Breast cancer screening programmes in Switzerland, 2010-2015

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In 2015, nearly 3 in 5 women aged 50-69 years had access to a free-of-charge mammography screening within one of the ten organized programmes in Switzerland.

The outcomes of 8 programmes monitored across the years 2010-2015 show a stable quality of mammography performance, largely in line with the indicator values recommended by the European Guidelines. However, a substantial heterogeneity of performance subsists across programmes.

The participation rate in organised screening is slightly below 50 percent and has decreased in the more recent years due to the inclusion of a large new programme with a relatively low participation. The participation of longer running programmes, however, is rather stable.

It is recommended to monitor annually the Swiss organized mammography screening programmes. This will support improved recording of follow-up data and lead to more routine in extracting appropriate monitoring data from the information system.

Summary

This fourth national monitoring report for *Swiss Cancer Screening* shows the results of organised mammography screening in Switzerland for the years 2010-2015, subdivided into two triennial periods, 2010-2012 and 2013-2015, respectively.

The number of regional programmes increased from 7 in 2010 to 10 in 2015, currently covering the geographical area of 12 cantons. In 2015, 56.5 percent of the 50-69 years old women 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 (VD, VS, GE, FR, BEJUNE, SG-GR, TG) in the period 2010-2012 and from 8 programmes (with BE) in the period 2013-2015. The coverage by invitation rate increased from 91% in 2010-2012 to 98% in 2013-2015. Almost 290,000 from the 680,000 eligible women in 2013-2015 attended for screening, resulting in a participation rate of 42.5%. The participation decreased by more than 4% compared to 2010-2012, mainly due to the low participation in the large new programme of Canton of Bern. Similar decreases between the two triennial periods were found in the first round participation (32.9% vs. 38.3%) and in the reattendance of the women who participated in the previous round (81.7% vs. 85.6%). Without Bern, the overall participation rate was stable around 47% and the first round participation around 38-39%. Participation rates are likely slightly underestimated, as some participation records could not be extracted from the new information system MC-SIS.

Prevalent screening in 2013-2015 led to a recall rate (73.0 per 1000 women screened) slightly higher than recommended by the European Guidelines but substantially lower than in 2010-2012 (86.9 per 1000). The main consequence of the reduced recall rate is a substantially lower false-positive rate (67 vs. 80 per 1000). There is a concomitant but less pronounced decrease in breast cancer detection (6.1 vs. 6.9 per 1000) given the slightly increased positive predictive value of the screening examination (8.4% vs. 8.0%). Although the classifications of tumour characteristics are partly incomplete, most tumour distribution proportions are in accordance with the European Guidelines.

The results of incident screening in 2013-2015 and 2010-2012 were quite similar, with exception of a somewhat lower breast cancer detection rate (4.5 vs. 5.1 per 1000). These results were close to or fully in line with the desirable values recommended by the European Guidelines. The variation in results of the regional programmes was much smaller than in prevalent screening.

The most important consequences for screened women, e.g. the chance to be recalled and to get a false- or true-positive screening result, hardly differed between the two time periods. This points to a stable performance of Swiss breast cancer screening programmes over time.

It is recommended to monitor annually the Swiss organized mammography screening programmes. This will support improved recording of follow-up data and lead to more routine in extracting appropriate monitoring data from the information system.

This fourth national monitoring report for *Swiss Cancer Screening* shows the results of organised mammography screening in Switzerland for the years 2010-2015. The shift towards a new information system in the last years and difficulties in extracting data for analytical purpose led to an interruption of the annual monitoring for some years[1]. In 2018, data became available again for monitoring the period 2010 up to and including 2015. However, the accessibility of older screening data in the new information system is not complete and led to the loss of an estimated 4 percent of screening and follow-up records. Although this loss appears to be non-selective, slight differences in outcomes of regional programmes compared to the previously published reports across the years 2010, 2011 and 2012 occur. Because data from the joint programme of the Cantons of St.Gallen and Graubünden could be included for the first time in this fourth monitoring report, national outcomes as of 2011 are not comparable anymore with those of previous reports.

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.

In this report, national results are presented for the 3-year period 2013-2015 in comparison with the previous triennial period 2010-2012. This approach leads to more stable results as they are based on larger numbers. Also, the presentation of the outcomes may become easier to follow.

Methods

Data for this monitoring report were extracted from the MC-SIS database that is used by all regional programmes. Records of all women were included in this monitoring report who had an invitation letter for a screening examination or had requested a screening examination between 2010 and 2015, and at the moment of invitation were at least 50 years old and not older than 70 years, 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.

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 proposal of Swiss Cancer Screening[2] that is mainly based on the European Guidelines for Quality Assurance[3]. All indicators were independently double-checked and their values compared with the standards recommended by the European Guidelines.

[1] When extracting the monitoring data from the MC-SIS database, some data could not be well accessed leading to missing values for several variables. This might in particular affect figures on coverage and participation leading to an underestimation of these indicators.

[2] Swiss Cancer Screening. National monitoring of organized mammography screening programmes in Switzerland. Proposal. Bern: Swiss Cancer Screening, rev. 24.0 from 15.12.2017.

