eligible women at the beginning of a calendar year will be invited during this same year; the other half will be invited in the following year. The *coverage by invitation rate* is therefore based on the number of invited women among half of all eligible women. Of the 910,485 (half of 1,820,969) eligible women in 2016-2018, 774,348 were invited which results in a *coverage by invitation* rate of 85.0%. (Table 1, *Coverage and participation rates*).

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

The main reason for this rate being lower than in the two preceding triennial periods (91.4% and 98.6%, respectively) is that the programme of Bern suspended its screening activity between November 2017 and September 2018 (*coverage by invitation rate* of 54.8%).

The *coverage by invitation* rate is never precisely 100%. The target population determined at the beginning of a calendar year is a dynamic population continuously altered by migration into and out of the catchment area of a programme. Also, depending on when women are invited during the year, this can lead to both a higher or lower coverage rate than 100%. Furthermore, some women opt out of a programme or become ineligible in subsequent screening rounds resulting in a decreased number of invited women.

Table 1 **Activity statistics, coverage and participation rates 2010-2012, 2013-2015 and 2016-2018, and minimum (min.) and maximum (max.) value of the regional programmes within the corresponding time period (ages 50-69)**

Activity statistics	2010-2012	min.	max.	2013-2015	min.	max.	2016-2018	min.	max.
Target population (programs in monitoring)	958'196	60'613	251'279	1'420'449	23'756	266'956	1'824'015	72'593	397'114
Women invited (incl. self-referrals)	439'456	33'230	114'016	702'593	14'257	136'448	777'394	34'342	132'003
Women screened	210'243	12'262	61'297	293'423	3'780	62'825	374'222	11'921	69'187
Coverage and participation rates	2010-2012	min.	max.	2013-2015	min.	max.	2016-2018	min.	max.
Eligible women invited	436'500	32'727	113'462	697'968	14'184	135'282	774'348	34'257	131'617
Women screened (within 1 year)	203'826	12'334	57'932	294'854	4'180	63'327	354'857	10'839	66'765
Coverage by invitation[a]	**91.4%**	77.8%	108.9%	**98.6%**	94.4%	119.8%	**85.0%**	54.8%	103.7%
Participation rate[a]	**46.7%**	31.4%	59.7%	**42.2%**	25.7%	59.9%	**45.8%**	31.6%	59.9%
1st round participation rate[a]	**37.4%**	27.7%	52.9%	**32.2%**	25.8%	52.6%	**39.7%**	28.6%	52.6%
Reattendance[a]	**85.7%**	74.4%	89.2%	**83.3%**	71.1%	89.0%	**80.6%**	64.6%	88.1%

[a] based on eligible population per year

Some 350,000 women invited between 2016 and 2018 participated within one year resulting in a *participation rate* of 45.8% (Table 1, *Coverage and participation rates*). Compared to 2013-2015, the *participation rate* increased by 3.5% and was only slightly lower than in 2010-2012 (46.7%). With 31.6%, the minimum value at single programme's level (BS) was the highest of all 3 triennial periods; the highest participation rate of a single programme (BEJUNE) was nearly 60% and stable across the time periods. The recent increase in participation rate was mainly due to a higher attendance by more than 5% in the SG-GR, BE and GE programmes that had the lowest participation rates in the previous time periods.

Participation rate (within 1 year following the invitation)

The *participation rate* within 1 year measures the proportion of eligible women that attended the programme within one year after having been invited for a screening examination. The examination can take place in another year than the year in which the woman has been invited.

The participation rate within 1 year must not be confused with the *activity index* specified in the annual reports of the 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.

The *first round participation rate* increased by 7.5% between 2013-2015 and 2016-2018 (from 32.2% to 39.7%) and was also higher than in 2010-2012 (37.4%). The variation between the programmes was similar to that observed for the overall participation.

The *reattendance rate*, a measure for the compliance of those screened in the previous round, was 80.6% between 2016 and 2018, which is lower than in the two previous time periods. This is due to the lower reattendance in the first years after the implementation of new programmes, whereas most of the long-time established programmes show a stable high reattendance exceeding 85%.

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 three years prior to the current invitation).

Figure 3 illustrates the annual participation, first round participation and reattendance rates between 2010 and 2018 by calendar year. It shows clearly that all participation indicators decreased after the start of three new programmes (BE, BS, TI), but thereafter recovered with an increasing trend in the 3 most recent years.

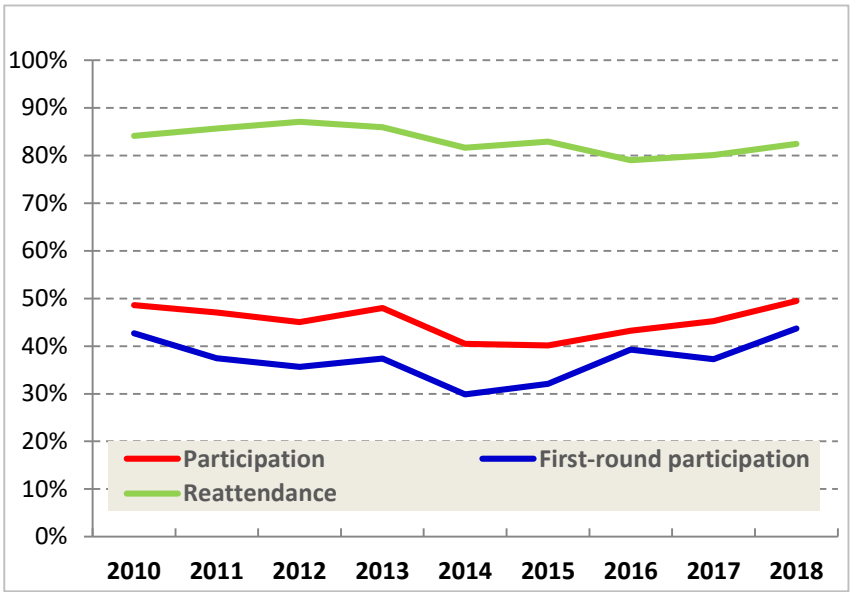


Figure 3

Annual participation, first round participation and reattendance rates 2018-2018 by year (all programmes, ages 50-69)

Figure 4 presents age-specific participation rates for 2010-2018 by calendar year. All age groups show a similar evolution from a higher level in 2010 to a lowest level (dip) round 40% in 2014-2015 followed by a

strong increase up to and including 2018. Interestingly, the youngest age group participated slightly more during the dip, whereas in recent years, women aged 65-69 had the highest participation rate.

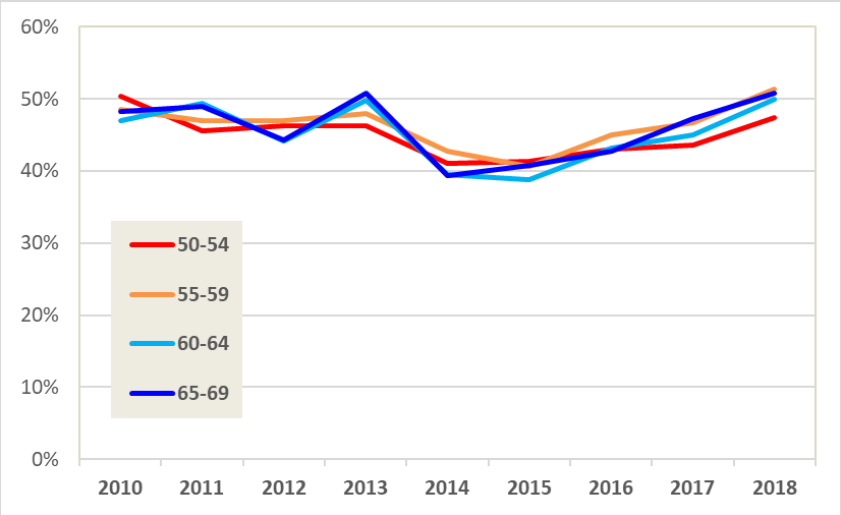


Figure 4

Annual age-specific participation rates 2010-2018 by 5-year age group (all programmes, ages 50-69)

Results of mammography screening in women aged 50-69 years

Prevalent screening (Table 2a)

In total, 374,222 screening examinations were performed between 2016 and 2018 (see Table 1), of which 114,216 (30.5%) were prevalent (initial) screening mammographies (Table 2a). Some 9,168 women were recalled for a diagnostic assessment, resulting in a recall rate of 80.3 per 1000 prevalent screens. This rate is nearly 10% higher than in the period 2013-2015 (72.7 per 1000), but around 10% lower than in 2010-2012 (87.3 per 1000). The prevalent recall rate during the total 9-year period exceeded the acceptable level[1] of 70 per 1000 recommended by the European Guidelines. Only two programmes (BE and TI) had a recall rate within the range of the European Guidelines, of which one (TI) even lay within the range of the desirable level (less than 50 per 1000). The recall rate of the other eight programmes varied between 72.2 (BEJUNE) and 132.5 (BS) per 1000, with outliers of 159.8 of 160.8 per 1000 in the years 2017 and 2018 for the BS programme. Recall rates far beyond 100 per 1000 must be considered as too high as they will lead to false-positive results in more than 10% of the screened women.

