WETENSCHAPPELIJK INSTITUUT
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INSTITUT SCIENTIFIQUE
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BMR RBM

THE BELGIAN CYSTIC FIBROSIS REGISTRY

SUMMARY REPORT 2008

BMR Belgisch Mucoviscidose Register
RBM Registre Belge de la Mucoviscidose

ERRATUM

Table 1, Table 4, Figure 14 and Figure 22 have been updated.

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WHAT is Cystic Fibrosis?

Cystic Fibrosis (CF) is a hereditary disease with autosomal recessive transmission: only subjects who have inherited two disease causing mutations – one from each parent - are affected. It has an incidence of 1 in 2850 live births in Belgium (1).

The disease is caused by the alteration (mutation) of the *CFTR* (Cystic Fibrosis Transmembrane Conductance Regulator) gene which is located on the long arm of chromosome 7. More than 1500 mutations have been identified in the *CFTR* gene since its discovery in 1989. The *CFTR* gene codes for the CFTR protein. This is an ion channel involved in the regulation of chloride ion transport across the cell membrane. It is mainly found in the cell membranes of the respiratory and digestive tract, the sweat glands and the reproductive tract. The dysfunction of the CFTR protein leads to the production of sweat with a high salt content and mucus secretions with an abnormal viscosity causing dysfunction of many organs such as the lungs, pancreas and liver.

In the respiratory tract, thick mucus production results in persistent cough caused by chronic infection and inflammation leading to severe bronchial obstruction and finally lung destruction.

In the pancreas, the sticky exocrine pancreatic secretions lead to obstruction and blocking of the ducts with secondary damage to the secretory gland tissue. Diminished secretion of pancreatic enzymes leads to fat and protein malabsorption causing steatorrhea (fatty stools) and failure to thrive. Fat malabsorption also causes deficiency of fat soluble vitamins (A, D, E and K).

Most of the children with CF have a history of recurrent chest infections, steatorrhea and failure to thrive.

Newborns with CF can be affected by meconium ileus: intestinal obstruction with vomiting, abdominal distension and delay in passing the first meconium stools. The spectrum of presenting features is very wide and can vary with the age at time of clinical presentation. The diagnosis is usually made in early childhood but in some patients with late or milder symptoms it can occur later into adulthood.

Although there is no neonatal CF screening program in Belgium yet, infants with CF can be identified in the first weeks of life by assessing their blood immunoreactive trypsin (IRT) combined with the most frequent CFTR mutations.

The sweat test remains the gold standard for the diagnosis of CF. In the majority of patients with typical features, the sweat test is diagnostic. It will reveal an excessive quantity of chloride (salt) (> 60 mEq/L). In atypical forms, the sweat test chloride levels can fall into the intermediate range (30-60 mEq/L).

It is advised to perform genotyping in all patients with CF, to identify the CF causing mutations. The most common mutation in Belgium is F508del.

Today there is no causal cure for CF, treatment is symptomatic and is essentially based on respiratory (e.g. physiotherapy, inhalation therapy, antibiotics), digestive and nutritional management (e.g. pancreatic enzymes and hypercalorie diet).

Due to medical progress and intensification of the care for patients with CF, the quality of life and the life expectancy have increased. Promising therapies aiming to correct the basic defect are being evaluated.

CF Patient care in Belgium

Since 1999, 7 CF reference centres have been accredited by the National Institute for Health and Disability Insurance (INAMI - RIZIV) and receive financial support. An annual care and revalidation agreement (CF convention) for patients with CF is signed between each of the 7 CF reference centres and the RIZIV-INAMI. Each centre has specific expertise in CF care and ensures multidisciplinary follow-up of the patients in order to provide optimal medical, paramedical, psychological and social care to the patient and their relatives.
Most of the persons with CF in Belgium are followed in one of the 7 national CF reference centres and are recorded in the national CF Registry.

The Belgian Cystic Fibrosis Registry (BMR-RBM)

The intent of a CF Registry is to include, in a single database, the entire population of patients with CF, within a defined geographical area. In 2008, 1087 persons with CF attending a Belgian CF reference centre were registered in the BMR-RBM.

The BMR-RBM was started in 1999 as a scientific project initiated by the Medical Committee of the CF-patient organisation (BVSM-ABLM[1]) and the 7 CF-reference centres in Belgium collecting data of 1998. It was coordinated by the Vrije Universiteit Brussel (VUB). The main sponsor was the CF-Patient organisation, the cosponsor was the Fund Alfonse and Jean Forton of the King Baudouin Foundation. The VUB sponsored the overheads. After 5 years the scientific project came to an end and new sponsors were contacted.

In 2006, the RIZIV-INAMI became the principal sponsor and the Registry was transferred to the section of Public Health and Surveillance of the Institute of Public Health (IPH). Since then, the IPH ensures the collection and the management of the data under the supervision of the board of the BMR-RBM and the guidance of a scientific steering group. The board consists of a physician from each CF centre and the scientific collaborators of the IPH. The scientific steering group holds all stakeholders (representatives of the INAMI-RIZIV, patient association, CF Centers and scientific collaborators of the IPH).

The Belgian CF Registry lies since 2006 within the framework of the CF convention described above. Participation in collection of data for the CF Registry is one of the obligatory tasks of the CF reference centres.

The objectives of the Registry are :

1 | to study epidemiological aspects of CF in Belgium

2 | to provide an evaluation tool for the assessment of the management and quality of care for patients with CF

3 | to provide a database for scientific research to CF researchers

4 | to participate in European and international projects or registries.

[1] BVSM-ABLM : Belgische Vereniging voor Strijd tegen Mucoviscidose
Association belge de Lutte contre la Mucoviscidose

Prior to the registration, the physicians provide each patient and their parents (or legal representative) information about the objectives of the Registry.

The patients are only included in the Registry after signing an informed consent. They are identified by a unique code. Their names are never transferred to the Registry.

The clinical data is collected by the treating physician from medical records and consists of more than 200 variables.

These are divided into 2 sections:

1 | The core data contains demographic data, age of CF diagnosis and initial symptoms, genotype, sweat test results and nasal transepithelial difference. This data is collected when the patient enters the Registry and is updated if necessary during follow-up years.

2 | Yearly follow-up sheets collect clinical data (height, weight), lung function (forced expiratory volume in one second (FEV1), vital capacity (FVC), FEF 25-75), complications that occurred or still active during the registration year, microbiology, treatments as well as social data.

SUMMARY OF REPORT 2008

The data presented in this report relates to the population observed in 2008 and also shows cumulative data since the start of the data registration in 1998 for some selected attributes.

1 | DEMOGRAPHIC DATA

Table 1 | Demographic data since the start of the Registry

	Number of patients	New diagnoses	Median age (years)	Age range (years)	Males (%)	Adults ≥ 18 yrs (%)	Number of lung (-heart) transplants	Deaths reported
1998	566	37	14.9	0.0 - 55.6	50.4	38.5	13	5
1999	604	26	15.2	0.2 - 56.2	52.5	39.1	4	12
2000	761	35	14.8	0.1 - 57.3	51.8	37.7	10	9
2001	785	28	14.5	0.0 - 58.6	52.9	38.9	13	9
2002	825	31	15.3	0.3 - 58.9	52.8	42.3	11	10
2003	855	32	15.8	0.0 - 55.0	54.3	43.4	9	14
2004	887	35	16.6	0.1 - 55.9	53.9	45.6	13	8
2005	945	47	17.5	0.3 - 56.8	52.1	48.1	11	3
2006	1026	52	17.4	0.2 - 60.9	51.4	48.6	14	7
2007	1057	32	17.4	0.0 - 62.0	51.4	49.3	16	8
2008	1087	25	18.1	0.1 – 67.4	51.7	50.2	17	5

Table 1 shows that 1087 patients were followed by the multidisciplinary teams of the reference centres in 2008. The number of patients enrolled in the Registry has doubled since 1998. In 2008, the median age was 18.1 years with an age range from 0.1 to 67.4 years and the proportion of males of 51.7%. The percentage of adults has risen steadily since the start of the Registry and now represent 50.2% of the total number of patients. In 2008, 17 patients received a lung transplant and there were 25 new diagnoses and 5 deaths reported.