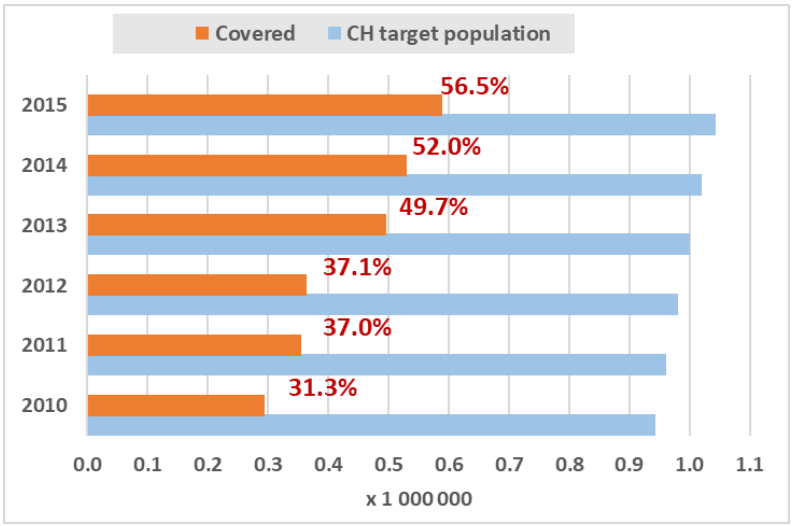
[3] Perry N, Broeders M, de Wolf C, Törnberg S, Holland R, von Karsa L and Puthaar E (eds.). European Guidelines for Quality Assurance in breast cancer screening and diagnosis. Fourth Edition. Luxembourg: Office for Official Publications of the European Communities, 2006.

Breast cancer screening in Switzerland

At the beginning of 2015 slightly over 1 million women aged 50-69 years lived in Switzerland. Of these women, the target population for breast cancer screening, 56.5 percent lived in a canton with a screening programme, nearly twice as much as in 2010 (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

Swiss (CH) coverage of target population (women aged 50-69 years) by regional breast cancer screening programmes (source: Federal Office of Statistics)



Breast cancer screening is organized and carried out per canton or region. By 2010, programmes were fully implemented for years in the 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 and the Cantons of Jura and Neuchâtel) but there was no joint monitoring. In 2010, the first two programmes from the German-speaking cantons of St.Gallen and Thurgau were implemented , 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.

As agreed by *Swiss Cancer Screening*, new programmes contribute the first time to the Swiss monitoring in the calendar year in which they were active during the whole year and have completed a full screening round (2011 for Thurgau, St.Gallen and Graubünden; 2014 for Bern; 2016 only for Basel-Stadt and Ticino).

In the period 2010-2012 contributed five to seven (TG and SG-GR as of 2011) programmes to the Swiss monitoring and in the period 2013-2015 seven to eight (BE as of 2014) programmes. This means that new programmes were implemented during both time periods. The integration of new programmes leads to differences across years in the distribution of womens' ages and in that of initial (prevalent) and subsequent (incident) screening examinations. One has to realise that both age and the kind of screening examination have impact on the outcomes of breast cancer screening. In a non-steady-state situation of screening, as it was the case in Switzerland during 2010-2015, the comparison of outcomes between different calendar years or time periods must be interpreted with caution (Appendix 1). For the same reason, trends over the total six year-period cannot easily be described.

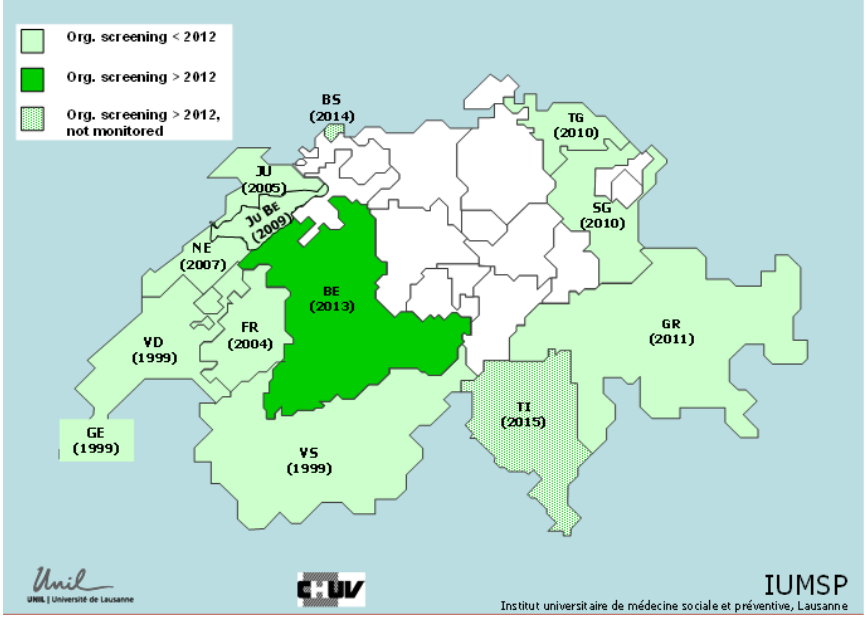


Figure 2

Swiss geographical coverage by regional breast cancer screening programmes (year of start implementation)

Screening activities (Table 1)

In the period 2013-2015, the eight regional programmes invited 683,732 women for screening and performed 277,896 screening mammographies within the 3-year period (Table 1, *Activity statistics*). Invitational activities increased by more than half compared to 2010-2012, whereas the increase in the number of women screened was about a third.

