Sources for FactCheck

Figures

Mortality Data: The data are from the Global Cancer Observatory, International Agency for Research on Cancer (IARC) Cancer Surveillance Branch. Select Cancer Over Time, then select Trends.
Measure: Mortality
Sexes: Female
Cancer Sites: Breast
Populations: United Kingdom, USA
Ages: 40-49, 50+

The default graphic display smoothed lines (LOESS regression algorithm), our graphs use the underlying data and 3 year moving averages.

Screening Practice: Over 70% of women age 50 to 70 are regularly screened in the UK and the US.[1] In the UK there is no organized and little opportunistic screening of women in their 40s, while in the USA 60% of women in this age group have been regularly screened since 1993.[2]

Note: For the "Here's another way to look at the data" slide, we obtained more recent US data (up to 2020) from the mortality files contained in the Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Mortality

References

1. Williams J, Garvican L, Tosteson AN, Goodman DC, Onega T. Breast cancer screening in England and the United States: a comparison of provision and utilisation. Int J Public Health. 2015;60(8):881-890. doi:10.1007/s00038-015-0740-5.
2. Health, United States, 2020-2021. Mammography. CDC/National Center for Health Statistics/Division of Analysis and Epidemiology (Accessed June 8, 2023).

Table

Benefit
Mortality data

Death from any cause: The 10-year chance of death from any cause is for U.S. women age 40 years is **1.96%;** data from the Social Security Administration (see **figure S1**, below). We used 2019 (i.e., pre-COVID) data to avoid underestimating the chance of breast cancer death (i.e., more COVID deaths mean fewer women alive to die from breast cancer).

No trials have shown that screening mammograms reduce a woman's chance of dying overall. The low end of the range provided assumes that all women who avoid a breast-cancer death do not die from another cause. The high end assumes all women who avoid a breast cancer death die from another cause.

Calculations for age 40*
(*For actual calculations for ages 40, 50 and 60, **see spreadsheet**: Calculations for fact check for mammgraphy tables_F.xlxs).

Death from breast cancer: The 10-year chance of death from breast cancer is for U.S. women age 40 years. Data are from the National Cancer Institute (DEVCAN) (see **Figure S2,** below).

SEER 22 Incidence and Mortality, 2000-2021 (2020 Excluded)

Selections:

Statistic Type = Probability of Dying of Cancer;
Year = 2018-2021 (2020 Excluded);
Race = All Races;
Sex = Female;
Site = Breast -- In Situ & Mal;
Starting Age = 40;
Ending Age = 50;

Results:

0.14%

https://surveillance.cancer.gov/devcan/canques.html

But this value (0.14%) includes women who have and who have not undergone screening mammography. To estimate the chance of breast cancer death with and without mammography we solved the following equation. One key input is the relative risk reduction for breast cancer death given a program of mammography screening. Below we solve the calculation twice: (a) using the RR=0.70 based on the US Preventive Services Task Force report[1] and (b) using RR=0.87 from the Cochrane Collaboration estimate based for the low risk of bias trials.[2]

*a. 10-year chance of breast cancer death without mammograms **using USPTSF's** RR=0.70*

overall breast cancer mortality	=	breast cancer mortality *without* screening * RR * % screened	+	breast cancer mortality *without* screening * % not screened

$$0.14\% = [X * 0.70 * 59.1\%] + [X * 39.9\%]$$

Where,
0.14% is the overall chance of breast cancer death for a 40-year-old US woman [from the National Cancer Institute (DEVCAN).

X = the chance of death *without* screening.

RR = relative risk of death for women undergoing regular screening vs. no screening = 0.70 based on the US Preventive Services Task Force modeling report[2].

% screened = 59.1%.
The most recent data from the National Center for Health Statistics reports that 59.1% of women age 40-49 have undergone a mammogram in the last 2 years[3].