A first mammography screening within organized programmes enabled to detect 745 breast cancers between 2016 and 2018, resulting in a detection rate of 6.5 per 1000 prevalent screens and a positive predictive value of mammography (PPV) of 8.4% (adjusted for missing outcomes of the assessment after recall). In other words, one out of 12 *recalled* women was diagnosed with a breast cancer. The false-positive rate was 73.7 per 1000 prevalent screens, thus 1 out of 12 *screened* women had an assessment with a benign outcome. At the programme level, the detection rate varied between 4.9 (TG) and 7.6 (VD) per 1000, the PPV between 5.2% (TG) and 13.9% (TI), and the false-positive rate between 41.6 (TI) and 125.0 (BS) per 1000.

Prevalent and incident screening

When screening a population for the first time, one expects to find a large number of asymptomatic cancers (cancers in a preclinical phase). A perfect screening test would theoretically detect all these prevalent cancers. For this reason, a first (initial) screening test is also called *prevalent screening*. Prevalent screening leads to relatively high recall and breast cancer detection rates. The positive predictive value of the mammography, however, is 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 (more than 80%) of all screens are *incident screens*. The *prevalent screens* are mainly performed among young 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.

[1] The European Guidelines give for several indicators two levels of recommended reference values: *acceptable* values are the minimum level that a screening programme should aim at to reach the ultimate goal (breast cancer mortality reduction), but results approaching the *desirable* level will increase the chance to reach this goal.

Table 2a Results *prevalent* screening 2010-2012, 2013-2015 and 2016-2018, and minimum (min.) and maximum (max.) value of the regional programmes 2016-2018, (ages 50-69)

Screening tests performed	2010-2012	2013-2015	Eur. GL	2016-2018	min.	max.
Prevalent (first) mammographies	74'011	106'339		114'216	4'263	25'800
Referrals						
Recalled women	6'463	7'735		9'168	420	1'693
Recall rate (per 1000 screens)	**87.3**	**72.7**	**<70 (<50)**	**80.3**	48.3	132.5
Completeness follow-up referrals	*99.8%*	*99.2%*		*97.2%*	*90.6%*	*99.8%*
False-positive rate (per 1000 screens)	**80.2**	**66.6**		**73.7**	41.6	125.0
Breast cancer detection rate (/1000)	**7.1**	**6.2**	**NA**	**6.5**	4.9	7.6
Positive predictive value (PPV adjusted)[a]	**8.2%**	**8.5%**		**8.4%**	5.2%	13.9%
Screen-detected breast cancers						
Screen-detected breast cancers (N)	527	654		745	21	171
Tumour (pT) size determined	*95.6%*	*90.5%*		*93.6%*	*86.0%*	*100.0%*
Lymph nodal status (pN) determined	*79.9%*	*67.3%*		*73.8%*	*59.1%*	*86.1%*
Tumour behaviour determined	*99.6%*	*86.2%*		*93.3%*	*63.6%*	*100.0%*
Ductal carcinoma in situ (DCIS)	**19.7%**	**19.0%**	**10% (10-20%)**	**18.8%**	4.5%	32.1%
Invasive breast cancers (N)	421	440		555	14	131
- invasive node-negative cancers	**80.0%**	**76.6%**	**NA (>70%)**	**80.0%**	61.3%	92.3%
- invasive cancers <=10mm (T1a+T1b)	**29.7%**	**29.3%**	**NA (>25%)**	**31.5%**	12.5%	40.5%
- invasive cancers <15mm	**40.4%**	**48.0%**	**50% (>50%)**	**50.1%**	28.6%	60.3%
Early stage breast cancers (stage 0+I)	**63.9%**	**65.1%**	**NA (>70%)**	**68.1%**	51.2%	76.6%
Advanced stage breast cancers (stage II+)	**31.9%**	**25.8%**	**NA (<30%)**	**26.0%**	17.0%	38.9%
Stage undetermined	*4.2%*	*9.0%*		*5.9%*	*0.0%*	*14.0%*

[a] based on known follow-up only

Eur. GL: European Guidelines recommendations
Acceptable level (Desirable level)
NA: not applicable

The results of prevalent screening for 2016-2018 lay in between those of the two preceding triennial periods. In general, particular caution is needed when interpreting differences in the outcomes of prevalent screening across time. The comparison between the three time periods is hampered by the fact that the age distribution of initially screened women differs between the periods, and possible previous opportunistic screening means that some prevalent (initial) screening examinations indeed were incident (subsequent) screening examinations. By limiting the comparison of prevalent screening outcomes to the newly invited young women aged 50 and 51 years only, at least the impact on the results of differences in age distribution can be excluded (see Section Prevalent screening in women aged 50 and 51 years). However, the influence of previous opportunistic screening remained and data to account for this were unavailable.

With regard to the tumour characteristics of the screen-detected breast cancers, it can be concluded that most of the corresponding indicators fulfilled the recommendations of the European Guidelines. However, not all characteristics could fully be determined which might lead to a slight under- or overestimation of the proportion of tumour sizes or stages. At single programmes' level, the absolute numbers of screen-detected cancers were sometimes so small that the proportions became unstable and unreliable and did not allow a reasonable interpretation.

Results on non-invasive and invasive assessment procedures cannot be presented as the corresponding data still were not reliably extracted. Regularly (much) less invasive assessment procedures were reported than breast cancers detected, which is not realistic as the confirmatory diagnosis of cancer is based on invasive examinations. Strangely, this problem arose more often in incident screening.

Incident screening (Table 2b)

Approximately two thirds of the 260,006 incident (subsequent) screening mammographies between 2016 and 2018 were performed within a time interval of 22 to 26 months after the previous screen (Table 2b, *Screening examinations performed*). A timely subsequent screening examination around two years after the previous one is thought to be most favourable for the ultimate objective of breast cancer mortality reduction. Some 8,300 of the subsequently screened women in 2016-2018 were recalled for a diagnostic assessment, resulting in 1,233 diagnosed breast cancers. The recall rate of 31.9 per 1000 incident screens nearly met the acceptable level recommended by the European Guidelines (<50). The breast cancer detection rate was 4.7 per 1000 screeens, the positive predictive value of mammography screening (PPV, adjusted for missing follow-up) 15.1%, and the false-positive rate was 27.2 per 1000 screens. The recall rate was slightly lower than in the two preceding triennial periods with, however, the same breast cancer detection rate as between 2013 and 2015, resulting in a higher PPV compared to 2013-2015.

The variation between regional programmes was much less pronounced in incident than in prevalent screens and did not present extreme outliers. The only notable exception was the BS programme which also had the highest prevalent recall rate (incident recall rate of 61.4 per 1000 between 2016 and 2018 for a relatively high breast cancer detection (6.4 per 1000) but a lower than national average PPV [10.6%]). Half the programmes (VS, BEJUNE, SG-GR, BE, TI) showed a recall rate attaining the desirable level of the European Guidelines (<30 per 1000) and a concomitant PPV above 17%, resulting in breast cancer detection rates of around 5 per 1000.