The largest programme has invited and screened approximately three times more women than the smallest one. The magnitude of the variation in absolute numbers across programmes does however not reflect that programmes were not all active during the whole 3-year-period.

The activity figures do not provide a participation rate, because the reported invitations and screening examinations are not necessarily linked to each other. Some women will attend only in the year following the year of invitation. A screening mammography at the beginning of 2013 (and falling in the period 2013-2015) may thus be the result of an invitation in 2012 (period 2010-2012). Some women invited in 2015 will participate in 2016, *i.e.* beyond the period covered by this report.

Coverage and participation rates (Table 1)

Around 4500 (0.3%) from the 1,4 million women targeted in 2013-2015 were excluded (Table 1, *Coverage and participation rates*). As a woman is 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. From the 696,111 eligible women in 2013-2015, 679,261 were invited which results in a *coverage by invitation* rate of 97.6 percent. This rate is higher than in 2010-2012 (90.6%).

Coverage rate

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

Ideally, the latter should include screening mammographies performed outside the organised programme, 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.

One might tend to think that the ideal *coverage by invitation* rate would be precisely 100 percent. But the target population is a dynamic population continuously altered by immigration into and emigration 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 percent. Furthermore, some women opt out of a programme, or become ineligible in subsequent screening resulting in a decreased number of invited women.

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

Activity statistics	2010-2012	min.	max.	2013-2015	min.	max.
Target population (programs in monitoring)	958,196	60,613	251,279	1,396,693	99,115	266,956
Women invited (incl. self-referrals)	435,309	32,580	113,913	683,732	47,731	136,382
Women screened	201,952	11,779	58,528	277,896	20,051	59,782
Coverage and participation rates	2010-2012	min.	max.	2013-2015	min.	max.
Eligible women invited	432,720	32,230	113,359	679,261	47,381	135,193
Women screened (within 1 year)	202,931	12,293	57,439	289,005	19,909	62,578
Coverage by invitation[a]	**90.6%**	88.0%	107.0%	**97.6%**	94.0%	105.6%
Participation rate[a]	**46.9%**	31.3%	59.6%	**42.5%**	25.6%	59.8%
1st round participation rate[a]	**38.3%**	27.8%	52.7%	**32.9%**	25.9%	50.9%
Reattendance[a]	**85.6%**	74.3%	89.2%	**81.7%**	67.4%	89.0%
[a] based on eligible population per year						

Nearly 290,000 women invited in 2013-2015 attended the programme within one year after getting the invitation letter (Table 1, *Coverage and participation rates*). This results in a *participation rate* of 42.5 percent. Compared to 2010-2012, the *participation rate* decreased by 4.4 percent. The main reason is the rather low participation in the new programme in Bern (25.6%) that has a strong impact given the relatively large size of the invited population. Furthermore, the participation rates might be somewhat underestimated because of a limited accessibility to some mammography events (see Footnote 1).

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. It does not matter, if the examination takes 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 rate of the activity index can substantially differ from the participation rate.

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).

The *first round participation rate* of 32.9 percent in 2013-2015 was substantially lower than in 2010-2012 (38.3%). This rate is strongly influenced by the programme in Bern that in the first round invited women of all ages. The large proportion of first invited older women with a relatively lower participation had a negative impact on the first round participation rate.

The *reattendance rate* gives the participation compliance of women who have been screened in the previous round. This rate is with 81.7 percent in 2013-2015 slightly lower than in the period 2010-2012 (85.6%).

When excluding the data from Bern, participation rates appear to be rather stable: the overall participation would be 46.7 percent (46.9% in 2010-2012) and the first round participation rate would become with 39.2 percent slightly higher than in 2010-2012 (38.3%). When considering only the five first programmes that are in a steady state situation as of 2011, reattendance rates were similar between the two time periods (85.6% and 85.5%, respectively).

Results of mammography screening

Prevalent and incident screening

When screening a population for the first time, one should 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 the opportunity to compare the current mammogram with previous ones, what results in high 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 screening 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 is an *incident screen*. The *prevalent screens* are mainly performed among young women who reach 50 years of age and newly belong to the target population.

Because results importantly differ 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 (see Appendix 1).

Prevalent screening (Table 2a)

In the period 2013-2015, some one hundred thousand women underwent a prevalent screening mammography, that is 36.0 percent of all 277,896 women screened within this time period. Some 7,308 women were recalled for a diagnostic assessment, resulting in a recall rate of 73.0 per 1000 screens (Table 2a). This rate is slightly higher than the acceptable level of 70 per 1000 recommended by the European Guidelines.

The screening led to the detection of 609 breast cancers or 6.1 per 1000 prevalent screens. The positive predictive value of mammography screening (PPV) was 8.4 percent; that means that one in 12 women with a positive examination is diagnosed with a breast cancer. The false-positive rate was 66.9 per 1000 prevalent screens. Compared with the period 2010-2012, 14 per 1000 less women have been recalled in the most recent period. The main consequence of this lower recall rate was a relative reduction of 16 percent of the false-positive rate (66.9 vs. 80.0 per 1000) with a simultaneous relative decrease of the breast cancer detection by 12 percent (6.1 vs. 6.9 per 1000), resulting in a marginally higher PPV in the period 2013-2015.