Solving for X, the results are:

Chance of death **without screening** = 0.17%
Chance of death **with screening** = .70X = 0.12%

*b. 10-year chance of breast cancer death with mammograms using **the Cochrane Collaboration's RR=0.87see based on low risk of bias trials (see Figure S3, below).**[3]*

$$y = [0.87 * 0.17]$$

Chance of death **without screening** = 0.17%
Chance of death **with screening** = .0.87y = 0.15%

Harms

False alarms (any and false alarms resulting in a biopsy): Estimates are based on data from the National Cancer Institute–funded Breast Cancer Surveillance Consortium[4]. The low and high estimates (26.4% and 51.2%, respectively) are for women age 40-49 at low or high risk for false positive based on breast density (see **Figure S4**, below).

The corresponding figures for woman age 50-59 are

Overdiagnosis: Data for annual screening are from Pace, et al.[5] For biennial screening we divided the chance by 2 given half the number of screens.

References

1. US Preventive Services modeling report.
Trentham-Dietz A, Chapman CH, Jayasekera J, et al. Breast Cancer Screening With Mammography: An Updated Decision Analysis for the U.S. Preventive Services Task Force [Internet]. Rockville (MD): Agency for Healthcare Research and Quality (US); 2024 Apr. (Technical Report, No. 231s.) Available from: https://www.ncbi.nlm.nih.gov/books/NBK603560/

2. Gøtzsche PC, Jørgensen KJ. Screening for breast cancer with mammography. Cochrane Database of Systematic Reviews 2013,
Issue 6. Art. No.: CD001877. DOI: 10.1002/14651858.CD001877.pub5.
https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD001877.pub5/full?highlightAbstract=mammographi%7Cmammography

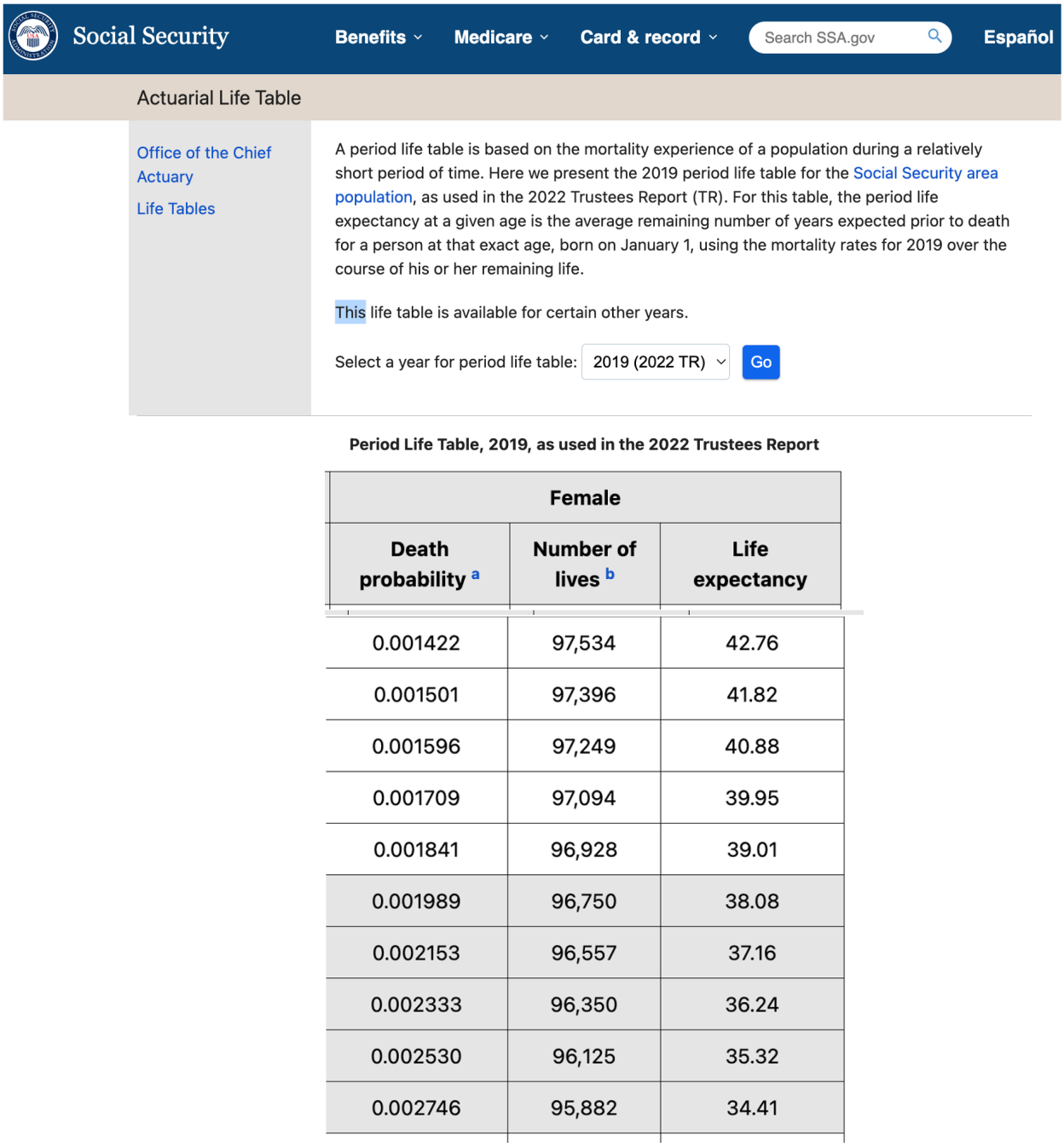
3. Miller JW, King JA, Trivers KF, et al. Vital Signs: Mammography Use and Association with Social Determinants of Health and Health-Related Social Needs Among Women — United States, 2022. MMWR Morb Mortal Wkly Rep 2024;73:351-357.
DOI: http://dx.doi.org/10.15585/mmwr.mm7315e1.