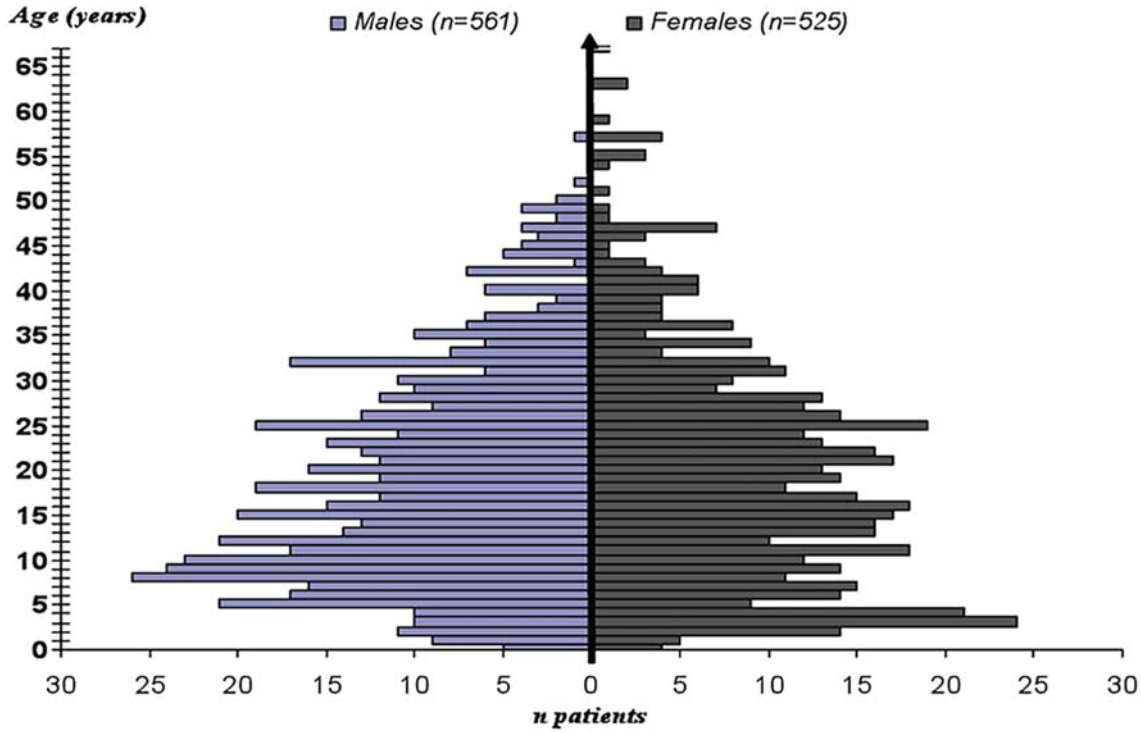


Figure 1 | Age distribution related to gender for patients with CF on December 31, 2008

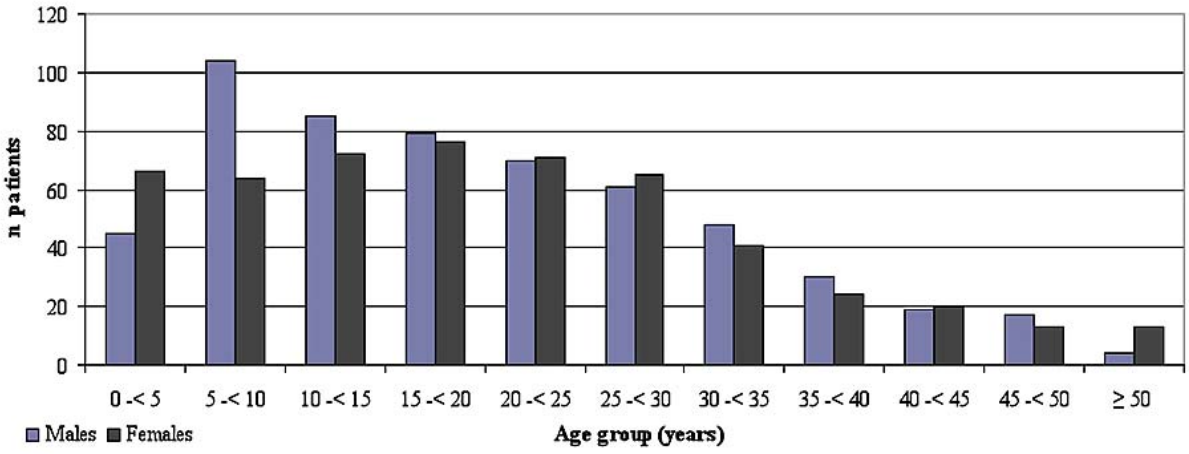


Figure 2 | Gender distribution of patients with CF by 5 year age groups

Figure 1 & 2 show the age distribution of the patients with CF at December 31, 2008 by gender. The age distribution over the years is shown in figure 3. It shows an increase in the total number of patients and also in the proportion of patients aged 40 years and above. Whereas 7 (1.2%) patients were older than 40 years in 1998, this number reached 85 (7.8%) in 2008. In 2008 more than half of the registered patients were adults (figure 4).

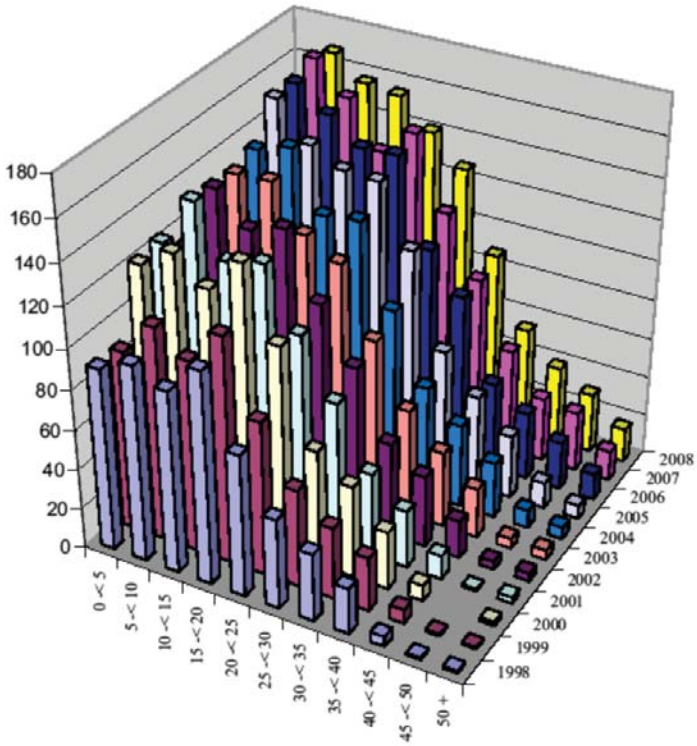
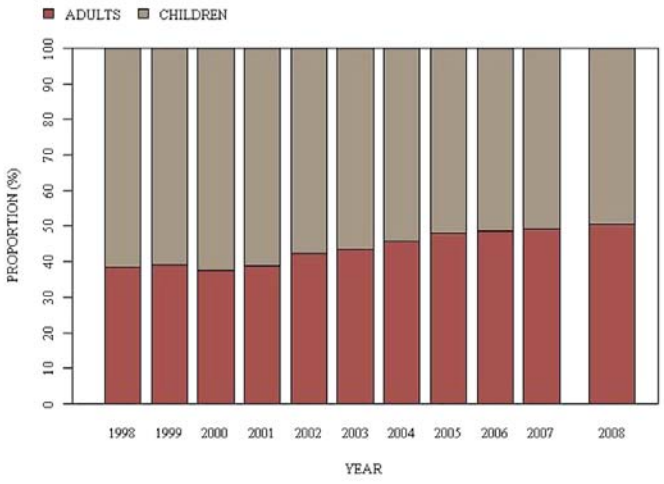