Table 2a **Results *prevalent* screening 2010-2012 and 2013-2015, and minimum (min.) and maximum (max.) value of the regional programmes within the corresponding time period**

Screening tests performed	2010-2012	min.	max.	Eur.GL	2013-2015	min.	max.
Prevalent (first) mammographies	72,289	5,754	21,181		100,070	5,725	30,889
Referrals	**2010-2012**	**min.**	**max.**	**Eur.GL**	**2013-2015**	**min.**	**max.**
Recalled women	6,281	473	2,064		7,308	296	1,929
Recall rate (per 1000 screens)	**86.9**	58.1	103.8	**<70 (<50)**	**73.0**	44.0	109.4
Completeness follow-up referrals	99.9%	99.4%	100.0%		99.2%	98.3%	100.0%
False-positive rate (per 1000 screens)	**80.0**	52.3	96.6		**66.9**	38.9	101.8
Breast cancer detection rate (/1000)	**6.9**	5.8	8.0	**(>)3 x IR**	**6.1**	4.6	7.5
Positive predictive value (PPV adjusted[a])	**8.0%**	6.2%	10.0%		**8.4%**	4.6%	11.8%
Screen-detected breast cancers	**2010-2012**	**min.**	**max.**	**Eur.GL**	**2013-2015**	**min.**	**max.**
Screen-detected breast cancers (N)	499	35	170		609	34	174
Tumour (pT) size determined	95.4%	84.3%	100.0%		89.5%	75.0%	99.4%
Lymph nodal status (pN) determined	77.0%	64.7%	83.5%		64.9%	35.3%	80.0%
Tumour behaviour determined	96.6%	86.3%	100.0%		83.7%	43.6%	100.0%
Ductal carcinoma in-situ (DCIS)	**19.6%**	11.4%	26.1%	**10% (10-20%)**	**18.9%**	8.3%	30.6%
Invasive breast cancers (N)	384	27	131		395	24	129
- invasive node-negative cancers	**80.5%**	76.8%	87.9%	**NA (>70%)**	**78.0%**	73.2%	85.2%
- invasive cancers ≤ 10 mm (T1a+T1b)	**28.9%**	18.9%	45.5%	**NA (>25%)**	**29.1%**	17.9%	59.3%
- invasive cancers < 15 mm	**39.6%**	26.5%	55.4%	**50% (>50%)**	**47.8%**	28.6%	66.7%
Early stage breast cancers (stage 0+I)	**61.5%**	48.1%	70.6%	**NA (>70%)**	**64.0%**	55.8%	73.5%
Advanced stage breast cancers (st. II+)	**34.3%**	15.7%	50.6%	**NA (<30%)**	**25.9%**	16.7%	34.5%
Stage undetermined	4.2%	0.0%	13.7%		10.0%	0.6%	25.0%

[a] based on known follow-up only

Eur.GL: European Guidelines recommendations
Acceptable level (Desirable level)
IR: (underlying) cancer incidence rate
NA: not applicable

There is a large variation in the mentioned indicators between regional programmes; this variation is also substantially larger than in 2010-2012. A recall rate or a false-positive rate above 100 per 1000 prevalent screens must be considered much too high. This means that at least 1 out of every 10 first screened women is recalled or has a false-positive result.

Recall rate, false-positive rate, breast cancer detection rate and positive predictive value of the screening test (PPV)

The *recall rate* gives the proportion of screened women that is recalled for diagnostic assessment due to a suspect mammographic finding ("screen-positive" women).

The *false-positive rate* gives the proportion of screened women in whom the clinical assessment after being recalled did not result in a breast cancer diagnosis.

The *breast cancer detection rate* gives the proportion of screened women diagnosed with breast cancer after being recalled for clinical assessment ("true-positive" result of screening).

The *positive predictive value of the screening test (PPV)* measures the proportion of recalled (screen-positive) women that is diagnosed with breast cancer during the clinical assessment.

In programmes with a high participation and a low level of opportunistic screening, a breast cancer detection of less than 5 per 1000 prevalent screens and a PPV of 4.6 percent would be considered as too low. According to the European Guidelines, the detection rate in prevalent screening should be at least the threefold of the underlying breast cancer incidence rate (IR) for the corresponding ages. However, this standard assumes no screening prior to organised screening and it is not easy to decide the

underlying incidence in presence of long-standing organised and/or widespread opportunistic screening.

The characteristics of the screen-detected breast cancers cannot easily be interpreted given the relatively low percentages of determined tumour size (<90%), tumour behaviour (<84%), lymph nodal status (<65%) and tumour stage (90%) (Table 2a, *Screen-detected breast cancers*). However, most indicators of early detection are in accordance with the European Guidelines. A 19 percent ductal carcinoma in-situ (DCIS) as such is a reasonable proportion, but the definite result depends on how many DCIS are contained in the group with undetermined tumour behaviour. For the same reason, the proportion of early or advanced tumour stages might be underestimated based on data currently available. The large variation in missing information, in particular together with a relatively small number of screen-detected breast cancers can lead to unstable and unreliable proportions of tumour sizes and stages.