4. Ho TH, Bissell MCS, Kerlikowske K, et al. Cumulative Probability of False-Positive Results After 10 Years of Screening With Digital Breast Tomosynthesis vs Digital Mammography. *JAMA Netw Open.* 2022;5(3):e222440. doi:10.1001/jamanetworkopen.2022.2440.

5. Pace LE et. al. A Systematic Assessment of Benefits and Risks to Guide Breast Cancer Screening Decisions. JAMA. 2014;311(13):1327-1335].

Supporting screen shots

Figure S1/ chance of death overall



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Actuarial Life Table

Office of the Chief Actuary

Life Tables

A period life table is based on the mortality experience of a population during a relatively short period of time. Here we present the 2019 period life table for the Social Security area population, as used in the 2022 Trustees Report (TR). For this table, the period life expectancy at a given age is the average remaining number of years expected prior to death for a person at that exact age, born on January 1, using the mortality rates for 2019 over the course of his or her remaining life.

This life table is available for certain other years.

Select a year for period life table: 2019 (2022 TR) Go

Period Life Table, 2019, as used in the 2022 Trustees Report

Female		
Death probability [a]	Number of lives [b]	Life expectancy
0.001422	97,534	42.76
0.001501	97,396	41.82
0.001596	97,249	40.88
0.001709	97,094	39.95
0.001841	96,928	39.01
0.001989	96,750	38.08
0.002153	96,557	37.16
0.002333	96,350	36.24
0.002530	96,125	35.32
0.002746	95,882	34.41

Period Life Table, 2019, as used in the 2022 Trustees Report

overall 10-year mortality female age 40

age		pdie1	n deaths in 1	survive
40	100000	0.001422	142.2	99857.8
41	99857.8	0.001501	149.88656	99707.913
42	99707.913	0.001596	159.13383	99548.78
43	99548.78	0.001709	170.12886	99378.651
44	99378.651	0.001841	182.9561	99195.695
45	99195.695	0.001989	197.30024	98998.394
46	98998.394	0.002153	213.14354	98785.251
47	98785.251	0.00233	230.16963	98555.081
48	98555.081	0.00253	249.34436	98305.737
49	98305.737	0.002746	269.94755	98035.789
			1964.2107	1.96%

