

# THE CANADIAN CYSTIC FIBROSIS REGISTRY



— 2015 —  
ANNUAL REPORT

## CYSTIC FIBROSIS

Cystic fibrosis (CF) is a rare disease affecting almost 4,200 Canadians or roughly 1 in 3,600 live births. CF is a progressive, multi-system disease that affects mainly the lungs and digestive system. In the lungs, where the effects are most devastating, a build-up of thick mucous causes severe respiratory problems. Mucous and protein also build up in the digestive tract, making it difficult to digest and absorb nutrients from food. In addition to the physical effects of the disease, mental health concerns are emerging and being addressed as anxiety and depression are common among this population. Individuals with CF may reach the point where they require a lung transplant; most fatalities of people with CF are due to lung disease. Currently, there is no cure.

## CYSTIC FIBROSIS CANADA

Cystic Fibrosis Canada is a national charitable not-for-profit corporation established in 1960, and is one of the world's top three charitable organizations committed to finding a cure for CF. As an internationally-recognized leader in funding CF research, innovation, and clinical care, we invest more funding in life-saving CF research and care than any other non-government agency in Canada.

Since 1960, Cystic Fibrosis Canada has invested more than \$244 million in leading research, innovation and care, resulting in one of the world's highest survival rates for Canadians living with CF. For more information, visit [www.cysticfibrosis.ca](http://www.cysticfibrosis.ca).

Our mission is to end CF. We will help all people living with CF by funding targeted world-class research, supporting and advocating for high-quality individualized CF care and raising and allocating funds for these purposes.

**Our vision is a world without cystic fibrosis.**

This publication is also available online. Please visit us at [www.cysticfibrosis.ca](http://www.cysticfibrosis.ca)

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Cover page: Patient from a CF clinic in Ontario  
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*Published: June 2017*

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# THE CANADIAN CYSTIC FIBROSIS REGISTRY



The *Canadian Cystic Fibrosis Registry* (CCFR) is the only source of national CF clinical information spanning nearly five decades. This incredible collection of CF data is used to accelerate our knowledge and understanding of CF that will transform into better care and outcomes for those living with CF.

Participating CF patients who attend any of the accredited 42 CF clinics across Canada are represented in the CCFR. Data are submitted by the CF clinics on behalf of patients. Given that the majority of CF patients attend one of these clinics, we are confident that the CCFR includes data on virtually all Canadians diagnosed with CF — giving a comprehensive picture of the CF population in this country.

Cystic Fibrosis Canada publishes the Canadian CF Registry Annual Report on national summary statistics to further educate and promote awareness of CF. We would like to acknowledge the involvement and continued participation of CF patients who consent to having their data submitted, and the exceptional effort and contribution from CF clinic team members who collect and enter the data.



The Canadian CF Registry is a valuable resource for the CF community and provides powerful data that can be used for clinical care, research, advocacy and quality improvement initiatives. The data is also extremely useful in identifying potentially eligible individuals for new CF treatments as well as evaluating the impact of new therapies on health outcomes. We are extremely grateful to all the CF patients and their families for participating and to all the clinics for their hard work in providing the data. Without everyone's support, we would not be able to put together this report.

**DR. ANNE STEPHENSON**  
MEDICAL DIRECTOR, REGISTRY, CYSTIC FIBROSIS CANADA  
AND CF PHYSICIAN, ST. MICHAEL'S HOSPITAL, TORONTO



We are truly grateful to the Canadian CF community for their tireless effort and dedication resulting in the continued success of the Canadian CF Registry. Together, we will realize our vision of a world without CF!

**NORMA BEAUCHAMP**  
PRESIDENT & CEO, CYSTIC FIBROSIS CANADA

## HOW TO READ THE REPORT

All data presented in this report have been re-calculated for each year indicated in order to include data that might have been updated or missed in previous years. This ensures that data can be compared accurately between different years within this report. It also means that discrepancies might occur when comparing historical reports with the current one.

Patients who were reported by any of the 42 accredited Canadian CF clinics in 2015 were included in this report.

For those who are under 18 years of age, those individuals are categorized as *children* and those 18 years of age or older are categorized as *adults*. For the purposes of this report, age is calculated as of December 31, 2015.

# 2015

# HIGHLIGHTS

Almost **4,200 Canadians** with CF received care at one of the **42 specialized CF clinics** based in hospitals across Canada

THE MEDIAN AGE OF CANADIANS WITH CF IS **22.3 YEARS**

There were **124 new diagnoses made in 2015**: 60 were through newborn screening and 12 were over 18 years of age

**59.2%** of CF patients are diagnosed within their first year of life

**60.5%** OF ALL PEOPLE WITH CF IN CANADA ARE **ADULTS**

Cumulatively, CF patients underwent **over 1,000 courses of home IV therapy** in 2015

CUMULATIVELY, CF PATIENTS SPENT OVER **25,000 DAYS IN HOSPITAL** AND ATTENDED OVER **18,000 CLINIC VISITS** IN 2015

FEV<sub>1</sub> percent predicted (a measure of lung function) is improving for persons with CF: **half of all 30 year olds** with CF had an **FEV<sub>1</sub> greater than 65.7%** in 2015 compared to **49.8%** two decades ago

OF THE 47 PATIENTS WHO DIED IN 2015, **HALF WERE UNDER 29.7 YEARS OF AGE**

THE **MEDIAN AGE OF SURVIVAL** FOR CANADIANS WITH CF IS CURRENTLY **ESTIMATED TO BE 52.1 YEARS OF AGE**

**85.4%** of Canadians with CF must take **pancreatic enzymes** to digest food and absorb nutrients

**27.8% of female adults** with CF and **17.5% of male adults** with CF are classified as **underweight**

**44.2% of all children under 2 years** and **44.1% of all children between 2-17 years** are above the national goal of **50<sup>th</sup> BMI percentile**

**49 CF PATIENTS RECEIVED TRANSPLANTS** IN 2015 AND HAD A **MEDIAN AGE OF 28.5 YEARS** AT THE TIME OF TRANSPLANT

**36.0%** and **51.1% of all patients** with CF are **infected in their lungs with harmful bacteria** such as *Pseudomonas aeruginosa* and *Staphylococcus aureus* respectively

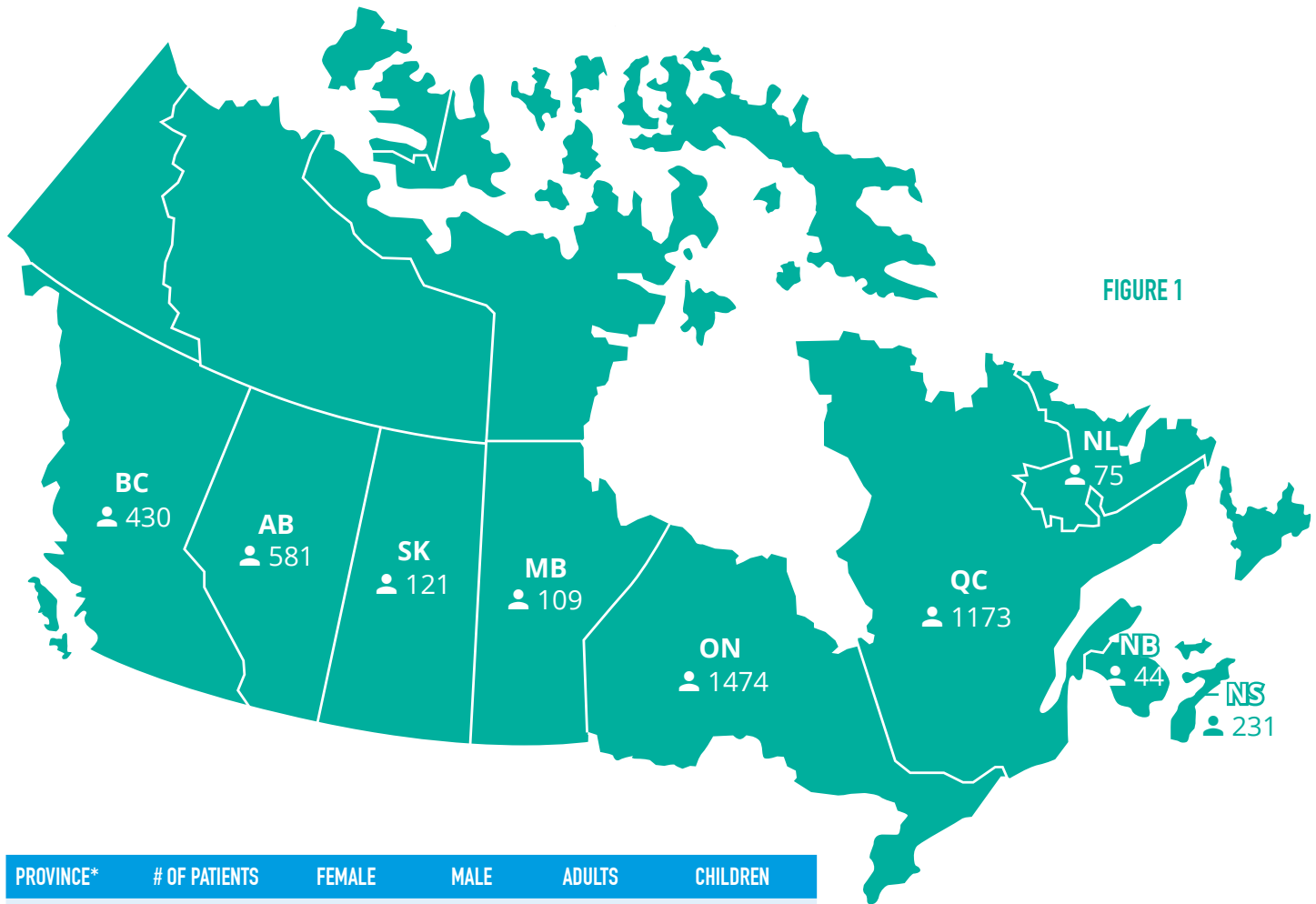
**23.7% of all CF patients have CF-related diabetes**, and 42.6% of these individuals are 35 years of age and older

Over **2,000 different mutations** in the *CFTR* gene have been identified; however **89.3% of CF patients in Canada** carry at least one copy of the most common CF-causing mutation, **F508del**

# DEMOGRAPHIC DATA

## CANADIANS WITH CYSTIC FIBROSIS

In 2015, there were a total of 4,192 individuals with CF who attended one of the 42 accredited CF clinics across Canada (Figure 1 Map of Canada). There were 124 new diagnoses of CF and the total Canadian CF population has been steadily increasing over the past two decades (Figure 2). Note that individuals may be counted in multiple provinces if they attended CF clinics in different provinces but they are only counted once (i.e. unique individuals) in the national reported numbers.



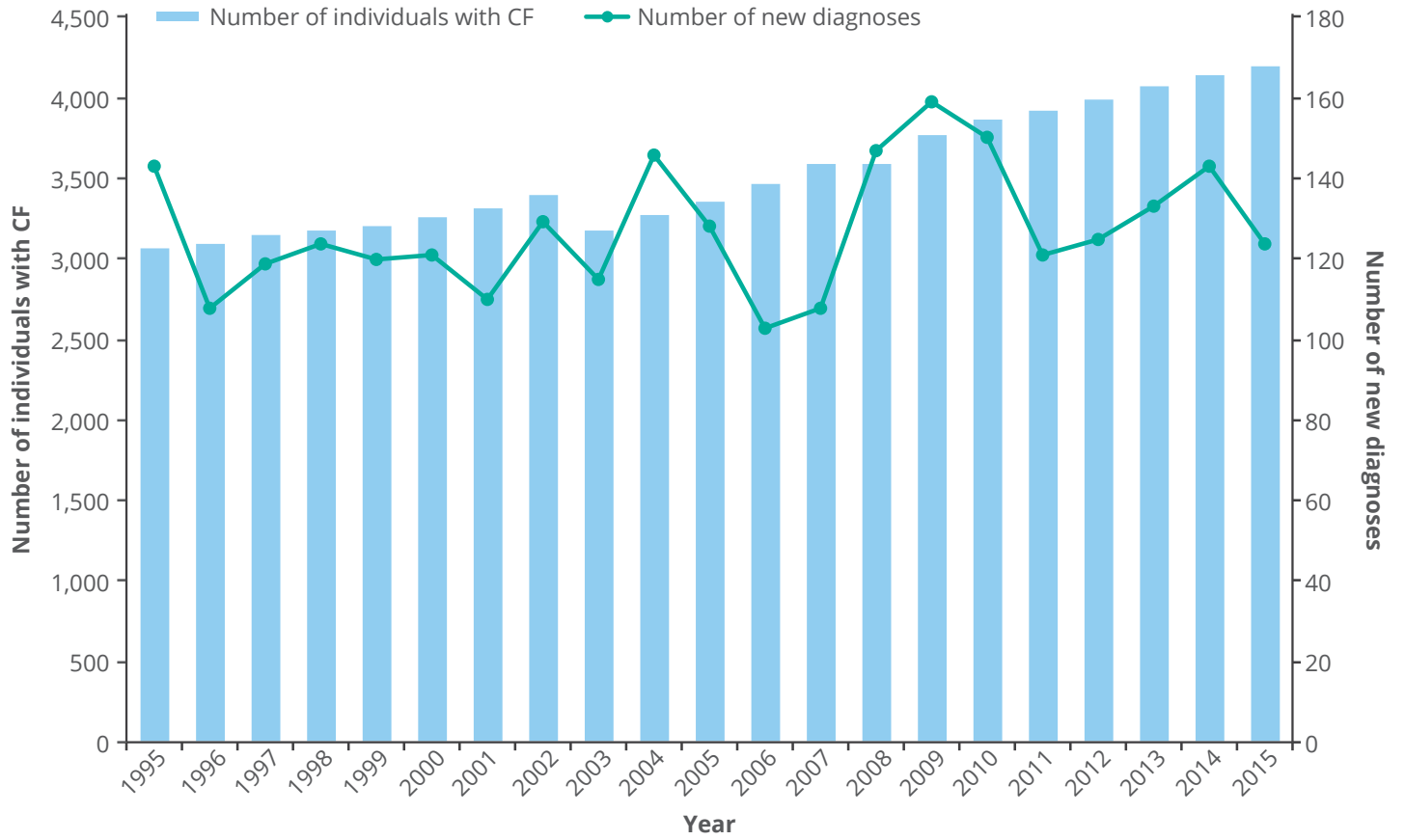
| PROVINCE* | # OF PATIENTS | FEMALE | MALE | ADULTS | CHILDREN |
|-----------|---------------|--------|------|--------|----------|
| AB        | 581           | 277    | 304  | 329    | 252      |
| BC        | 430           | 179    | 251  | 271    | 159      |
| MB        | 109           | 46     | 63   | 57     | 52       |
| NB        | 44            | 22     | 22   | 33     | 11       |
| NL        | 75            | 28     | 47   | 50     | 25       |
| NS        | 231           | 110    | 121  | 136    | 95       |
| ON        | 1474          | 717    | 757  | 883    | 591      |
| QC        | 1173          | 541    | 632  | 739    | 434      |
| SK        | 121           | 48     | 73   | 65     | 56       |

\* individuals with CF living in provinces or territories not listed here are included if reported on by other CF clinics

# DEMOGRAPHIC DATA

## NUMBER OF CANADIANS WITH CYSTIC FIBROSIS

**FIGURE 2**  
Total number of Canadians with CF and new diagnoses, 1995 to 2015



# DEMOGRAPHIC DATA

## AGE DISTRIBUTION OF CANADIANS WITH CYSTIC FIBROSIS

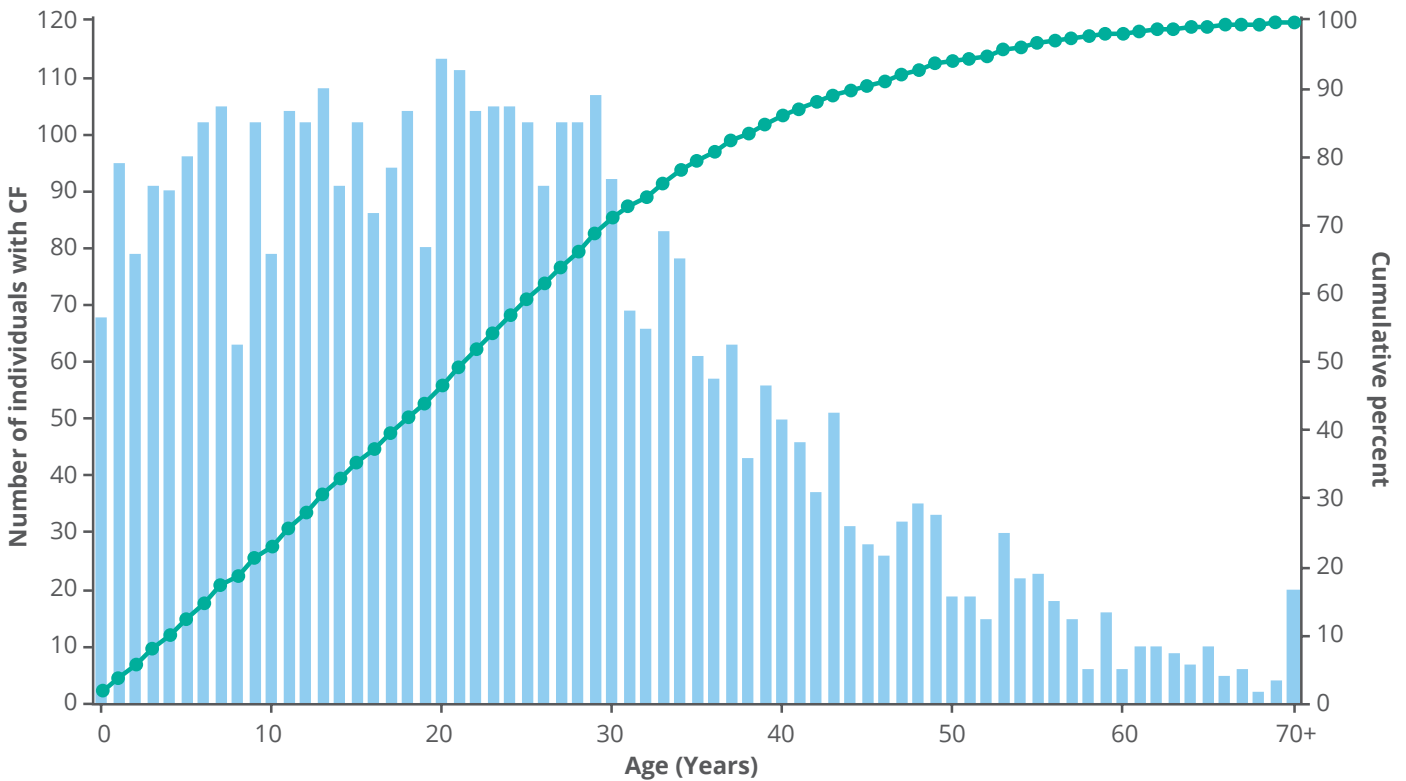
Figure 3 shows the age distribution of the Canadian CF population in 2015. The ages of individuals with CF range from birth to more than 70 years old. The median age of all individuals reported on in 2015 was 22.3 years, with 60.5% of individuals over 18 years of age (Figure 6) and 15.3% over 40 years of age.

