



Public Health  
Agency of Canada

Agence de la santé  
publique du Canada



# Information on Mammography

for Women Aged 40 and Older:

A Decision Aid for Breast Cancer Screening in Canada



Canada

**“Information on Mammography for Women Aged 40 and Older: A Decision Aid for Breast Cancer Screening in Canada”** is a product of the Canadian Breast Cancer Screening Initiative (CBCSI). The CBCSI is a part of the Canadian Breast Cancer Initiative. The Initiative includes the Public Health Agency of Canada, provincial/territorial breast screening programs, professional associations, non-governmental organizations, and women.

The Chronic Disease Management Division, Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada funded the project. No financial benefit will result from its publication.

#### **MEDICAL DISCLAIMER/NOTICE:**

This material is meant to provide information only. It is not a substitute for a professional medical opinion. Readers are encouraged to confirm the information in this booklet with other sources, including their health care provider. Readers should carefully review the information and ask any questions that arise with their health care provider or other qualified health care professional. If you have a medical problem, please contact a qualified health care professional. You should never ignore professional advice or delay seeking treatment based on the information contained in this booklet.

The content of this booklet is based on accepted medical practice and scientific research available at the time of production.

© Her Majesty the Queen in Right of Canada, 2009

Cat. No. HP5-86/2009E ISBN:978-1-100-13749-0

Online

Cat. No. HP5-86/2009E-PDF ISBN:978-1-100-13750-6

# Information on Mammography

for Women Aged 40 and Older

A Decision Aid for Breast Cancer Screening in Canada



Note: Scientific references and technical notes are accessible upon request or online.

[www.publichealth.gc.ca/decisionaids](http://www.publichealth.gc.ca/decisionaids)

## ACKNOWLEDGEMENTS:

The Public Health Agency of Canada would like to acknowledge the contribution of the Provincial and Territorial organized breast cancer screening programs which contribute to the Canadian Breast Cancer Screening Database at the Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada.

We also wish to thank Dr. Alexandra Barratt and Dr. Kirsten Howard for guiding and contributing to the mathematical models that outline the possible harms and benefits of breast cancer mammography in Canada.

This booklet was developed using the decision support format of the Ottawa Health Research Institute, Ontario, Canada.

You may use, copy, and distribute this document for research or educational purposes, provided that this page is included with all copies of the document. Information reprinted from this document should be cited using direct reference to the original source.

Suggested citation: *Public Health Agency of Canada. Information on Mammography for Women Aged 40 and Older: A Decision Aid for Breast Cancer Screening in Canada.* Chronic Disease Management Division, Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, 2009.

## TABLE OF CONTENTS

### INTRODUCTION:

What is a Decision Aid .....	1
------------------------------	---

### BREAST CANCER FACTS:

How common is breast cancer in Canada? .....	1
--	---

What are the risk factors for breast cancer? .....	1
--	---

What protects you against breast cancer? .....	3
--	---

### BREAST CANCER SCREENING:

What is breast cancer screening? .....	3
--	---

What is a mammogram? .....	3
----------------------------	---

Are mammograms safe? .....	4
----------------------------	---

What might happen if you participate in breast cancer screening mammography? .....	5
--	---

What are the possible benefits and harms of screening mammograms? .....	6
---	---

### HAVING A REGULAR SCREENING MAMMOGRAM:

Women aged 40-49 years .....	9
------------------------------	---

Women aged 50-69 years .....	11
------------------------------	----

Women aged 70-79 years .....	13
------------------------------	----

### HELP WITH YOUR DECISION

Personal worksheet .....	14
--------------------------	----

Where else can you get help with your decision? .....	15
---	----

## WHAT IS A DECISION AID?

A decision aid is used to increase your knowledge so that you can make better informed decisions about your own health care.

This booklet is a decision aid. It is for women aged 40 and older who:

- do not have breast cancer;
- do not have any breast problems; and
- have not been told that they are at high risk of breast cancer.

Its goal is to provide you with information on breast cancer screening using mammography and to help you decide whether to be part of breast cancer screening or not. In this booklet, you will learn about breast cancer risks, mammography's benefits and harms, and how to decide about screening mammography based on your age group (40-49; 50-69; 70-79). *Refer to age specific pages to help you decide about screening!*

On page 14, there is a worksheet which we suggest you complete to help you make your decision about breast cancer screening using mammograms. You may wish to discuss it with your health care provider.

## HOW COMMON IS BREAST CANCER IN CANADA?

Breast cancer is one of the most common forms of cancer in women. Each year, more than 22,000 women

develop breast cancer in Canada and more than 5,000 women die of the disease. Based on current rates, one in nine women in Canada is expected to develop breast cancer during her lifetime.

The risk of getting breast cancer goes up as women get older. The risk of developing breast cancer in the next 10 years is as follows:

- 13 out of 1,000 women in their 40s
- 23 out of 1,000 women in their 50s
- 29 out of 1,000 women in their 60s
- 31 out of 1,000 women in their 70s

Since 1999, the rate of new cases of breast cancer has stabilized, and death rates have steadily declined.

## WHAT ARE THE RISK FACTORS FOR BREAST CANCER?

Risk factors are conditions that may increase your chance of developing breast cancer. Some risk factors are major, while others are minor.<sup>1-4</sup> It is important to understand that most women will have some of these risk factors.

- A **major risk** is one that puts you at least twice the risk of breast cancer compared to someone without that risk factor.
- A **minor risk** is one that put you at less than twice the risk.

### MOST WOMEN WILL HAVE SOME OF THESE RISK FACTORS

#### Major risk factors for breast cancer

- Being aged 50 or older.<sup>1-5</sup>
- Dense breast tissue as shown by a mammo-gram. Breast density is often lower as women age and after menopause.<sup>1-3, 6-9</sup>
- Having a previous breast tissue sample (biopsy) that showed cells that look abnormal (atypical hyperplasia).<sup>1-4,10</sup>
- A mother or sister with breast cancer especially if they learned they had breast cancer before age 50.<sup>1-5, 11-13</sup> If more than one immediate family member had breast cancer<sup>12</sup>, or if your family has a history of ovarian cancer.<sup>11</sup> Some families may have mutation of a breast cancer gene (a permanent change in the DNA of either of the genes known as BRCA 1 or BRC2).<sup>1,3-4,14-15</sup>
- Repeated radiation to the chest due to treatment of a disease (such as Hodgkin's). The risk is highest if you were exposed to the radiation between ages 13 to 30.<sup>1-4</sup>

#### Minor risk factors for breast cancer

- Not having any children or being more than 30 years old when a first child was born.<sup>1-2, 4, 13,16</sup>
- Starting your monthly periods (menstruation) before age 12.<sup>1-2,4-5,13</sup>
- Late menopause (after age 55).<sup>1-3,13</sup>
- Current use of hormone replacement therapy that totals 5 years or more.<sup>1-4,17-21</sup>
- Current use of the birth control pills and for 10 years after you stop taking them.<sup>1-2,4,22-24</sup>
- Overweight after menopause.<sup>1,3,25-27</sup>
- Having more than one drink of alcohol per day.<sup>1-3,19,28-31</sup>

*If you are not sure about whether you have some of these risk factors, talk to your health care provider.*

Although more research is necessary before conclusions can be made, some scientific studies show other risk factors that may be linked to a higher risk of breast cancer including:<sup>31-37</sup>

- a diet high in fat,
- smoking, or
- being exposed to second-hand smoke.

**You may want to check off all your major and minor risk factors so that you can refer back to them later.**

- **How many major risk factors do you have?**
- **How many minor risk factors do you have?**

To get a better sense of your breast cancer risk, you can ask your health care provider or use the Breast Cancer Risk Calculator available on the Public Health Agency of Canada website ([www.publichealth.gc.ca/decisionaids](http://www.publichealth.gc.ca/decisionaids)). This tool uses seven risk factors to predict the risk of breast cancer.