Figure S2/ Overall chance of breast cancer death
(source: https://surveillance.cancer.gov/devcan/canques.html)

a/ for age 40-49

SEER 22 Incidence and Mortality, 2000-2021 (2020 Excluded)

Selections:

Statistic Type = Probability of Dying of Cancer;
Year = 2018-2021 (2020 Excluded);
Race = All Races;
Sex = Female;
Site = Breast -- In Situ & Mal;
Starting Age = 40;
Ending Age = 50;

Results:

0.14%

Table Variable:

Notes:

Statistics are provided by the Surveillance Research Program (SRP), NCI for research purposes only.
The cancer sites defined in this database are based on ICD-0-3 for incidence cases, ICD-10 for mortality cases, and include Kaposi Sarcoma and Mesothelioma as individual sites. For more information, see http://surveillance.cancer.gov/devcan/faqs.html.
The SEER 22 areas include San Francisco, Connecticut, Hawaii, Iowa, New Mexico, Seattle, Utah, Atlanta, San Jose-Monterey, Los Angeles, Alaska Native Registry, Rural Georgia, California excluding SF/SJM/LA, Kentucky, Louisiana, New Jersey, Greater Georgia, Idaho, New York, Massachusetts, Texas and Illinois.
The 1995-1999 cases from California excluding SF/SJM/LA, Kentucky, Louisiana and New Jersey are not publicly available. These cases were used for followback to determine whether a tumor was the first occurance of a tumor for that particular cancer site.

Suggested Citations:

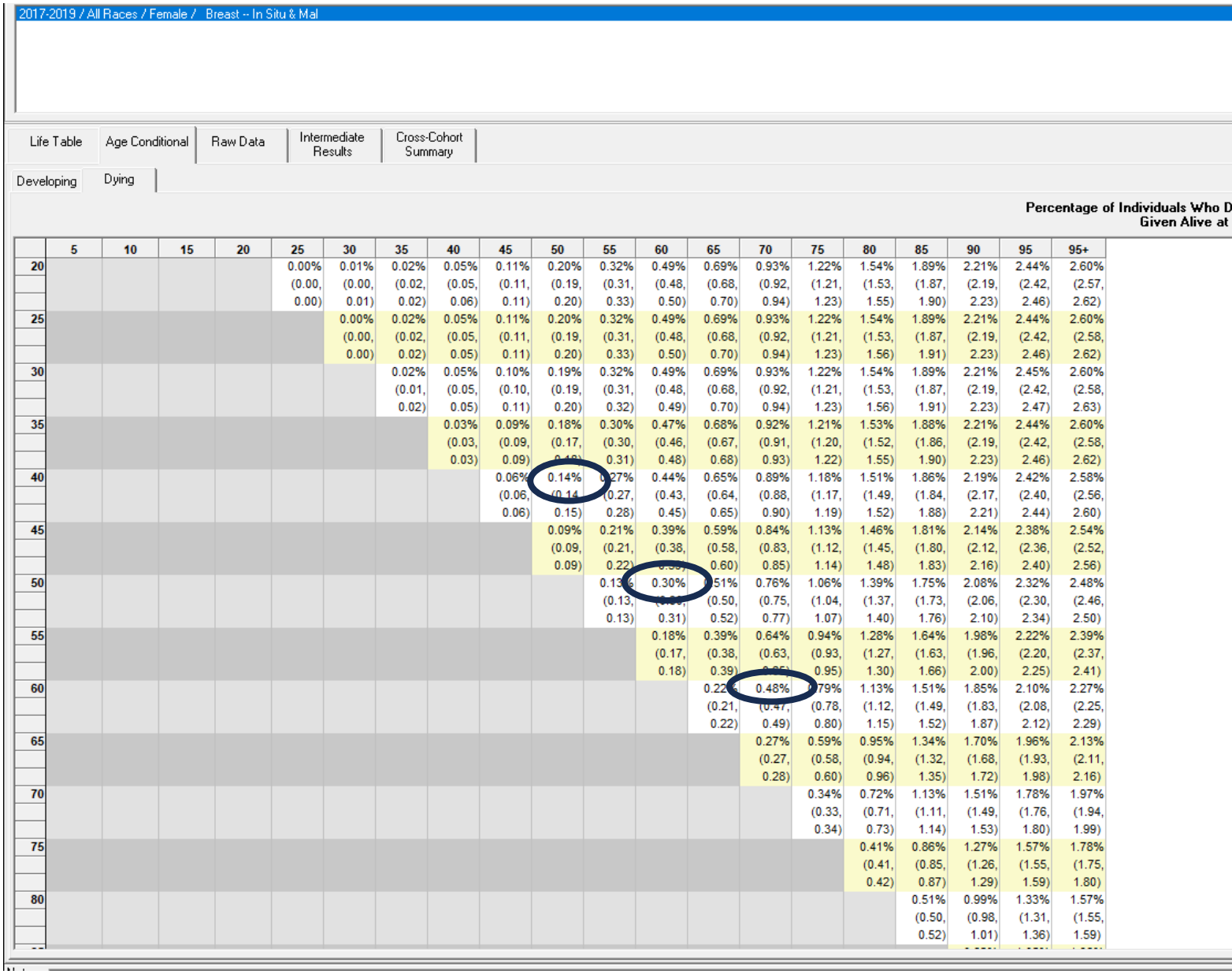
Software Citation: Probability of Developing or Dying of Cancer Software, Version 6.9.1. Surveillance Research Program, Statistical Methodology and Applications Branch, National Cancer Institute, 2024. http://surveillance.cancer.gov/devcan