Table 2b Results *incident* screening 2010-2012, 2013-2015 and 2016-2018, and minimum (min.) and maximum (max.) value of the regional programmes 2016-2018 (ages 50-69)

Screening tests performed	2010-2012	2013-2015	Eur. GL	2016-2018	min.*	max.*
Incident (subsequent) mammographies	136'232	187'084		260'006	4'673	54'392
Subsequent screens within 22-26 months	*68.9%*	*67.1%*		*65.4%*	*56.5%*	*86.8%*
Referrals						
Recalled women	4'664	6'216		8'300	264	2'081
Recall rate (per 1000 screens)	**34.2**	**33.2**	**<50 (<30)**	**31.9**	25.0	61.4
Completeness follow-up referrals	*99.8%*	*99.3%*		*98.6%*	*92.7%*	*100.0%*
False-positive rate (per 1000 screens)	**29.1**	**28.5**		**27.2**	20.7	55.0
Breast cancer detection rate (/1000)	**5.1**	**4.7**	**(>)1.5 * IR**	**4.7**	4.0	6.4
Positive predictive value (PPV adjusted)[a]	**15.0%**	**14.2%**		**15.1%**	10.2%	18.9%
Screen-detected breast cancers						
Screen-detected breast cancers (N)	699	879		1'233	30	260
Tumour (pT) size determined	*99.1%*	*97.4%*		*95.9%*	*80.0%*	*98.1%*
Lymph nodal status (pN) determined	*82.7%*	*80.9%*		*80.4%*	*61.4%*	*86.1%*
Tumour behaviour determined	*99.9%*	*99.2%*		*96.8%*	*71.3%*	*100.0%*
Ductal carcinoma in situ (DCIS)	**17.2%**	**18.3%**	**10% (10-20%)**	**16.4%**	9.9%	24.5%
Invasive breast cancers (N)	578	711		991	25	221
- invasive node-negative cancers	**82.2%**	**77.9%**	**(>)75%**	**80.4%**	76.2%	92.0%
- invasive cancers <=10mm (T1a+T1b)	**34.1%**	**34.3%**	**>=25% (>30%)**	**35.6%**	26.2%	46.8%
- invasive cancers <15mm	**55.0%**	**56.3%**	**50% (>50%)**	**55.1%**	44.0%	71.1%
Early stage breast cancers (stage 0+I)	**74.2%**	**71.7%**	**75% (>75%)**	**71.7%**	66.2%	80.0%
Advanced stage breast cancers (stage II+)	**24.9%**	**26.1%**	**25% (<25%)**	**24.7%**	13.3%	28.6%
Stage undetermined	*0.9%*	*2.3%*		*3.6%*	*0.0%*	*20.0%*

[a] based on known follow-up only

* incident screens BS 2016 and TI 2016-17 excluded (N=3796)

Eur. GL: European Guidelines recommendations

Acceptable level (Desirable level)

IR: (underlying) breast cancer Incidence Rate

NA: not applicable

Except for the determination of the lymph nodal status (pN), which was particularly low in one programme (BE), data on tumour characteristics were relatively complete and more often so in prevalent screens, as observed in previous monitoring reports (Table 2b, *Screen-detected breast cancers*). Of all 1233 screen-detected breast cancers, 16.4% were ductal carcinoma in situ (DCIS), 71.7% were early stage and 24.7% advanced stage cancers (stage unknown in 3.6%). Of the invasive cancers, 80.4% were lymph node-negative, 35.6% smaller or equal to 10 mm in size and 55.1% smaller than 15 mm.

Except the proportion of early stage cancers recurrently below the recommended value, the performance indicators for screen-detected breast cancers were fully in line with the desirable levels recommended by the European Guidelines. It also did not differ substantially from the values found in 2010-2012 and 2013-2015.

Results of mammography screening in specific age groups

Prevalent screening in women aged 50 and 51 years

As already mentioned, the interpretation of results of prevalent screening in all targeted women (ages 50-69) is difficult as long as a stable steady state situation is not reached nationally[2]. Every new regional programme starts in the first round with the invitation of all women aged 50-69 (or 50-74) in its catchment area. In the next invitation rounds, the great 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 the previous round.

A prevalent screening examination is the first mammography of a woman performed within a screening programme. These examinations consist of mammographies after a first invitation or due to a later subsequent invitation, e.g. when the concerned women did not show up following the first or some following invitations. In the latter case, these women will be older than 50 or 51 years. As the occurrence of breast cancer strongly increases with age, a prevalent screening round will result in a higher detection rate when the proportion of screened elderly women increases.

Figure 5 **Age-distribution of initially screened women (prevalent screening), 2010-2018; A: all programmes; B: regional programmes in steady state situation (VD, VS, GE, FR, BEJUNE)**

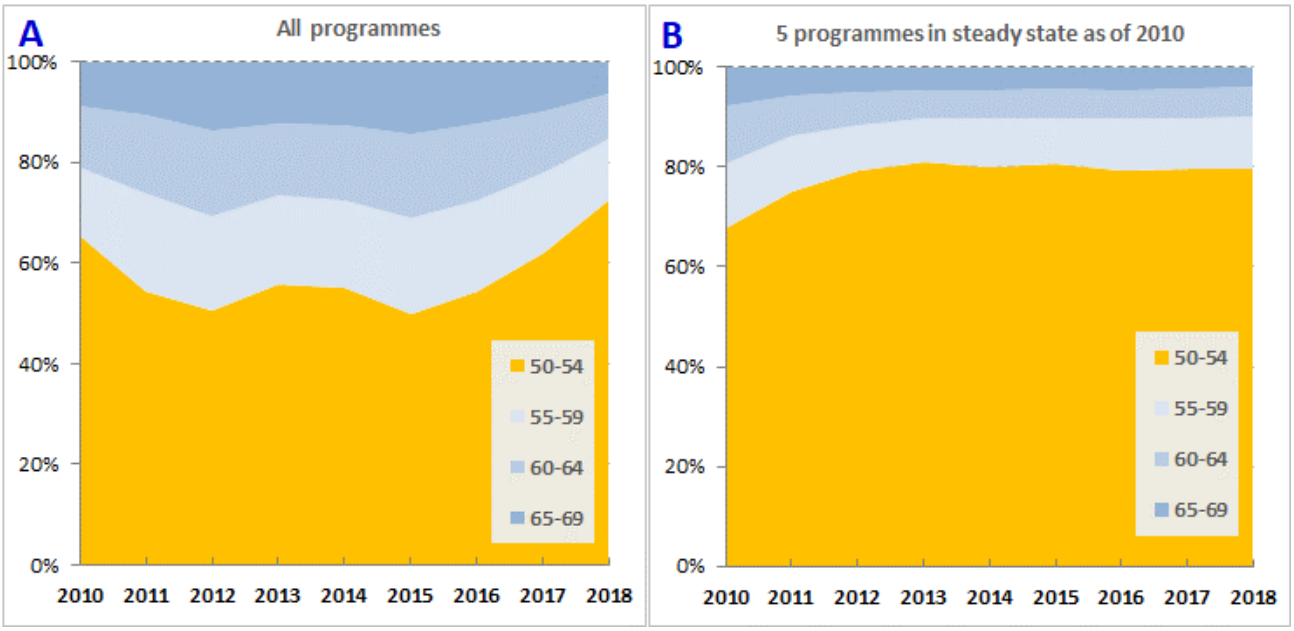


Figure 5 shows the age distribution by year of prevalently screened women in all 10 Swiss programmes (Figure 5A) between 2010 and 2018 and for the 5 longest standing regional programmes that were in a steady state situation as of 2010 (VD, VS, GE, FR and BEJUNE; Figure 5B). In the steady state situation of a programme, more than 80% of the first screened women are younger than 55 years (Figure 5B). When old and new programmes are combined (Figure 5A), the proportion of 50-54 years old women drops below 60% when a new programme starts, as it was the case between 2011 and 2016 with 5 new programmes implemented.

[2] A programme can be considered to be in a steady state situation when the proportion of incidence screening remains stable above 80% and the proportion of first (prevalent) screened women aged 50-54 is stable and represents above 80% of all first screened women aged 50-69.

As the vast majority of prevalently screened women are young, limiting analyses of prevalent screening results to women aged 50 and 51 years improves comparability across programmes. These “newcomers” are of special interest because they have somewhat different risks compared to older screened women. Programmes should consider providing this specific information to young women when invited them for the first time.