### WHAT PROTECTS YOU AGAINST BREAST CANCER?

Be aware of the risk factors that you can change. These include your weight, diet, and whether you smoke or drink alcohol. Studies show that women can reduce their risk by being physically active.<sup>18,38-39</sup> Women who have given birth to more children and women who breastfed have lower breast cancer risk.<sup>4,13,18,40-41</sup>

### WHAT IS BREAST CANCER SCREENING?

Breast cancer screening is an attempt to find cancer even when there may not be any symptoms. The goal is to find breast cancer early, when it is small and less likely to have spread to other parts of the body. This reduces a woman's chance of dying from the disease. The most common method of breast cancer screening is a mammogram.

### WHAT IS A MAMMOGRAM?

A mammogram is a medical test that uses x-rays to take pictures of the internal structure of the breast. The testing is also known as "mammography". Mammograms are done for two reasons:

**Screening:** When women participate on a routine basis to have mammograms done to find breast cancer at an early stage. This type of mammogram looks for signs that breast cancer may be developing, even though no symptoms are there.

**Diagnostic:** This is typically done to check for breast cancer after a lump or any other sign/symptom has been found such as pain, skin thickening, nipple discharge, or a change in breast size or shape. It may also be used as a second test if a screening mammogram finds something that is not normal.



Here's how a **screening mammogram** works:

- You will be seated or standing in front of a machine used only for mammograms.
- The x-ray technologist will place your breast onto a plastic plate on the machine. As a second plastic plate is lowered onto the breast, the pressure will even out the breast tissue. This allows the machine to get as clear a picture as possible. The tolerance to pressure on the breast varies among women.<sup>42</sup>
- A special low-dose x-ray is then used to look for breast patterns or lumps that are not normal. These may be too small for you or your health care provider to find by feeling your breast.
- The same procedure then occurs with the other breast.
- High quality mammogram finds some breast cancers when they are very small—2 to 4 years before they would be felt.<sup>43</sup>

### ARE MAMMOGRAMS SAFE?

Mammograms involve exposure to x-rays and x-ray radiation has been found to cause cancer. The amount of radiation you receive during one screening mammogram will be based on:

- the amount of fat in your breast tissue (density); and
- the number of images taken.

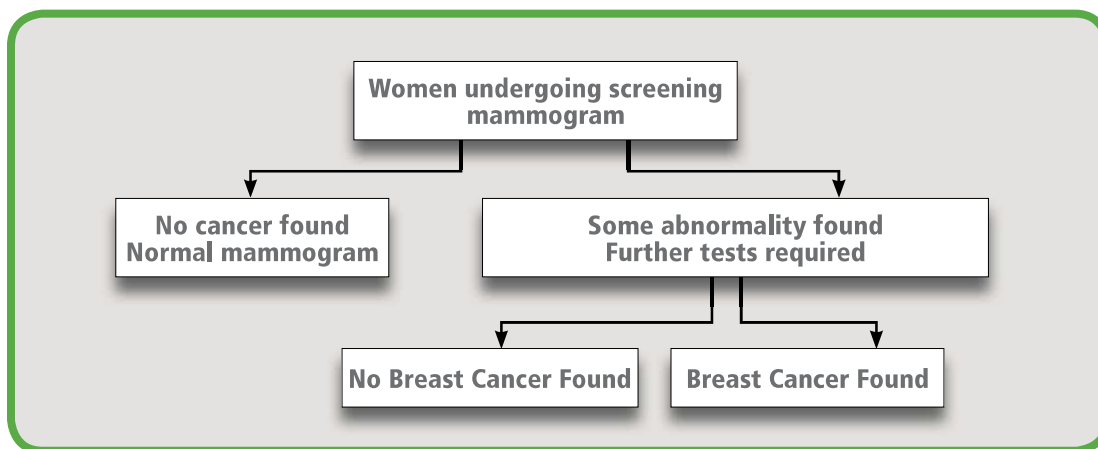
Your total exposure to radiation from screening mammograms will depend on the number of mammograms you have had. X-ray technologists are experts in breast positioning and know how to reduce

the amount of radiation you receive. The amount of radiation that you get from a screening mammogram is almost the same as the amount you would receive over 3 months from your usual surroundings (e.g. sun, rocks, soil, buildings, air and food).<sup>44</sup> Studies show that the risk of a new cancer starting due to radiation to the breast from breast screening mammography is extremely low.<sup>45-48</sup> The benefits of early diagnosis and treatment of breast cancer far outweigh the risk of being exposed to the small amount of radiation from a screening mammogram.



## WHAT MIGHT HAPPEN IF YOU PARTICIPATE IN BREAST CANCER SCREENING MAMMOGRAPHY?

You may experience one of the following outcomes as shown in the Figure below.



Note: Cancer may occur in between screening visits.



## WHAT ARE THE POSSIBLE BENEFITS AND HARMS OF SCREENING MAMMOGRAMS?

The possible benefits and harms linked to breast screening mammograms are listed in the table below. Consider each statement on its own to determine *how important* each one is to you.

### Possible Benefits

#### Peace of mind

You may feel less worried when you know that you do not have cancer on your screening mammogram.

#### Catching cancer at an early stage and simpler treatment

If your mammogram finds something abnormal, you will be carefully monitored and/or treated. In Canada, more than 97% of breast cancers found by organized screening programs are at an early stage. If your cancer is at an *early stage*, you may have simpler surgery and less need for chemotherapy.

#### Reduced chance of dying from breast cancer

The purpose of breast screening mammograms is to find breast cancer early. This reduces your chance of dying from breast cancer due to early diagnosis and simpler treatment.

### Possible Harms

#### Cancer may not be found

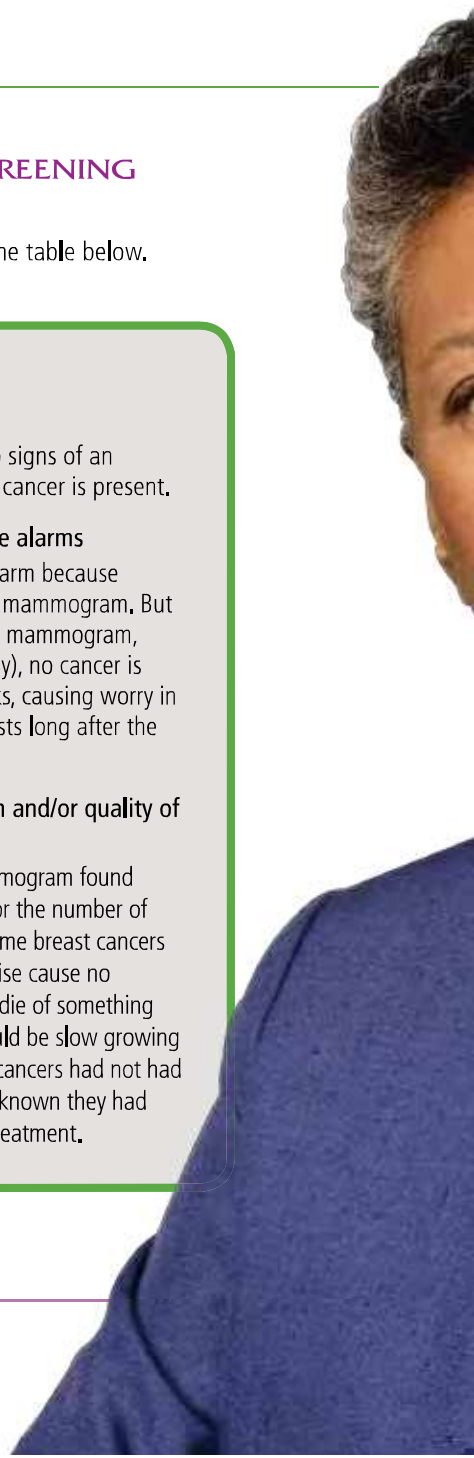
Your mammogram may show no signs of an abnormality even though breast cancer is present.