Incident screening (Table 2b)

Table 2b Results *incident* screening 2010-2012 and 2013-2015, and minimum (min.) and maximum (max.) value of the regional programmes within the corresponding time period

Seventy percent of the 177,826 incident (subsequent) screening mammographies in 2013-2015 were performed within a time interval of 22 to 26 months after the previous screen (Table 2b, *Screening*

Screening tests performed	2010-2012	min.*	max.*	Eur.GL	2013-2015	min.$	max.$
Incident (subsequent) mammographies	129,663	15,723	46,957		177,826	12,746	47,467
subsequent screens within 22-26 months	72.0%	70.0%	80.2%		70.2%	63.6%	81.1%
Referrals	2010-2012	min.*	max.*	Eur.GL	2013-2015	min.$	max.$
Women recalled	4,449	537	1,528		5,894	430	1,986
Recall rate (per 1000 screens)	**34.3**	24.2	53.9	<50 (<30)	**33.1**	17.9	43.9
Completeness follow-up referrals	100.0%	99.9%	100.0%		99.3%	99.0%	99.8%
False-positive rate (per 1000 screens)	**29.2**	19.0	48.8		**28.6**	13.2	39.6
Breast cancer detection rate (/1000)	**5.1**	5.0	5.2	(>)1.5 x IR	**4.5**	3.8	5.4
Positive predictive value (PPV adjusted[a])	**14.9%**	9.4%	21.2%		**13.8%**	10.0%	26.2%
Screen-detected breast cancers	2010-2012	min.*	max.*	Eur.GL	2013-2015	min.$	max.$
Screen-detected breast cancers (N)	661	80	235		808	49	255
Tumour (pT) size determined	94.7%	90.6%	100.0%		93.9%	80.3%	100.0%
Lymph nodal status (pN) determined	79.0%	71.1%	87.5%		77.0%	68.4%	83.3%
Tumour behaviour determined	95.5%	91.9%	100.0%		95.0%	81.2%	100.0%
Ductal carcinoma in-situ (DCIS)	**16.5%**	10.0%	21.1%	10% (10-20%)	**18.1%**	12.8%	22.4%
Invasive breast cancers (N)	522	70	182		622	38	198
- invasive node-negative cancers	**82.2%**	76.3%	91.2%	(>)75%	**78.1%**	75.0%	84.2%
- invasive cancers ≤ 10 mm (T1a+T1b)	**32.8%**	27.4%	37.1%	≥25% (>30%)	**33.4%**	23.7%	42.9%
- invasive cancers < 15 mm	**54.8%**	45.7%	61.5%	50% (>50%)	**54.3%**	44.1%	62.6%
Early stage breast cancers (stage 0+I)	**70.8%**	66.3%	76.0%	75% (>75%)	**67.9%**	56.4%	74.6%
Advanced stage breast cancers (st. II+)	**23.9%**	21.3%	30.0%	25% (<25%)	**26.6%**	22.8%	34.7%
Stage undetermined	5.3%	0.0%	9.4%		5.4%	0.0%	19.7%

* incident screens SG-GR 2012 (N=326) excluded

$ incident screens BE 2015 (N=1131) excluded

[a] based on known follow-up only

Eur.GL: European Guidelines recommendations

Acceptable level (Desirable level)

IR: (underlying) cancer incidence rate

NA: not applicable

examinations performed). Due to a subsequent screen, 5,894 women were recalled for a diagnostic assessment and 808 breast cancers were detected. This results in a recall rate of 33.1 per 1000 incident screens close to the desirable level recommended by the European Guidelines, a breast cancer detection rate of 4.5 per 1000, a positive predictive value of mammography screening (PPV) of 13.8 percent, and a false-positive rate of 28.6 per 1000. These outcomes are similar to those in the period 2010-2012, with exception of a somewhat lower breast cancer detection rate (4.5 vs. 5.1 per 1000). The variation between regional programmes is modest and does not present extreme outliers.

In contrast to the prevalent screens, tumour characteristics are more complete, particularly for the period 2013-2015 (Table 2b, *Screen-detected breast cancers*). Of the 808 screen-detected cancers, 18.1 percent was a ductal carcinoma in-situ and 77.0 percent an invasive breast cancer; 67.9 percent of breast cancers were detected in an early stage (stage I) and 26.6 percent in an advanced stage (stages II+). Of invasive cancers, four out of five presented without lymph node involvement, one third was smaller than 10 mm in size, and more than half smaller than 15 mm.

The distribution of screen-detected breast cancers was mostly in line with the desirable levels recommended by the European Guidelines and quite similar to that in the period 2010-2012. One regional programme had a relatively large proportion of undetermined tumour behaviour and tumour stage; as a consequence the proportions of DCIS and early-stage cancer seem to be too low. Otherwise, no proportions in regional programmes differed remarkably from the national means.

Main consequences for women participating in mammography screening (Figure 3)

Women should know about the potential consequences when they participate in mammography screening. The chance 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 estimated and presented in this report. The currently available data do not contain sufficient information on clinical diagnostic assessment and no information on interval cancers (cancer diagnosed after a negative mammography and before the next due screen).

Figure 3 shows the rates of recall, true- and false-positive results per 1000 women aged 50-51 undergoing a first (prevalent) screening examination (Figure 3A) and per 1000 women of all ages with a subsequent (incident) screen (Figure 3B). The focus on 50-51 year old women in prevalent screening (Figure 3A) improves the comparability across programmes with varying years of operation (see box *Prevalent and incident screening*). For this same reason, the incident screening rates in Figure 3B are based on the five regional programmes (VD, VS, GE, FR, BEJUNE) being in a steady state situation as of 2011. The rates do not differ much during the two time periods, though they were minimally increased in the young first invited and screened women in period 2013-2015 but rather stable in incident screens.