Table 3 Results *prevalent* screening 2010-2012, 2013-2015 and 2016-2018, ages 50-51

Screening tests performed	2010-2012	2013-2015	Eur. GL	2016-2018
Prevalent (first) mammographies	27'804	39'261		49'029
Referrals				
Recalled women	2'499	3'495		4'913
Recall rate (per 1000 screens)	**89.9**	**89.0**	**<70 (<50)**	**100.2**
Completeness follow-up referrals	*99.8%*	*99.1%*		*97.6%*
False-positive rate (per 1000 screens)	**84.5**	**83.6**		**94.5**
Breast cancer detection rate (/1000)	**5.4**	**5.4**	**NA**	**5.7**
Positive predictive value (PPV adjusted)[a]	**6.0%**	**6.1%**		**5.8%**
Screen-detected breast cancers				
Screen-detected breast cancers (N)	149	213		279
Tumour (pT) size determined	*97.3%*	*91.1%*		*92.5%*
Lymph nodal status (pN) determined	*72.5%*	*75.1%*		*69.5%*
Tumour behaviour determined	*100.0%*	*97.7%*		*94.3%*
Ductal carcinoma in situ (DCIS)	**27.5%**	**22.5%**	**10% (10-20%)**	**24.4%**
Invasive breast cancers (N)	108	160		195
- invasive node-negative cancers	**80.6%**	**76.9%**	**NA (>70%)**	**79.0%**
- invasive cancers <=10mm (T1a+T1b)	**33.3%**	**30.0%**	**NA (>25%)**	**29.2%**
- invasive cancers <15mm	**45.4%**	**50.6%**	**50% (>50%)**	**50.8%**
Early stage breast cancers (stage 0+I)	**70.5%**	**66.7%**	**NA (>70%)**	**66.3%**
Advanced stage breast cancers (stage II+)	**27.5%**	**25.4%**	**NA (<30%)**	**26.9%**
Stage undetermined	*2.0%*	*8.0%*		*6.8%*
[a] based on known follow-up only	Eur. GL: European Guidelines recommendations			
	Acceptable level (Desirable level)			
	NA: not applicable			

The number of prevalent (first) mammographies in young 50-51 years old women increased from 28 thousand in the period 2010-2012 to nearly 50 thousand in 2016-2018 (Table 3). In the first two triennial periods, the recall rate was between 89 and 90 per 1000, but increased in 2016-18 to 100.2 per 1000. This increase was mainly due to extreme outliers (over 220 per 1000 screens in 2017 and 2018) from one new programme (BS) and to a general tendency to recall more young women. This higher recall rate led to a slightly higher breast cancer detection rate (5.7 per 1000 in 2016-2018 vs. 5.4 per 1000 in the preceding periods). However, given the slightly lower PPV of mammography (5.8%) in 2016-18, there was also a relatively strong rise in false-positive rate (94.5 per 1000 vs. ca. 84 per 1000 in the preceding time periods).

The proportion of ductal carcinoma in situ (DCIS) varied between 22.5% and 27.5%. Albeit these proportions exceeded the recommended value (for ages 50-69), proportions of 20-25% in such young women have been observed internationally in mammography screening programmes. Other tumour specification indicators were mostly in line with the recommended values of the European Guidelines.

Figure 6 presents the annual trends of recall, false-positive and breast cancer detection rates for women aged 50-51 years. It clearly shows that the false-positive rate narrowly follows the recall rate, whereas the impact of changes in the recall rate on the detection rate is rather modest. The higher likelihood for young women to be recalled following a prevalent screening examination and to have a false-positive result than older women is mainly due to the denser tissue of the young breast. This makes the interpretation of mammographic findings more difficult, especially as no previous mammograms are available for comparison. Consequently, the risk of a recall and of a false-positive result will be markedly lower for these women in the following (incident) screening rounds.

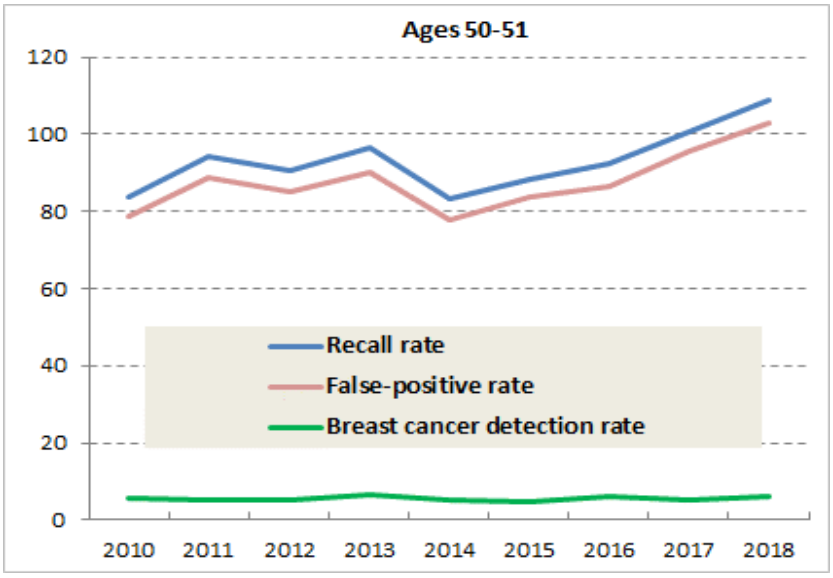


Figure 6

Annual recall, false-positive and breast cancer detection rates (per 1000) 2010-2018, prevalent screening, ages 50-51 years

Mammography screening in women aged 50-74 years

Since available scientific evidence is deemed sufficient 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[3]. Swiss regional programmes already accepted self-referred women aged 70 and over for screening before 2010. In 2014, 5 programmes (GE, FR, BEJUNE, BE, BS) started to systematically invite this age group, followed by 2 others in 2016 (VD) and 2019 (VS) (Figure 7). Because of the selection bias in self-referred women, the presentation of results in this section is limited to the 6 programmes with a systematic invitation policy for this age group.

In 2014, a bit more than a quarter of the female Swiss population aged 70-74 years was living in a canton covered by a screening programme that systematically invited women up to and including 74 years (Figure 8). This coverage rate increased to 44.3% in 2020.

[3] Lauby-Secretan B, Scoccianti C, Loomis D, et al. Breast-cancer screening: viewpoint of the IARC working group. *N Engl J Med* 2015; 372: 2353-8.

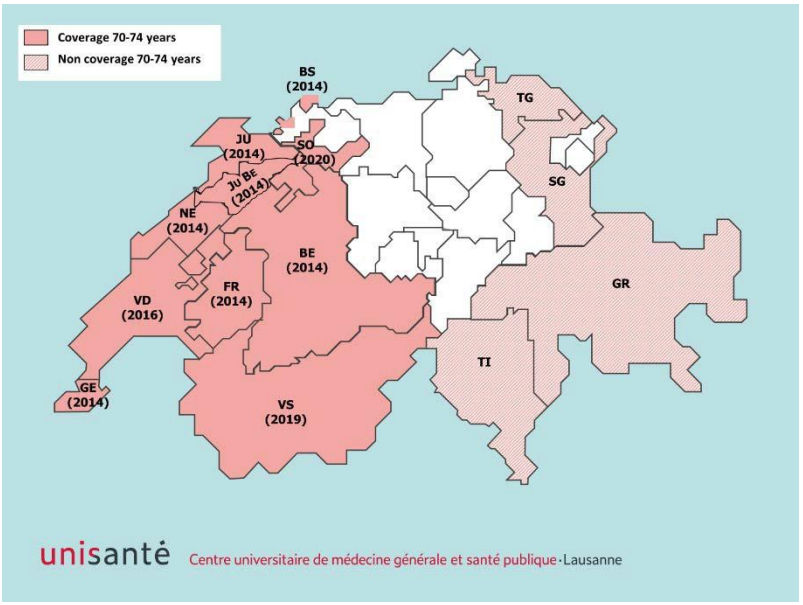


Figure 7

Geographical coverage in Switzerland of women aged 70-74 years by regional breast cancer screening programmes (year of start implementation), 2014-2020

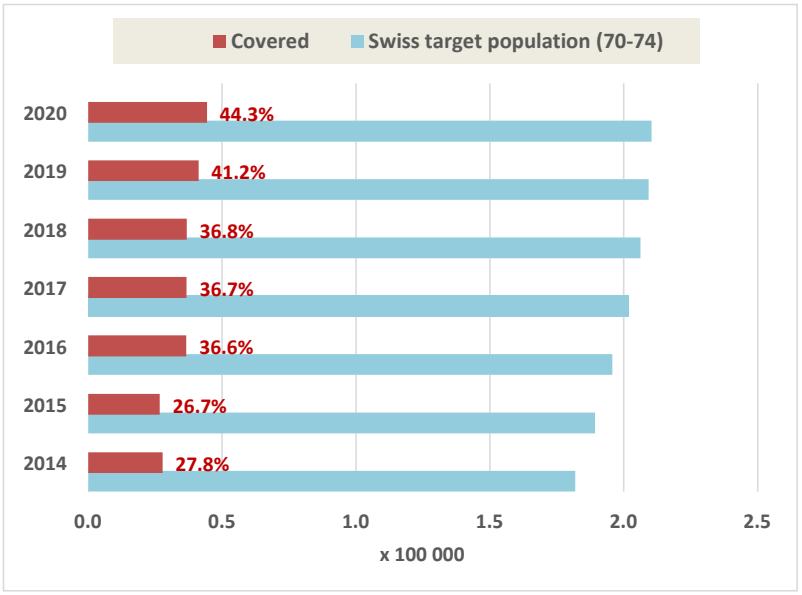


Figure 8

National coverage of target population (women aged 70-74 years) by regional breast cancer screening programmes, 2014-2020 (*source target population: Federal Office of Statistics*)

Table 4 shows the outcomes of systematic mammography screening for women aged 70 to 74 years by year and for the triennial period 2016-2018. Given the still relatively small numbers of screened women of this age group, results were combined for prevalent and incident screening examinations.