Methods Citations: Fay, M.P., Pfeiffer, R., Cronin, K.A., Le, C. and Feuer, E.J. (2003) "Age-conditional probabilities of developing cancer" Statistics in Medicine, 22(11): 1837-1848.

Fay, M.P. (2003) "Estimating Age-conditional probability of developing cancer using a Piecewise Mid-Age Group Joinpoint Model for the Rates". Statistical Research and Applications Branch, National Cancer Institute, Technical Report #2003-03-A.

Database Citation: Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) DevCan database: "SEER 22 Incidence and Mortality, 2000-2021 (2020 Excluded)". National Cancer Institute, DCCPS, Surveillance Research Program, Surveillance Systems Branch, released May 2024, based on the November 2023 submission. Underlying mortality data provided by NCHS (www.cdc.gov/nchs).

b/ For ages 40, 50 and 60 (from DevCan, National Cancer Institute)



2017-2019 / All Races / Female / Breast -- In Situ & Mal

Life Table | Age Conditional | Raw Data | Intermediate Results | Cross-Cohort Summary

Developing | Dying

Percentage of Individuals Who D
Given Alive at

	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	95+
20					0.00% (0.00, 0.00)	0.01% (0.00, 0.01)	0.02% (0.02, 0.02)	0.05% (0.05, 0.06)	0.11% (0.11, 0.11)	0.20% (0.19, 0.20)	0.32% (0.31, 0.33)	0.49% (0.48, 0.50)	0.69% (0.68, 0.70)	0.93% (0.92, 0.94)	1.22% (1.21, 1.23)	1.54% (1.53, 1.55)	1.89% (1.87, 1.90)	2.21% (2.19, 2.23)	2.44% (2.42, 2.46)	2.60% (2.57, 2.62)
25						0.00% (0.00, 0.00)	0.02% (0.02, 0.02)	0.05% (0.05, 0.05)	0.11% (0.11, 0.11)	0.20% (0.19, 0.20)	0.32% (0.31, 0.33)	0.49% (0.48, 0.50)	0.69% (0.68, 0.70)	0.93% (0.92, 0.94)	1.22% (1.21, 1.23)	1.54% (1.53, 1.56)	1.89% (1.87, 1.91)	2.21% (2.19, 2.23)	2.44% (2.42, 2.46)	2.60% (2.58, 2.62)
30							0.02% (0.01, 0.02)	0.05% (0.05, 0.05)	0.10% (0.10, 0.11)	0.19% (0.19, 0.20)	0.32% (0.31, 0.32)	0.49% (0.48, 0.49)	0.69% (0.68, 0.70)	0.93% (0.92, 0.94)	1.22% (1.21, 1.23)	1.54% (1.53, 1.56)	1.89% (1.87, 1.91)	2.21% (2.19, 2.23)	2.45% (2.42, 2.47)	2.60% (2.58, 2.63)