#### Extra tests and worry from false alarms

Some women will have a false alarm because something abnormal is found on mammogram. But after more tests (such as another mammogram, an ultrasound or perhaps a biopsy), no cancer is found. This may take 4 to 6 weeks, causing worry in women. Sometimes, the worry lasts long after the test results are known.

#### No improvement to your length and/or quality of life and unnecessary diagnosis

Even though your screening mammogram found breast cancer, your quality of life or the number of years you live may not change. Some breast cancers found by screening would otherwise cause no problems because women would die of something else first. These breast cancers could be slow growing cancers. So, if women with these cancers had not had screening, they might never have known they had cancer and would not have had treatment.



## HAVING A REGULAR SCREENING MAMMOGRAM

In Canada, experts agree that the benefits of screening mammograms outweigh the harms for women aged 50 to 69. For younger and older women, the balance of benefits and harms is not so clear. Talk to your health care provider about your breast cancer risk and decide what is right for you.

Health officials recommend that women aged 50-69 years have breast screening mammograms once every two years. Note that women aged 40-49 years who choose to have a screening mammogram, usually have it done once a year.

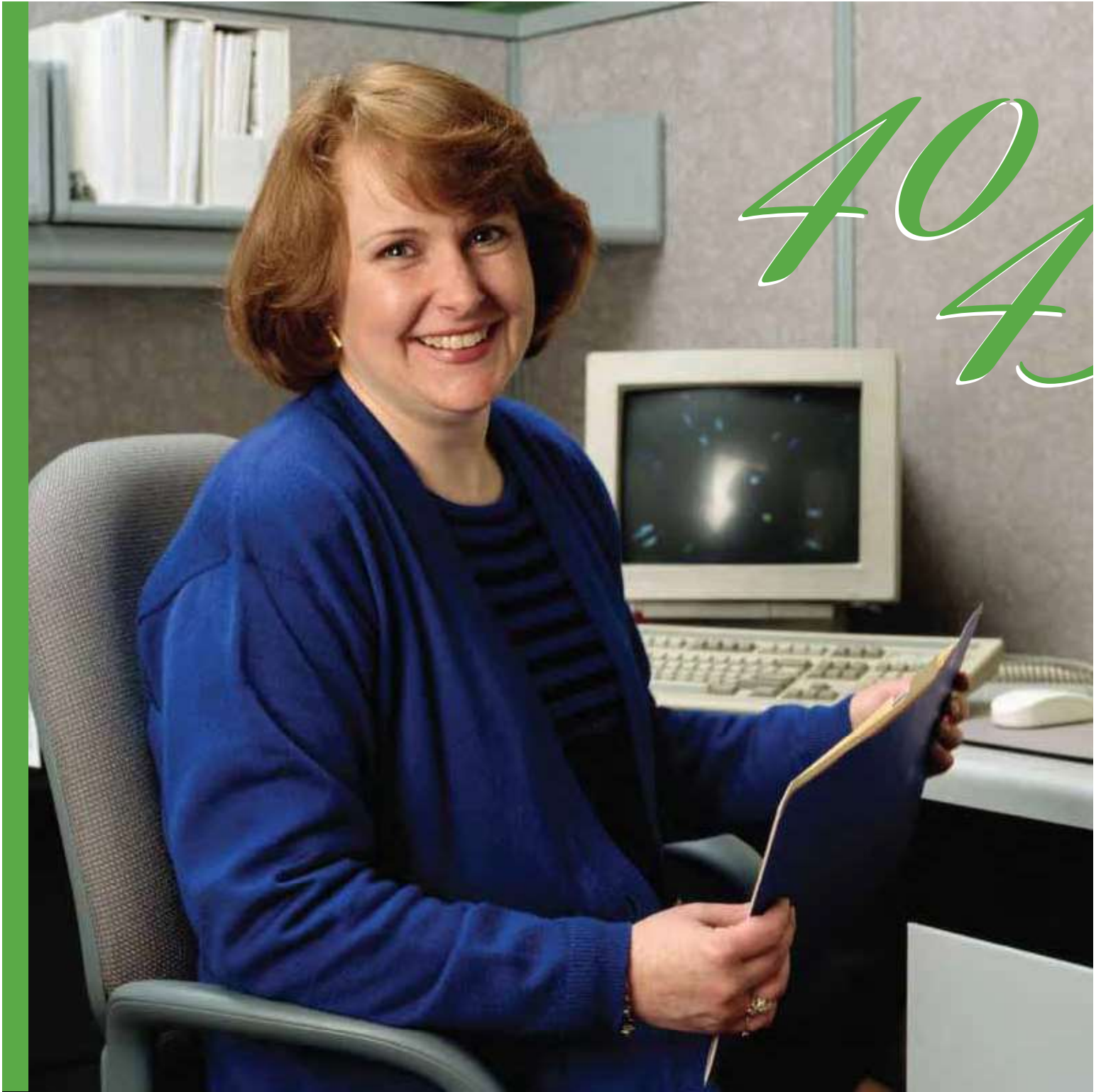
The following pages discuss the results that Canadian women (of different age groups) can expect if they decide to have breast screening mammograms. The numbers presented are estimates from a mathematical model of breast cancer screening, based on the recent data (2000–2004) from the Canadian Breast Cancer Screening Database.

*The risk of getting breast cancer goes up as you get older.*

**REVIEW THE SPECIFIC PAGE THAT TELLS YOU ABOUT THE SCREENING OUTCOMES FOR YOUR AGE GROUP!**

*The next few pages will help you to understand how likely you are to experience a benefit or harm from mammography.*







**WOMEN AGED 40-49 YEARS**

If you decide to have screening mammograms, what are your chances of experiencing the screening outcomes (as shown in the Figure on page 5)?

Imagine 1000 women aged 40 years starting screening and being screened once every year over 10 years. What would happen? We found that these women will typically experience the following outcomes:

- ◆ 981 women will not have breast cancer.
- 451 women will have normal results.
- 549 women will have abnormal results at some point during 10 years.
  - 533 of the abnormal results will be false alarms, which turn out to be normal after further testing.

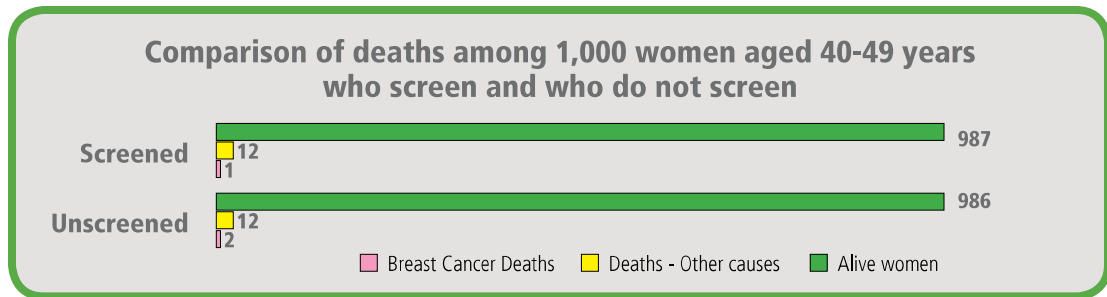
- ◆ 16 women will have breast cancer detected by screening.
- ◆ 3 women will develop breast cancer in between screening visits.

Since screening aims to reduce the risk from dying from breast cancer, we can estimate the number of women that need to be screened to prevent one death.