Between 2016 and 2018, 38.2% of the 79,515 invited women aged 70-74 participated. The participation rate increased strongly from 31.8% in 2016 to 45.7% in 2018, approaching the rate observed for women aged between 50 and 69 years in 2018 (49.5%).

Of 26,687 screening mammographies performed during 2016-2018, 11.8% were prevalent examinations. The proportion of prevalent examinations strongly decreased from 19.5% in 2016 to 5.2% in 2018. The recall rate in 2016-2018 was 36.1 per 1000 screens, the false-positive rate 27.6 per 1000 and the breast cancer detection rate 8.5 per 1000, resulting in a positive predictive value of mammography screening (PPV) of 24.1%. Of the 227 detected cancers, 12.3% were ductal carcinoma in situ (DCIS). All these performance indicators were remarkably stable over the years 2016, 2017 and 2018.

The other tumour specification indicators for the period 2016-2018, such as the proportions of lymph node negative invasive cancers, small invasive tumour sizes and advanced stages were comparable with those found in incident screening examinations in women aged 50-69 (data not shown).

Table 4 **Invitations, participation and results *all* screening examinations 2016-2018, ages 70-74**

Invitations and participation	2016	2017	2018	2016-2018
Invitations	26'877	32'627	20'011	79'515
Participation rate[a]	**31.8%**	**38.8%**	**45.7%**	**38.2%**
Screening tests performed				
All (prevalent and incident) mammographies	8'205	10'307	8'175	26'687
Prevalent screens (%)	*19.5%*	*10.9%*	*5.2%*	*11.8%*
Referrals				
Recalled women	300	365	298	963
Recall rate (per 1000 screens)	**36.6**	**35.4**	**36.5**	**36.1**
Completeness follow-up referrals	*98.0%*	*96.4%*	*99.3%*	*97.8%*
False-positive rate (per 1000 screens)	**28.4**	**26.8**	**27.8**	**27.6**
Breast cancer detection rate (/1000)	**8.2**	**8.6**	**8.7**	**8.5**
Positive predictive value (PPV adjusted)[b]	**22.8%**	**25.3%**	**24.0%**	**24.1%**
Screen-detected breast cancers				
Screen-detected breast cancers (N)	67	89	71	227
Ductal carcinoma in situ (DCIS)	**11.9%**	**13.5%**	**11.3%**	**12.3%**
[a] based on eligible population per year				
[b] based on known follow-up only				

Main risks for women participating in mammography screening (ages 50-74)

Women should know about the potential benefits and risks of mammography screening before they decide about their participation. The estimated risks of being recalled for diagnostic assessment, being diagnosed with a breast cancer (true-positive result) or having a false-positive result of the screening examination are presented below. The currently available data did not contain sufficient information on clinical diagnostic assessment and did not include any information on interval cancers (cancer diagnosed after a negative mammography and before the next due screen).

Figure 9 compares the rates of recall, true- and false-positive results per 1000 screens at different ages by type of screening round (prevalent, incident). The selected combinations of age and type of screening – only the youngest women for prevalent screening; only programmes in a steady state situation for incident screening – improve the comparability across time periods and allow better interpretations of possible trends.

In general, the estimated risks were relatively stable for each combination across the time periods but differed greatly between younger and older women. It can be concluded that first invited women aged 50-51 years experienced three times more frequently than older women a false-positive result when participating in screening (Figure 9A). The likelihood to be diagnosed with breast cancer was highest in elderly women (Figure 9C), and above 50% greater than for women aged 50-51 years.

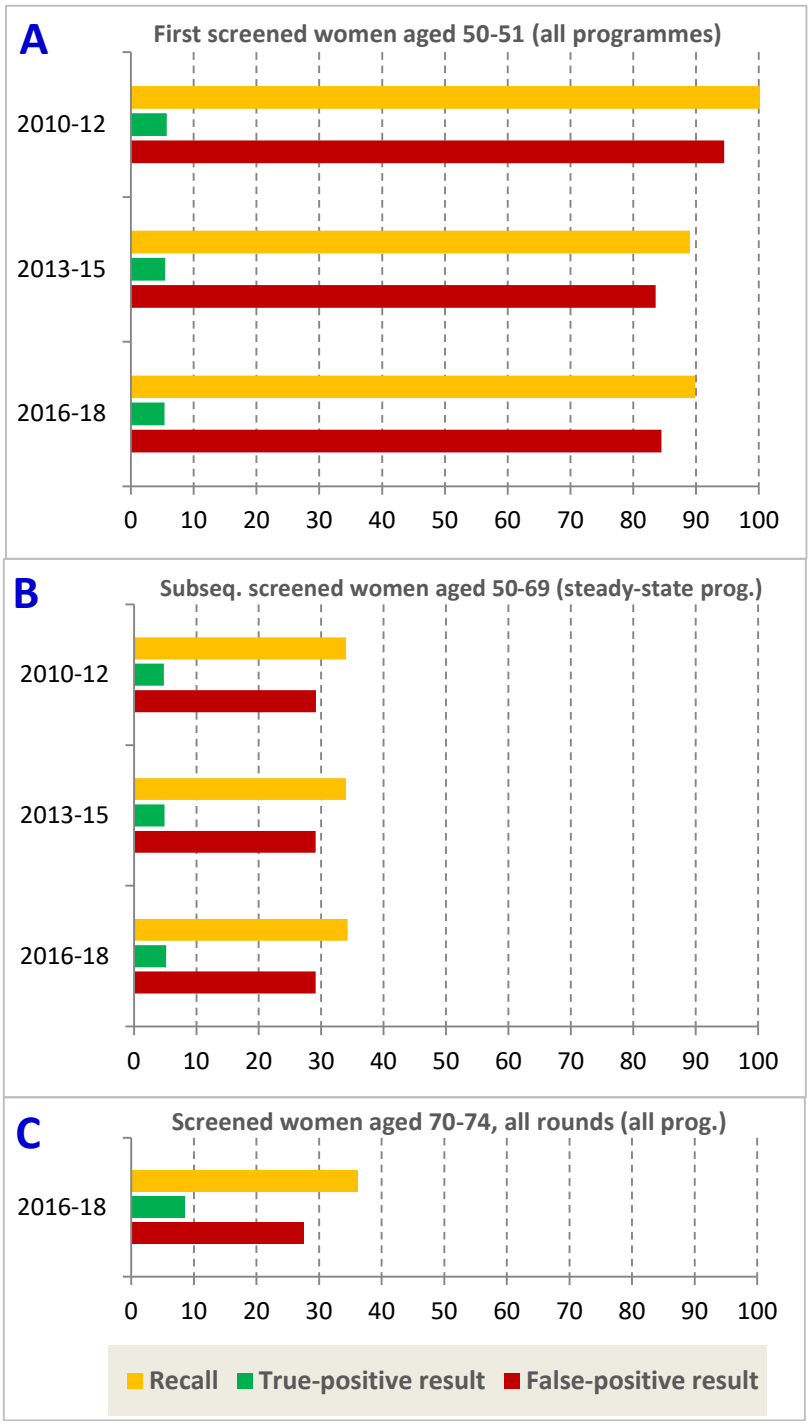


Figure 9

Risk per 1000 women of a recall, true-positive result (screen-detected breast cancer) or false-positive result in mammography screening in 2010-2012, 2013-2015 and in 2016-2018 for