Figure 3 | Number of patients by age categories and by registration year

Figure 4 | Proportion of children and adults : 11 years evolution



2 | DIAGNOSIS

2.1 | Diagnostic signs

In a patient with suggestive symptoms, a family history of cystic fibrosis or a positive neonatal screening test, the diagnosis of CF is confirmed by an abnormal sweat test and/or the identification of two mutations in the *CFTR* gene. Although no national neonatal screening program was implemented in Belgium, some children were screened for CF. Most patients present with a combination of respiratory and/or gastrointestinal symptoms. Chronic cough, recurrent chest infections, chronic sinusitis are the most common presenting respiratory signs. Common gastrointestinal symptoms include meconium ileus (obstruction of the bowel with sticky secretions in the newborn infant), chronic diarrhea and failure to thrive due to malabsorption. Less frequently, salt loss, jaundice or a rectal prolapse are the first diagnostic signs. In some cases, the diagnosis of cystic fibrosis is delayed until adulthood. Most of these patients are expected to have had a milder clinical course.

The diagnostic signs or clinical presentation are illustrated in table 2.

In the Registry, It is possible to report more than one diagnosis sign or symptom for the same patient. Over the years, the commonest clinical presentation of CF remains acute or recurrent respiratory problems. Other common features on presentation were failure to thrive, chronic diarrhea/steatorrhea and meconium ileus. About 16.0% of the patients were diagnosed via neonatal screening test.

Table 2 | Reasons for CF diagnosis

	1998	2003	2008
Acute or recurrent respiratory problems	43.2	43.4	44.7
Failure to thrive	23.5	22.9	24.5
Chronic diarrhea/steatorrhea/malabsorption	27.5	24.0	22.6
Neonatal screening test	15.3	15.5	16.2
Meconium ileus	15.9	14.3	13.6
Family history	8.7	7.8	9.4
Nasal polyposis / chronic sinusitis	2.5	3.4	4.0
Rectal prolapse	3.8	2.7	3.1
Intestinal obstruction (other than meconium ileus)	3.0	3.0	2.9
Prenatal diagnosis	0.8	1.8	2.1
Dehydration / electrolyte imbalance	1.5	1.5	1.6
Neonatal jaundice	0.6	0.5	0.7
Infertility	0.4	0.9	0.7
Diagnosis other	.	6.3	7.1

The reasons for diagnosis are not mutually exclusive.

2.2 | Age at diagnosis

In figure 5, the bars represent the number of patients diagnosed in each age group. The curve shows the cumulative percentage. From data 2008, the median age at diagnosis was 6.9 months with 65 % of the patients diagnosed before their first birthday. In 7.2 % of the patients, diagnosis was delayed until adulthood (18 years or older).

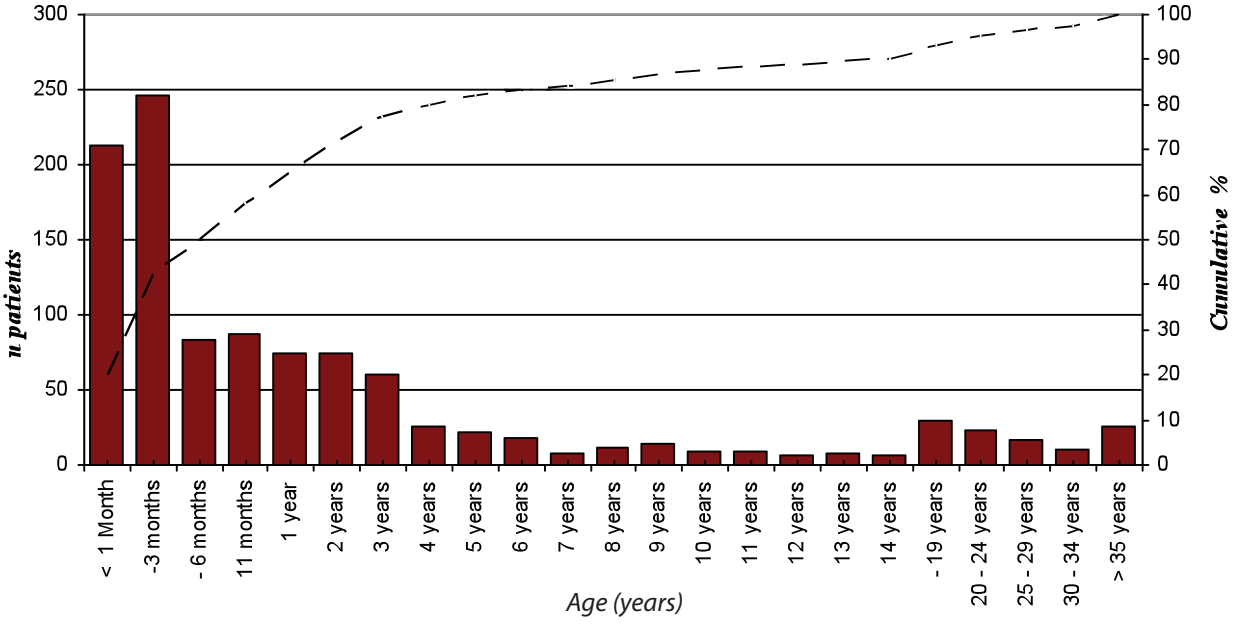


Figure 5 | Age at diagnosis of CF

2.3 | Genotyping

About 98% of the patients registered in 2008 have undergone a genetic analysis. Almost half (46.8%) were homozygote for F508del and 84.4% of the patients had this mutation on at least one of their alleles (table 3). The proportion of patients in which only one or no mutation was identified was 14.2%.

Table 4 shows that the most common genetic mutation, F508del, was identified in 65.3% of the alleles. The G542X and N1303K were both identified in 2.7%. The group labeled 'other mutations' are those mutations which were present in less than 0.5% of the alleles. Respectively 917 (84.4%), 53 (4.9%) and 52 (4.8%) of the patients were carriers of either the F508del, G542X, N1303K mutation on at least one allele.

Table 3 | Genotype: mutation pairs (chromosomes)

	n	%
F508del- F508del	502	46.2
F508del-Other	344	31.6
F508del-NI	71	6.5
Other-Other	86	7.9
Other-NI	33	3.0
NI-NI	35	3.2
Subtotal	1071	
Missing	16	1.5
Total	1087	

NI = not identified

Table 4 | Most frequent mutations (alleles) and number of patients carrying those mutations

	N patients	% patients		N alleles	% alleles
F508del	917	84.4		1419	65.3
G542X	53	4.9		58	2.7
N1303K	52	4.8		58	2.7
1717-1G->A	32	2.9		32	1.5
3272-26A->G	27	2.5		27	1.2
R117H	26	2.4		26	1.2
S1251N	26	2.4		26	1.2
A455E	21	1.9		21	1.0
R553X	19	1.7		19	0.9
2789+5G->A	18	1.7		18	0.8
W1282X	16	1.5		16	0.7
L927P	11	1.0		11	0.5
2183AA->G	11	1.0		11	0.5
3849+10kbC->T	11	1.0		11	0.5
I507del	10	0.9		11	0.5
R1162X	10	0.9		12	0.6
Others	186	17.4		196	9.2
Not identified*	136	12.5		170	7.8
Subtotal				**2142**	
Missing	16	1.5		32	
Total				**2174**	

3 | ANTHROPOMETRY (HEIGHT, WEIGHT AND BMI)

In this section data from 102 patients who have received (a) transplant(s) have been excluded.