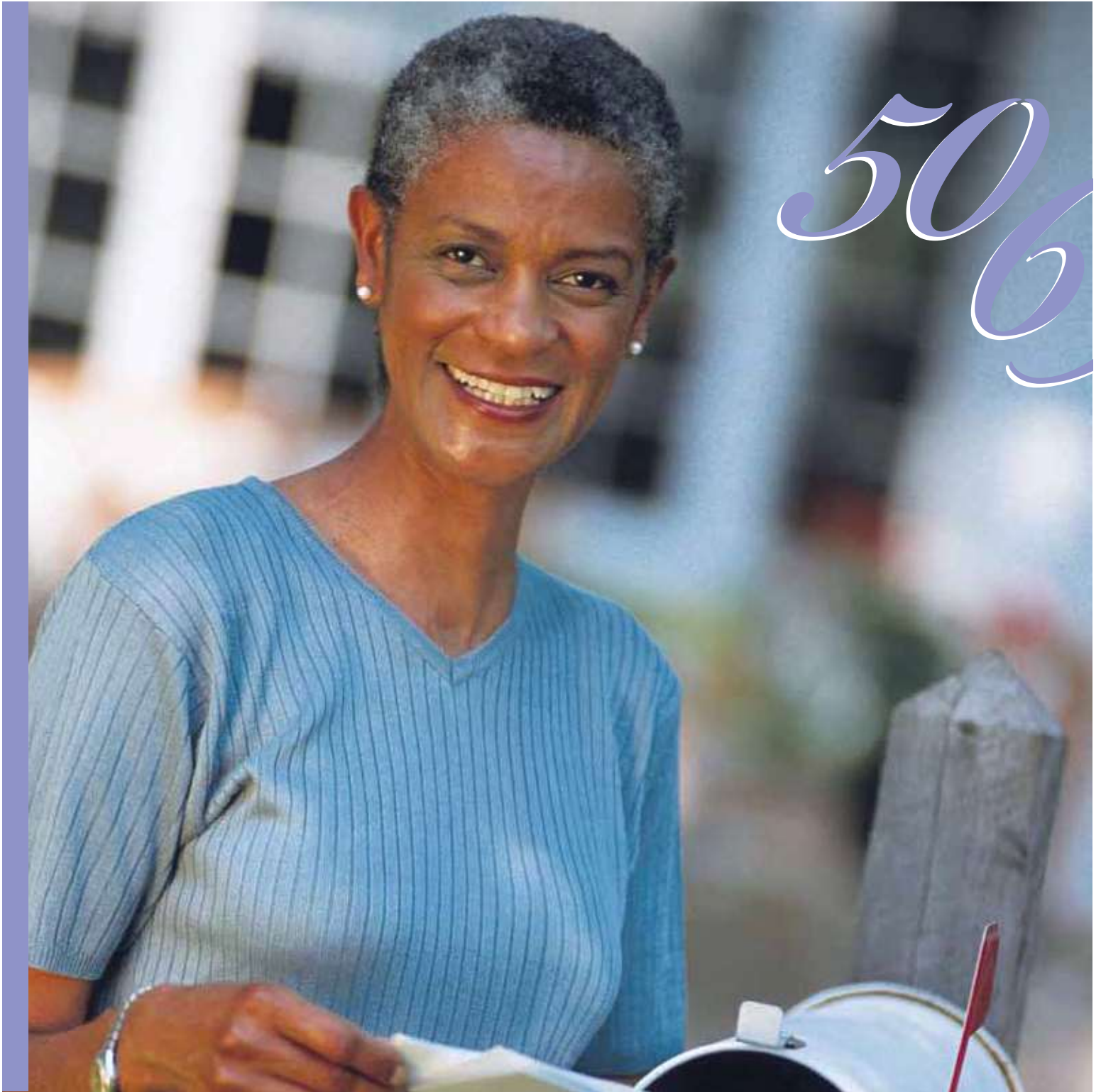
If we screen 1,000 women **aged 40-49 years** once a year for a period of 10 years:

- 1 death from breast cancer will be prevented.
- 12 women will die from some cause other than breast cancer.
- 2 women will die of breast cancer despite breast cancer screening.

**HOW WILL THIS AFFECT MY CHANCE OF DYING FROM BREAST CANCER?**



The bars chart shows that death from breast cancer is uncommon. Screening prevents one death from breast cancer among 1,000 women screened each year between ages 40 and 49.





### WOMEN AGED 50-69 YEARS

If you decide to have screening mammograms, what are your chances of experiencing the screening outcomes (as shown in the Figure on page 5)?

Imagine 1,000 women aged 50 years starting screening and being screened once every two years for a period of 20 years. What would happen? We found that these women will typically experience the following outcomes:

- ◆ 940 women will not have breast cancer.
- 426 women will have normal results.
- 574 women will have abnormal results at some point during 20 years.
  - 529 of the abnormal results will be false alarms, which turn out to be normal after further testing.

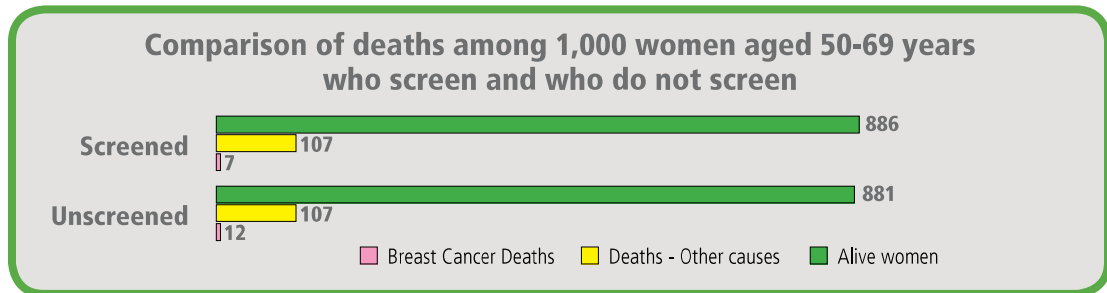
- ◆ 45 women will have breast cancer detected by screening.
- ◆ 15 women will develop breast cancer in between screening visits.

Since screening aims to reduce the risk from dying from breast cancer, we can estimate the number of women that need to be screened to prevent one death.

If we screen 1,000 women **aged 50-69 years** once every two years for a period of 20 years:

- 5 deaths from breast cancer will be prevented.
- 107 women will die from some cause other than breast cancer.
- 7 women will die of breast cancer despite breast cancer screening.