**FIGURE 3**

Age distribution, as of December 31, 2015

Number of individuals with CF

Cumulative percent



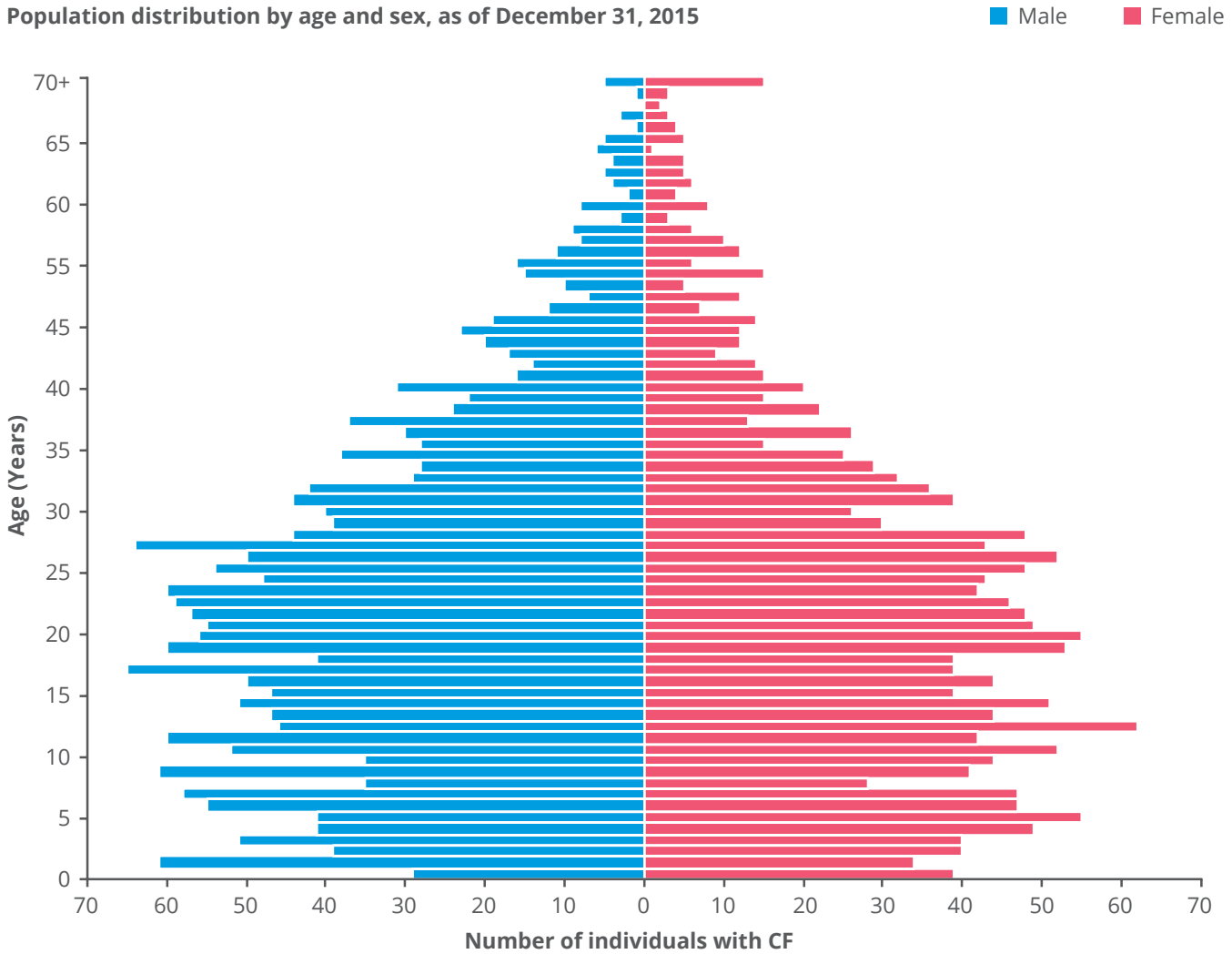


# DEMOGRAPHIC DATA

## AGE AND SEX DISTRIBUTION OF CANADIANS WITH CYSTIC FIBROSIS

Males accounted for 53.6% of individuals reported on in 2015 with 8.5% of males and 6.8% of females over the age of 40 (Figure 4).

**FIGURE 4**  
Population distribution by age and sex, as of December 31, 2015

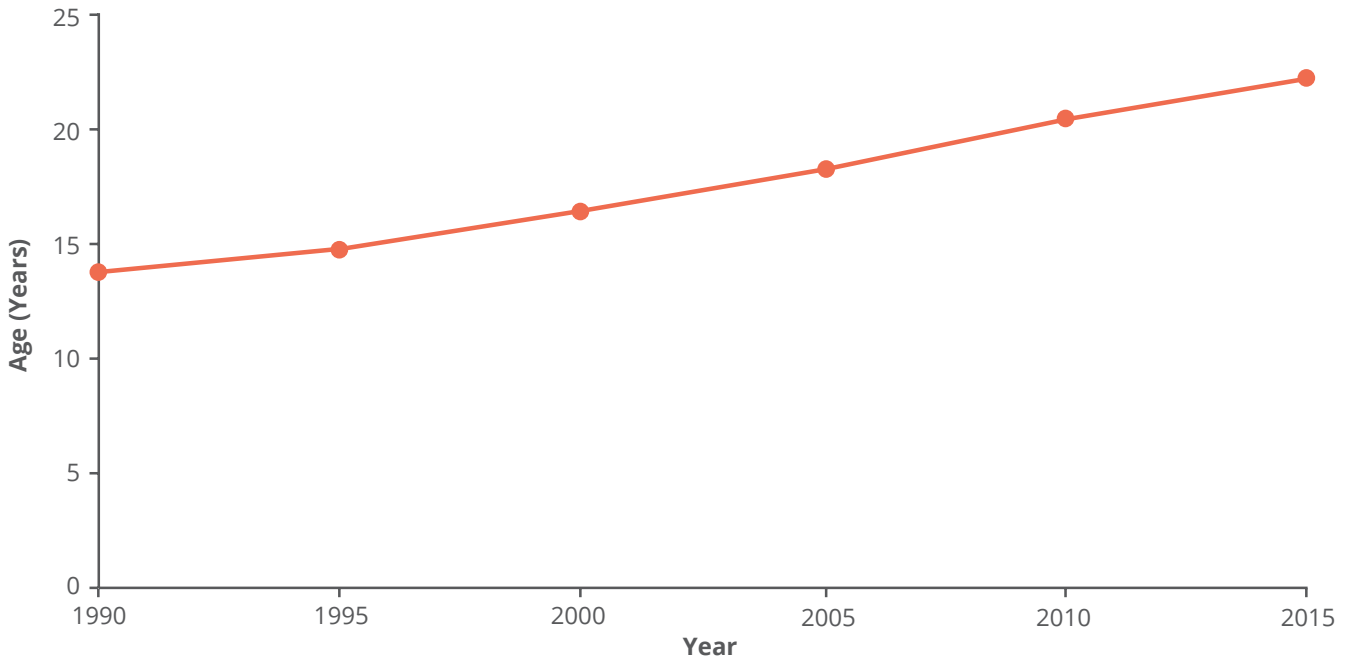


# DEMOGRAPHIC DATA

## MEDIAN AGE OF CANADIANS WITH CYSTIC FIBROSIS

The current median age of individuals with CF reported on in 2015 was 22.3 years, almost nine years higher than it was in 1990 (Figure 5).

**FIGURE 5**  
Median age, 1990 to 2015

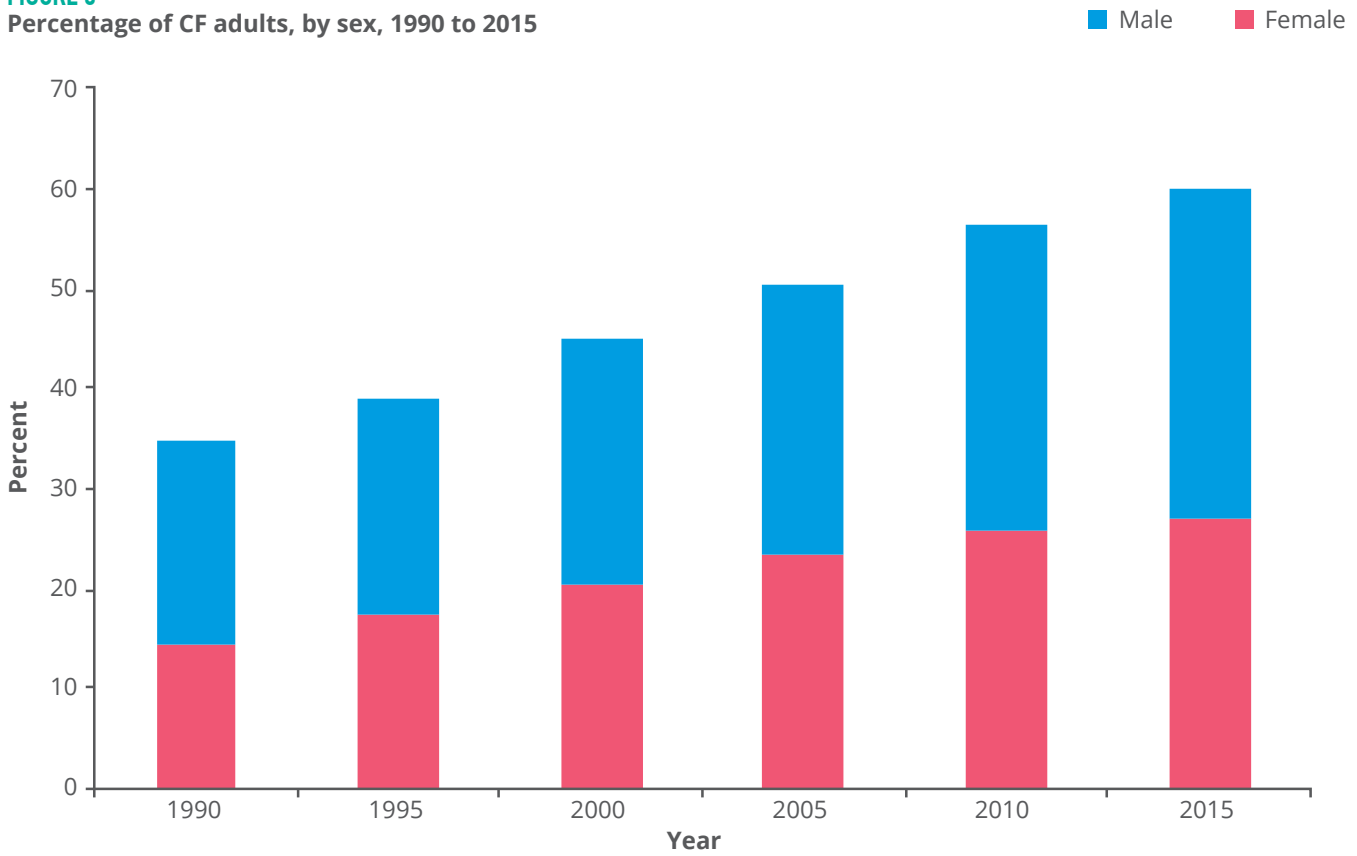


# DEMOGRAPHIC DATA

## CANADIAN ADULTS WITH CYSTIC FIBROSIS

Adults (individuals 18 years of age or older) accounted for 60.5% of individuals in the CCFR in 2015 with 27.3% adult females and 33.1% adult males (Figure 6).

**FIGURE 6**  
Percentage of CF adults, by sex, 1990 to 2015



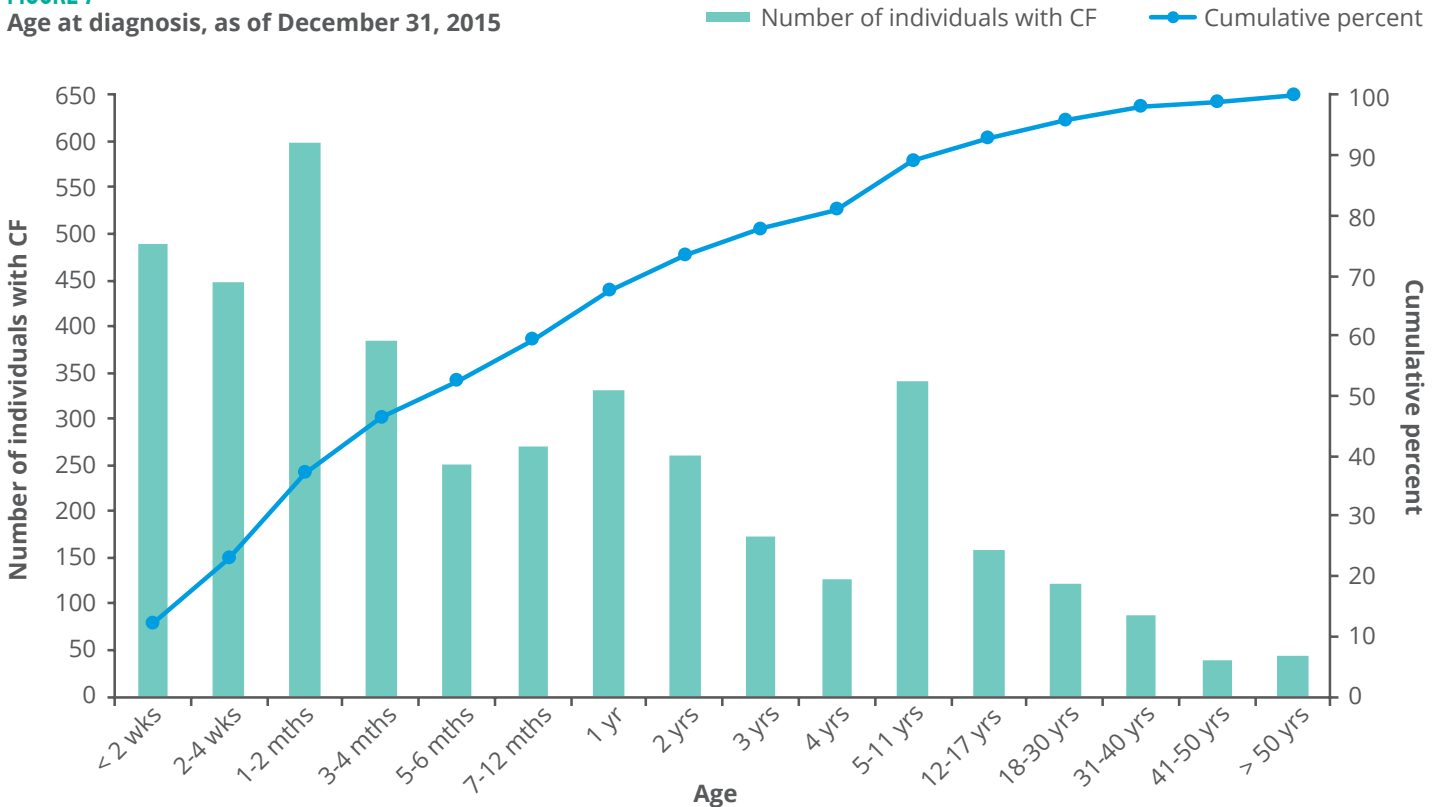
# DIAGNOSIS

## AGE AT DIAGNOSIS

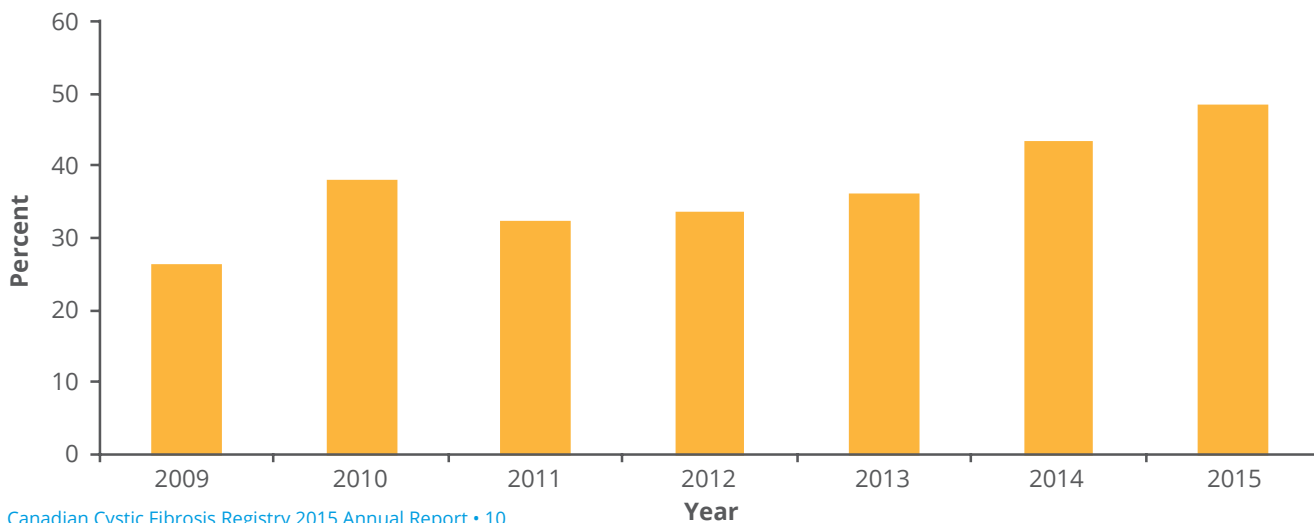
By one year of age, 59.2% of individuals were diagnosed with CF, and over two thirds (67.2%) were diagnosed by the age of two years (Figure 7). Adults diagnosed later in life (18 years or older) account for only 7% of all diagnoses.

Figure 8 shows the percentage of newborns diagnosed through the NBS program over the last seven years. In 2015, nearly half of those newly diagnosed (60 patients, 48.4%) were diagnosed through NBS. Newborn screening for CF started in Alberta at the beginning of 2007 followed by Ontario (2008), Saskatchewan (2009), British Columbia (2009), Manitoba (2011), Nova Scotia (2014), Newfoundland (2014), New Brunswick (2014), PEI (2015) and Quebec (announced in 2017).

**FIGURE 7**  
Age at diagnosis, as of December 31, 2015



**FIGURE 8**  
Percentage of all new diagnoses made through the NBS program, 2009 to 2015

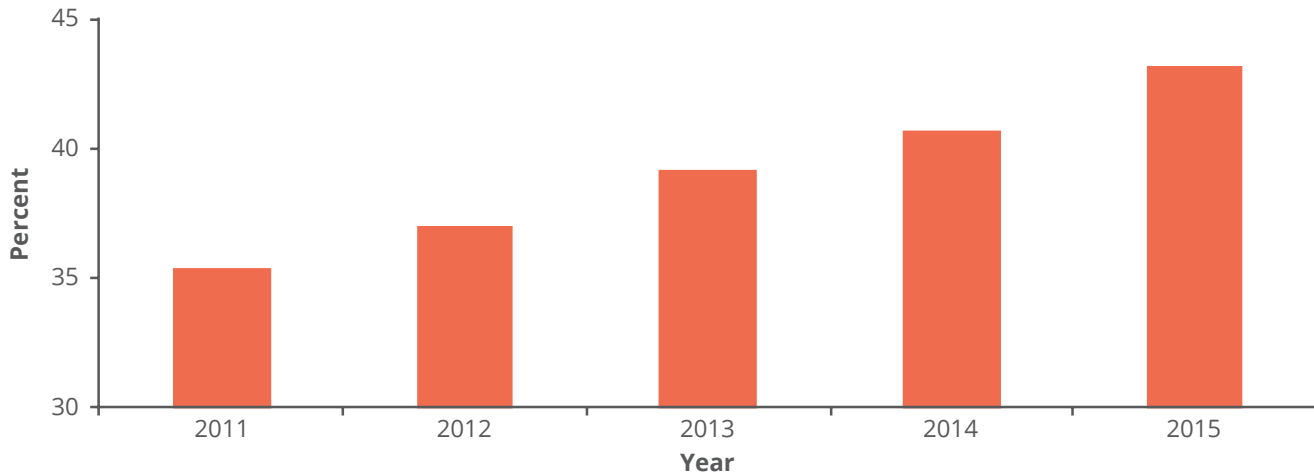


# DIAGNOSIS

## SWEAT CHLORIDE TESTING

Sweat chloride testing is used in the diagnosis of CF. Individuals with CF typically have a sweat chloride value greater than 60 mmol/L whereas values between 40 and 59 mmol/L are indeterminate. Values lower than 40 mmol/L are considered in the normal range. The Registry began capturing sweat chloride test results in 2011. In 2015, there were 43.1% (1,808) individuals with CF with at least one sweat chloride test result recorded (Figure 9).