Persons with CF are known to be prone to nutritional deficiencies. Because of thick mucus, the pancreas is unable to produce and/or carry digestive enzymes to the instestines. This leads to poor absorption of proteins, fats and fat soluble vitamins resulting in poor weight gain and growth. Nutritional care is of great importance for patients with CF. Maintaining or achieving a better nutrional status has a positive impact on lung function. For this reason, close follow-up of height, weight and BMI is standard practice in all CF centers.

3.1 | Height

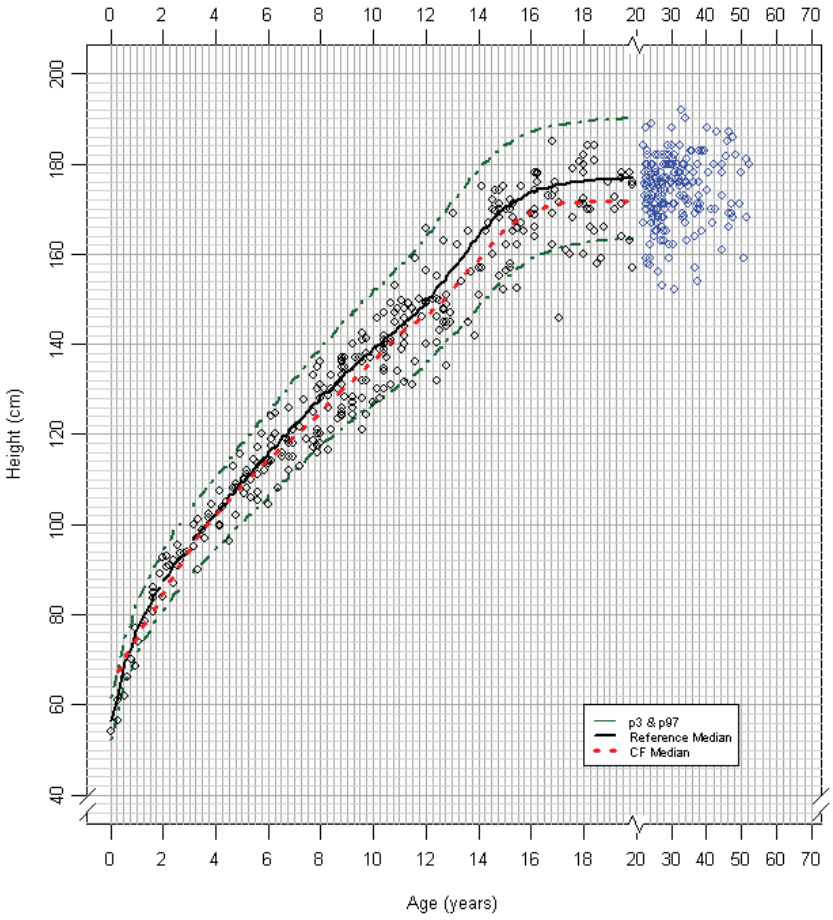


Figure 6 | Height in males.

Figures 6 & 7 show the height of 581 children with CF (310 males and 271 females) aged between 0 and 20 years (using the CDC reference curves (2)). Most male and female CF children had a height within the normal range, between the 3rd and 97th percentile (green lines). The median height of children with CF (dotted red line) was below the median height of the reference population (black line), meaning that patients with CF are shorter than their healthy peers. 8.3% of the patients were considered to be too short, with a height below the 3rd percentile. The height of the 383 adults (age ≥ 20 years) (192 males and 191 females) are represented by the blue scatters plots.

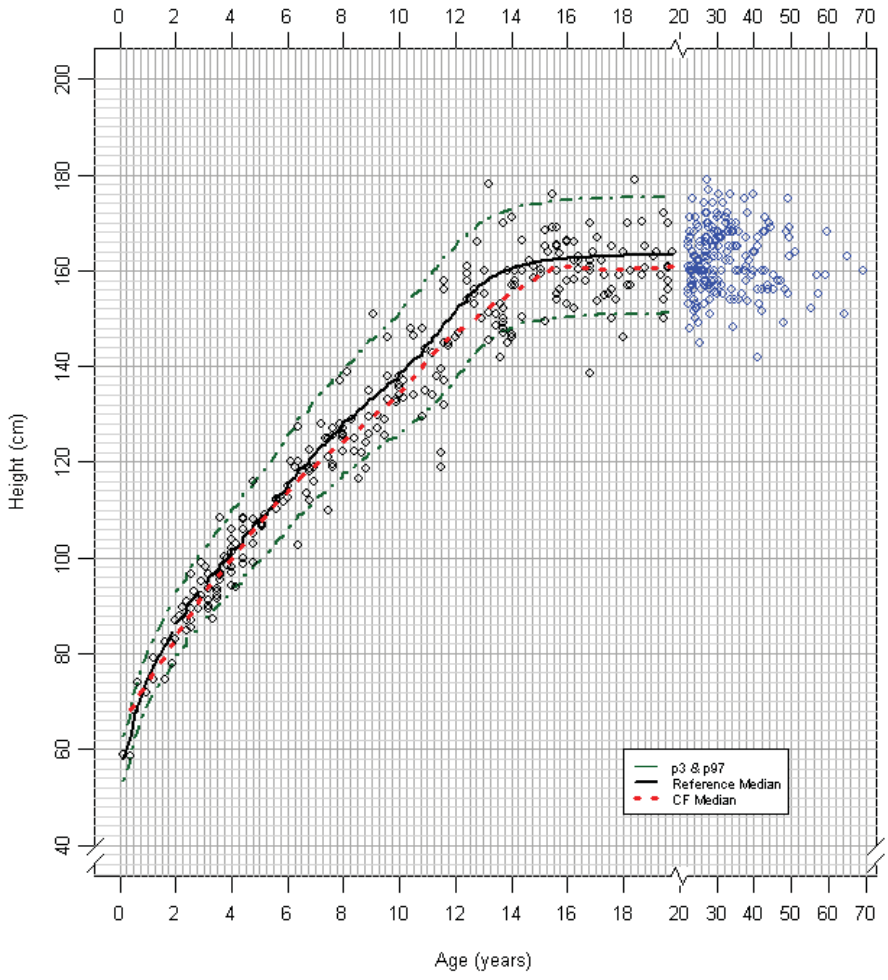


Figure 7 | Height in females.

3.2 | Weight

Figures 8 & 9 show the scatter plots of weight of 587 children with CF (316 males and 271 females). The weight of most of the patients was between the 3rd and 97th percentile with a higher proportion below the 50th percentile. 12.4% of the patients (11.8% of the males and 13.1% of the females) were underweighted (weight below the 3rd percentile). The median weight for the patients with CF (dotted red line) was below the median weight for the reference population (black line). The blue dots represent the weight of 377 adults (older than 20 years); 186 males and 191 females.

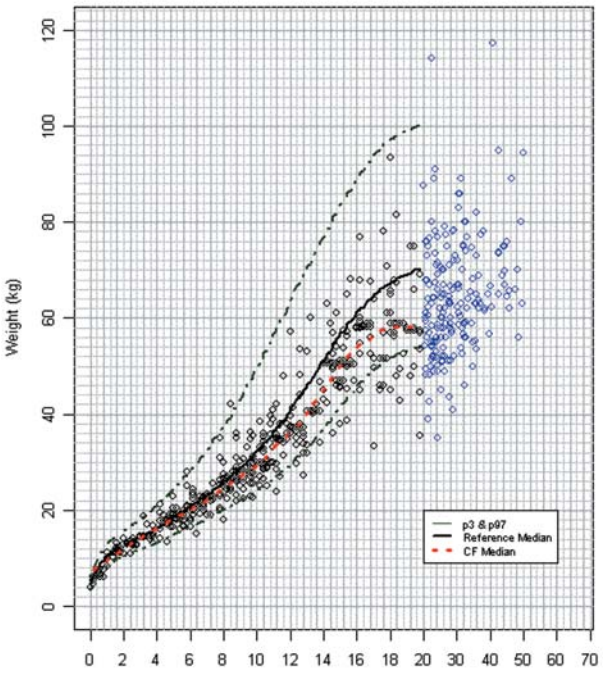


Figure 8 | Weight in males.