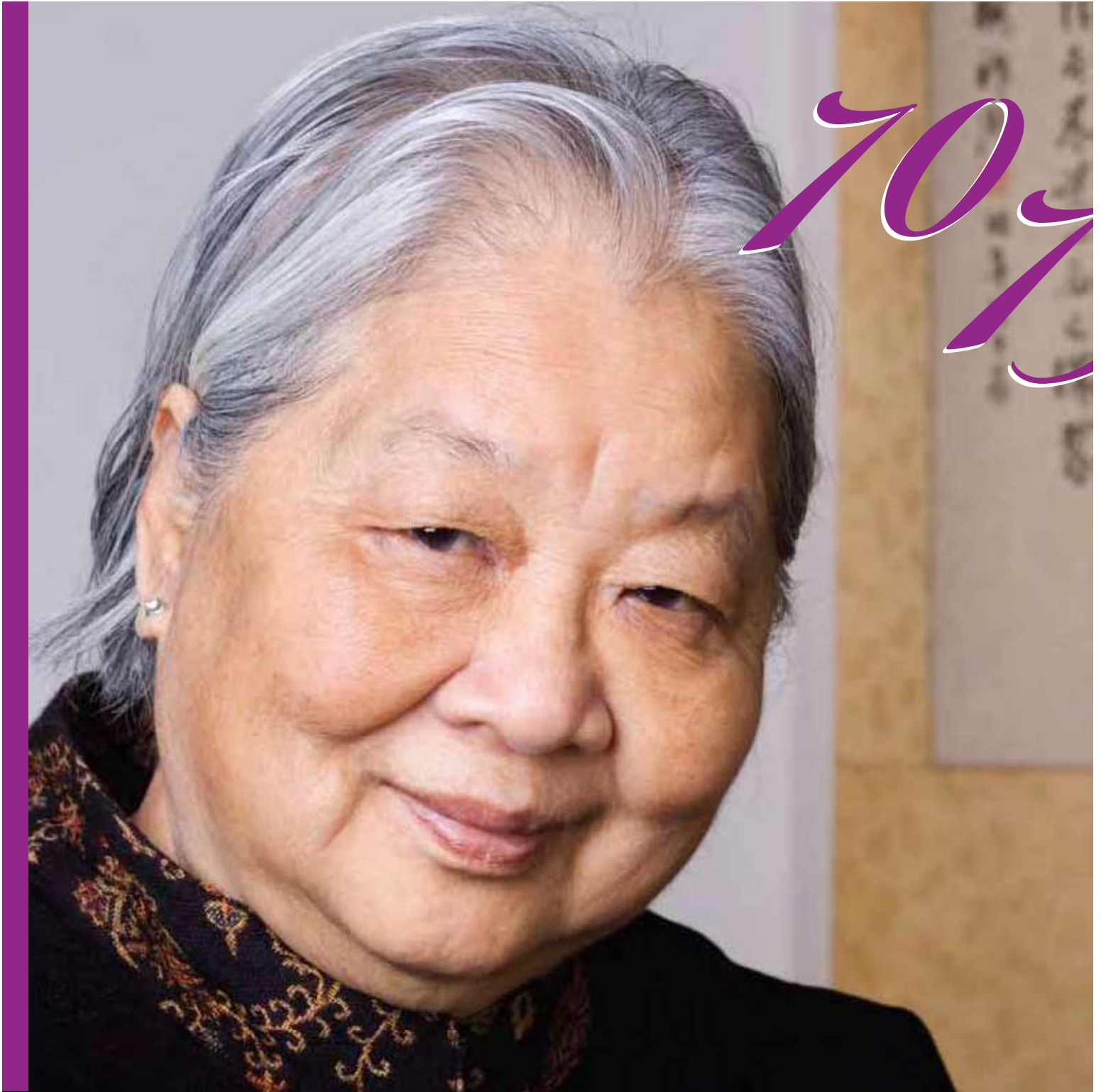
### HOW WILL THIS AFFECT MY CHANCE OF DYING FROM BREAST CANCER?



The bar chart shows that screening prevents 5 breast cancer deaths among 1,000 women screened once every two years between ages 50 and 69.

*Across Canada, health officials recommend that women aged 50 to 69 have a breast screening mammogram once every two years.*







### WOMEN AGED 70-79 YEARS

If you decide to participate in the screening program or you are already in the screening program, what are your chances of experiencing the screening outcomes (as shown in the Figure on page 5)?

Imagine 1,000 women aged 70 years undergoing screening once every two years for a period of 10 years. What would happen? We found that these women will typically experience the following outcomes:

- ◆ 961 women will not have breast cancer.
- 756 women will have normal results.
- 244 women will have abnormal results at some point during 10 years.
  - 213 of the abnormal results will be false alarms, which turn out to be normal after further testing.

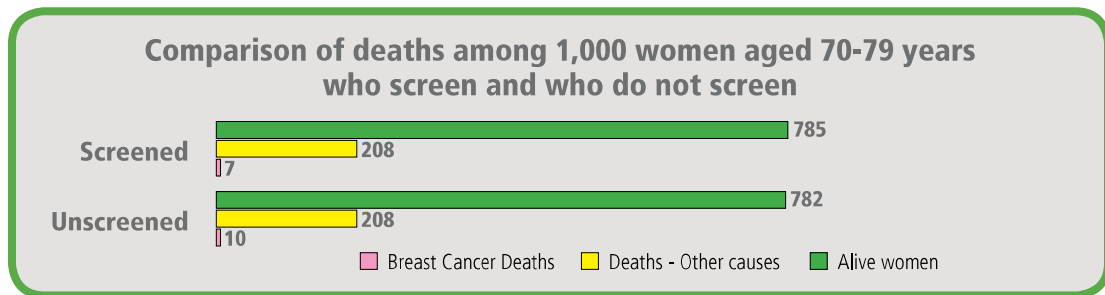
- ◆ 31 women will have breast cancer detected by screening.
- ◆ 8 women will develop breast cancer in between screening visits.

Since screening aims to reduce the risk from dying from breast cancer, we can estimate the number of women that need to be screened to prevent one death.

If we screen 1,000 women **aged 70-79 years** once every two years for a period of 10 years:

- 3 deaths from breast cancer will be prevented.
- 208 women will die from some cause other than breast cancer.
- 7 women will die of breast cancer despite breast cancer screening.

### HOW WILL THIS AFFECT MY CHANCE OF DYING FROM BREAST CANCER?



The bar chart shows that screening prevents 3 breast cancer deaths among 1,000 women screened once every two years between ages 70 and 79.

### Think about your options for breast screening

1. You can start having mammograms.
2. You can keep on having mammograms.
3. You can stop having mammograms.

**HELP WITH YOUR DECISION —  
WHAT DO YOU DO NEXT?**

**Fill out the Personal Worksheet!**

This worksheet aims to help you consider the key points as you decide about screening mammograms. It is not intended to tell you exactly what to do. It is simply to help you collect your thoughts. Please complete the worksheet and if you feel that you need to discuss this further, then talk to your health care provider.

The worksheet will help organize your thoughts by going through the following:

**Step 1: How do you rate your risk of breast cancer and overall health?**

- How do you feel about your risk of breast cancer?  
 Very worried    A little worried    Not worried
- How do you rate your overall health?  
 I am in good health    My health is okay  
 I am in poor health

**Step 2: What are you doing for breast health?**

- Do you have a breast exam with a health professional as part of your regular health check-up?  
 Yes    No
- Have you had a screening mammogram within the last 2 years?  
 Yes    No
- Do you limit alcohol to 1 drink or less each day?  
 Yes    No

Do you have a healthy body weight?

- Yes    No

Do you do moderate exercise at least 4 times in a week (Examples of moderate exercise are brisk walking or swimming for 30 to 60 minutes, 4 times a week?)

- Yes    No

**Step 3: How important are the possible benefits and harms of having mammograms?**

Look at each of the benefits and harms  
 Add any other benefits and harms important to you  
 Decide how important each is by checking them off with (√)

Possible Benefits		Possible Harms	
Peace of mind		Cancer may not be found	
Catching cancer at an early stage and simpler treatment		Extra tests and worry from false alarms	
Reduced chance of dying from breast cancer		No improvement in length or quality of life and unnecessary diagnosis	
Other Benefits		Other Harms	

**Step 4: How do you feel about screening mammograms?**

- Choose the statement that reflects how you feel:  
 I want to start or continue mammograms  
 Not sure  
 I do not want to start or continue mammograms

**Step 5: Who should decide whether or not you continue mammograms?**

- I should, after thinking about the advice I received from my health care provider
- I want to share the decision-making with my health care provider
- I want my health care provider to decide
- I am not sure

**Step 6: What questions do you have about whether or not to start having or to continue to have mammograms?**

---



---



---



---



---



---

**Step 7: You may wish to share your worksheet with your health care provider.**

**WHERE ELSE CAN YOU GET HELP WITH YOUR DECISION?**

Here is a **list of resources** that may help you decide what to do:

- The worksheet in this booklet provides you with the key points you need think about as you decide

whether screening mammograms are right for you or not.