**FIGURE 9**  
Percentage of individuals with CF with at least one sweat chloride test result, 2011 to 2015

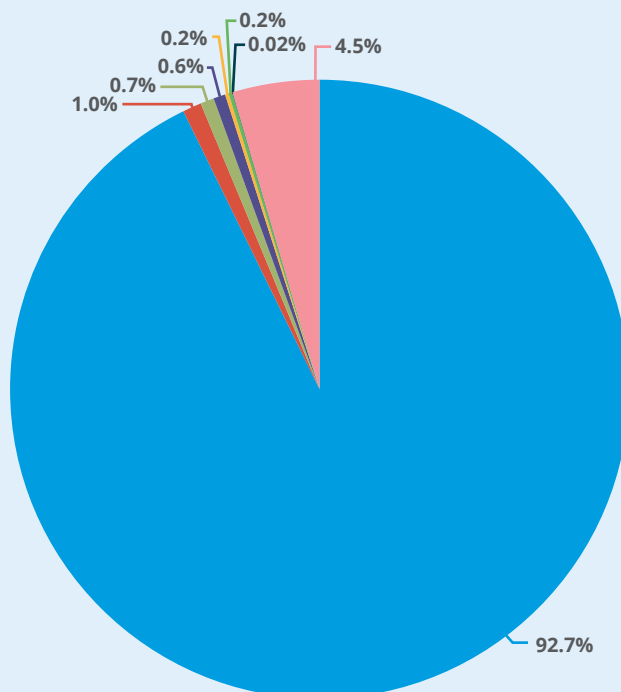


# ETHNICITY

The majority of the Canadian CF population is Caucasian (92.7%). Of those remaining who have an identified ethnicity (Figure 10), they are divided among five other ethnic groups (First Nations, Black, Asian, South Asian and Hispanic). Race is captured through self-report.

**FIGURE 10**  
Ethnicity, 2015

- Caucasian
- First Nations
- Black
- Asian
- South Asian
- Two or more races
- Hispanic
- Not listed



# GENOTYPE

CF is caused by one or more mutations in a single gene located on chromosome 7, termed the Cystic Fibrosis Transmembrane Regulator (*CFTR*) gene. The *CFTR* gene codes for the CFTR protein which functions as a chloride channel and is involved in many cellular functions. To date, more than 2,000 different mutations in the *CFTR* gene have been identified.

The most common CF mutation worldwide is a three base-pair deletion in the *CFTR* gene resulting in the deletion of the phenylalanine (F) residue at position 508 in the CFTR protein, commonly referred to as **F508del**. CF disease-causing mutations can be classified into five major categories depending on the how the mutation impacts the production and function of the CFTR protein. There are some mutations where the impact on the CFTR protein is not clear or unknown therefore these cannot be classified. CFTR protein modulator medications target specific classes of mutations.

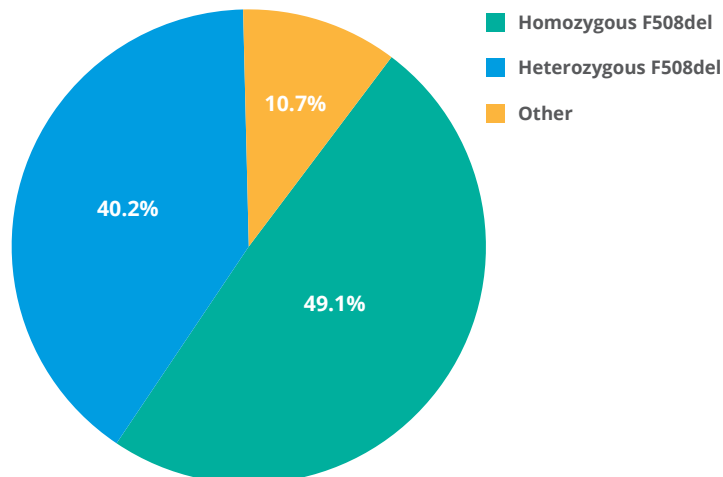


**TABLE 1**  
Classification of CFTR mutations based on the impact on the CFTR protein

| CLASS | HOW CFTR PROTEIN IS AFFECTED  | EXAMPLES                 |
|-------|---|--------------------------|
| I     | No functional CFTR protein is made  | G542X, W1282X, 621+1G->T |
| II    | CFTR protein is abnormal and destroyed by the cell before it reaches the cell membrane          | F508del, G85E            |
| III   | CFTR protein reaches the cell membrane but the channel is blocked                               | G551D                    |
| IV    | CFTR protein reaches the cell membrane but the channel does not move chloride the way it should | R117H, R334W             |
| V     | The CFTR protein is made and works properly but the quantity of protein made is insufficient    | 3849+10kbC->T            |

4,127 individuals with CF reported in 2015 have genetic information recorded with almost 50% carrying two F508del mutations (Figure 11) and almost 90% carrying at least one F508del mutation (Table 2). Figure 12 shows that the genotype distribution is similar among adults (18+ years) and children (0-17 years). In the entire CCFR, 4,750 (92.9%) of 5,113 individuals are reported as being alive and have at least one CF mutation recorded.

**FIGURE 11**  
Genotype (based on N = 4,127), 2015

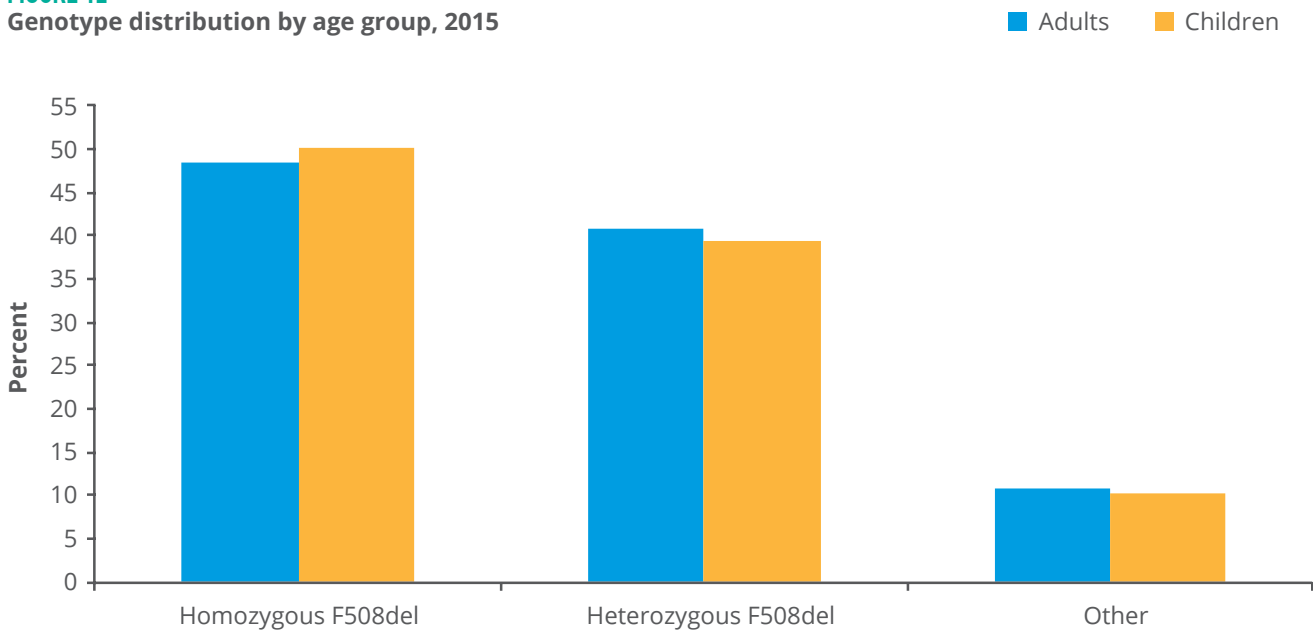


# GENOTYPE

**TABLE 2**  
Frequency of CF mutations on one or both alleles (top ten)

| GENOTYPE  | NUMBER | PERCENT |
|-----------|--------|---------|
| F508del   | 3,687  | 89.3    |
| G21+1G->T | 243    | 5.9     |
| G542X     | 147    | 3.6     |
| G551D     | 125    | 3.0     |
| 711+1G->T | 112    | 2.7     |
| A455E     | 101    | 2.4     |
| N1303K    | 85     | 2.1     |
| R117H     | 85     | 2.1     |
| G85E      | 66     | 1.6     |
| M1101K    | 59     | 1.4     |

**FIGURE 12**  
Genotype distribution by age group, 2015



# RESPIRATORY

## MEDIAN FEV<sub>1</sub> PERCENT PREDICTED

Lung function measurements are critical for evaluating lung health and are reliably measured starting at six years of age. FEV<sub>1</sub> (forced expiratory volume in one second) is the volume of air that a person can forcibly blow out in one second. FEV<sub>1</sub> percent predicted for an individual is calculated by comparing their FEV<sub>1</sub> to the average FEV<sub>1</sub> of a healthy population of similar age, height, race and sex.

Global Lung Initiative (GLI) equations<sup>1</sup> are used to calculate the percent predicted FEV<sub>1</sub> values. In this report, the first complete stable lung measurement of the year was used per individual with CF to summarize lung function, otherwise, the first complete measurement regardless of the lung status was used.

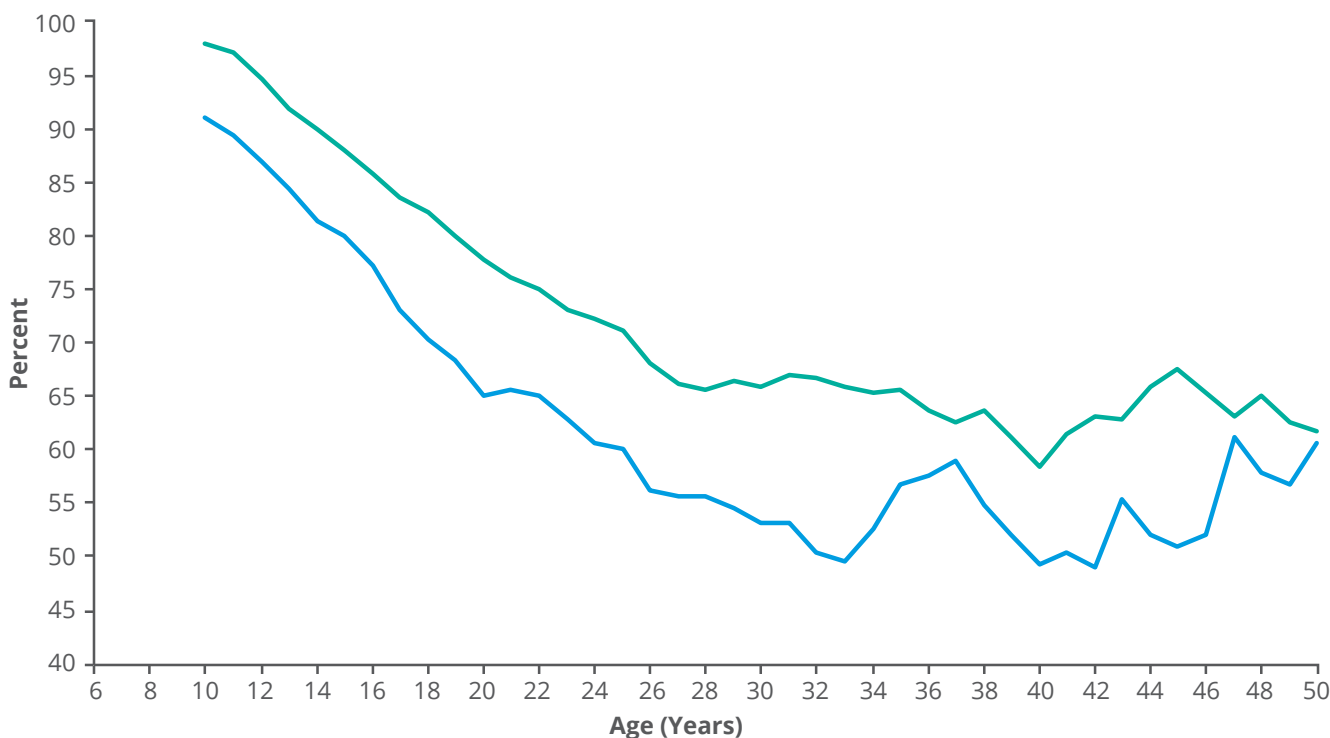
Figure 13 shows the median FEV<sub>1</sub> percent predicted from the ages 6 to 50 years in a 5-year moving average window. While at an individual patient level, lung function tends to decline with age, at a population level the median FEV<sub>1</sub> percent predicted has increased over the years. In 2015, the median FEV<sub>1</sub> was 65.7% at 30 years of age compared to 49.8% in 1995 marking an improvement of nearly 16% over the last two decades. Interestingly, the trends between these two time periods are similar. From ages 6 to 30 years, there is a steady decline in annual lung function, with a slightly larger average annual drop in 1995 (1.9%) than in 2015 (1.6%). Consistently, the teenage years is a time of significant change with the largest drop in lung function occurring in both time periods during the challenging transition to adulthood.

Figure 14 indicates that individuals born recently have a higher median FEV<sub>1</sub> percent predicted and a slower rate of decline than those born earlier (average annual decline of 1.0% in the 2006-2010 birth cohort compared to 1.2% in the 1986-1990 birth cohort).

**FIGURE 13**

Median FEV<sub>1</sub> percent predicted vs. age (in a 5-year moving window), 1995 and 2015\*

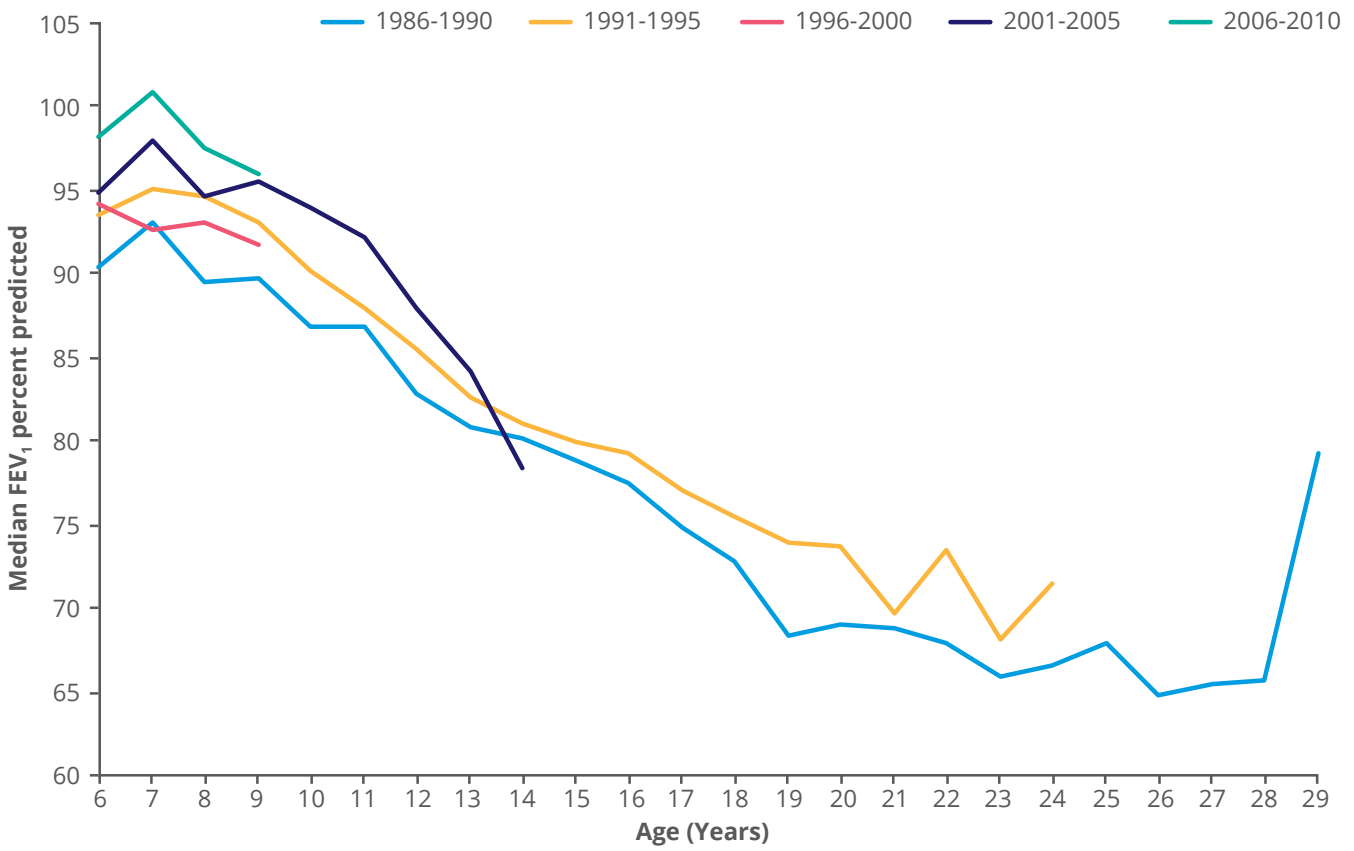
— 1995 — 2015





# RESPIRATORY

**FIGURE 14**  
Median FEV<sub>1</sub> percent predicted by birth cohorts\*



\*GLI reference equations used to calculate FEV<sub>1</sub> percent predicted values

# RESPIRATORY

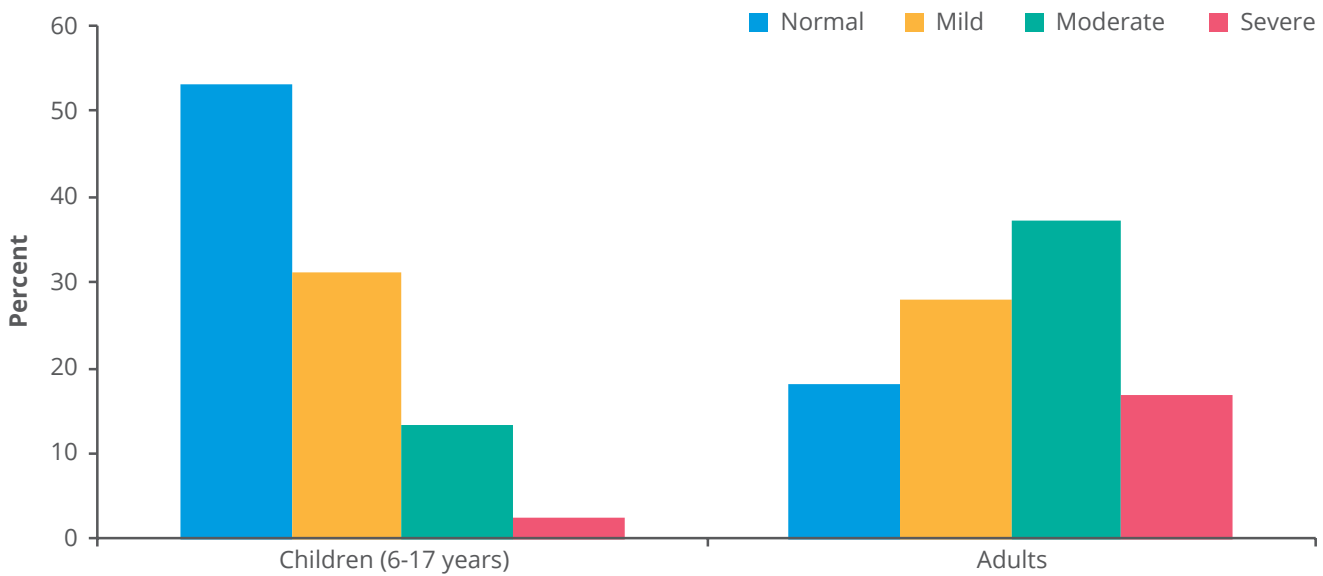
## RESPIRATORY STATUS

The majority (53.1%) of children, ages 6 to 17 years, have normal lung function while the majority (37.3%) of adults have moderate lung function (Figure 15). Figure 16 shows that over time, the median FEV<sub>1</sub> percent predicted has been steadily increasing for both age groups. Table 3 summarizes the FEV<sub>1</sub> percent predicted classified by lung function severity and includes data from all patients reported on in 2015, including those who are post-transplant.