35								0.03% (0.03, 0.03)	0.09% (0.09, 0.09)	0.18% (0.17, 0.19)	0.30% (0.30, 0.31)	0.47% (0.46, 0.48)	0.68% (0.67, 0.68)	0.92% (0.91, 0.93)	1.21% (1.20, 1.22)	1.53% (1.52, 1.55)	1.88% (1.86, 1.90)	2.21% (2.19, 2.23)	2.44% (2.42, 2.46)	2.60% (2.58, 2.62)
40									0.06% (0.06, 0.06)	0.14% (0.14, 0.15)	0.27% (0.27, 0.28)	0.44% (0.43, 0.45)	0.65% (0.64, 0.65)	0.89% (0.88, 0.90)	1.18% (1.17, 1.19)	1.51% (1.49, 1.52)	1.86% (1.84, 1.88)	2.19% (2.17, 2.21)	2.42% (2.40, 2.44)	2.58% (2.56, 2.60)
45										0.09% (0.09, 0.09)	0.21% (0.21, 0.22)	0.39% (0.38, [illegible])	0.59% (0.58, 0.60)	0.84% (0.83, 0.85)	1.13% (1.12, 1.14)	1.46% (1.45, 1.48)	1.81% (1.80, 1.83)	2.14% (2.12, 2.16)	2.38% (2.36, 2.40)	2.54% (2.52, 2.56)
50											0.13% (0.13, 0.13)	0.30% ([illegible], 0.31)	0.51% (0.50, 0.52)	0.76% (0.75, 0.77)	1.06% (1.04, 1.07)	1.39% (1.37, 1.40)	1.75% (1.73, 1.76)	2.08% (2.06, 2.10)	2.32% (2.30, 2.34)	2.48% (2.46, 2.50)
55												0.18% (0.17, 0.18)	0.39% (0.38, 0.39)	0.64% (0.63, [illegible])	0.94% (0.93, 0.95)	1.28% (1.27, 1.30)	1.64% (1.63, 1.66)	1.98% (1.96, 2.00)	2.22% (2.20, 2.25)	2.39% (2.37, 2.41)
60													0.22% (0.21, 0.22)	0.48% ([illegible], 0.49)	[illegible]79% (0.78, 0.80)	1.13% (1.12, 1.15)	1.51% (1.49, 1.52)	1.85% (1.83, 1.87)	2.10% (2.08, 2.12)	2.27% (2.25, 2.29)
65														0.27% (0.27, 0.28)	0.59% (0.58, 0.60)	0.95% (0.94, 0.96)	1.34% (1.32, 1.35)	1.70% (1.68, 1.72)	1.96% (1.93, 1.98)	2.13% (2.11, 2.16)
70															0.34% (0.33, 0.34)	0.72% (0.71, 0.73)	1.13% (1.11, 1.14)	1.51% (1.49, 1.53)	1.78% (1.76, 1.80)	1.97% (1.94, 1.99)
75																0.41% (0.41, 0.42)	0.86% (0.85, 0.87)	1.27% (1.26, 1.29)	1.57% (1.55, 1.59)	1.78% (1.75, 1.80)
80																	0.51% (0.50, 0.52)	0.99% (0.98, 1.01)	1.33% (1.31, 1.36)	1.57% (1.55, 1.59)