- Your health care provider.
- The website [www.publichealth.gc.ca/decisionaids](http://www.publichealth.gc.ca/decisionaids) for:
  - an on-line version of this booklet.
  - the brochure *Breast Cancer and Your Risk*. This includes a list of breast cancer risk factors and tips on how to assess your risk.
  - the document *Organized Breast Cancer Screening Programs in Canada: Report on Program Performance in 2003 and 2004*. This includes more information on breast cancer screening mammography programs in Canada.
- Other Canadian breast cancer websites:
  - Canadian Cancer Society ([www.cancer.ca](http://www.cancer.ca)) or call the Cancer Information Service at 1-888-939-3333.
  - Canadian Breast Cancer Network ([www.cbcn.ca](http://www.cbcn.ca)).
  - Canadian Breast Cancer Foundation ([www.cbcf.org](http://www.cbcf.org)).
  - Canadian Partnership Against Cancer ([www.cancerview.ca](http://www.cancerview.ca)).

To find an organized breast cancer screening program in your area, use the telephone numbers listed below.

If an organized program is not available in your region, your health care provider will refer you to your nearest radiology service.

- |                  |                |
|------------------|----------------|
| Alberta          | 1-800-667-0604 |
| British Columbia | 1-800-663-9203 |

## FOR WOMEN AGED 40 AND OLDER

---

Manitoba	1-800-903-9290
New Brunswick	Call your Regional Health Authority
Newfoundland	1-800-414-3443
Northwest Territories	1-867-873-0452
Nova Scotia	1-800-565-0548
Nunavut	Call your health care provider or Health Centre
Ontario	1-800-668-9304
Prince Edward Island	1-888-858-2915
Quebec	Call your health care provider or Info-Santé
Saskatchewan	1-800-567-7271 or 1-800-667-0017
Yukon	1-867-393-8738.

To obtain additional copies please send your requests to [publications@hc-sc.gc.ca](mailto:publications@hc-sc.gc.ca) or call our toll free number 1-866-225-0709 (TTY: 1 800 267-1245) and ask for Publications. This publication can also be accessed electronically at [www.publichealth.gc.ca/decisionaids](http://www.publichealth.gc.ca/decisionaids)

To share your feedback on the decision aid, please contact the Public Health Agency of Canada by email at [PHAC\\_Web\\_Mail@phac-aspc.gc.ca](mailto:PHAC_Web_Mail@phac-aspc.gc.ca).

Literature references and technical notes for the booklet are available on our website: [www.publichealth.gc.ca/decisionaids](http://www.publichealth.gc.ca/decisionaids)



## REFERENCES

1. Dumitrescu RG, Cotarla I. Understanding breast cancer risk-where do we stand in 2005? *Journal of Cellular and Molecular Medicine*. 2005; 9(1): 208-21.
2. Veronesi U, Boyle P, Goldhirsch A, Orecchia R, Viale G. Breast cancer. *The Lancet*. 2005; 365:1727-41.
3. Singletary SE. Rating the risk factors for breast cancer. *Annals of Surgery*. 2003; 237(4):474-82.
4. Health Canada. Summary report: Review of lifestyle and environmental risk factors for breast cancer. Minister of Public Works and Government Services, Ottawa, Canada. 2001.
5. Gail M, Brinton LA, Byar DP, et al. Projecting individualized probabilities of developing breast cancer for white females who are being examined annually. *Journal of the National Cancer Institute*. 1989; 81: 1879-86.
6. Boyd NF, Guo H, Martin LJ et al. Mammographic density and the risk and detection of breast cancer. *New England Journal of Medicine*. 2007; 356(3):227-36.
7. Boyd NF, Rommens JM, Vogt K, et al. Mammographic breast density as an intermediate phenotype for breast cancer. *Lancet Oncology*. 2005; 6:798-808.
8. Boyd NF, Byng JW, Jong RA et al. Quantitative classification of mammographic densities and breast cancer risk: Results from the Canadian National Breast Screening Study. *Journal of the National Cancer Institute*. 1995; 87(9):670-5.
9. Barlow W, White E, Ballard-Barbash R, et al. Prospective breast cancer risk prediction model for women undergoing screening mammography. *Journal of the National Cancer Institute*. 2006; 98 (17):1204-14.
10. London SJ, Connolly JL, Schnitt SJ, Colditz GA. A prospective study of benign breast disease and the risk of breast cancer. *Journal of the American Medical Association*. 267(7); 941-44.
11. Lux MP, Fasching PA, Beckman MW. Hereditary breast and ovarian cancer: Review and future perspectives. *Journal of Molecular Medicine*. 2006; 84(1):16-28.
12. Beral V, Bull D, Doll R, et al. Familial breast cancer: Collaborative reanalysis of individual data from 52 epidemiological studies including 58 209 women with breast cancer and 101 986 women without the disease. *The Lancet*. 2001; 358(9291):1389-99.
13. Kelsey JL, Gammon MD, John EM. Reproductive factors and breast cancer. *Epidemiologic Reviews*. 1993; 15(1):36-47.
14. Chen S, Parmigiani G. Meta-analysis of BRCA1 and BRCA2 penetrance. *Journal of Clinical Oncology*. 2007; 25(11):1329-33.

15. Antoniou A, Pharoah PD, Narod S, et al. Average risks of breast and ovarian cancer associated with BRCA1 or BRCA2 mutations detected in case series unselected for family history: a combined analysis of 22 studies. *American Journal of Human Genetics*. 2003; 72:1117-30.
16. Britt K, Ashworth A, Smalley M. Pregnancy and the risk of breast cancer. *Endocrine-Related Cancer*. 2007; 14:907-33.
17. Hofvind S, Moeller, Bjoern, Thoresen S, Ursin G. Use of hormone therapy and risk of breast cancer detected at screening and between mammographic screens. *International Journal of Cancer*. 2006; 118:3112-7.
18. Clarke CA, Purdie DM, Glaser SL. Population attributable risk of breast cancer in white women with immediately modifiable risk factors. *BMC Cancer*. 2006; 6:170.
19. Million Women Study Collaborators. Breast cancer and hormone-replacement therapy in the Million Women Study. *The Lancet*. 2003; 362:419-27.
20. Chlebowski RT, Hendrix SK, Langer RD. Influence of estrogen plus progestin on breast cancer and mammography in healthy postmenopausal women: The Women's Health Initiative Randomized Trial. *The Journal of the American Medical Association*. 2003; 289 (24): 3243-53.
21. Anderson GL, Autier P, Beral V et al. Combined estrogen-progestogen menopausal therapy. *IARC Monographs on the evaluation of carcinogenic risks of humans*. 2007; 91: 217-35.
22. Anderson GL, Autier P, Beral V et al. Combined estrogen-progestogen contraceptives. *IARC Monographs on the evaluation of carcinogenic risks of humans*. 2007; 91: 50-60.
23. Kahlenborn C, Modugno F, Potter D, Severs W. Oral contraceptive use as a risk factor for premenopausal breast cancer: A meta-analysis. *Mayo Clinic Proceedings*. 2006; 81(1):1290-1302.
24. Collaborative Group on Hormonal Factors in Breast Cancer. Breast cancer and hormonal contraceptives: collaborative reanalysis of individual data on 53,297 women with breast cancer and 100,239 women without breast cancer from 54 epidemiological studies. *Lancet*. 1996; 347:1713-27.
25. Renehan AG, Tyson M, Egger M, Heller R, Zwahlen M. Body-mass index and incidence of cancer: a systematic review and meta-analysis of prospective observational studies. *The Lancet*. 2008; 371(9612): 569-578.
26. Carmichael AR. Obesity as a risk factor for development and poor prognosis of breast cancer. *BJOG: An International Journal of Obstetrics and Gynecology*. 2006; 111(10):1160-6.