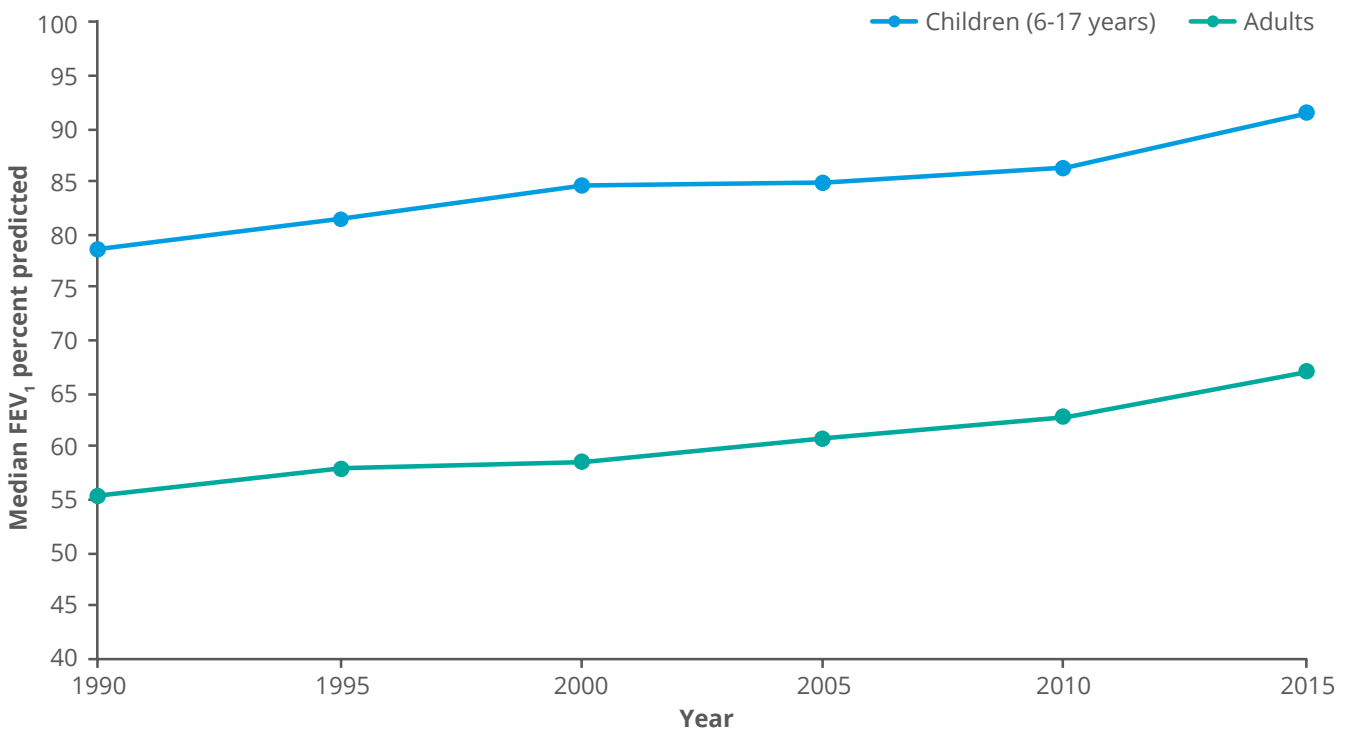
**TABLE 3**  
FEV<sub>1</sub> percent predicted classification

| CLASSIFICATION | RANGE    |
|----------------|----------|
| Normal         | ≥ 90%    |
| Mild           | 70 – 89% |
| Moderate       | 40 – 69% |
| Severe         | < 40%    |

**FIGURE 15**  
Respiratory status of children and adults with CF, 2015



**FIGURE 16**  
Median FEV<sub>1</sub> percent predicted values for children (6 to 17 years) and adults with CF, 1990 to 2015

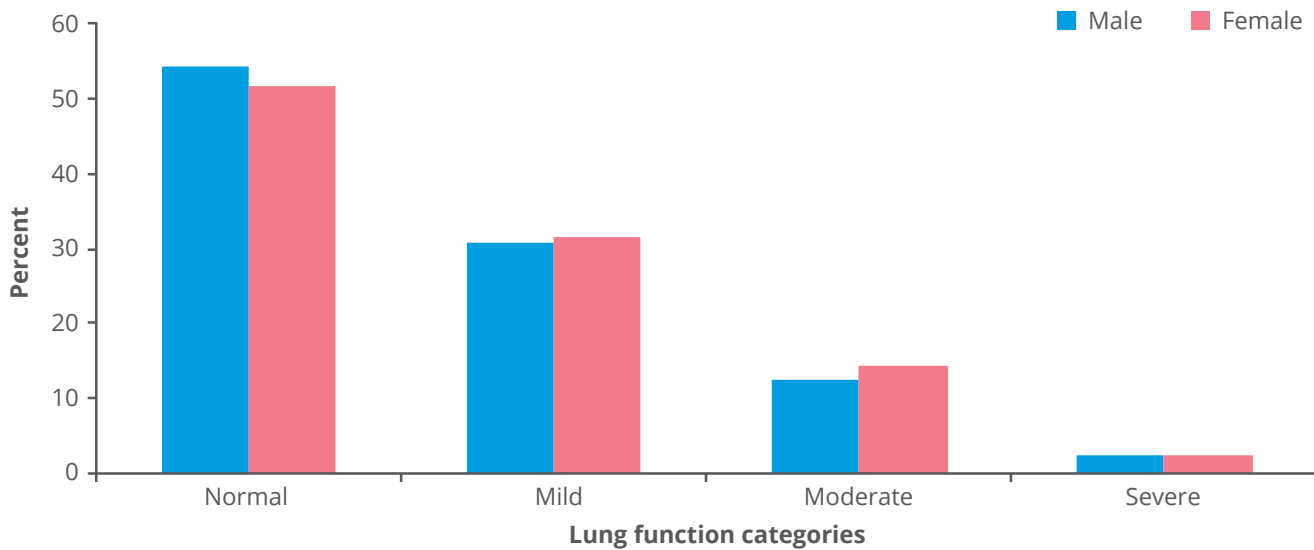


# RESPIRATORY

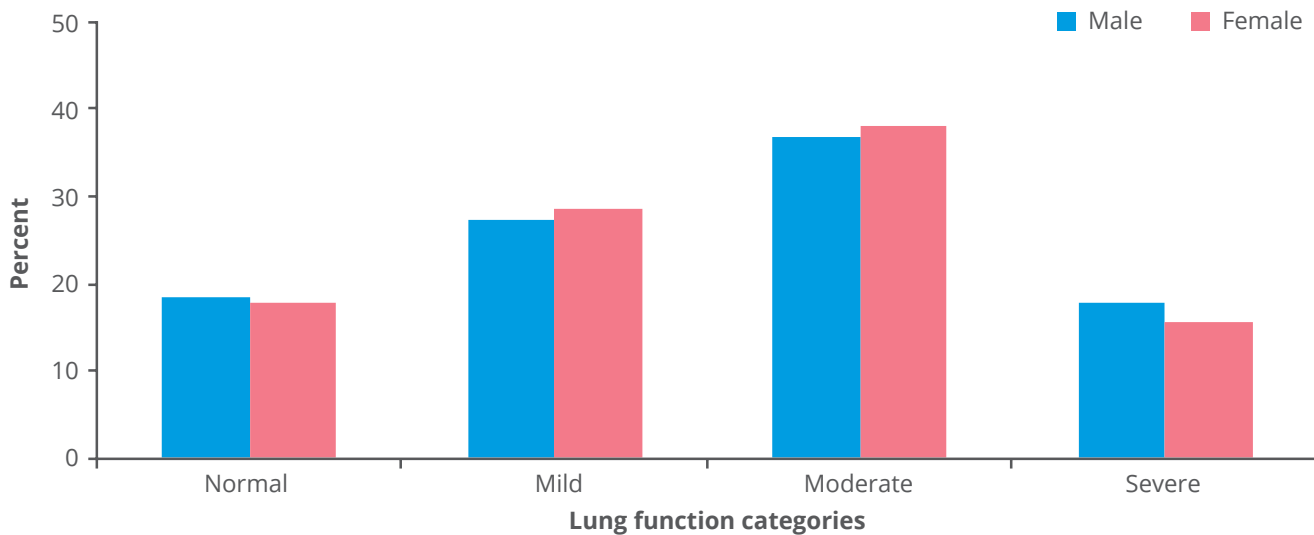
## RESPIRATORY STATUS BY SEX

Figures 17 and 18 show that the distribution of people within each lung function category is similar between males and females.

**FIGURE 17**  
Respiratory status of children (6 to 17 years) with CF, by sex, 2015



**FIGURE 18**  
Respiratory status of adults (18 years of age and older) with CF, by sex, 2015



# NUTRITION

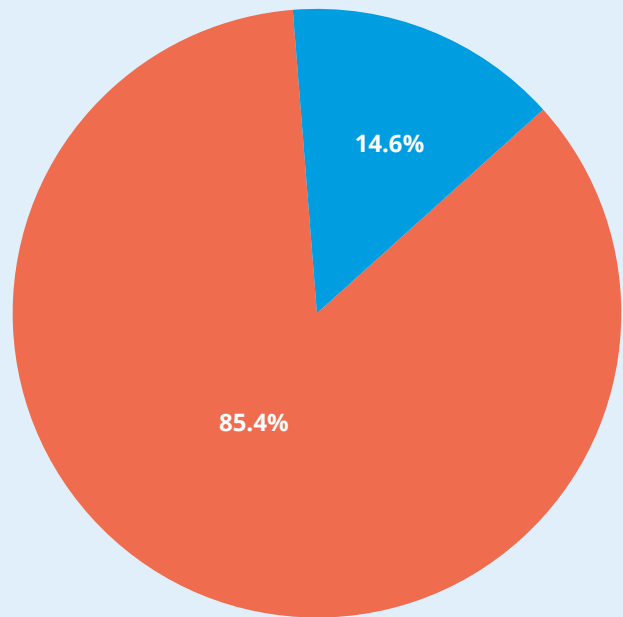
## PANCREATIC STATUS

Malnutrition is common in individuals with CF as a result of pancreatic insufficiency. Pancreatic enzymes are given as supplements to help with digestion and absorption of nutrients. In 2015, 85.4% of individuals with CF were taking supplemental pancreatic enzymes (pancreatic insufficient), whereas 14.6% did not require oral pancreatic enzyme supplementation to digest their food (pancreatic sufficient) (Figure 19).

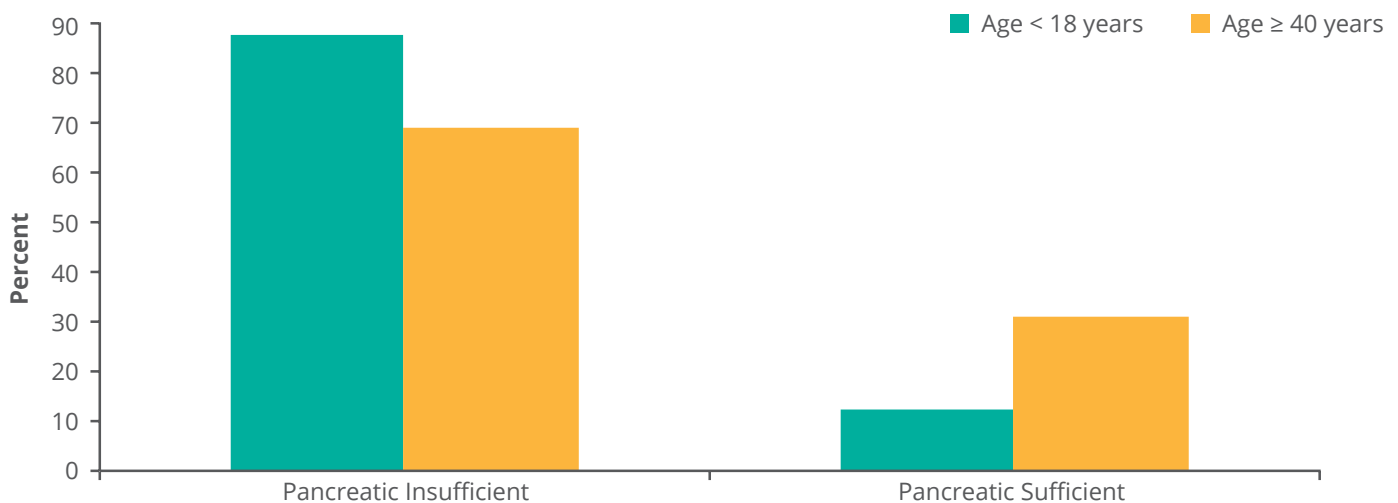
For individuals 40 years of age or older, 30.9% were pancreatic sufficient (Figure 20). This is a reflection of the fact that individuals diagnosed with CF as adults are more likely to have milder mutations that are associated with pancreatic sufficiency.

**FIGURE 19**  
Pancreatic sufficiency in individuals with CF, 2015

- Pancreatic Insufficient
- Pancreatic Sufficient



**FIGURE 20**  
Pancreatic status by age group, 2015



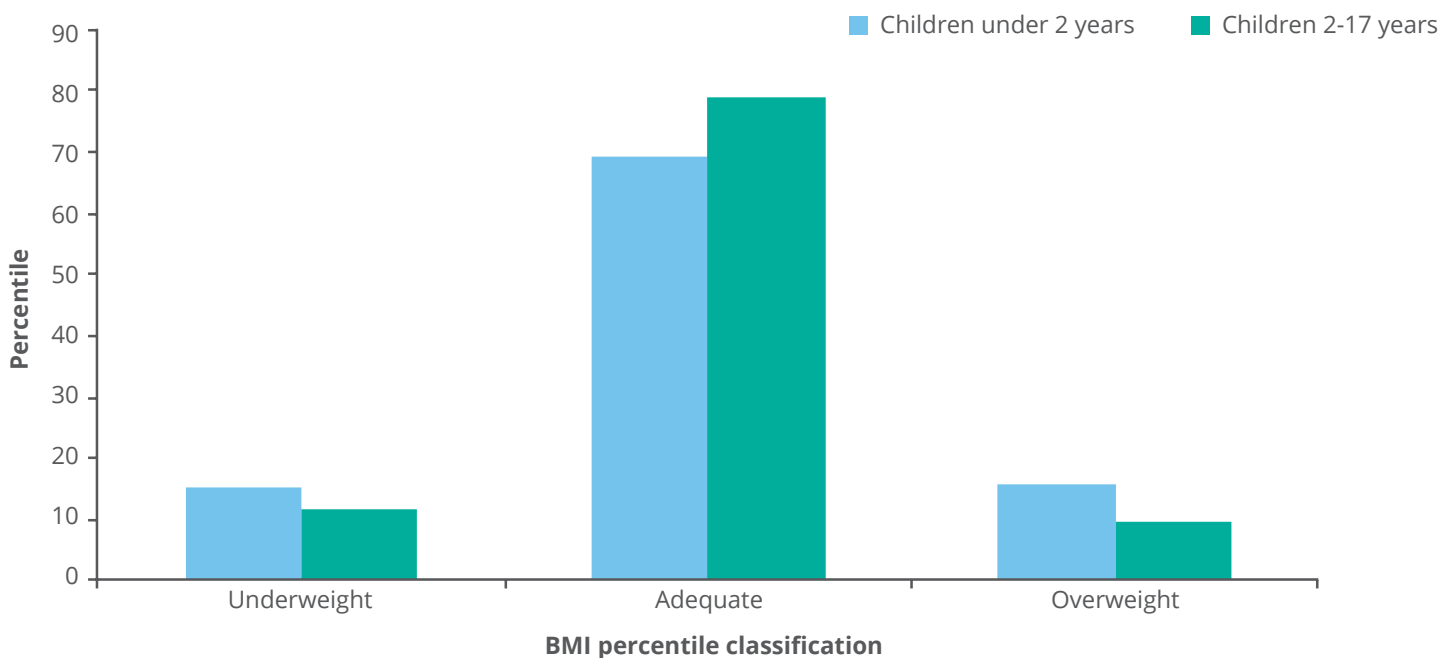
# NUTRITION

## BMI PERCENTILE

BMI percentiles are calculated for children under 2 years of age following the World Health Organization guidelines<sup>2</sup> and for children ages 2 to 17 years, the Centers for Disease Control and Prevention guidelines<sup>2</sup> are followed. BMI percentiles allow comparisons to be made between the individual's height and weight and other children who are the same age and sex. Table 4 summarizes the BMI percentile classification categories<sup>3</sup> using either guidelines.

The national median BMI percentile for babies is 43.7% (under 2 years of age) and 44.9% for children (ages 2-17 years). Overall, the BMI percentile distribution between the paediatric groups are very similar with the majority of children with CF having an adequate weight, 69.2% for children under 2 years and 78.9% for children 2-17 years (Figure 21). A small percentage (9.4%) of children 2-17 years are considered overweight. The national goal for children with CF is 50<sup>th</sup> BMI percentile and approximately 44% of all children are above the national goal.

**FIGURE 21**  
BMI percentile classification, 2015

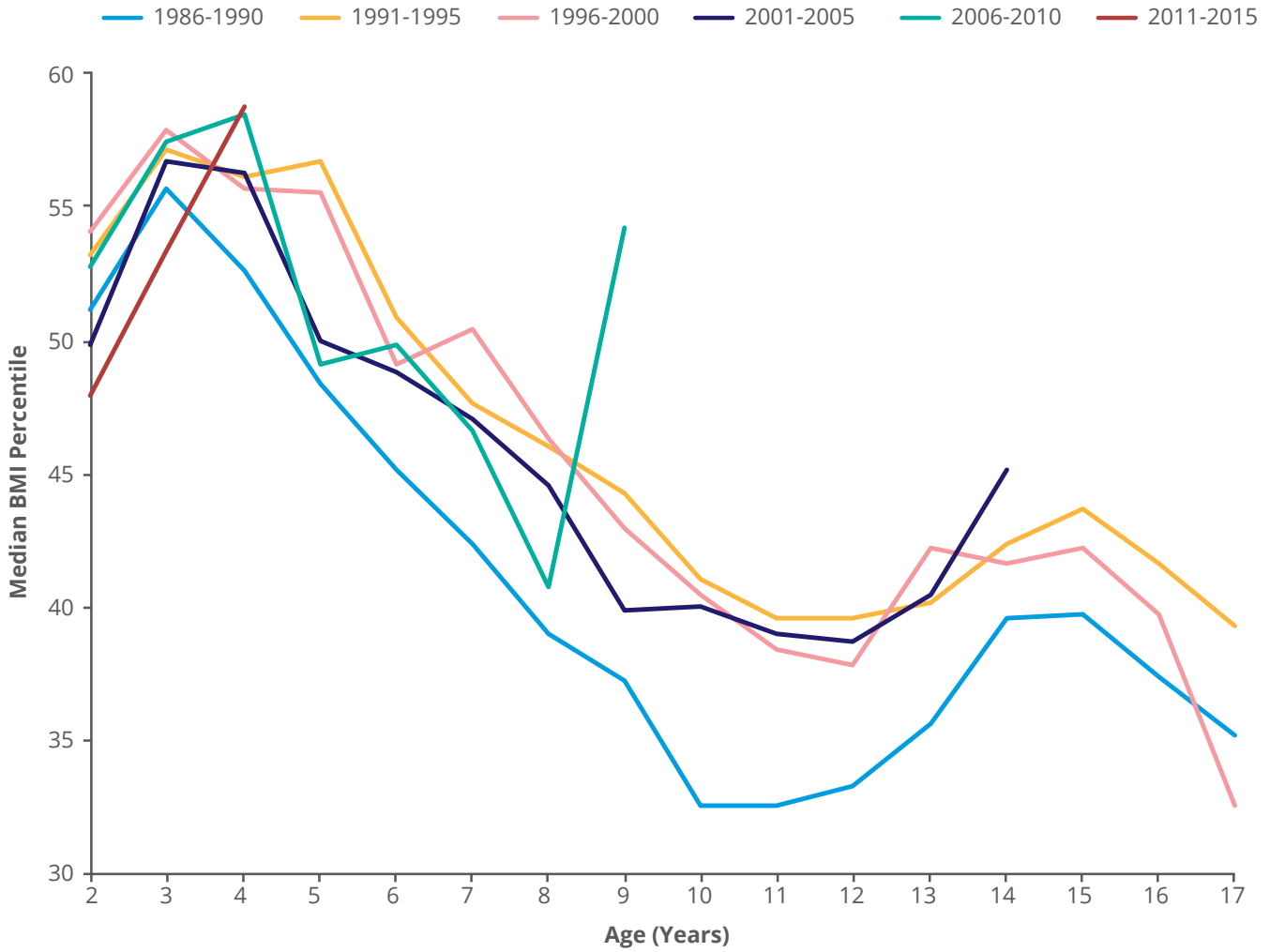


**TABLE 4**  
BMI percentile classification

| CLASSIFICATION | RANGE   |
|----------------|---|
| Underweight    | < 10 <sup>th</sup> percentile                             |
| Adequate       | 10 <sup>th</sup> percentile - 84 <sup>th</sup> percentile |
| Overweight     | ≥ 85 <sup>th</sup> percentile                             |