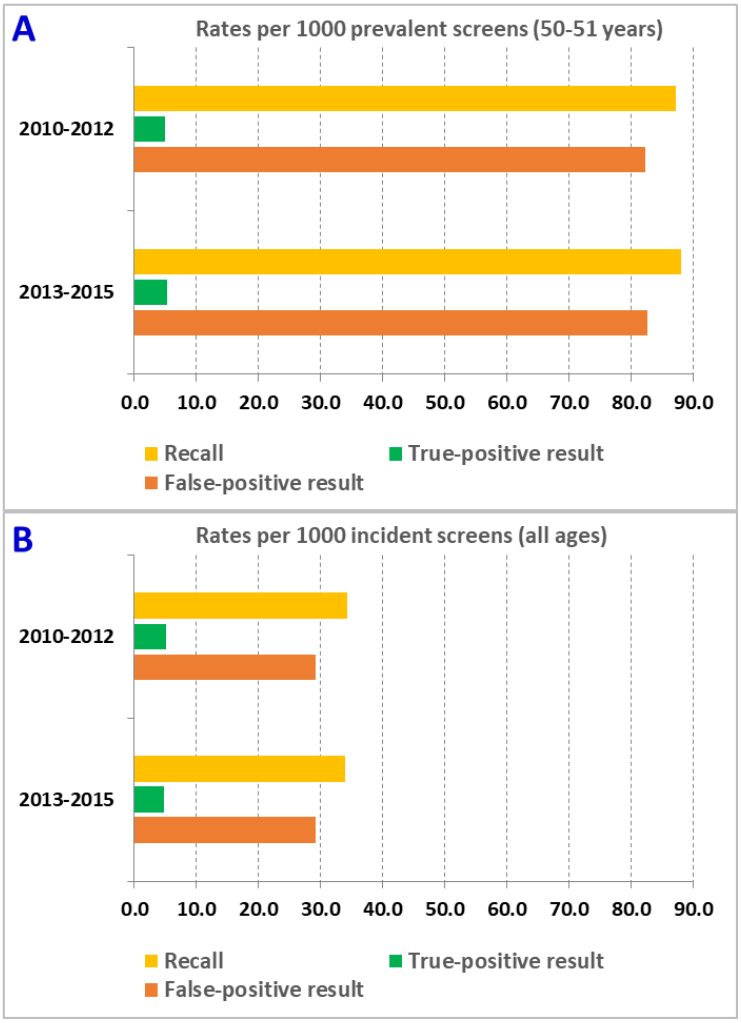
Young women with a prevalent screening examination have a higher likelihood than the total screened population to be recalled and to have a false-positive result. This is due to the denser tissue of the young breast that makes the interpretation of mammographic findings more difficult, the more as no previous mammograms are available for comparison. In the following (incident) screening rounds, however, the chance of a recall and a false-positive result will be remarkably lower for these women.

Figure 3

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

A: first screened women aged 50-51 years (prevalent screens; excl. data SG-GR), and

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



Appendices

APPENDIX 1 shows how ages and types of screening round are distributed depending on the implementation status of the regional programmes.

In APPENDIX 2, the main national outcomes are specified by calendar year between 2010 and 2015.

APPENDIX 1 Distribution of ages and screening examinations in prevalent and incident rounds

Age distribution

In the first round of a programme, the total eligible population, e.g. all women aged 50 to 69 years, are invited for a prevalent screening examination. In the next invitation rounds, the great majority of first invited women is 50 years old; the small proportion of older women are those who immigrated into the catchment area of the programme after the previous round. As the occurrence of breast cancer is age-dependent, a prevalent screening round will result in higher recall and detection rates when the proportion of screened elderly women increases.

Figure 4 shows the annual difference in age distribution of screened women in the prevalent round between all programmes (Figure 4A) and the 5 regional programmes in a steady state situation as of 2011 (VD, VS, GE, FR and BEJUNE; Figure 4B).