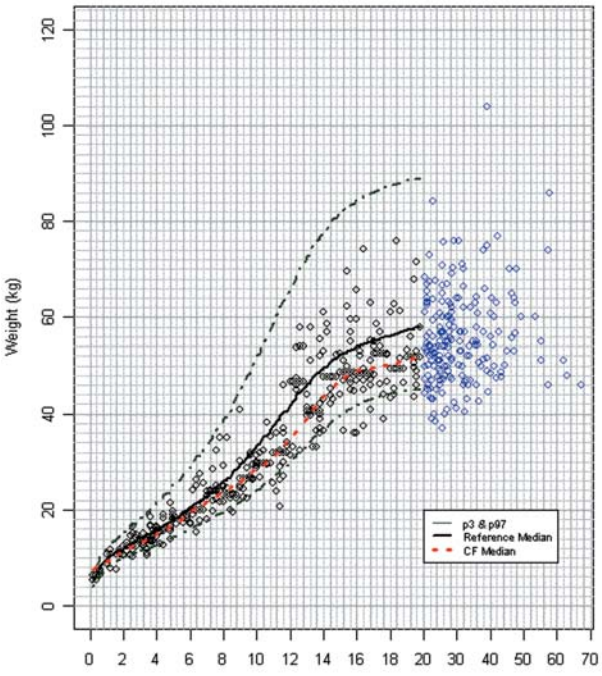


Figure 9 | Weight in females.

3.3 | BMI

The body mass index (BMI) can be obtained by dividing the weight (in kg) by the square of the height (in m). BMI is a 'rough' measure of nutritional status, a higher BMI reflecting better nutrition. Figure 10 and 11 show a decreasing median BMI percentile (red line) with age in the Belgian children with CF. Ideally, children with CF should have a median BMI close to that of the non-CF

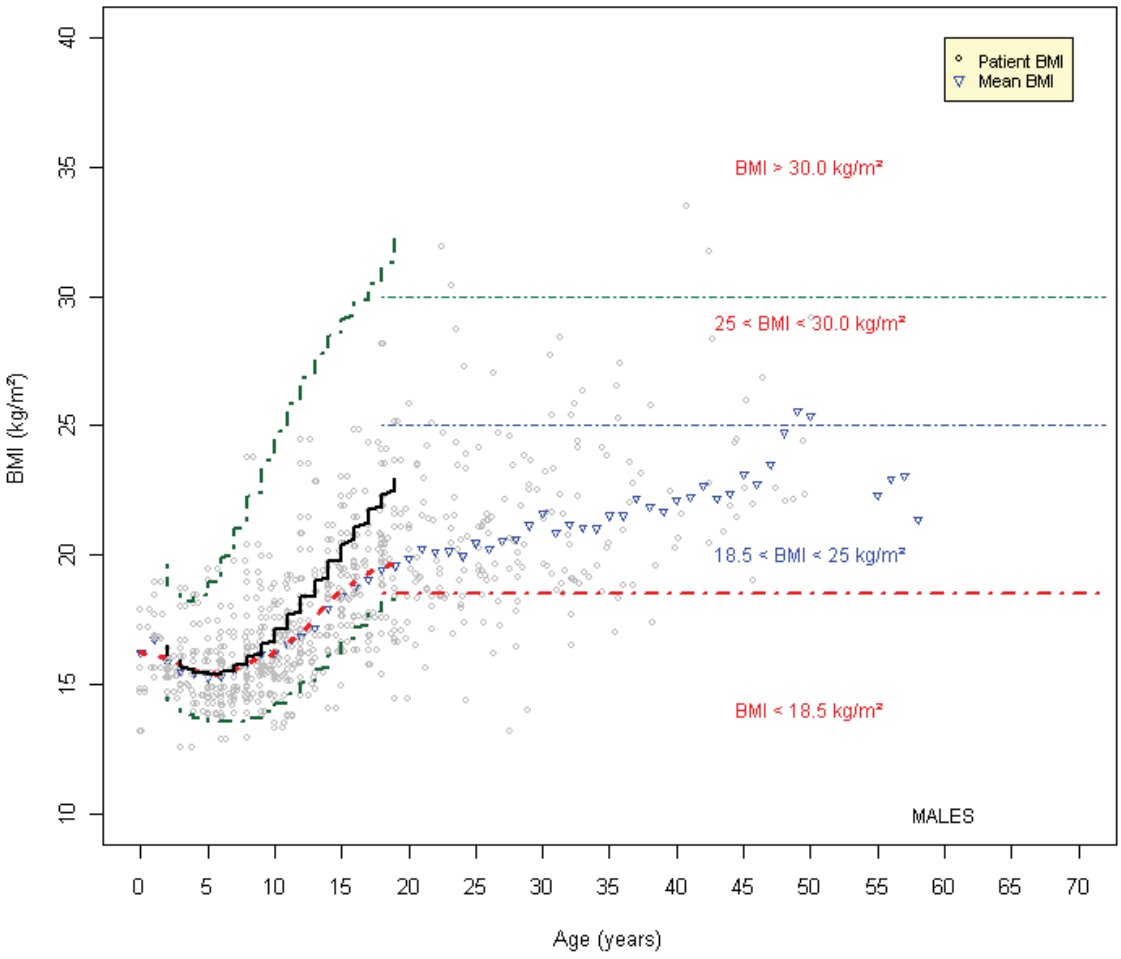


Figure 10 | BMI in males

In adults, the patients are classified as underweight (< 18.5 kg/m^2), in the normal range (18.5-25 kg/m^2) or as overweight (> 25 kg/m^2). In 2008, the BMI was in the normal ranges (18.5-25 kg/m^2) in 70.4% of the adult patients (69.4% of the males and 72.4% of the females). The proportion of underweight adult patients was 18.8% (19.2% and 18.6% in males and females respectively).