# NUTRITION

**FIGURE 22**  
Median BMI percentile for children 2-17 years by birth cohort

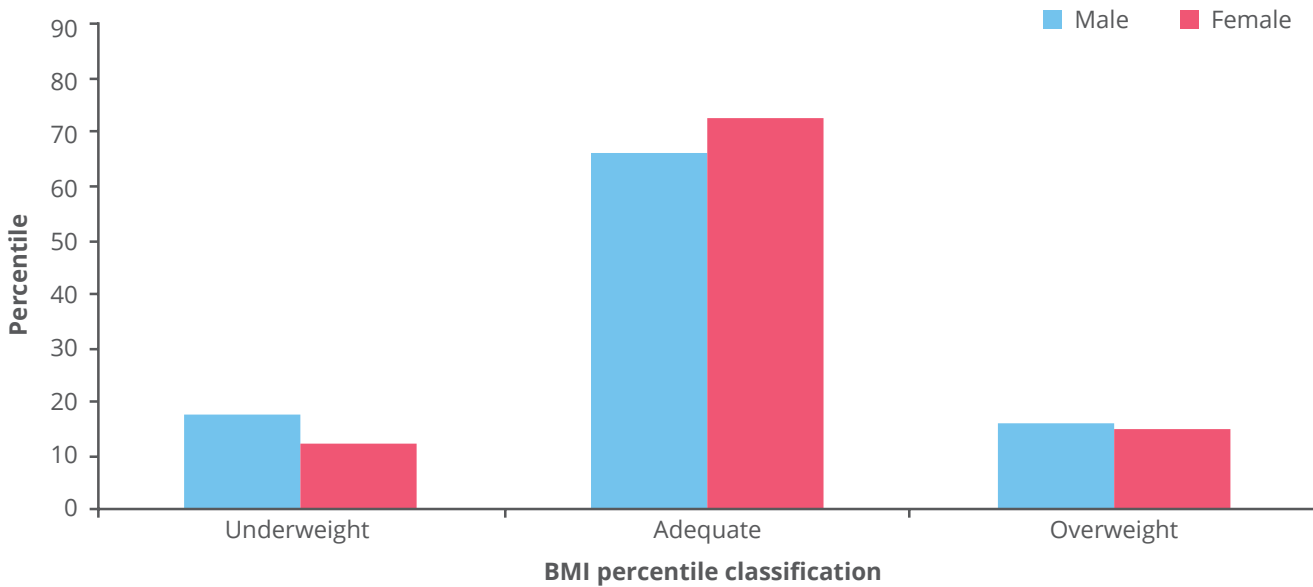


# NUTRITION

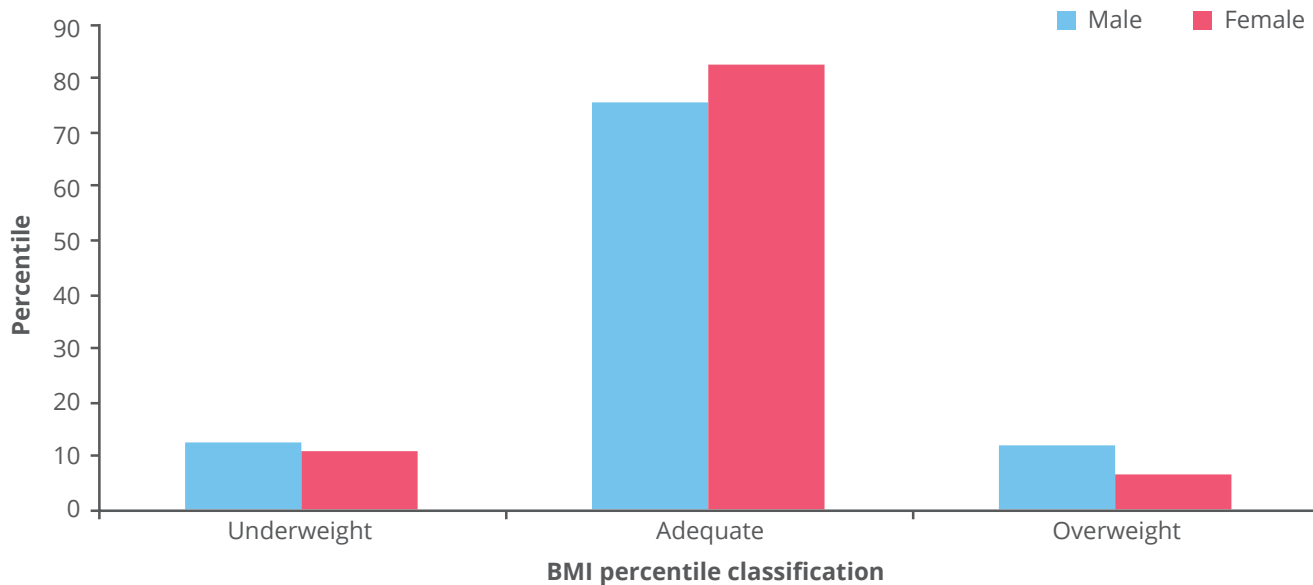
## BMI PERCENTILE BY SEX

Figures 23 and 24 show the BMI percentile classifications for males and females in children under 2 years (N = 224) and children 2-17 years (N = 1,505). In both age groupings, there were slightly more females with an adequate weight than males. BMI percentiles have been increasing over time for both males and females (Figure 25).

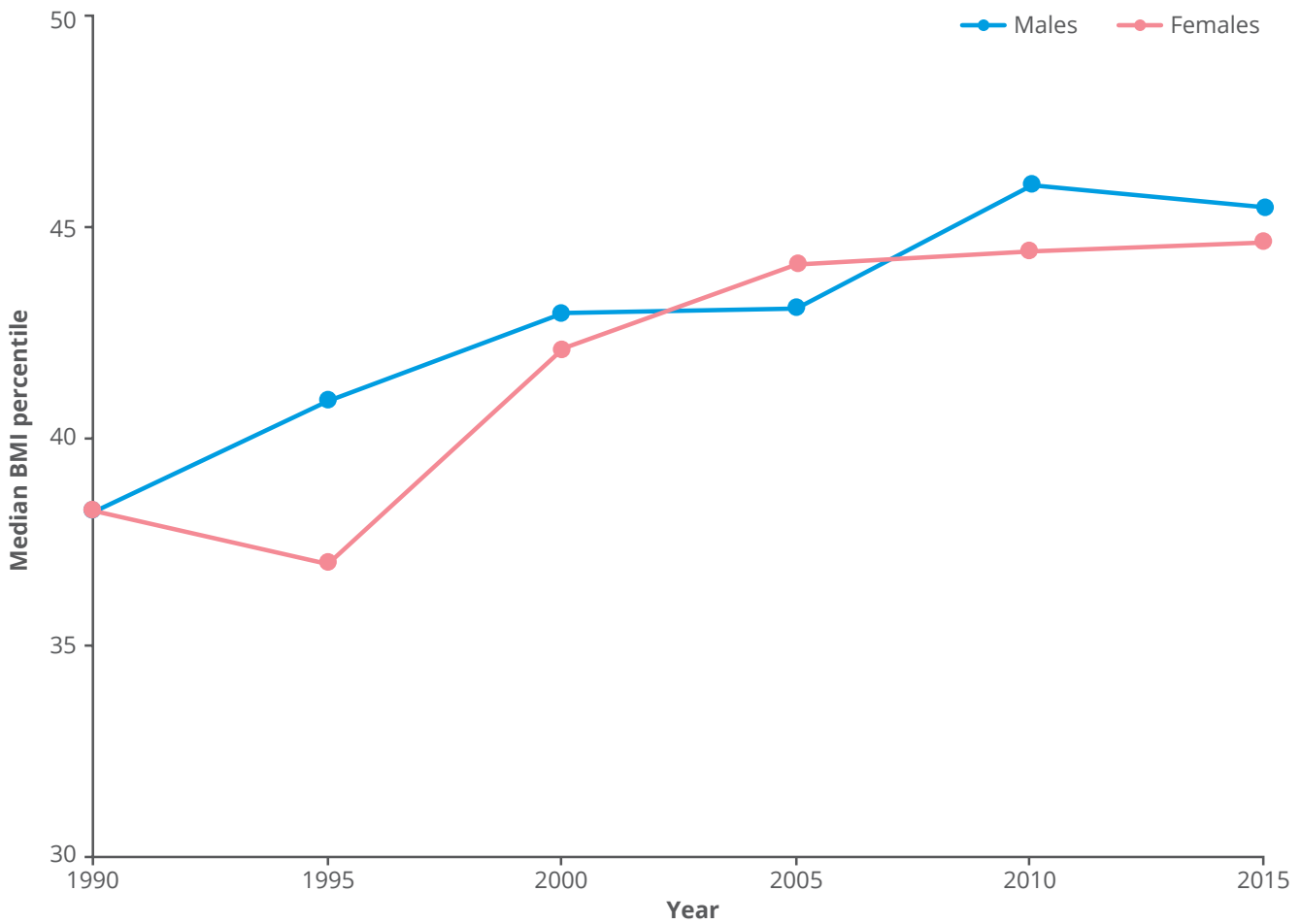
**FIGURE 23**  
**BMI percentile classification for children under 2 years, by sex, 2015**



**FIGURE 24**  
**BMI percentile classification for children 2-17 years, by sex, 2015**



**FIGURE 25**  
Median BMI percentiles for children 2-17 years, by sex, 1990 to 2015





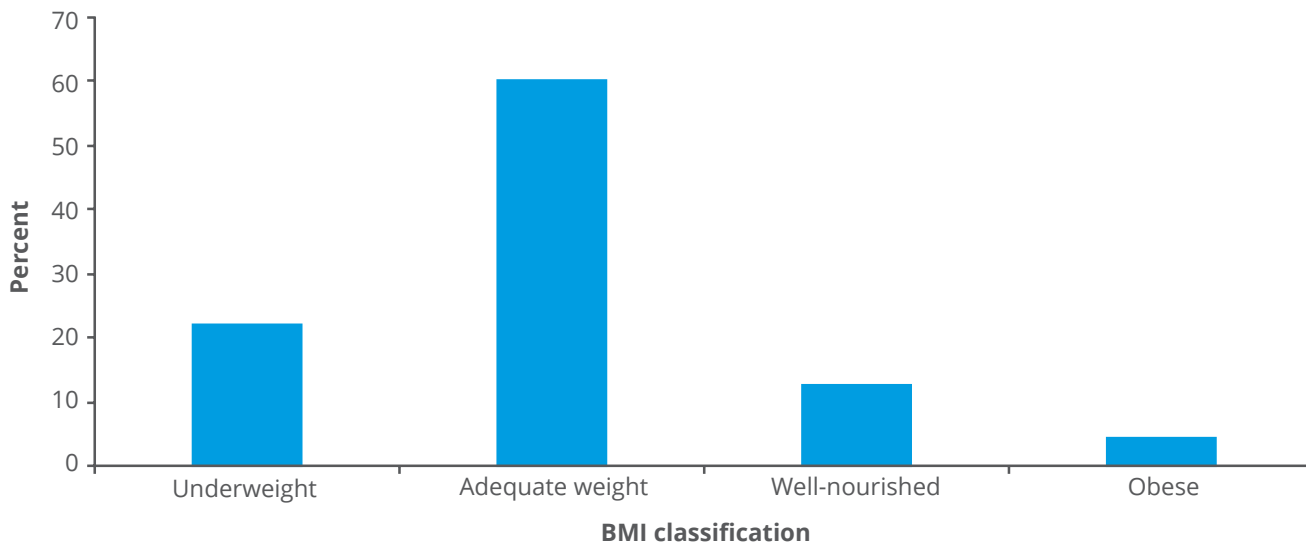
# NUTRITION

## BODY MASS INDEX (BMI)

Body mass index (BMI) is a measure of a person’s nutritional status and is based on their weight (in kilograms) and height (in metres). Typically, this is calculated for adults only because they have attained their maximal height. Children are rapidly growing and therefore, one must consider the child’s age when assessing their nutritional status.

The national median BMI for adults ( $\geq 18$  years) is 22.3 kg/m<sup>2</sup>. Table 5 below describes the BMI classifications and their BMI ranges. In 2015, the majority (60.4%) of the adult CF population had an adequate weight while 22.2% were considered underweight and 4.7% were considered obese (Figure 26).

**FIGURE 26**  
BMI classification for adults with CF, 2015



**TABLE 5**  
BMI classification

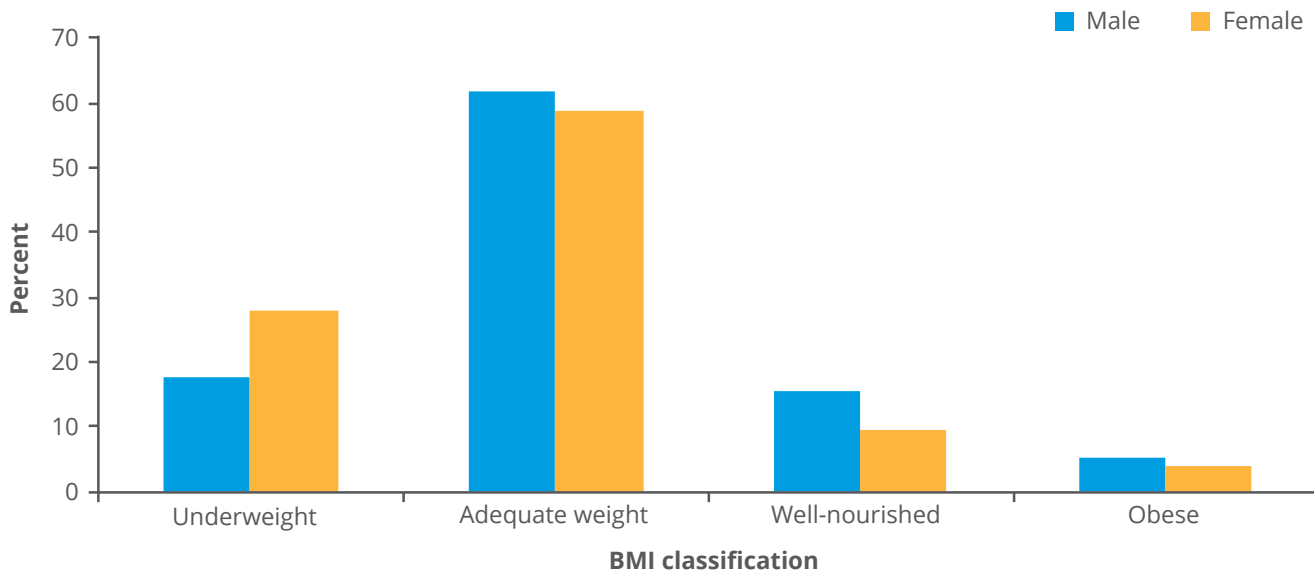
| CLASSIFICATION  | RANGE                         |
|-----------------|-------------------------------|
| Underweight     | < 20.0 kg/m <sup>2</sup>      |
| Adequate weight | 20.0 - 25.9 kg/m <sup>2</sup> |
| Well-nourished  | 26 - 29.9 kg/m <sup>2</sup>   |
| Obese           | $\geq 30$ kg/m <sup>2</sup>   |

# NUTRITION

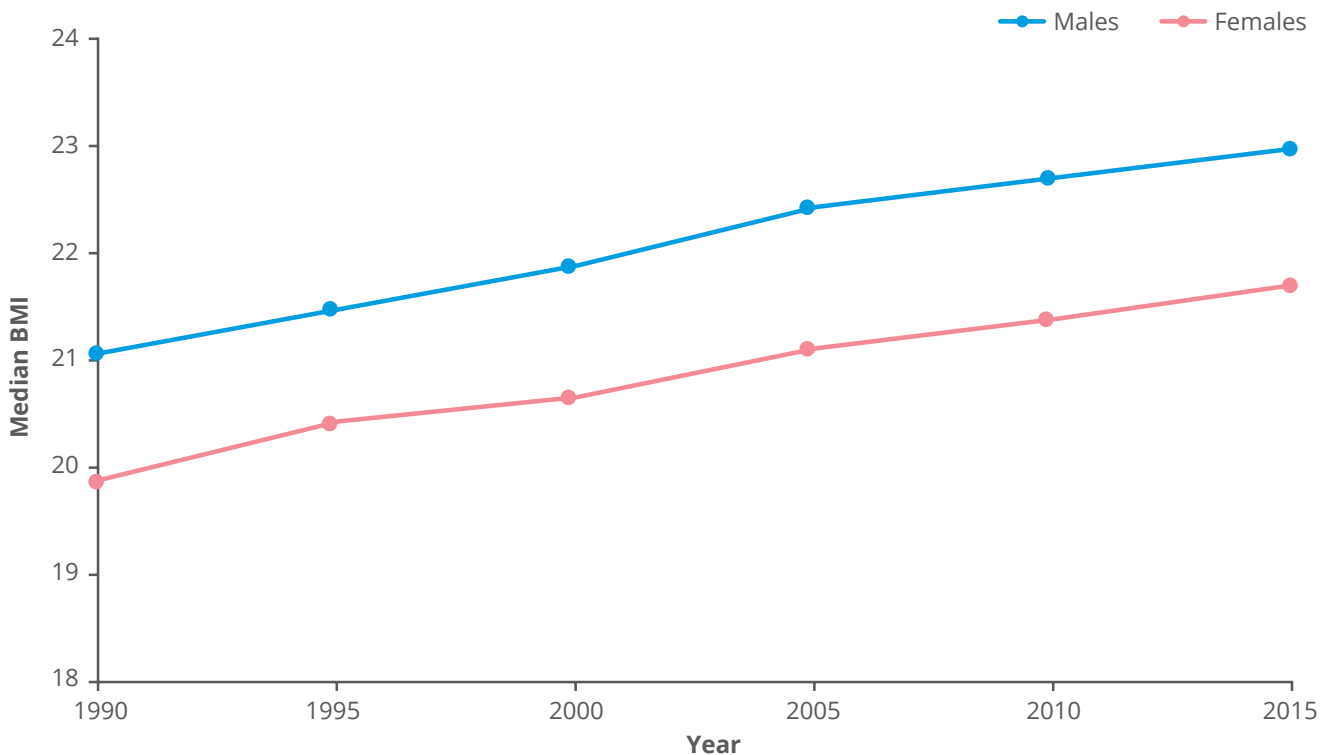
## BMI BY SEX

Figure 27 shows the breakdown of BMI categories for adult males and females. Individuals who are muscular may have a BMI between 26-29 kg/m<sup>2</sup> due to increased weight from high muscle mass. In 2015, a larger percentage of females (27.8%) are considered underweight (BMI < 20 kg/m<sup>2</sup>) compared to males (17.5%). Over the past 25 years, the median BMI has been steadily rising within the CF adult population (Figure 28) and can be attributed to fewer individuals who are underweight (Figures 29-30).