A: first screened women aged 50-51 years (prevalent screens; all programmes);

B: subsequently screened women aged 50-69 years (incident screens; regional programmes in steady state situation as of 2010: VD, VS, GE, FR, BEJUNE); and

C: screened women aged 70-74 years (prevalent and incident screens combined; 6 regional programmes as of 2016: GE, FR, BEJUNE, BE, BS, VD), 2016- 2018

APPENDIX

Results of regional programmes by triennial time period and type of screening round, 2010-2018

Table S1: Results by screening programmes, ages 50-69

	2010-2012										
Activity statistics	CH	VD	VS	GE	FR	BEJUNE	TG[b]	SG-GR[b]			
Target population	958'196	251'279	117'840	161'382	94'132	108'300	60'613	164'650			
Women invited (incl. self-referrals)	439'456	114'016	56'412	71'463	45'595	54'508	33'230	64'232			
Women screened	210'243	61'297	33'843	23'334	24'950	32'312	12'262	22'245			
Coverage and participation rates	CH	VD	VS	GE	FR	BEJUNE	TG[b]	SG-GR[b]			
Women screened (within 1 year)	203'826	57'932	33'497	22'224	24'234	31'127	12'334	22'478			
Coverage by invitation[a]	91.4%	90.5%	95.4%	88.1%	96.6%	100.3%	108.9%	77.8%			
Participation rate[a]	46.7%	51.1%	59.7%	31.4%	53.4%	57.5%	37.7%	35.2%			
1st round participation rate[a]	37.4%	40.7%	52.9%	27.7%	50.0%	47.5%	38.0%	32.5%			
Proportion 1st round participation[a]	35.2%	19.2%	19.4%	29.3%	23.3%	27.6%	100.0%	98.2%			
Reattendance[a]	85.7%	86.7%	89.2%	74.4%	85.9%	88.2%	-	-			
	2013-2015										
Activity statistics	CH	VD	VS	GE	FR	BEJUNE	TG	SG-GR	BE[c]	BS[d]	
Target population	1'420'449	266'956	127'836	167'771	103'974	112'618	99'115	261'132	257'291	23'756	
Women invited (incl. self-referrals)	702'593	126'379	60'719	84'672	51'503	53'789	48'909	125'917	136'448	14'257	
Women screened	293'423	62'825	35'557	27'365	27'432	32'444	20'894	50'095	33'031	3'780	
Coverage and participation rates	CH	VD	VS	GE	FR	BEJUNE	TG	SG-GR	BE[c]	BS[d]	
Women screened (within 1 year)	294'854	63'327	34'351	27'035	27'620	32'028	20'058	51'511	34'744	4'180	
Coverage by invitation[a]	98.6%	94.4%	94.7%	100.3%	98.8%	95.2%	98.3%	96.3%	105.6%	119.8%	
Participation rate[a]	42.2%	50.4%	56.9%	32.3%	53.9%	59.9%	41.4%	41.0%	25.7%	29.5%	
1st round participation rate[a]	32.2%	42.9%	49.9%	28.0%	48.7%	51.0%	36.0%	33.5%	25.8%	29.1%	
Proportion 1st round participation[a]	36.2%	20.0%	18.3%	28.4%	21.1%	18.2%	36.7%	48.9%	96.5%	100.0%	
Reattendance[a]	83.3%	85.8%	89.0%	76.1%	86.3%	88.4%	80.1%	71.1%	-	-	
	2016-2018										
Activity statistics	CH	VD	VS	GE	FR	BEJUNE	TG	SG-GR	BE[e]	BS	TI
Target population	1'824'015	282'170	136'368	176'360	112'929	116'765	108'215	275'141	397'114	72'593	146'360
Women invited (incl. self-referrals)	777'394	132'003	63'624	81'757	53'501	57'038	52'360	117'365	109'133	34'342	76'271
Women screened	374'222	69'187	35'425	32'374	30'749	35'336	20'198	56'417	43'141	11'921	39'474
Coverage and participation rates	CH	VD	VS	GE	FR	BEJUNE	TG	SG-GR	BE[e]	BS	TI
Women screened (within 1 year)	354'857	66'765	34'741	30'574	30'081	34'004	20'482	55'189	35'519	10'839	36'663
Coverage by invitation[a]	85.0%	93.4%	93.1%	92.4%	94.6%	97.5%	96.5%	85.3%	54.8%	94.5%	103.7%
Participation rate[a]	45.8%	50.7%	54.9%	37.6%	56.4%	59.9%	39.3%	47.0%	32.7%	31.6%	48.5%
1st round participation rate[a]	39.7%	46.3%	47.6%	36.6%	50.7%	52.6%	32.7%	41.5%	29.8%	28.6%	39.0%
Proportion 1st round participation[a]	30.5%	21.4%	17.5%	28.4%	20.5%	18.1%	21.1%	24.6%	47.1%	59.3%	65.4%
Reattendance[a]	80.6%	83.3%	88.1%	76.2%	86.2%	87.4%	77.9%	80.6%	64.6%	71.3%	80.2%

[a] based on eligible population per year

[b] TG and SG-GR years 2011-2012

[c] BE years 2014-2015

[d] BS year 2015

[e] Screening activity suspended during 10 months (2017-2018)