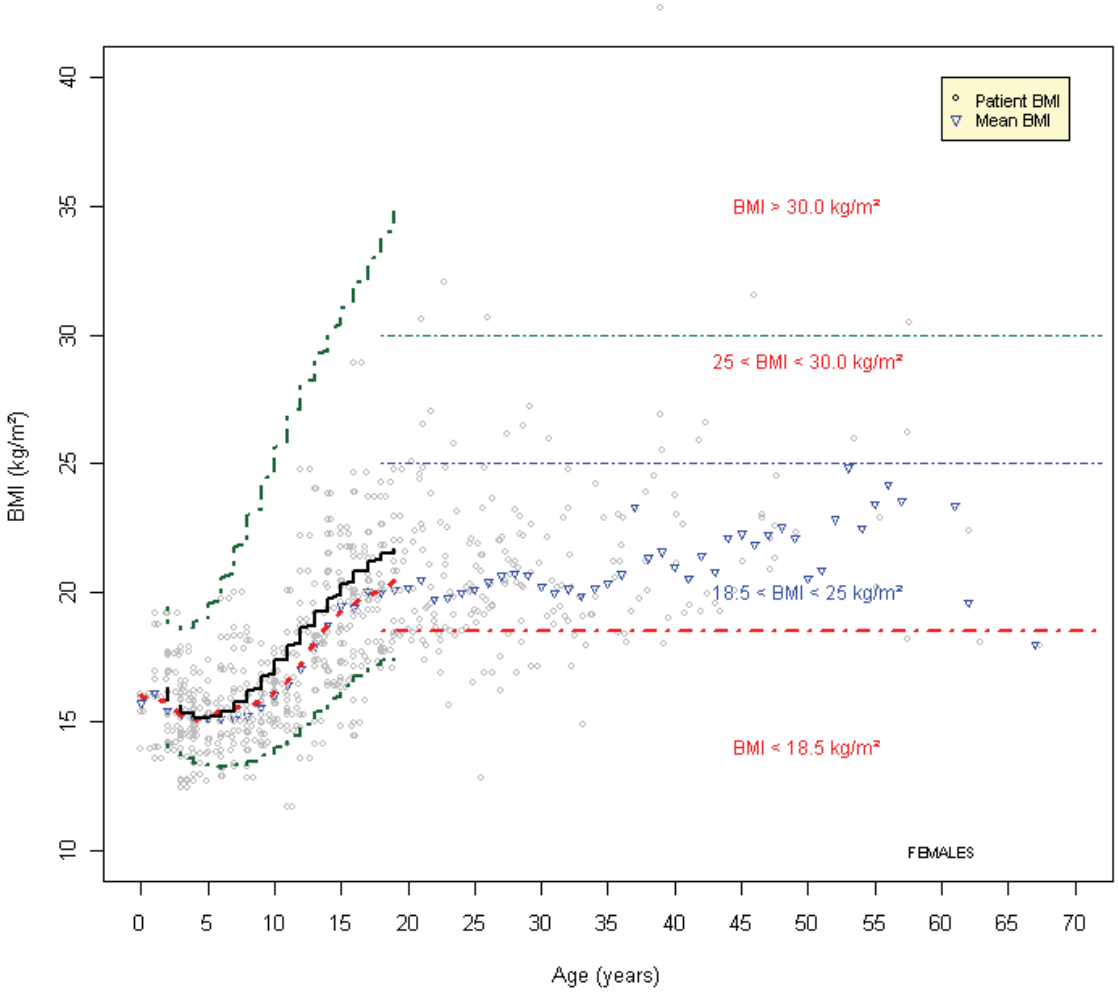


Figure 11 | BMI in females

Figures 12 and 13 show the evolution of BMI over the last 11 years of analysis in the Belgian children (figure 12) and adults (figure 13) with CF homozygous for F508del. Only patients homozygous for F508del were included in this analysis, to compare a similar population over the years. In the reference population, by definition, 10% of the children have a BMI below the 10th percentile (see

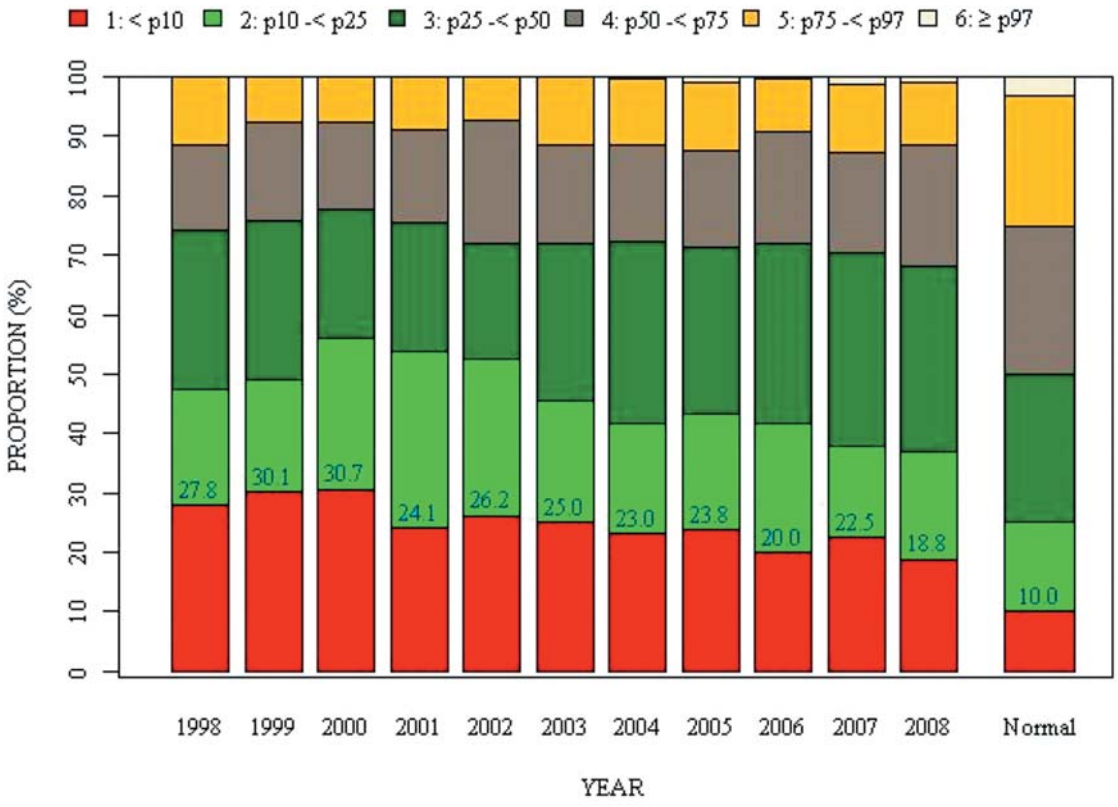


Figure 12 | CDC BMI percentiles of F508del homozygous children aged 2-20 years.

last bar of figure 12, red part). In the children with CF, over the last 11 years, the proportion of patients with a low BMI (below the 10th percentile) has steadily decreased from 27.8% in 1998 to 18.8% in 2008. Among the adults, the proportion of underweight individuals has decreased from 38.1% to 21.1% over the same period (figure 13).

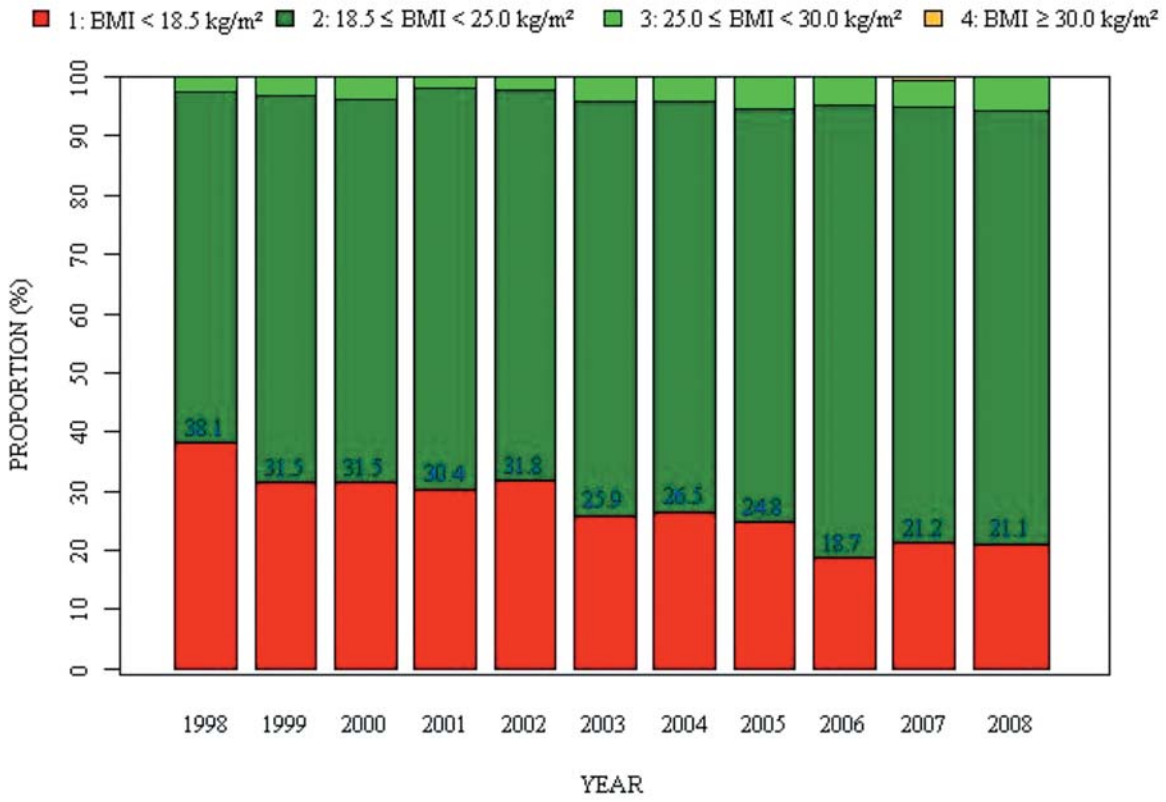


Figure 13 | Proportions of F508del homozygous adult patients in each BMI group.