**FIGURE 27**  
BMI classification for adults with CF, by sex, 2015

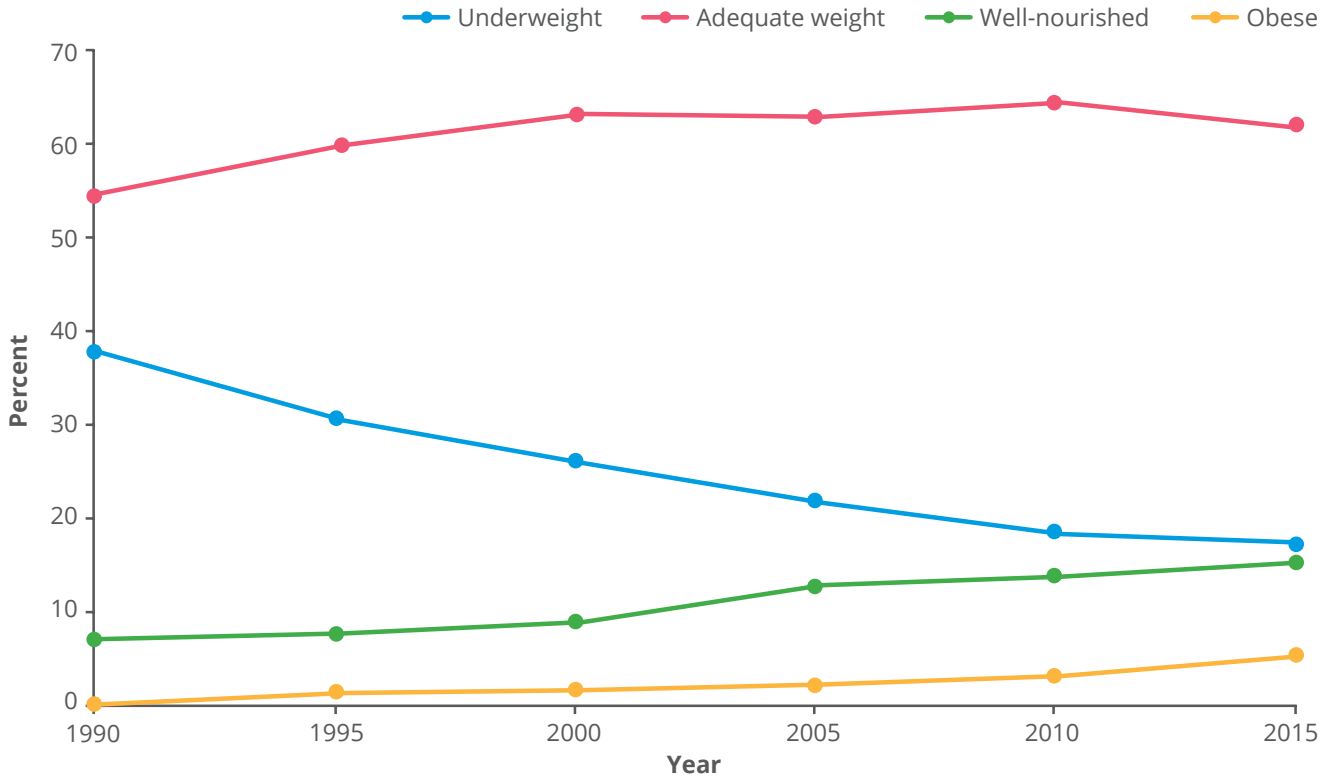


**FIGURE 28**  
Median BMI values for adults with CF, by sex, 1990 to 2015

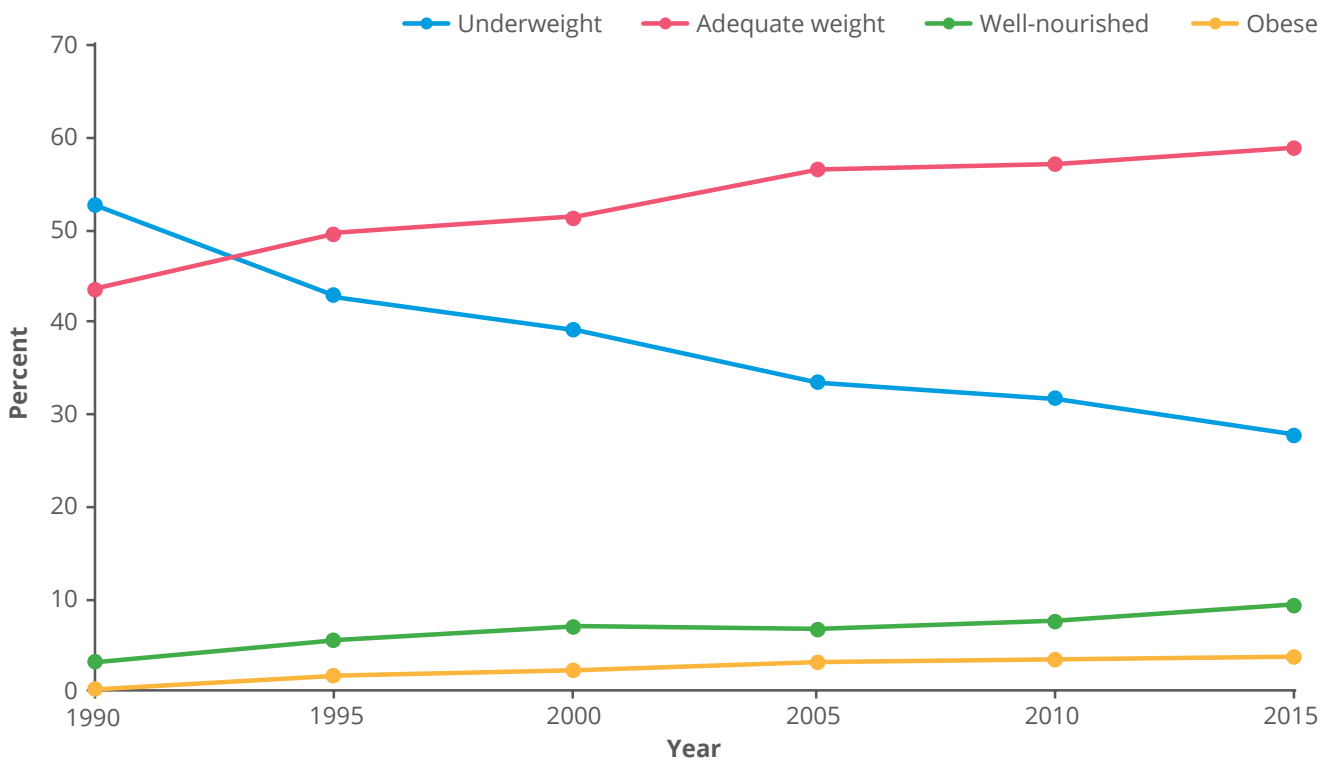


# NUTRITION

**FIGURE 29**  
Percentage of male adults per BMI classification from 1990 to 2015



**FIGURE 30**  
Percentage of female adults per BMI classification from 1990 to 2015



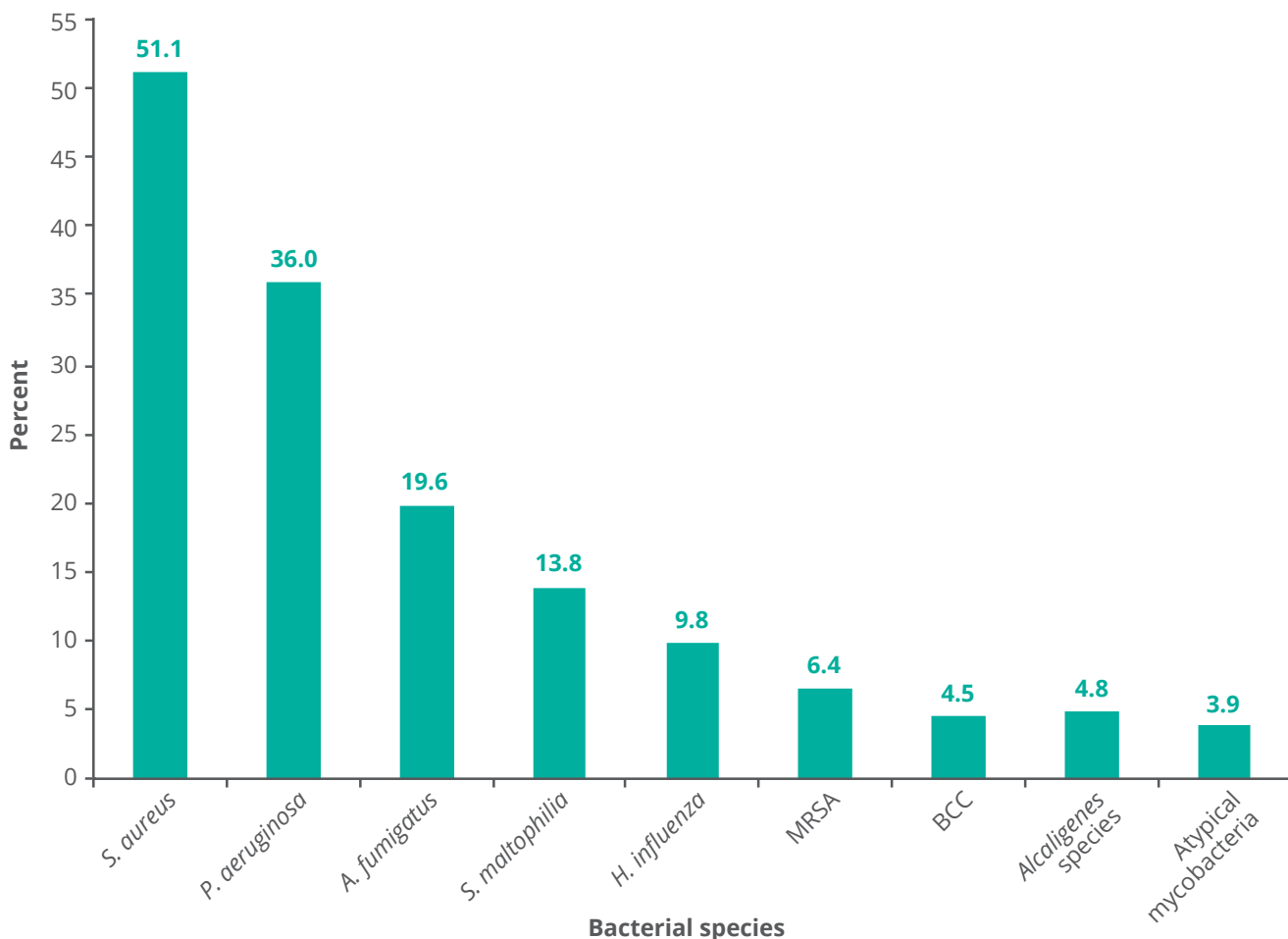
# MICROBIOLOGY

## BACTERIAL SPECIES AND RESPIRATORY INFECTIONS

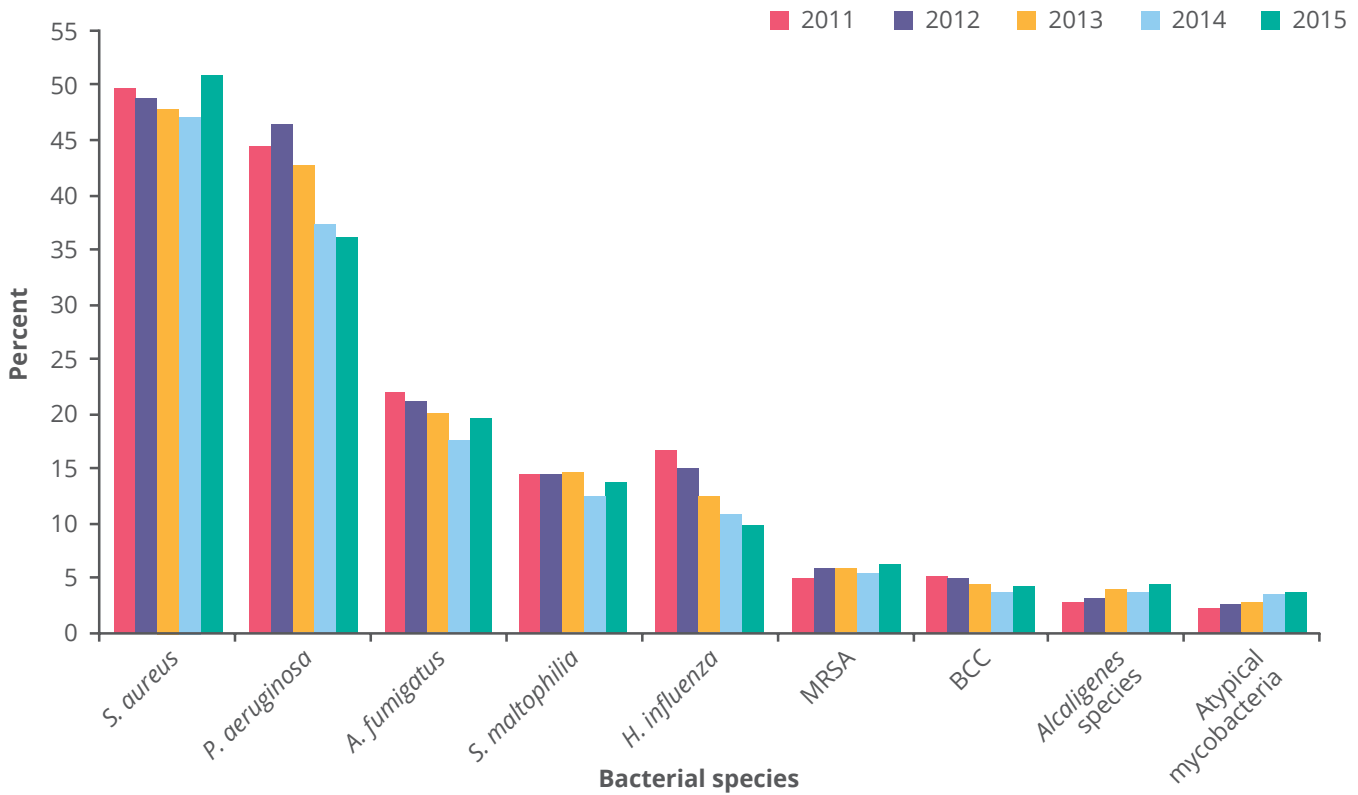
Overall, *Pseudomonas aeruginosa* (36.0%) and *Staphylococcus aureus* (51.1%) are the most common pulmonary pathogens in Canadians with CF (Figure 31). MRSA was added to the CCFR as of 2003. In 2011, clinics began to record additional microbiology data including the prevalence of *Alcaligenes (achromobacter)* species and Atypical mycobacteria.

Since 2010, an interesting trend has emerged with a slight decline in the prevalence of the more common pulmonary pathogens and a slight increase in some of the less common ones (Figure 32). Interestingly, some pathogens are more prevalent in certain age groups. *Staphylococcus aureus* is more common in children with CF and *Pseudomonas aeruginosa* is more common in the adult CF population (Figure 33). The prevalence of *Stenotrophomonas maltophilia* is highest in the teen years (11-17 years) and appears to be lower in older individuals. *Burkholderia cepacia* complex (BCC) is more commonly seen in older individuals with CF but the prevalence is low (4.5%). New acquisition of BCC in general has decreased substantially over the years, due to infection control practices, making its prevalence low in children. However, those individuals who previously acquired BCC are aging, making the prevalence of this organism higher in older individuals.

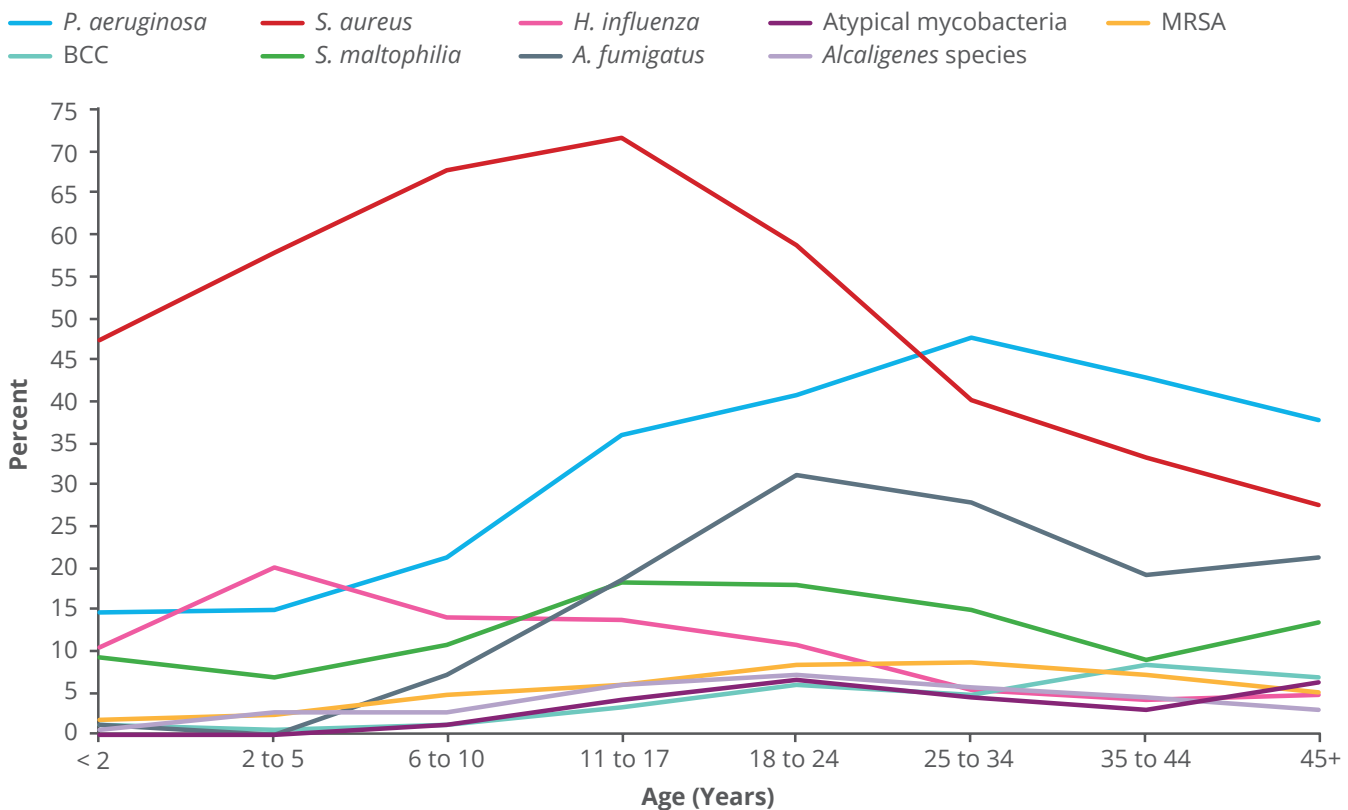
**FIGURE 31**  
Prevalence of bacterial species cultured from airways of individuals with CF (all ages), 2015



**FIGURE 32**  
Prevalence of respiratory infections, 2010-2015



**FIGURE 33**  
Age-specific prevalence of respiratory infections in individuals with CF, 2015



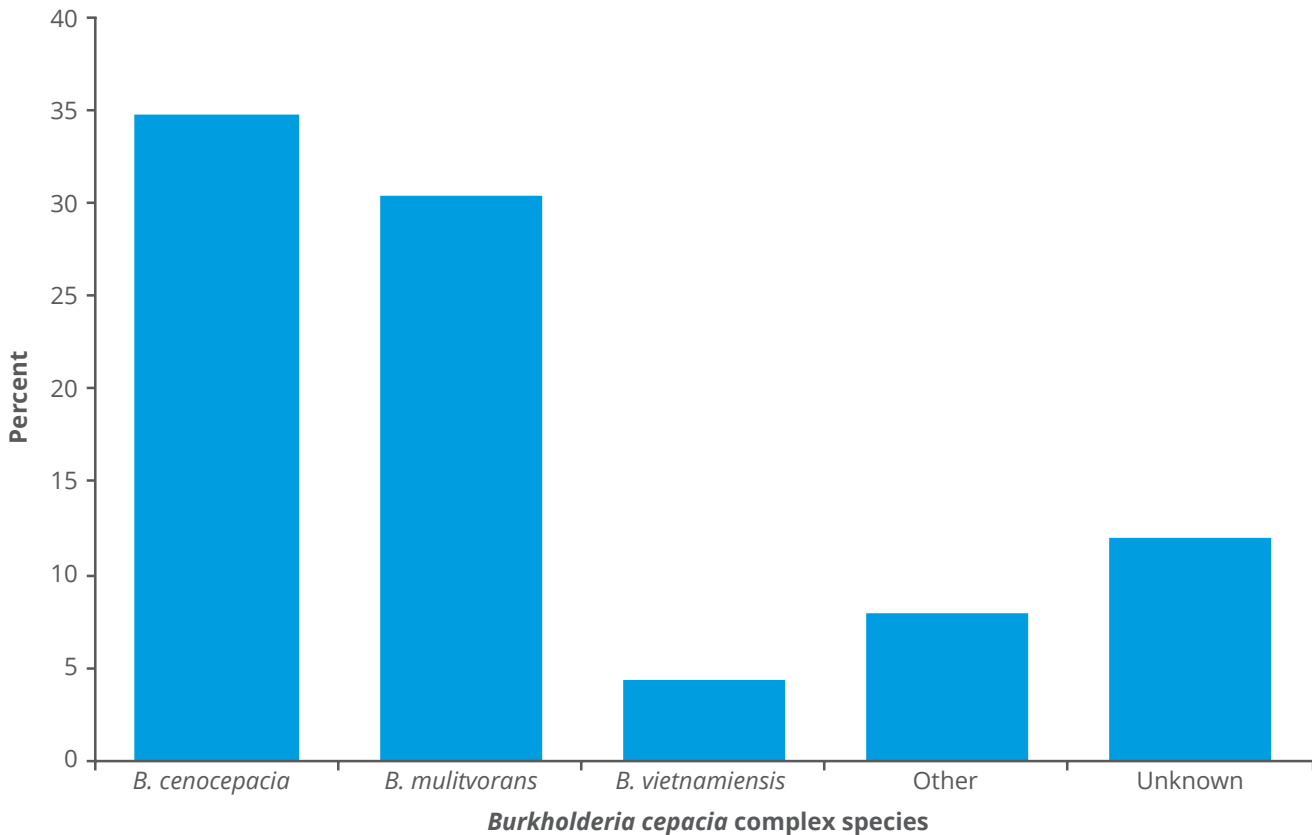
# MICROBIOLOGY

## BURKHOLDERIA CEPACIA COMPLEX (BCC)

There were 188 (4.5%) individuals with CF who grew *Burkholderia cepacia* complex (BCC) species in 2015. *B. cenocepacia* and *B. multivorans* were the two most common types of BCC species. Of the individuals with BCC in 2015, 157 (83.5%) were adults and 49 (26.1%) adults were over the age of 40 (Figure 35). Not all BCC bacteria have been speciated as 12.1% of the BCC species in the CCFR were classified as unknown. Although BCC has been reported on for decades, the ability to specify the type of BCC species was added to the CCFR in 2011.