Figure S3 - Relative risk reduction of breast cancer death with mammography screening

a/ USPTSF (used for all 3 tables, ie, ages 40, 50 and 60)
https://www.ncbi.nlm.nih.gov/books/NBK603560/

Table 5. Median Lifetime Benefits (and Range Across Six Models) of Screening Strategies With Digital Breast Tomosynthesis for a Cohort of 1,000 40-Year-Old Female Persons Compared With No Screening According to Screening Interval, Starting Age, and Stopping Age

Interval and Age Group[a]	Breast Cancer Mortality Reduction, %
Biennial	
50-74	25.4 (18.8-29.4)
45-74	27.5 (21.7-31.2)
40-74	30.0 (24.0-33.7)

b/ Cochrane collaboration (low risk of bias trials)[3] for ages 40, 50 and 60.

<50

Analysis 1.5. Comparison 1 Screening with mammography versus no screening, Outcome 5 Deaths ascribed to breast cancer, 13 years follow up, women below 50 years of age.

Study or subgroup	Screening n/N	No screening n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
1.5.1 Adequately randomised trials					
Canada 1980a	105/25214	108/25216		22.17%	0.97[0.74,1.27]
Malmö 1976	8/3658	16/3769		3.24%	0.52[0.22,1.2]
UK age trial 1991	105/53884	251/106956		34.52%	0.83[0.66,1.04]
Subtotal (95% CI)	**82756**	**135941**		**59.93%**	**0.87[0.73,1.03]**
Total events: 218 (Screening), 375 (No screening)					
Heterogeneity: $Tau^2=0$; $Chi^2=2.29$, df=2(P=0.32); $I^2=12.69\%$					
Test for overall effect: Z=1.66(P=0.1)					

Age 50+

Analysis 1.6. Comparison 1 Screening with mammography versus no screening, Outcome 6 Deaths ascribed to breast cancer, 13 years follow up, women at least 50 years of age.

Study or subgroup	Screening n/N	No screening n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
1.6.1 Adequately randomised trials					
Canada 1980b	107/19711	105/19694		14.5%	1.02[0.78,1.33]
Malmö 1976	79/17430	92/17426		12.7%	0.86[0.64,1.16]
Subtotal (95% CI)	**37141**	**37120**		**27.2%**	**0.94[0.77,1.15]**
Total events: 186 (Screening), 197 (No screening)					
Heterogeneity: $Tau^2=0$; $Chi^2=0.69$, df=1(P=0.41); $I^2=0\%$					
Test for overall effect: Z=0.57(P=0.57)					

Source:
https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD001877.pub5/full?highlightAbstract=mammographi%7Cmammography

Figure 4/ False positive risk with bienniel mammography (digital tomosynthesis) for women age 40.

	Cumulative probability (95% CI)	
Age and density	≥ 1 false positive recall	≥ 1 false positive with biopsy
Age, 40-49 y	26.4 (18.5 to 34.8)	4.3 (1.5 to 8.1)
Almost entirely fatty	38.1 (34.6 to 41.6)	6.6 (5.1 to 8.1)
Scattered fibroglandular densities	51.9 (48.9 to 54.9)	9.5 (8.0 to 11.0)
Heterogeneously dense	51.2 (45.7 to 56.9)	10.0 (7.3 to 12.9)
Extremely dense		
Age, 50-59 y	18.3 (15.5 to 21.3)	4.1 (2.8 to 5.7)
Almost entirely fatty	31.6 (30.0 to 33.2)	5.1 (4.3 to 5.8)
Scattered fibroglandular densities	41.0 (39.1 to 42.8)	8.3 (7.3 to 9.4)
Heterogeneously dense	42.2 (37.7 to 46.7)	10.9 (8.2 to 14.0)
Extremely dense		
Age, 60-69 y	17.2 (14.6 to 20.1)	4.5 (3.1 to 6.2)
Almost entirely fatty	28.7 (27.2 to 30.3)	4.4 (3.8 to 5.1)
Scattered fibroglandular densities	34.9 (33.0 to 37.0)	7.3 (6.2 to 8.3)
Heterogeneously dense	34.8 (29.2 to 40.4)	8.0 (4.7 to 11.5)
Extremely dense		