4| Lung function

Because most patients with CF develop progressive pulmonary disease, measures of pulmonary involvement, in particular FEV1, have been used as markers of disease severity and to predict survival. However, considerable heterogeneity exists in prognosis and severity, even among patients of the same genotype.

The forced expiratory volume in 1 second (FEV1) is the amount of air that a person is able to expire forcefully in one second, following full inspiration. The percent predicted FEV1 is a clinical parameter to monitor lung function impairment and is expressed as a percentage of the predicted value for a reference population with same age, gender, height (using Wang-Hankinson equations (4, 5).

The FEV1% predicted values are divided in four classes for the CF population corresponding to different degrees of lung function impairment: normal lung function (≥ 90%), mild (70-89%) moderate (40-69%) and severe (< 40%) lung function impairment. The data presented excludes patients who have benefited from a lung transplant. Below the age of 6 years lung function measurements are not always reliable and are thus not reported here.

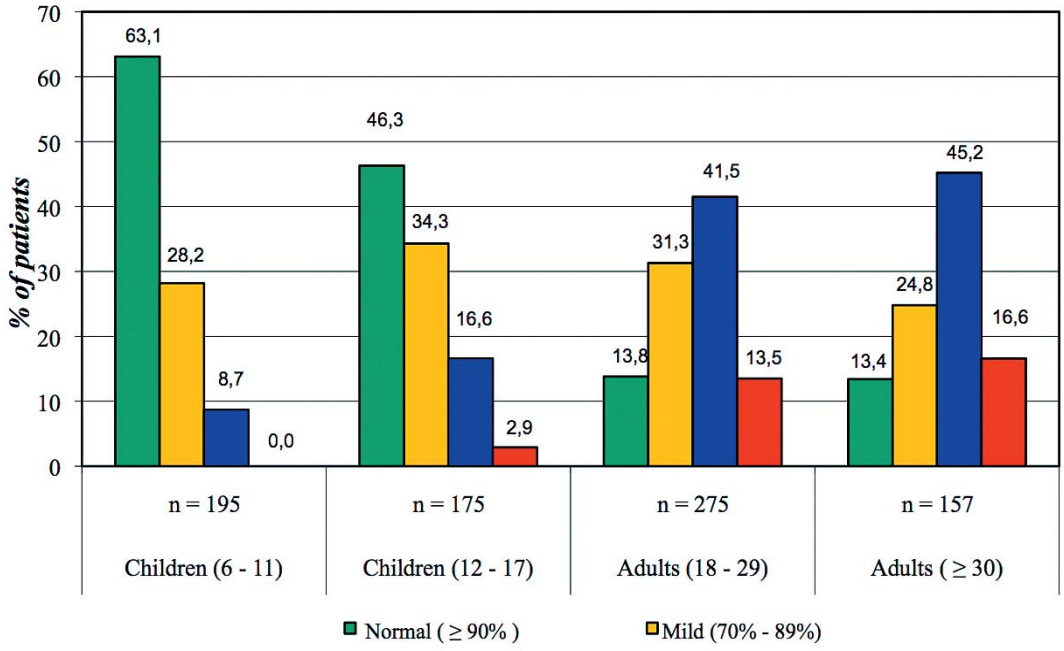


Figure 14| Classification of patients in various FEV1% predicted severity group categories by age groups

In 2008 (figure 14), the lung function at the last outpatient clinic of the year was reported in the Registry and was available for 97.6% of the patients aged 6 years and above.The majority of children below 12 years (91.3%) had a normal lung function or a mild lung function impairment (≥ 70%) whereas in the adult population aged 30 years and above this was only 38.2 %. No child less than 12 years had severe lung function impairment while this was the case in 16.6 % of the adults aged 30 years and above.

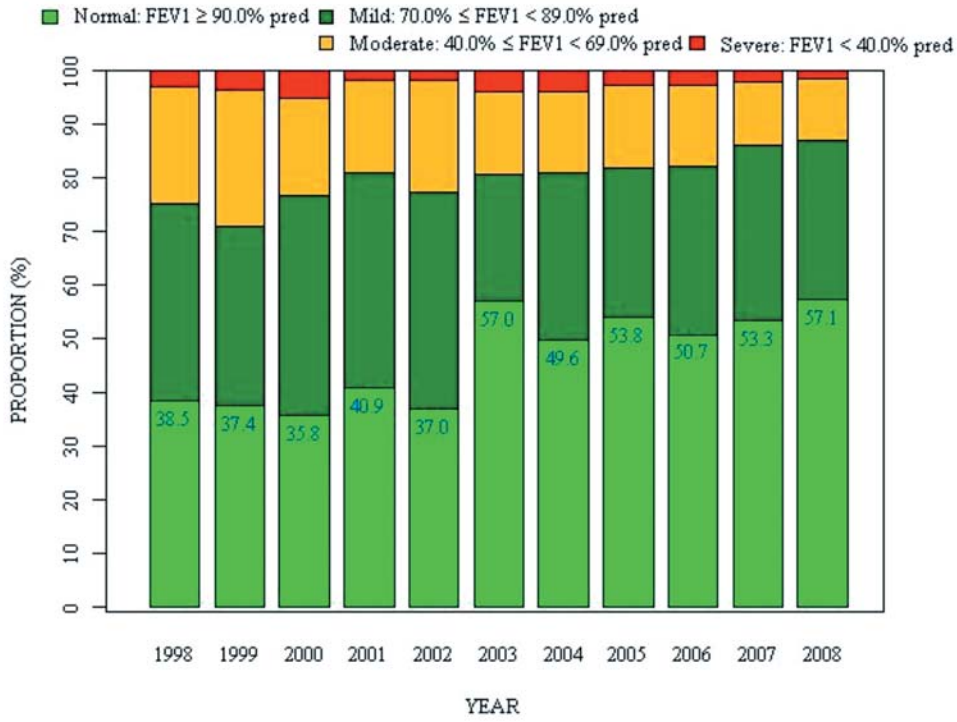


Figure 15 | Proportions of F508del homozygous children in various FEV1% severity categories over the last 11 years.

Figures 15 and 16 show the proportion of children and adults in the different classes of lung function impairment over the last 11 years. Only patients with the most frequent genetic mutation (F508del homozygote) were included in this analysis, to compare a similar population over the years. The proportion of children with % of predicted FEV1 higher than 90% (light green) has increased over the years from about 38.5% in 1998 to almost 57.1% in 2008.

Amongst the adults (figure 16), over the years, there is a decline in the proportion of patients with severe lung function impairment (values less than 40.0% of the predicted, in red on the graph) from about 31.6% in 1998 to 16.3% in 2008.