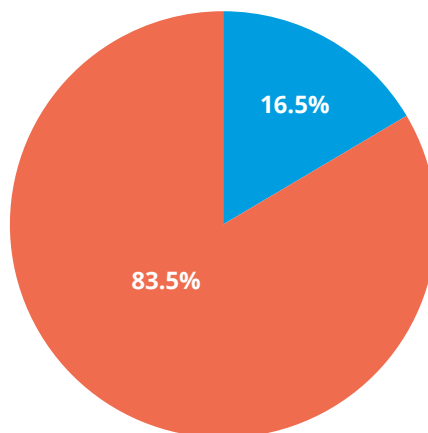
Note: The prevalence of *B. gladioli* was 10.3%, though it was not included in Figure 34 because it is not officially recognized as part of the BCC.

**FIGURE 34**  
*Burkholderia cepacia* complex species, 2015



**FIGURE 35**  
*Burkholderia cepacia* complex distribution by age, 2015

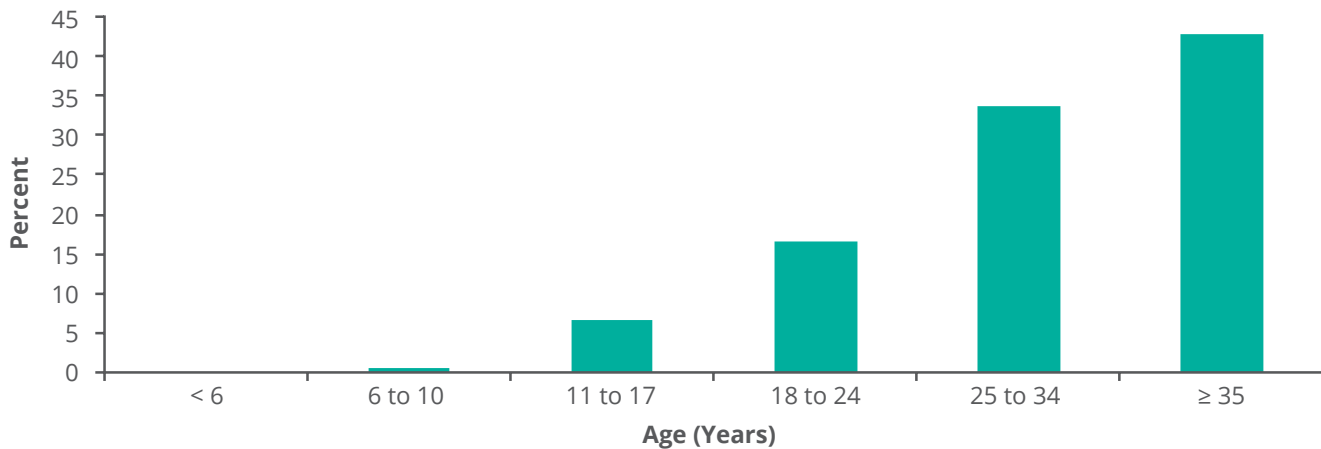
- Children
- Adults



# CF-RELATED DIABETES (CFRD)

Figure 36 shows the increasing prevalence of CFRD with age. CFRD was reported in 992 (23.7%) individuals with CF in 2015 and of those, 22.0% have had a transplant, 49.3% were female and 42.6% were 35 years of age or older.

**FIGURE 36**  
Percentage of individuals with CF with CFRD by age (based on N = 992), 2015

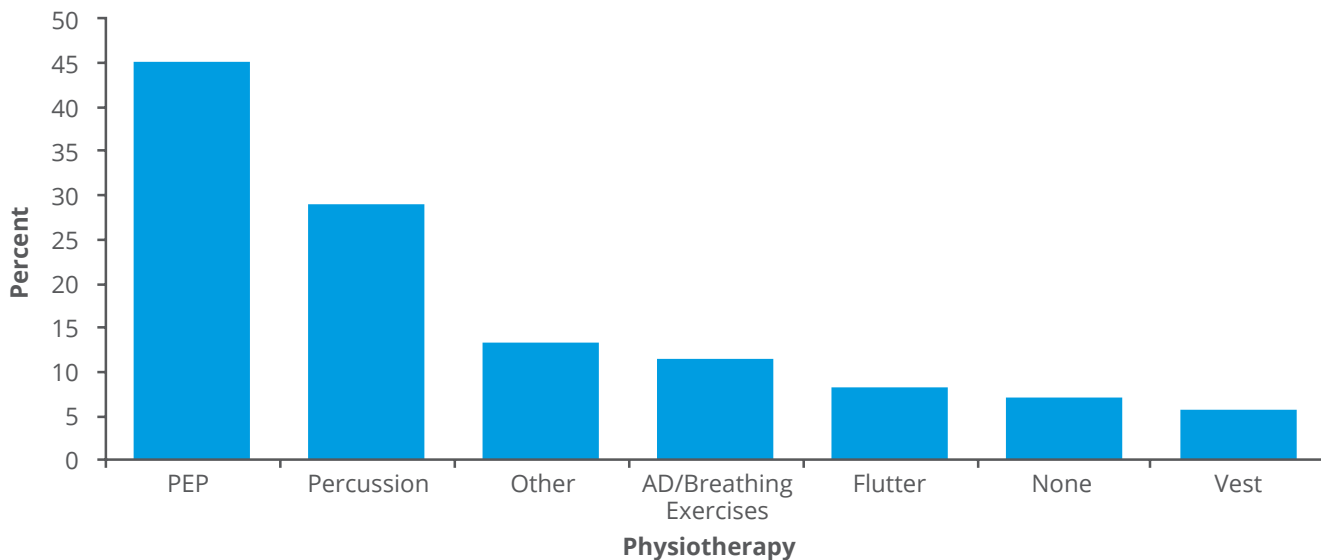


# PHYSIOTHERAPY

Physiotherapy is done to help clear mucous from airways using a variety of methods. Multiple forms of physiotherapy can be used with positive expiratory pressure (PEP) and percussion being the most commonly used by individuals with CF living in Canada (Figure 37).

Note: Individuals who have ever received a lung transplant (7.1%) were excluded from these calculations because, typically, chest physiotherapy is not part of routine post-transplant treatment.

**FIGURE 37**  
Physiotherapy (based on N = 3,894), 2015



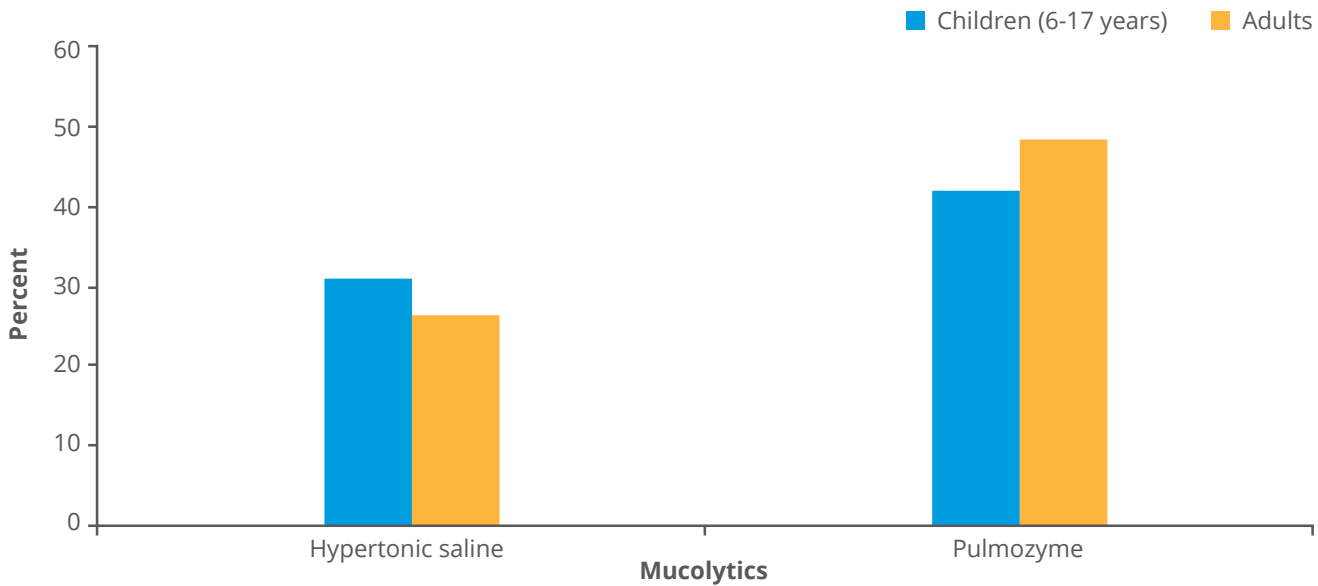
# MEDICATIONS

In 2015, there were a total of 3,375 individuals over the age of 6 years (1,131 children over 6 years and 2,244 adults) who have never received a transplant. Of those, 2,028 (60.1%) were prescribed mucolytic therapy during the calendar year (hypertonic saline and/or Pulmozyme®) (Figure 38).

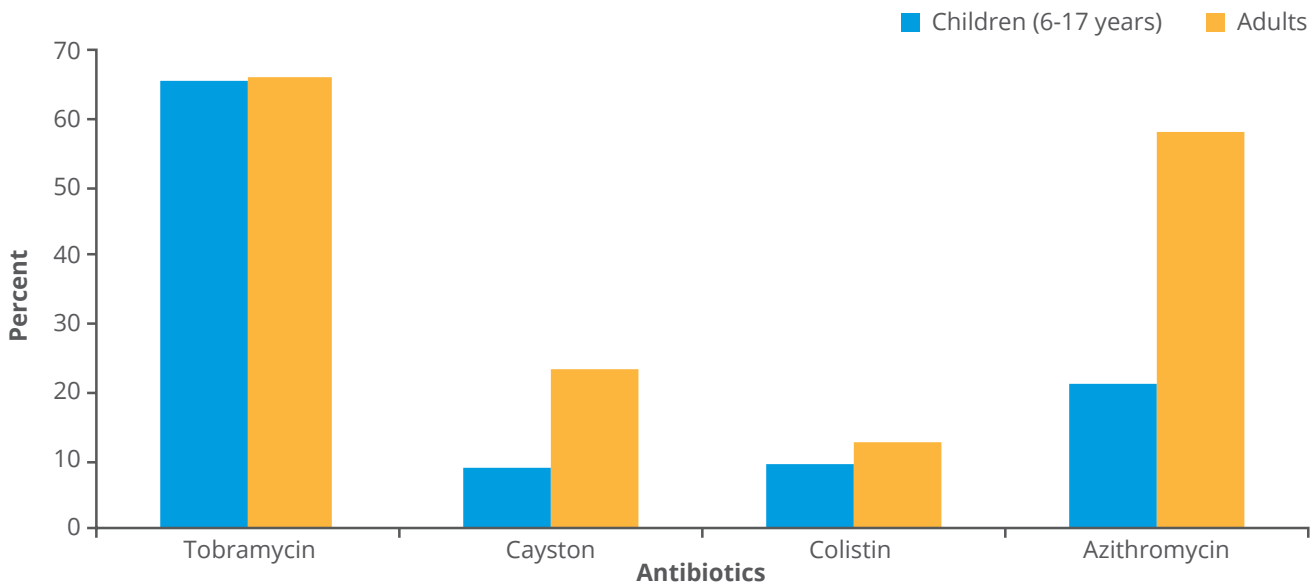
Individuals over the age of 6 years who have never received a transplant and were reported to have *Pseudomonas aeruginosa* in the reporting year include 338 children (6-17 years) and 1,013 adults. There were 238 children (6-17 years) (70.4%) and 818 adults (80.8%) who were prescribed inhaled antibiotic treatment, and 72 children (6-17 years) (21.3%) and 590 adults (58.2%) who were prescribed macrolide therapy (azithromycin) (Figure 39).

There are 35 children and 56 adults with a G551D mutation who are currently taking KALYDECO® (ivacaftor) in 2015.

**FIGURE 38**  
Percentage on mucolytics, by age group, 2015



**FIGURE 39**  
Percentage on antibiotics, by age group, 2015





# HOSPITALIZATION AND HOME IV

In 2015, 2,076 hospitalizations were recorded adding up to over 25,000 days spent in hospital (Table 6) not including visits to the out-patient CF clinics. A total of 4,131 (98.5%) individuals with CF visited a CF clinic at least once with 3,226 (78.1%) having three or more clinic visits. Out of those reported with more than three clinic visits, 1,507 (90.9%) were children and 1,719 (67.8%) were adults. At home, individuals with CF had 1,022 courses of home IV therapy adding up to almost 18,000 days on home IV antibiotics.

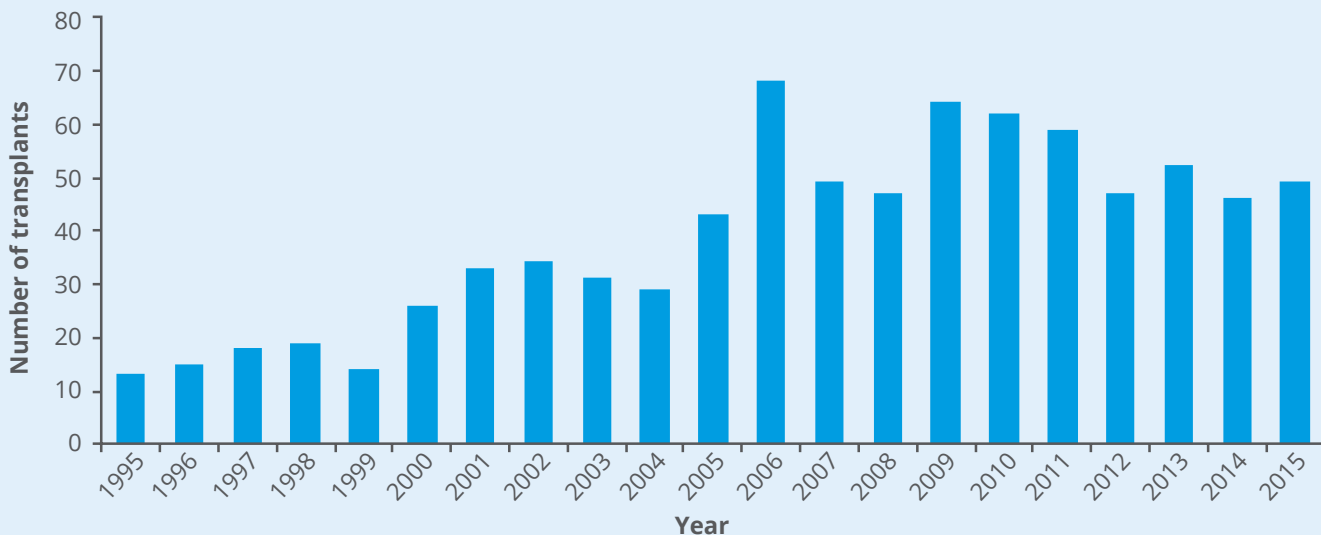
**TABLE 6**  
Number of hospital days and home IV courses, 2015

|                  | TOTAL NUMBER |
|------------------|--------------|
| Hospital Days    | 25,770       |
| Hospitalizations | 2,076        |
| Clinic Visits    | 18,425       |
| Home IV Courses  | 1,022        |
| Home IV Days     | 17,831       |

# TRANSPLANTS

Figure 40 shows the number of transplants carried out per year as reported in the CCFR. In 2015, 49 individuals with CF received a transplant with a median age of 28.5 years at the time of transplant. Although the numbers provided represent primarily lung transplants, individuals who received other combinations (e.g. lung-liver, liver, heart-lung, etc.) are also included in the total. As of December 31, 2015, there were 722 individuals with CF reported as having received one or more transplants. Of those individuals, the median age was 28.5 years at the time of transplant and 426 individuals were reported as being alive with 55.8% of them being male.