27. Eliassen HA, Colditz GA, Rosner B, Willett WC, Hankinson SE. Adult weight change and risk of postmenopausal breast cancer. *Journal of the American Medical Association*. 2006;296(2):193-201.
28. Suzuki R, Orsini N, Mignone L, Saji S, Wolk A. Alcohol intake and risk of breast cancer defined by estrogen and progesterone receptor status - A meta-analysis of epidemiological studies. *International Journal of Cancer*. 2008; 122: 1832-41.
29. Key J, Hodgson S, Omar RZ, Jensen TK, et al. Meta-analysis of studies of alcohol and breast cancer with consideration of the methodological issues. *Cancer Causes Control*. 2006; 17(6):759-70.
30. Smith-Warner S, Spiegelman D, Yaun SS, et al. Alcohol and breast cancer in women: a pooled analysis of cohort studies. *Journal of the American Medical Association*. 1998; 5-40.
31. Hamajima N, Hirose K, Tajima K, et al. Alcohol, tobacco and breast cancer--collaborative reanalysis of individual data from 53 epidemiological studies, including 58 515 women with breast cancer and 95 067 women without the disease. *British Journal of Cancer*. 2002; 87(11):1234-45.
32. Michels KB, Mhalla AP, Roset-Bahmanyar E, Beehler GP, Moysich KB. Diet and breast cancer: A review of the prospective observational studies. *Cancer*. 2007;109(12):2712-49.
33. Boyd NF, Stone J, Vogt KN, Connelly BS, Martin LJ, Minkin S. Dietary fat and breast cancer risk revisited: a meta-analysis of the published literature. *British Journal of Cancer*. 2003; 89:1672-85.
34. Ginsburg O, Ghadirian P, Lubinski J, et al. Smoking and the risk of breast cancer in BCRA 1 and BCRA2 mutation carriers: an update. *Breast Cancer Research and Treatment*. 2008; in press.
35. Alavanja M, Baron JA, Brownson RC et al. Tobacco smoke and involuntary smoking. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. 2004; 83: 1-1413.
36. Whittemore, AS, John EM, Felberg A, et al. Smoking and risk of breast cancer in carriers of mutations in BRCA1 or BRCA2 aged less than 50 years. *Breast Cancer Research and Treatment*. 2008; 109(1): 67-75.
37. Terry PD, Rohan TE. Cigarette smoking and the risk of breast cancer in women: A review of the literature. *Cancer Epidemiology Biomarkers and Prevention*. 2002; 11(10 I): 953-971.
38. Friedenreich CM, Cust AE. Physical activity and breast cancer risk: Impact of timing, type and dose of activity and population subgroup effects. *British Journal of Sports Medicine*. 2008; 42(8): 636-647.
39. Monninkhof EM, Elias SG, Vlems FA, et al. Physical activity and breast cancer: A systematic review. *Epidemiology*. 2007; 18(1): 137-57.



40. Bernier MO, Plu-Bureau G, Bossard N, Ayzac L, Thalabard JC. Breastfeeding and risk of breast cancer: a meta-analysis of published studies. *Human Reproduction Update*. 2000; 6(4):374-86.
41. Newcomb PA, Storer BE, Longnecker MP, et al. Lactation and a reduced risk of premenopausal breast cancer. *The New England Journal of Medicine*. 1994; 330:81-7.
42. Armstrong K, Moye E, Williams S, Berlin J, Reynolds E. Screening mammography in women 40 to 49 years of age: A systematic review for the American College of Physicians. *Annals of Internal Medicine*. 2007; 146:516-26.
43. Tabar L, Fagerberg G, Chen H-H, et al. Efficacy of breast cancer screening by age: New results from the Swedish Two-County Trial. *Cancer*. 1995; 75(10):2507-17.
44. American College of Radiology - Radiology Society of North America. Safety: Radiation Exposure in X-ray Examinations. Available at: [www.radiologyinfo.org/en/safety/index.cfm?pg=sfty\\_xray](http://www.radiologyinfo.org/en/safety/index.cfm?pg=sfty_xray).
45. Feig SE, Hendrick RE. Radiation risk from screening mammography of women aged 40-49 years. *Journal of the National Cancer Institute. Monographs*. 1997; 22:119-24.
46. Berrington de Gonzalez A, Reeves G. Mammographic screening before age 50 years in the UK: comparison of the radiation risks with the mortality benefit. *British Journal of Cancer*. 2005; 93:590-6.
47. Narod S, Lubinski J, Ghadirian P, et al. Screening mammography and risk of breast cancer in BCRA1 and BCRA2 mutation carriers: a case-control study. *Lancet Oncology*. 2006; 7:402-6.
48. Law J, Faulkner K, Young C. Risk factors for induction of breast cancer by X-rays and their implications for breast screening. *British Journal of Radiology*. 2007; 80:261-6.
49. National Cancer Institute [www.cancer.gov/cancertopics/factsheet/detection/screening-mammograms](http://www.cancer.gov/cancertopics/factsheet/detection/screening-mammograms)

## TECHNICAL NOTES

This information is for readers who want to know how the numbers were chosen and where they came from. You do not need to read this before you decide whether to start or continue having mammograms.

The following are the data sources, assumptions and calculations used in this decision aid. These are the best estimates based on available data. Data are subject to review as more information becomes available.

### a) Outcomes of Screening with Mammography

A mathematical model for the potential benefits and harms of breast cancer screening in Canada was developed by the Evidence and Risk Assessment Division, Centre for Chronic Disease Prevention and Control, at the Public Health Agency of Canada using a Markov design and TreeAge computer software.

The model investigated long term outcomes of regular mammography screening for three age groups: 40 to 49 years, 50 to 69 years and 70 to 79 years.

### Data sources were as follows:

1. Public Health Agency of Canada: 5-year (2000–2004) data from the Canadian Breast Cancer Screening Database (CBCSD) including the number of participants, total number of screening mammograms, screening results (normal/abnormal), diagnostic tests, breast cancer staging, and interval breast cancers. Annual data for the full screening period, for each group extracted for 10-year age groups (40 to 49, 50 to 59, 60 to 69, and 70 to 79 years). The CBCSD is a collection of data shared with the Public Health

Agency of Canada by provinces and territories with organized screening programs.

2. Statistics Canada: all cause mortality, breast cancer incidence (new cases) and mortality, and Canadian population counts.
3. Canadian Community Health Survey: reported overall participation in breast cancer mammography screening, including both organized and fee-for-service screening.

### Three scenarios were modeled:

- 40 to 49 years: 1,000 40-year old women participating in 10 annual screens vs. not screening at all;
- 50 to 69 years: 1,000 50-year old women participating in 10 biennial screens vs. not screening at all; and
- 70 to 79 years: 1,000 70-year old women following recommended screening between 50 and 69 years and continuing with an additional 5 biennial screens, vs. not continuing to screen into their 70s.

In order to calculate potential screening mammography risks and benefits in Canada, the following assumptions were used to produce the model:

- 100% re-screen compliance. Compliance was defined as having a re-screen  $\leq$  15 months for 40 to 49 years;  $\leq$ 30 months for women aged 50 years and older;
- Probabilities all constant over time;
- Detection rate same for both organized screens and fee-for-service screens; and

- People who have been recalled in the past have the same chance of being recalled as those who were not originally recalled.

Screening outcomes were modeled using full screening period data (10 to 20 years) from the CBCSD and defined as:

**Normal results:** calculated by subtracting the number of women who experience an abnormal result from the total cohort (1,000 women).

**False negatives:** the estimated number of women in the cohort given an initial normal result, but who are diagnosed with an interval breast cancer <12 months after their last screen and before their next scheduled screen.

**Abnormal results:** the estimated number of the women in the cohort who experience an abnormal result at least once over the full screening period.