Table S2a: Results *prevalence* screening by single programmes, ages 50-69

	2010-2012										
Screening tests performed	**CH**	**VD**	**VS**	**GE**	**FR**	**BEJUNE**	**TG[b]**	**SG-GR[b]**			
Prevalent (first) mammographies	74'011	11'767	6'551	6'842	5'811	8'934	12'261	21'845			
Recalls											
Women recalled	6'463	896	483	716	569	521	1'130	2'148			
Recall rate (per 1000 screens)	**87.3**	**76.1**	**73.7**	**104.6**	**97.9**	**58.3**	**92.2**	**98.3**			
Completeness follow-up referrals	99.8%	100.0%	99.8%	98.6%	100.0%	100.0%	99.7%	100.0%			
False-positive rate (per 1000 screens)	**80.2**	**70.0**	**66.7**	**97.2**	**91.7**	**52.5**	**85.1**	**89.9**			
Breast cancer detection rate (/1000)	**7.1**	**6.1**	**7.0**	**7.5**	**6.2**	**5.8**	**7.0**	**8.4**			
Positive predictive value (PPV adjusted[a])	**8.2%**	**8.0%**	**9.5%**	**7.2%**	**6.3%**	**10.0%**	**7.6%**	**8.6%**			
Screen-detected breast cancers											
Screen-detected breast cancers	527	72	46	51	36	52	86	184			
Tumour (pT) size determined	95.6%	100.0%	100.0%	94.1%	94.4%	96.2%	82.6%	99.5%			
Lymph nodal status (pN) determined	79.9%	87.5%	73.9%	78.4%	77.8%	75.0%	86.0%	77.7%			
Tumour behaviour determined	99.6%	100.0%	100.0%	98.0%	100.0%	100.0%	100.0%	99.5%			
Ductal carcinoma in-situ (DCIS)	**19.7%**	**12.5%**	**26.1%**	**19.6%**	**22.2%**	**25.0%**	**14.0%**	**21.7%**			
Invasive breast cancers (N)	421	63	34	40	28	39	74	143			
- invasive node-negative cancers	**80.0%**	**76.2%**	**82.4%**	**75.0%**	**78.6%**	**87.2%**	**78.4%**	**81.8%**			
- invasive cancers ≤ 10 mm (T1a+T1b)	**29.7%**	**41.3%**	**26.5%**	**17.5%**	**25.0%**	**38.5%**	**24.3%**	**30.1%**			
- invasive cancers < 15 mm	**40.4%**	**52.4%**	**26.5%**	**35.0%**	**39.3%**	**41.0%**	**28.4%**	**46.2%**			
Early stage breast cancers (stage 0+I)	**63.9%**	**66.7%**	**63.0%**	**54.9%**	**58.3%**	**80.8%**	**47.7%**	**69.6%**			
Advanced stage breast cancers (st. II+)	**31.9%**	**33.3%**	**37.0%**	**39.2%**	**36.1%**	**17.3%**	**34.9%**	**29.9%**			
Stage undetermined	4.2%	0.0%	0.0%	5.9%	5.6%	1.9%	17.4%	0.5%			
	2013-2015										
Screening tests performed	**CH**	**VD**	**VS**	**GE**	**FR**	**BEJUNE**	**TG**	**SG-GR**	**BE[c]**	**BS[d]**	
Prevalent (first) mammographies	106'339	12'543	6'491	7'761	5'781	5'921	7'672	24'503	31'888	3'779	
Referrals											
Women recalled	7'735	1'242	351	773	614	304	835	1'973	1'398	245	
Recall rate (per 1000 screens)	**72.7**	**99.0**	**54.1**	**99.6**	**106.2**	**51.3**	**108.8**	**80.5**	**43.8**	**64.8**	
Completeness follow-up referrals	99.2%	98.2%	99.1%	99.5%	98.9%	100.0%	99.5%	99.8%	99.4%	96.7%	
False-positive rate (per 1000 screens)	**66.6**	**92.0**	**48.2**	**95.0**	**100.3**	**45.4**	**101.3**	**73.1**	**38.9**	**58.2**	
Breast cancer detection rate (/1000)	**6.2**	**7.0**	**5.9**	**4.6**	**5.9**	**5.9**	**7.6**	**7.4**	**5.0**	**6.6**	
Positive predictive value (PPV adjusted[a])	**8.5%**	**7.2%**	**10.9%**	**4.7%**	**5.6%**	**11.5%**	**7.0%**	**9.2%**	**11.4%**	**10.5%**	
Screen-detected breast cancers											
Screen-detected breast cancers	654	88	38	36	34	35	58	182	158	25	
Tumour (pT) size determined	90.5%	98.9%	84.2%	86.1%	94.1%	97.1%	100.0%	98.4%	73.4%	92.0%	
Lymph nodal status (pN) determined	67.3%	84.1%	68.4%	80.6%	82.4%	82.9%	77.6%	74.7%	34.8%	72.0%	
Tumour behaviour dedetermined	86.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	43.0%	100.0%	
Ductal carcinoma in-situ (DCIS)	**19.0%**	**15.9%**	**31.6%**	**19.4%**	**17.6%**	**17.1%**	**22.4%**	**25.3%**	**8.2%**	**28.0%**	
Invasive breast cancers (N)	440	74	26	29	28	29	45	136	55	18	
- invasive node-negative cancers	**76.6%**	**71.6%**	**76.9%**	**82.8%**	**82.1%**	**79.3%**	**75.6%**	**75.0%**	**80.0%**	**77.8%**	
- invasive cancers ≤ 10 mm (T1a+T1b)	**29.3%**	**25.7%**	**30.8%**	**20.7%**	**60.7%**	**20.7%**	**22.2%**	**27.9%**	**30.9%**	**44.4%**	
- invasive cancers < 15 mm	**48.0%**	**50.0%**	**61.5%**	**31.0%**	**64.3%**	**44.8%**	**42.2%**	**44.9%**	**47.3%**	**66.7%**	
Early stage breast cancers (stage 0+I)	**65.1%**	**67.0%**	**73.7%**	**61.1%**	**73.5%**	**68.6%**	**63.8%**	**68.7%**	**55.7%**	**72.0%**	
Advanced stage breast cancers (st. II+)	**25.8%**	**31.8%**	**18.4%**	**25.0%**	**20.6%**	**28.6%**	**36.2%**	**29.7%**	**17.7%**	**20.0%**	
Stage undetermined	9.0%	1.1%	7.9%	13.9%	5.9%	2.9%	0.0%	1.6%	26.6%	8.0%	
	2016-2018										
Screening tests performed	**CH**	**VD**	**VS**	**GE**	**FR**	**BEJUNE**	**TG**	**SG-GR**	**BE[e]**	**BS**	**TI**
Prevalent (first) mammographies	114'216	14'795	6'200	9'207	6'316	6'383	4'263	13'881	20'300	7'071	25'800
Referrals											
Women recalled	9'168	1'693	477	854	701	461	420	1'186	1'194	937	1'245
Recall rate (per 1000 screens)	**80.3**	**114.4**	**76.9**	**92.8**	**111.0**	**72.2**	**98.5**	**85.4**	**58.8**	**132.5**	**48.3**
Completeness follow-up referrals	97.2%	97.9%	99.6%	98.1%	97.3%	99.8%	96.0%	99.1%	90.6%	97.5%	98.6%
False-positive rate (per 1000 screens)	**73.7**	**106.8**	**71.1**	**86.0**	**104.2**	**64.7**	**93.6**	**79.1**	**53.4**	**125.0**	**41.6**
Breast cancer detection rate (/1000)	**6.5**	**7.6**	**5.8**	**6.7**	**6.8**	**7.5**	**4.9**	**6.3**	**5.4**	**7.5**	**6.6**
Positive predictive value (PPV adjusted[a])	**8.4%**	**6.8%**	**7.6%**	**7.4%**	**6.3%**	**10.4%**	**5.2%**	**7.5%**	**10.2%**	**5.8%**	**13.9%**
Screen-detected breast cancers											
Screen-detected breast cancers	745	113	36	62	43	48	21	88	110	53	171
Tumour (pT) size determined	93.6%	92.9%	86.1%	98.4%	86.0%	100.0%	95.2%	98.9%	86.4%	92.5%	95.9%
Lymph nodal status (pN) determined	73.8%	80.5%	86.1%	77.4%	74.4%	83.3%	66.7%	76.1%	59.1%	67.9%	73.7%
Tumour behaviour dedetermined	93.3%	96.5%	100.0%	100.0%	93.0%	100.0%	95.2%	100.0%	63.6%	100.0%	98.8%
Ductal carcinoma in-situ (DCIS)	**18.8%**	**15.9%**	**13.9%**	**22.6%**	**18.6%**	**16.7%**	**28.6%**	**23.9%**	**4.5%**	**32.1%**	**22.2%**
Invasive breast cancers (N)	555	91	31	48	32	40	14	67	65	36	131
- invasive node-negative cancers	**80.0%**	**78.0%**	**61.3%**	**66.7%**	**87.5%**	**82.5%**	**85.7%**	**82.1%**	**92.3%**	**86.1%**	**78.6%**
- invasive cancers ≤ 10 mm (T1a+T1b)	**31.5%**	**29.7%**	**29.0%**	**31.3%**	**12.5%**	**25.0%**	**28.6%**	**26.9%**	**32.3%**	**38.9%**	**40.5%**
- invasive cancers < 15 mm	**50.1%**	**56.0%**	**48.4%**	**43.8%**	**31.3%**	**47.5%**	**28.6%**	**44.8%**	**52.3%**	**41.7%**	**60.3%**
Early stage breast cancers (stage 0+I)	**68.1%**	**61.9%**	**52.8%**	**61.3%**	**51.2%**	**72.9%**	**61.9%**	**72.7%**	**68.2%**	**75.5%**	**76.6%**
Advanced stage breast cancers (st. II+)	**26.0%**	**31.0%**	**38.9%**	**37.1%**	**34.9%**	**27.1%**	**33.3%**	**26.1%**	**18.2%**	**17.0%**	**20.5%**
Stage undetermined	5.9%	7.1%	8.3%	1.6%	14.0%	0.0%	4.8%	1.1%	13.6%	7.5%	2.9%

[a] based on known follow-up only

[b] TG and SG-GR years 2011-2012

[c] BE years 2014-2015

[d] BS year 2015

[e] Screening activity suspended during 10 months (2017-2018)