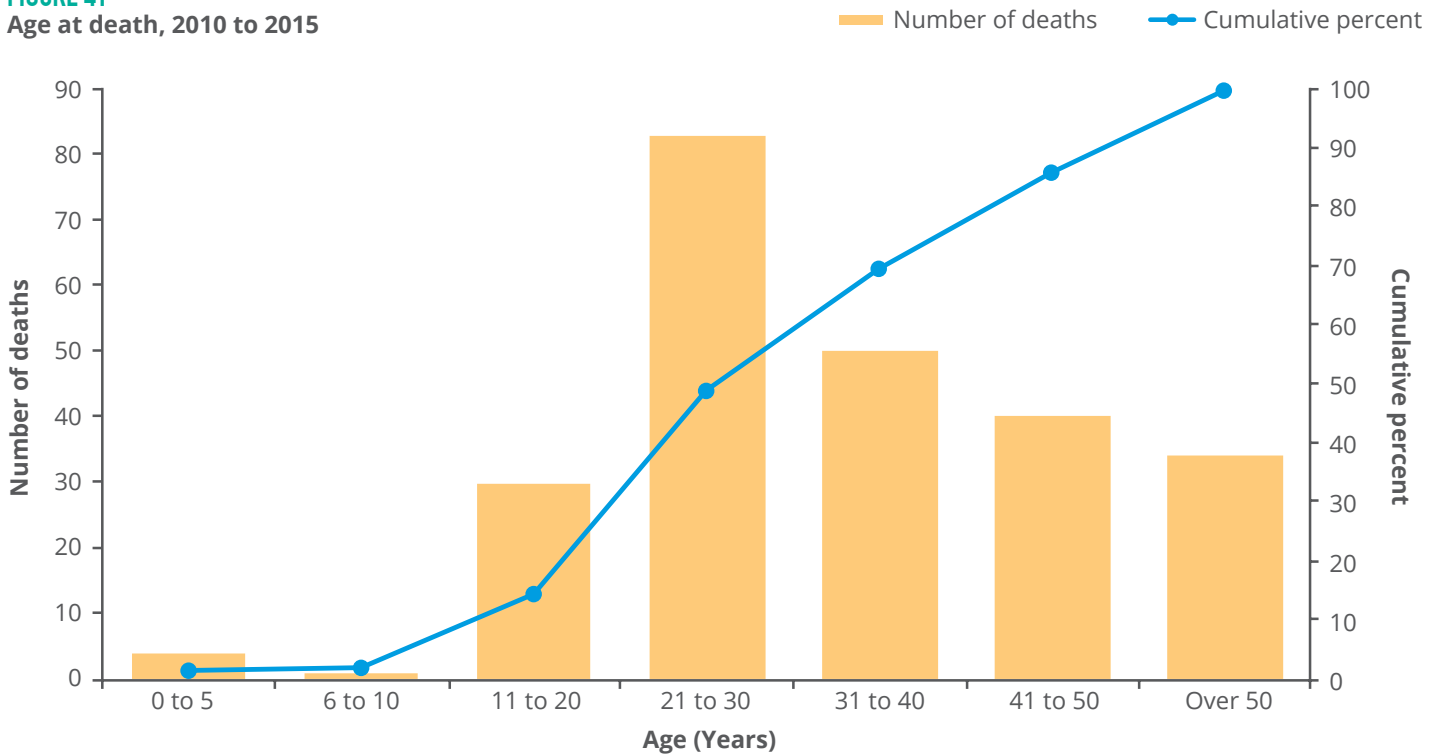
**FIGURE 40**  
Number of transplants per year, 1995 to 2015



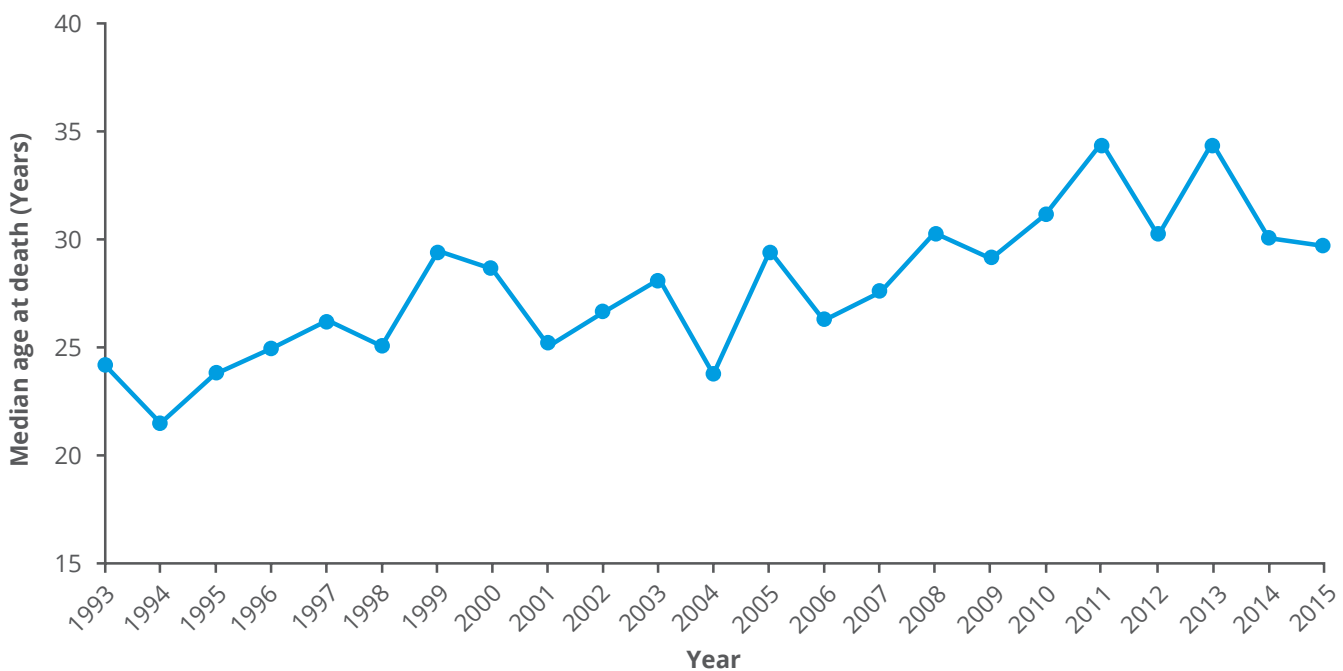
# SURVIVAL

There were 47 deaths recorded in the CCFR in 2015. The cumulative number of deaths reported in 2010 to 2015 are included in Figure 41. The median age at death in 2015 was 29.7 years of age (Figure 42) indicating that half of those who died were younger than the median age at death and the other half who died were older. The most common cause of death was related to pulmonary complications and 16 of the 47 (34.0%) individuals with CF who passed away in 2015 were post-transplant.

**FIGURE 41**  
Age at death, 2010 to 2015



**FIGURE 42**  
Median age at death, 1993 to 2015



# SURVIVAL

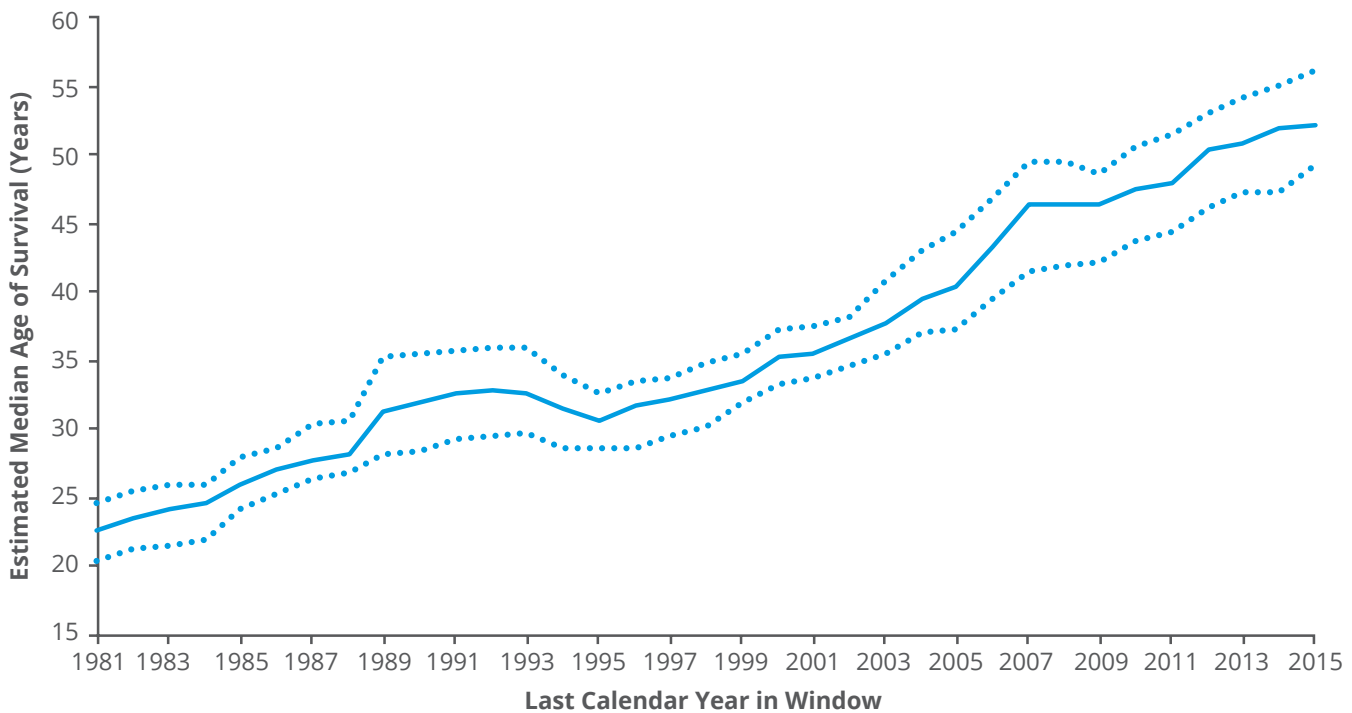
## ESTIMATED MEDIAN AGE OF SURVIVAL

The estimated median age of survival for Canadians with CF is calculated using the Cox proportional hazards model. As there are relatively few deaths per year in Canada, a 5-year rolling window was used to calculate the median age of survival to stabilize the estimates over time. The most recent 5-year window (2010-2015) included 4,776 people with CF and 242 deaths. The number of individuals with CF lost-to-follow-up was 225 (5.0%).

In 2015, the median age of survival is currently estimated to be **52.1 years of age** (Figure 43). The median age of survival is the estimated age to which 50% of the CF population would be expected to survive assuming that current treatments, therapies and mortality rates remain constant. Since transplant is considered a form of therapy for end-stage CF, transplanted individuals are included in the analysis because excluding deaths post-transplant would bias the survival estimates resulting in an overestimation of survival<sup>4</sup>.

Figure 44 shows that males continue to have a higher median age of survival compared to females. While the cause of lower survival in females is not well understood, it has been documented in published CF literature. Survival by birth cohort is presented in Figure 45 and indicates that survival is higher for those born more recently.

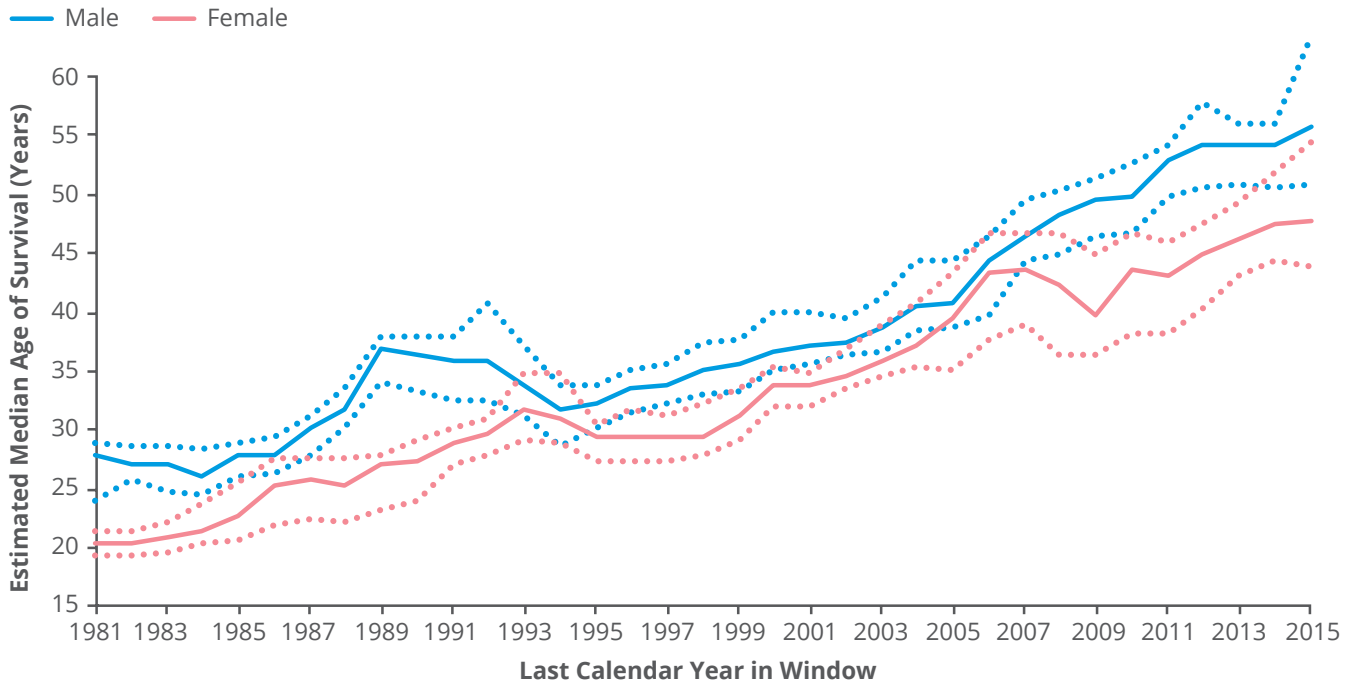
**FIGURE 43**  
Estimated median age of survival for a moving 5-year window with 95% confidence intervals, 1981 to 2015



# SURVIVAL

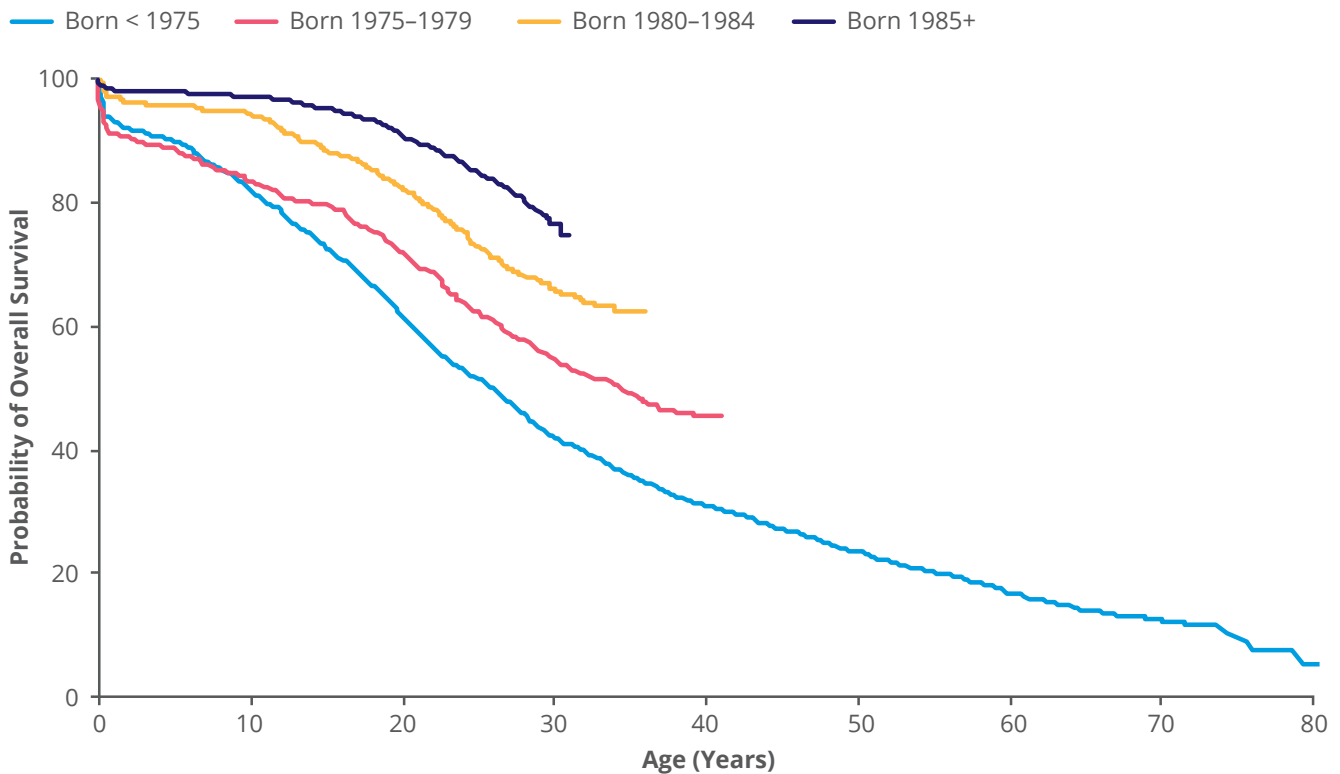
**FIGURE 44**

Estimated median age of survival for a moving 5-year window with 95% confidence intervals, by sex, 1981 to 2015



**FIGURE 45**

Overall survival by birth cohorts



### LIFE EXPECTANCY

The life expectancy is the average age to which someone can be expected to live. In other words, it is the **expected average length of life based on current age-specific mortality rates**. For the general population born today, life expectancy in Canada is 80 years for males and 84 years for females based on data from the World Health Organization<sup>5</sup>. This means that, *on average*, a male baby born today will be expected to live 80 years and a female baby, *on average*, will be expected to live to 84 years of age. Life expectancy is not the same as median age of survival. In comparison, the median age of survival is the estimated age beyond which 50 percent of the population will live - it is not an average.

It is possible to calculate the life expectancy in CF but we do not usually do it because it is influenced by extreme values more so than the median age of survival. For example, the life expectancy may change significantly if one or two people in the population lived until a very old age because it is calculating a mean age whereas the median age is less sensitive to extreme values and is a more robust measurement.

### MEDIAN AGE AT DEATH

The median age at death is very different than the median age of survival. Median age at death is calculated simply by taking into account all deaths in a given year, placing them in ascending order, and determining which age is the middle number. The median age at death is **calculated using only those individuals who have died in a given year**. In other words, of those who died in the year, half died before the median age at death and half died later than the median age at death.

This calculation does not provide information about the individuals who are still alive. You need to know the ages of those still living to get information on median survival.

### MEDIAN AGE OF SURVIVAL

Median age of survival is calculated based on cross-sectional data (i.e. data taken across different age groups) of the CF population and takes into consideration data from both individuals who have died AND those who are still alive. It is the **estimated age beyond which 50 percent of the CF population would be expected to live, assuming the mortality rate in CF remained constant**. This is NOT the age at which people with CF would be expected to die, (i.e. how long someone can expect to live, on average - see *life expectancy* above). Median age of survival is simply *one way* to evaluate survival in the CF population; however, there are other measures that provide us with additional information about how long people with CF are living (for example, median age at death and annual death rate).

When we say that the median age of survival in 2015 is 52.1 years, we are saying that if a child with CF is born in Canada in 2015, they have a 50% chance of living beyond 52.1 years of age based on current mortality rates. In other words, half of the CF population would be expected live to an age older than 52.1 years. Of course, mortality rates are not static and are constantly changing as new therapies and medicines for CF become available. Thus, this estimate is a reflection of the most accurate data that is available in 2015.

Keep in mind that these survival estimates apply to a population of individuals and do not necessarily apply to any one individual.

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**Jenna Sykes**, Research Biostatistician, St. Michael's Hospital, Toronto

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## CANADIAN CF CLINICS

|  |  |
|--|--|
| Victoria General Hospital, Victoria                        | St. Michael's Hospital, Toronto  |
| Royal Jubilee Hospital, Victoria                           | Kingston Health Sciences Centre, Kingston  |
| BC Children's Hospital, Vancouver                          | Children's Hospital of Eastern Ontario, Ottawa                                   |
| St. Paul's Hospital, Vancouver                             | Ottawa General Hospital, Ottawa  |
| Alberta Children's Hospital, Calgary                       | <i>Centre de santé et de services sociaux de Gatineau, Hull</i>                  |
| Foothills Hospital, Calgary                                | Montreal Children's Hospital, Montreal   |
| University of Alberta Hospitals, Edmonton                  | Montreal Chest Institute, Montreal   |
| Royal University Hospital, Saskatoon                       | <i>Hôpital Ste-Justine, Montréal</i>   |
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| Windsor Regional Hospital, Windsor                         | <i>Hôpital de Chicoutimi, Chicoutimi</i>   |
| London Health Sciences Centre, London                      | <i>Centre hospitalier régional de Rimouski, Rimouski</i>                         |
| Children's Hospital, London Health Sciences Centre, London | <i>Centre de santé et des services sociaux de Rouyn-Noranda, Rouyn-Noranda</i>   |
| Grand River Hospital, Kitchener                            | IWK Health Centre, Halifax   |
| St. Mary's Hospital, Kitchener                             | QEII Health Sciences Centre, Halifax   |
| Hamilton Health Sciences Corporation, Hamilton             | Saint John Regional Hospital, Saint John   |
| McMaster Children's Hospital, Hamilton                     | Janeway Children's Health Centre, St. John's                                     |
| The Hospital for Sick Children, Toronto                    | Health Sciences Centre, St. John's   |

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