Source: Ho TQ, et. al. Cumulative Probability of False-Positive Results After 10 Years of Screening With Digital Breast Tomosynthesis vs Digital Mammography. JAMA Network Open. 2022;5(3):e222440. doi:10.1001/jamanetworkopen.2022.2440. (excerpted from Tables 2 and 4)

Figure S5 - Overdiagnosis

Pace. JAMA. 2014;311(13):1327-1335. doi:10.1001/jama.2014.1398

Table 2. Estimated Benefits and Harms of Mammography Screening for 10 000 Women Who Undergo Annual Screening Mammography Over a 10-Year Period

Age, y	No. Diagnosed With Invasive Breast Cancer or DCIS During the 10 y of Screening[a]	No. of Breast Cancer Deaths in next 15 y[b]	No. of Deaths Averted With Mammography Screening Over Next 15 y[c]	No. of Breast Cancers or DCIS Diagnosed During the 10 y That Would Never Become Clinically Important (Overdiagnosis)[d]	No. (95% CI) With ≥1 False-Positive Result During the 10 y[e]	No. (95% CI) With ≥1 Unnecessary Biopsy During the 10 y[e]
40	190	27-32	1-16	?-104[f]	6130 (5940-6310)	700 (610-780)
50	302	56-64	3-32	30-137	6130 (5800-6470)	940 (740-1150)
60	438	87-97	5-49	64-194	4970 (4780-5150)	980 (840-1130)

Abbreviation: DCIS, ductal carcinoma in situ.

[a] Number of cancers expected to be diagnosed in the next 10 years from Surveillance, Epidemiology, and End Results (SEER) statistics[16] and also reported by Welch and Passow.[17] These numbers are from SEER incidence rates and reflect a combination of screened and unscreened women, so they would be higher in a completely screened population such as these 10 000 women by a number that depends on the magnitude of overdiagnosis.

[b] Number of women expected to die of breast cancer in the next 15 years among a screened cohort are from Welch and Passow,[17] who used SEER statistics[18] adjusted for mammography rates reported in the 2008 National Health Interview Survey.[19] The lower bound numbers represent death rates under the assumption of a breast cancer mortality risk reduction of 0.64 from mammography screening based on the benefit noted in the Swedish 2-County Trial[11]; the upper bound represents death rates under the assumption of a breast cancer mortality risk reduction of 0.95 based on the minimal benefit noted in the Canadian Trials.[10,15]

[c] Number of deaths averted are from Welch and Passow[17]; the lower bound represents breast cancer mortality reduction if the breast cancer mortality RR were 0.95 (based on minimal benefit from the Canadian trials[10,15]), and the upper bound represents the breast cancer mortality reduction if the RR were 0.64 (based on the Swedish 2-County Trial[11]).

[d] Overdiagnosed cases are calculated by Welch and Passow[17]; the lower bound represents overdiagnosis based on results from the Malmö trial,[20] whereas the upper bound represents the estimate from Bleyer and Welch.[21]

[e] False-positive and biopsy estimates and 95% CIs are 10-year cumulative risks reported in Hubbard et al[22] and Braithwaite et al.[23] For 60-year-old women we used estimates of false-positive results or biopsies in women aged 66 to 74 years with a Charlson score of 0.

[f] The lower bound estimate for overdiagnosis reported by Welch and Passow[17] came from the Malmö study,[20] which did not enroll women younger than 50 years.