Table S2b: Results *incidence* screening by single programmes, ages 50-69

2010-2012*											
Screening tests performed	**CH**	**VD**	**VS**	**GE**	**FR**	**BEJUNE**					
Incident (subsequent) mammographies	136'232	49'530	27'292	16'492	19'139	23'378					
Recalls											
Women recalled	4'664	1'611	709	881	886	564					
Recall rate (per 1000 screens)	**34.2**	**32.5**	**26.0**	**53.4**	**46.3**	**24.1**					
Completeness follow-up referrals	99.8%	99.9%	99.7%	99.7%	99.9%	99.8%					
False-positive rate (per 1000 screens)	**29.1**	**27.5**	**20.8**	**48.3**	**41.1**	**18.9**					
Breast cancer detection rate (/1000)	**5.1**	**5.0**	**5.2**	**5.1**	**5.2**	**5.3**					
Positive predictive value (PPV adjusted[a])	**15.0%**	**15.5%**	**19.9%**	**9.6%**	**11.3%**	**21.8%**					
Screen-detected breast cancers											
Screen-detected breast cancers	699	250	141	84	100	123					
Tumour (pT) size determined	99.1%	100.0%	99.3%	95.2%	100.0%	99.2%					
Lymph nodal status (pN) determined	82.7%	83.6%	83.0%	89.3%	79.0%	79.7%					
Tumour behaviour determined	99.9%	100.0%	100.0%	98.8%	100.0%	100.0%					
Ductal carcinoma in-situ (DCIS)	**17.2%**	**16.4%**	**17.0%**	**9.5%**	**21.0%**	**20.3%**					
Invasive breast cancers (N)	578	209	117	75	79	98					
- invasive node-negative cancers	**82.2%**	**79.9%**	**91.5%**	**85.3%**	**77.2%**	**77.6%**					
- invasive cancers ≤ 10 mm (T1a+T1b)	**34.1%**	**37.8%**	**27.4%**	**38.7%**	**35.4%**	**29.6%**					
- invasive cancers < 15 mm	**55.0%**	**61.2%**	**49.6%**	**56.0%**	**57.0%**	**45.9%**					
Early stage breast cancers (stage 0+I)	**74.2%**	**77.2%**	**75.9%**	**66.7%**	**77.0%**	**69.1%**					
Advanced stage breast cancers (st. II+)	**24.9%**	**22.8%**	**23.4%**	**28.6%**	**23.0%**	**30.1%**					
Stage undetermined	0.9%	0.0%	0.7%	4.8%	0.0%	0.8%					
2013-2015**											
Screening tests performed	**CH**	**VD**	**VS**	**GE**	**FR**	**BEJUNE**	**TG**	**SG-GR**			
Incident (subsequent) mammographies	187'084	50'282	29'066	19'604	21'651	26'523	13'222	25'592			
Referrals											
Women recalled	6'216	2'087	621	855	962	477	452	730			
Recall rate (per 1000 screens)	**33.2**	**41.5**	**21.4**	**43.6**	**44.4**	**18.0**	**34.2**	**28.5**			
Completeness follow-up referrals	99.3%	98.9%	99.5%	99.6%	99.2%	99.4%	99.1%	99.9%			
False-positive rate (per 1000 screens)	**28.5**	**36.0**	**17.1**	**38.7**	**39.7**	**13.2**	**30.2**	**24.5**			
Breast cancer detection rate (/1000)	**4.7**	**5.5**	**4.2**	**4.9**	**4.7**	**4.8**	**4.0**	**4.0**			
Positive predictive value (PPV adjusted[a])	**14.2%**	**13.3%**	**19.9%**	**11.4%**	**10.7%**	**26.6%**	**11.8%**	**14.0%**			
Screen-detected breast cancers											
Screen-detected breast cancers	879	275	123	97	102	126	53	102			
Tumour (pT) size determined	97.4%	99.3%	98.4%	92.8%	94.1%	96.0%	100.0%	99.0%			
Lymph nodal status (pN) determined	80.9%	80.4%	81.3%	80.4%	84.3%	81.7%	77.4%	80.4%			
Tumour behaviour dedetermined	99.2%	99.6%	99.2%	100.0%	99.0%	97.6%	100.0%	100.0%			
Ductal carcinoma in-situ (DCIS)	**18.3%**	**19.3%**	**17.9%**	**19.6%**	**14.7%**	**15.9%**	**22.6%**	**19.6%**			
Invasive breast cancers (N)	711	221	100	78	86	103	41	82			
- invasive node-negative cancers	**77.9%**	**78.3%**	**80.0%**	**80.8%**	**79.1%**	**75.7%**	**82.9%**	**70.7%**			
- invasive cancers ≤ 10 mm (T1a+T1b)	**34.3%**	**42.5%**	**31.0%**	**28.2%**	**38.4%**	**35.9%**	**22.0%**	**22.0%**			
- invasive cancers < 15 mm	**56.3%**	**65.6%**	**52.0%**	**44.9%**	**53.5%**	**61.2%**	**48.8%**	**47.6%**			
Early stage breast cancers (stage 0+I)	**71.7%**	**76.7%**	**74.8%**	**64.9%**	**68.6%**	**69.8%**	**66.0%**	**68.6%**			
Advanced stage breast cancers (st. II+)	**26.1%**	**22.5%**	**24.4%**	**27.8%**	**27.5%**	**26.2%**	**34.0%**	**30.4%**			
Stage undetermined	2.3%	0.7%	0.8%	7.2%	3.9%	4.0%	0.0%	1.0%			
2016-2018***											
Screening tests performed	**CH**	**VD**	**VS**	**GE**	**FR**	**BEJUNE**	**TG**	**SG-GR**	**BE[b]**	**BS[c]**	**TI[d]**
Incident (subsequent) mammographies	260'006	54'392	29'225	23'167	24'433	28'953	15'935	42'536	22'841	4'673	10'055
Referrals											
Women recalled	8'300	2'081	801	721	981	858	488	1'063	634	287	264
Recall rate (per 1000 screens)	**31.9**	**38.3**	**27.4**	**31.1**	**40.2**	**29.6**	**30.6**	**25.0**	**27.8**	**61.4**	**26.3**
Completeness follow-up referrals	98.6%	98.9%	100.0%	99.6%	98.3%	99.7%	97.3%	99.2%	92.7%	99.7%	99.5%
False-positive rate (per 1000 screens)	**27.2**	**33.5**	**22.2**	**26.9**	**36.1**	**24.1**	**25.4**	**20.7**	**23.3**	**55.0**	**21.8**
Breast cancer detection rate (/1000)	**4.7**	**4.8**	**5.2**	**4.2**	**4.0**	**5.6**	**5.3**	**4.3**	**4.4**	**6.4**	**4.5**
Positive predictive value (PPV adjusted[a])	**15.1%**	**12.6%**	**18.9%**	**13.6%**	**10.2%**	**18.8%**	**17.7%**	**17.2%**	**17.2%**	**10.5%**	**17.1%**
Screen-detected breast cancers											
Screen-detected breast cancers	1'233	260	151	98	98	161	84	181	101	30	45
Tumour (pT) size determined	95.9%	96.9%	93.4%	98.0%	95.9%	98.1%	97.6%	97.8%	90.1%	80.0%	97.0%
Lymph nodal status (pN) determined	80.4%	85.0%	86.1%	74.5%	74.5%	83.2%	79.8%	82.9%	61.4%	83.3%	80.6%
Tumour behaviour dedetermined	96.8%	98.8%	100.0%	99.0%	99.0%	98.8%	98.8%	98.9%	71.3%	100.0%	98.5%
Ductal carcinoma in-situ (DCIS)	**16.4%**	**13.8%**	**13.9%**	**24.5%**	**24.5%**	**15.5%**	**19.0%**	**16.0%**	**9.9%**	**16.7%**	**17.9%**
Invasive breast cancers (N)	991	221	130	73	73	134	67	150	62	25	38
- invasive node-negative cancers	**80.4%**	**81.4%**	**76.2%**	**79.5%**	**80.8%**	**79.9%**	**82.1%**	**79.3%**	**83.9%**	**92.0%**	**79.6%**
- invasive cancers ≤ 10 mm (T1a+T1b)	**35.6%**	**40.3%**	**26.2%**	**28.8%**	**39.7%**	**34.3%**	**35.8%**	**32.0%**	**46.8%**	**40.0%**	**40.7%**
- invasive cancers < 15 mm	**55.1%**	**61.5%**	**52.3%**	**46.6%**	**53.4%**	**56.0%**	**61.2%**	**47.3%**	**54.8%**	**44.0%**	**66.7%**
Early stage breast cancers (stage 0+I)	**71.7%**	**75.0%**	**66.2%**	**72.4%**	**70.4%**	**69.6%**	**71.4%**	**70.2%**	**74.3%**	**66.7%**	**80.6%**
Advanced stage breast cancers (st. II+)	**24.7%**	**21.9%**	**28.5%**	**25.5%**	**25.5%**	**28.6%**	**26.2%**	**28.2%**	**16.8%**	**13.3%**	**19.4%**
Stage undetermined	3.6%	3.1%	5.3%	2.0%	4.1%	1.9%	2.4%	1.7%	8.9%	20.0%	0.0%

[a] based on known follow-up only

* incident screens SG-GR and TG included In CH total only (N=401)

** incident screens BE and BS included in CH total only (N=1143)

*** incident screens BS 2016 and TI 2016-17 included in CH total only (N=3796)

[b] Screening activity suspended during 10 months (2017-2018)

[c] BS years 2017-2018

[d] TI year 2018