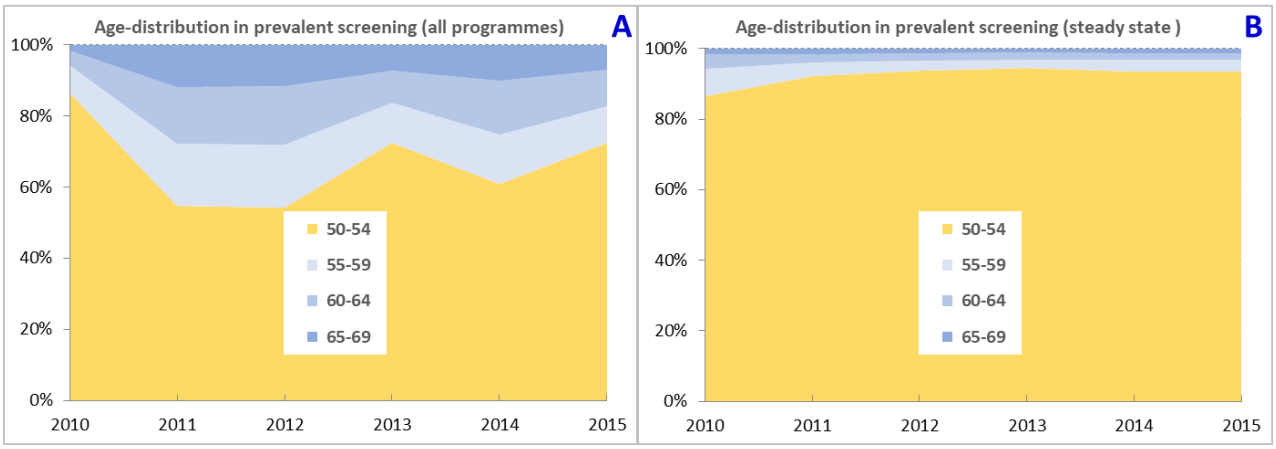


Figure 4 **Age-distribution of initially screened women (prevalent screening), 2010-2015; A: all programs; B: regional programmes in steady state situation (VD, VS, GE, FR, BEJUNE)**

More than 90 percent of the women who have a first screening mammography is younger than 55 years in the steady state situation, whereas this proportion falls to 60 percent when prevalent screens are mixed up between first and later screening rounds. This was the case in 2011 and 2012 with the implementation of the programmes in TG and SG-GR, and in 2014 with the implementation of the programme in BE. The more difficult interpretation of mammography in young women usually leads to higher recall rates in combination with a lower positive predictive value than in older women. This means that strongly alternating age distributions from one time period (calendar year) to another will impact on the outcomes such as recall and breast cancer detection rates, making temporal comparison difficult.

Distribution of screening examinations

More than 80 percent of the screening examinations is a subsequent (incident) screen in the second or further screening rounds. In subsequent screens, less breast cancers are detected than in prevalent screens. A higher proportion of subsequently screened women in one calendar year may lead to a lower breast cancer detection rate compared to years with relatively less subsequent screens.

Figure 5 shows the annual difference in distribution of prevalent (initial) and incident (subsequent) screening examinations between all programmes (Figure 5A) and the 5 programmes in a steady state situation as of 2011 (VD, VS, GE, FR and BEJUNE; Figure 5B). Due to the inclusion of first round (prevalent) screening examinations in the total for all regional programmes, the proportion of prevalent screens varies between

20 and 35 percent and reflects as in Figure 4A the implementation of new programmes. This proportion is much lower in the steady state situation and stable around 15 percent.

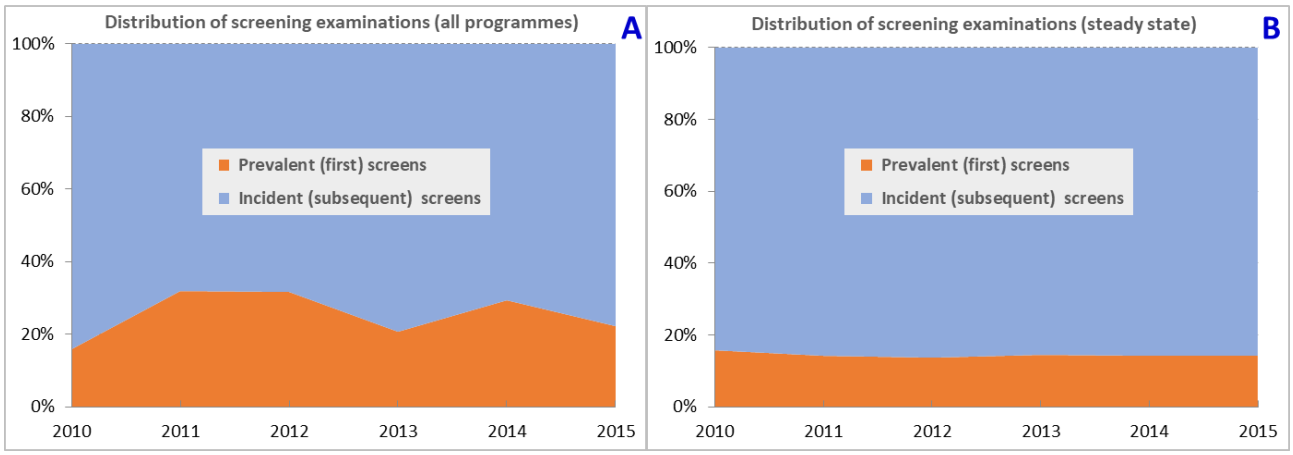


Figure 5 **Distribution of initial (prevalence) and subsequent (incidence) screening examinations, 2010-2015; A: all programs; B: regional programmes in steady state situation (VD, VS, GE, FR, BEJUNE)**

APPENDIX 2 Main results per year, Swiss breast cancer screening 2010-2015

Table App.2 Annual results of Swiss breast cancer screening 2010-2015 (prevalent and incident screening examinations combined)