**Further imaging only:** the estimated number of women in the cohort with an abnormal result who are recalled for at least one diagnostic mammogram or ultrasound over the full screening period with or without surgical consult or primary care referral, yet are not recalled for biopsy.

**Other tests and primary care:** the estimated number of women in the cohort with an abnormal result who are recalled for a surgical consult, clinical breast exam, or primary care, yet are not recalled for further imaging or biopsy.

**Imaging and biopsy:** the estimated number of women in the cohort with an abnormal result who are recalled for at least one biopsy (fine needle aspiration, core or open).

**False positives:** calculated by subtracting the number of breast cancers detected from the abnormal recall rate.

**Breast condition:** the estimated number of women in the cohort who receive a confirmed diagnosis of ductal carcinoma in situ (DCIS) during the full screening period.

**Invasive breast cancer:** the estimated number of women in the cohort who receive a confirmed diagnosis of invasive breast cancer during the full screening period.

**Early stage breast cancer:** the estimated number of women in the cohort whose breast cancer is diagnosed as an early stage (Tumor, Node, Metastasis (TNM) rating I-II). Cancer detected at earlier stages has more treatment options, less recurrence, and improved survival.

**Interval cancers:** includes the estimated number of women in the cohort who become symptomatic > 12 months after their last regular screen and before their next scheduled screen as well as any breast cancer that took >6 months to diagnose.

For more information on breast cancer screening mammography in Canada, refer to *Organized Breast Cancer Screening Programs in Canada: Report on Program Performance in 2003 and 2004*. Ottawa: Minister of Public Works and Government Services Canada, 2008. Website: <http://www.phac-aspc.gc.ca/publicat/2008/obcsp-podcs-03-04/participation-eng.php>

**b) Mammography Screening Effects on Mortality**

The goal of breast cancer screening mammography is to reduce mortality (death) from breast cancer. For the 40 to 49 and 50 to 69 year age groups in the Markov risk/benefit model, a 5-year gradual mortality benefit for screening was applied. For the 70 to 79 year age group, full mortality benefit was applied immediately as it was assumed women of this age group followed recommended biennial screening between 50 to 69 years of age. For the scenario where women stop screening at 70 years of age, a gradual reduction in mortality benefit was applied.

Relative risk reduction (RRR) was estimated to be 23%, 37% and 37% for each respective age group as described below:

**40 to 49 years:** Meta-analysis has shown a relative risk reduction (RRR) of deaths from breast cancer of women aged 40 to 49yrs to be between 7 and 23%.<sup>1</sup> After adjustment for compliance, it is reasonable to use a RRR of 23% for those women who actually attend for screening.<sup>2</sup> This value is supported by a model of screening outcomes conducted in Australia<sup>3</sup> as well as a recent randomized control trial showing mortality reduction adjusted for non-compliance in this age group at 24%.<sup>4</sup>

**50 to 69 years:** Meta-analyses have shown a relative risk reduction of deaths from breast cancer of approximately 25% for women aged 50 to 69 years.<sup>5,6</sup> In order to reflect the likely impact on women who actually attend regular screening, a compliance adjusted relative risk reduction of 37% was used.<sup>2</sup>

**70 to 79 years:** As the model assumes women over 70 years are continuing regular biennial screening, and the mortality benefit of screening is seen 5 years after the first screening visit (while in their 50s), it can be deduced that a woman in the 70 to 79 year age group will experience the same benefit as those 50 to 69 years of age if the woman's life expectancy is 5 years or more. This is supported by evidence from a large trial in Sweden showing screening is as effective in reducing mortality from breast cancer in women aged 65 to 69 as it is in women aged 50 to 64.<sup>7</sup> Although limited, published literature has estimated the relative mortality benefit in those over 70 years of age to be lower than that for those aged 50 to 59 years.<sup>8,9</sup> This is because relative to younger women, older women have a reduced life expectancy. However, the risk/benefit model allows for declining life expectancy by including the annual risk of death from any cause as the cohort ages. Similar assumptions were made by two other screening mammography Markov models.<sup>3,10</sup>

**Deaths prevented:** The number of lives extended as a result of screening is 1, 5 and 2.5 lives for the 40 to 49, 50 to 69 and 70 to 79 years cohorts of 1,000 women respectively. These results are comparable to those using data from Breast Screen Australia (0.5, 5, 2 lives).<sup>3</sup> However, in order to share the most accurate modeled values for readers of the decision aid, numbers have not been rounded up to the whole, but rather presented as the number of women who would need to be screened to prevent one death.

**Deaths from breast cancer:** the estimated number of women who die of breast cancer within the 10 year or 20 year screening period (40 to 49/70 to 79 and 50 to 69 age groups respectively) despite their efforts to screen. This number is not a percentage of the total 1,000 women cohort, but rather from within the number of women needing to be screened to save one life. This is specific to each age group. Data on deaths among women in each of the three age groups due to breast cancer for 2000–2004 were obtained from Statistics Canada.

**Deaths from other causes:** the estimated number of women who die of causes other than breast cancer within the 10 year or 20 year screening period (40 to 49/70 to 79 and 50 to 69 age groups respectively). This number is not a percentage of the total 1,000 women cohort, but rather from within the number of women needing to be screened to save one life. This is specific to each age group. Data on deaths among women in each of the three age groups due to all other (non-breast cancer) causes for 2000–2004 were obtained from Statistics Canada.

#### c) Breast Cancer Risk Factors

Upon review of current scientific evidence on the relative risk (RR) values for breast cancer risk factors, each was placed into either a major ( $RR \geq 2$ ) or minor ( $RR < 2$ ) category. Risk factors specific to very high risk or select sub-groups were not included. References can be found in the decision aid reference list.

#### TECHNICAL NOTES REFERENCES

1. Armstrong K, Moye E, Williams S, Berlin J, Reynolds E. Screening mammography in women 40 to 49 years of age: A systematic review for the American College of Physicians. *Annals of Internal Medicine*. 2007; 146:516-26.
2. Glasziou PP. Meta-analysis adjusting for compliance: the example of screening for breast cancer. *Journal of Clinical Epidemiology*. 1992; 45:1251-6.
3. Barratt A, Howard K, Irwig L, Salkeld G, Houssami N. Model of outcomes of screening mammography: information to support informed choices. *British Medical Journal*. 2005; (7497):936-8.
4. Moss SM, Cuckle H, Evans A, Johns L, Waller M, Bobrow L. Effect of mammographic screening from age 40 years on breast cancer mortality at 10 years' follow-up: a randomized control trial. *The Lancet*. 2006; 368:2053-60.
5. Kerlikowske K, Grady D, Rubin SM, Sandrock C, Ernster VL. Efficacy of screening mammography: a meta-analysis. *Journal of American Medical Association*. 1995; 273(2):149-54.
6. Nystrom L, Andersson I, Bjurstam N, Frisell J, Nordenskjold B. Long-term effects of mammography screening: updated overview of the Swedish randomized trials. *The Lancet*. 2002; 359:909-19.

7. Chen HH, Tabar I, Fagerberg G, Duffy SW. Effect of breast cancer screening after age 65. *Journal of Medical Screening*. 1995; 2(1):10-14.
8. Barratt A, Irwig L, Glasziou P, Salkeld G, Houssami H. Benefits, harms, and costs of screening mammography in women over 70 years of age: a systematic review. *Medical Journal of Australia*. 2002; 176:266-71.
9. Cox, B. The effect of service screening on breast cancer mortality rates. *European Journal of Cancer Prevention*. 2008; 17(4):306-311.
10. Kerlikowske K, Salzman P, Phillips KA, Cauley JA, Cummings SR. (1999). Continuing screening mammography in women aged 70-79 years. Impact on life expectancy and cost-effectiveness. *JAMA*, 282:2756-63.