Activity statistics	2010	2011	2012	2013	2014	2015	2010-2015	2010-2012	2013-2015
Target population (programs in monitoring)	239,236	355,564	363,396	371,190	507,473	518,030	2,354,889	958,196	1,396,693
Women invited (incl. self-referrals)	115,100	151,454	168,755	175,853	251,113	256,766	1,119,041	435,309	683,732
Women screened (within 1 year)	55,107	70,493	76,352	81,003	96,112	100,781	479,848	201,952	277,896
Coverage and participation rates	2010	2011	2012	2013	2014	2015	2010-2015	2010-2012	2013-2015
Eligible women invited	114,347	150,672	167,701	174,694	249,078	255,489	1,111,981	432,720	679,261
Screenees (within 12 months)	55,438	71,180	76,313	83,916	100,955	104,134	491,936	202,931	289,005
Coverage by invitation[a]	**95.9%**	**84.9%**	**92.6%**	**94.4%**	**98.6%**	**98.9%**	**94.7%**	**90.6%**	**97.6%**
Participation rate[a]	**48.5%**	**47.2%**	**45.5%**	**48.0%**	**40.5%**	**40.8%**	**44.2%**	**46.9%**	**42.5%**
1st round participation rate[a]	**42.8%**	**38.1%**	**37.1%**	**38.6%**	**30.1%**	**33.1%**	**35.1%**	**38.3%**	**32.9%**
Proportion 1st round participation[a]	27.0%	37.6%	40.5%	34.0%	37.2%	36.5%	35.9%	35.8%	36.0%
Reattendance[a]	**84.2%**	**85.4%**	**87.1%**	**79.5%**	**82.2%**	**83.1%**	**83.3%**	**85.6%**	**81.7%**
Screening results									
Screening tests performed	2010	2011	2012	2013	2014	2015	2010-2015	2010-2012	2013-2015
Women screened	55,107	70,493	76,352	81,003	96,112	100,781	479,848	201,952	277,896
- Prevalent (first) mammographies	14,856	26,534	30,899	27,504	35,780	36,786	172,359	72,289	100,070
%	27.0%	37.6%	40.5%	34.0%	37.2%	36.5%	35.9%	35.8%	36.0%
- Incident (subsequent) mammographies	40,251	43,959	45,453	53,499	60,332	63,995	307,489	129,663	177,826
%	73.0%	62.4%	59.5%	66.0%	62.8%	63.5%	64.1%	64.2%	64.0%
% subsequent within 22-26 months	71.6%	71.7%	72.6%	70.9%	70.1%	69.8%	71.0%	72.0%	70.2%
Recalls	2010	2011	2012	2013	2014	2015	2010-2015	2010-2012	2013-2015
Women recalled	2,547	4,019	4,164	4,342	4,294	4,566	23,932	10,730	13,202
Recall rate (per 1000 screens)	**46.2**	**57.0**	**54.5**	**53.6**	**44.7**	**45.3**	**49.9**	**53.1**	**47.5**
Completeness follow-up referrals	100.0%	99.9%	99.9%	99.7%	98.8%	99.3%	99.6%	99.9%	99.3%
False-positive rate (per 1000 screens)	**40.3**	**51.3**	**48.9**	**47.9**	**39.7**	**40.6**	**44.5**	**47.4**	**42.4**
Breast cancer detection rate (/1000)	**5.9**	**5.7**	**5.6**	**5.7**	**5.0**	**4.7**	**5.4**	**5.7**	**5.1**
Positive predictive value (PPV adjusted[b])	**12.8%**	**10.0%**	**10.4%**	**10.7%**	**11.3%**	**10.5%**	**10.8%**	**10.8%**	**10.8%**
Screen-detected breast cancers	2010	2011	2012	2013	2014	2015	2010-2015	2010-2012	2013-2015
Screen-detected breast cancers (N)	327	402	431	462	479	476	2,577	1,160	1,417
Tumour (pT) size determined	94.8%	95.0%	95.1%	92.4%	90.6%	93.1%	93.4%	95.0%	92.0%
Lymph nodal status (pN) determined	80.1%	75.6%	78.9%	76.0%	72.0%	67.4%	74.6%	78.1%	71.8%
Tumour behaviour determined	95.7%	96.3%	95.8%	94.4%	91.9%	84.5%	92.8%	95.9%	90.2%
Ductal carcinoma in-situ (DCIS)	**15.6%**	**20.6%**	**16.9%**	**18.4%**	**19.8%**	**17.0%**	**18.2%**	**17.8%**	**18.4%**
Invasive breast cancers (N)	262	304	340	351	345	321	1,923	906	1,017
- invasive node-negative cancers	**77.9%**	**84.5%**	**81.5%**	**78.3%**	**77.7%**	**78.2%**	**79.7%**	**81.5%**	**78.1%**
- invasive cancers ≤ 10 mm (T1a+T1b)	**31.3%**	**31.9%**	**30.3%**	**33.3%**	**31.3%**	**30.5%**	**31.5%**	**31.1%**	**31.8%**
- invasive cancers < 15 mm	**49.6%**	**45.7%**	**49.7%**	**54.7%**	**48.1%**	**52.6%**	**50.2%**	**48.3%**	**51.8%**
Early stage breast cancers (stage 0+I)	**63.0%**	**67.9%**	**68.7%**	**66.2%**	**65.3%**	**67.2%**	**66.5%**	**66.8%**	**66.3%**
Advanced stage breast cancers (st. II+)	**31.8%**	**27.1%**	**26.9%**	**26.2%**	**25.7%**	**27.1%**	**27.2%**	**28.4%**	**26.3%**
Stage undetermined	5.2%	5.0%	4.4%	7.6%	9.0%	5.7%	6.2%	4.8%	7.4%

[a] based on eligible population per year
[b] based on known follow-up only