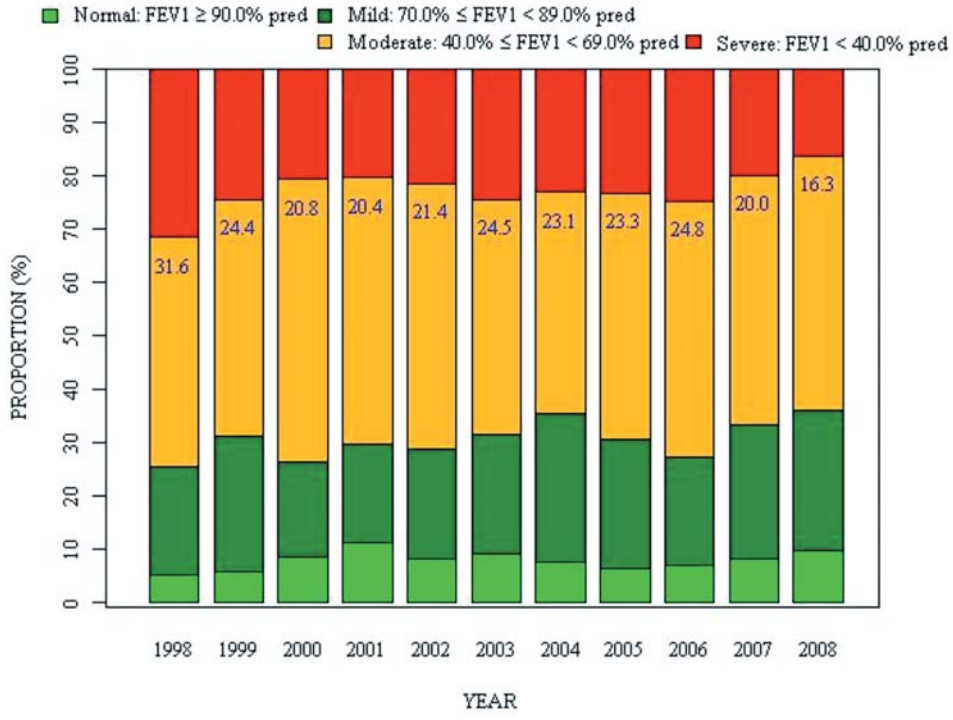


Figure 16 | Proportions of F508del homozygous adults in various FEV1 % severity categories.

The production of thick mucus in the lung increases the likelihood of bacterial infections and decreases the ability to protect against infection. Over time, inflammation and infection are responsible for lung damage.

Bacterial colonisation occurs very early in the natural history of the disease. In the initial stage, common bacteria such as *Staphylococcus aureus* and *Haemophilus influenzae* infect the lungs. The colonization by *Pseudomonas aeruginosa* and sometimes *Burholderia cepacia* may occur later. The airways of patients with CF may also be chronically colonized by fungi like *Aspergillus fumigatus*.

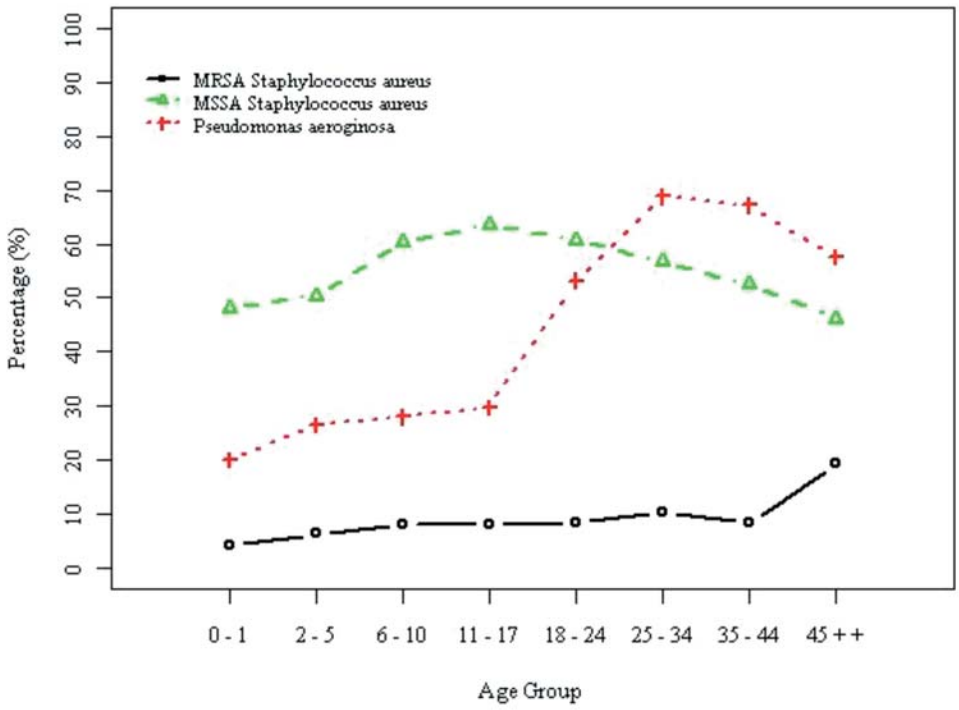


Figure 17 | Annual prevalence of *Pseudomonas aeruginosa, Methicillin sensible staphylococcus aeruginosa (MSSA), Methicilin resistant staphylococcus aeruginosa (MRSA)* related to to age groups in the Belgian CF-population

One of the main goals of CF care is to postpone by all possible means infections of pathogens such as *Pseudomonas Aeruginosa* and *Burkholderia cepacia* and to reduce the risk of chronic colonization which increases respiratory morbidity and treatment burden. In this section, a selection of pathogens are presented, based on their prevalence in the patient population.

In 2008, 96% of the patients had at least one culture during the year. The most prevalent pathogen in 2008 was *Pseudomonas Aeruginosa*; 41.8% of the patients tested positive while *Methicillin Resistant Staphylococcus Aureus (MRSA)* was detected in 8.2%. Only 2.5% tested positive for *Burkholderia cepacia*.

Annual prevalence related to age of typical CF-pathogens found in the sputum cultures done during the whole year 2008 is illustrated in figures 17 & 18.

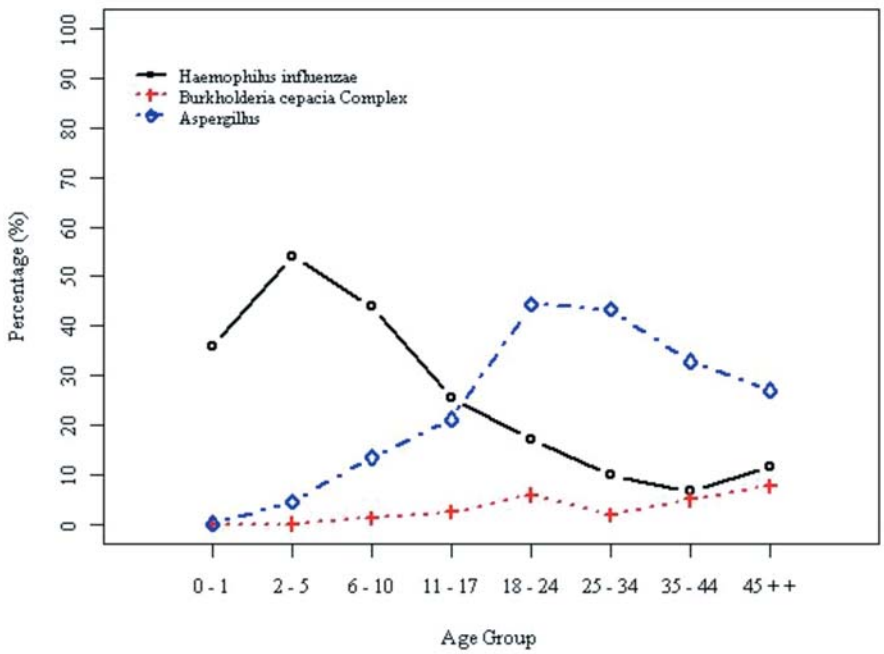


Figure 18 | Annual prevalence of *Haemophilus influenzae, Burkholderia cepacia* complex and *Aspergillus* related to age groups in the Belgian population with CF

In the Belgian CF population, *Pseudomonas aeruginosa* was found in about 25% of the patients in the first decade of life. This percentage rose in the second decade and reached 70% in the adult life (figure 17). The proportion of patients with chronic infection with Pseudomonas aeruginosa also increases with age (figure 19).

Methicillin Sensible Staphyloccoccus aureus (MSSA) was present in about 45% of the patients below the age of one year and this percentage increased progressively over the consecutive age groups reaching the highest percentage in the age range of 11-17 years (figure 17).

The prevalence of *Methicillin Resistant Staphylococcus aureus (MRSA)* was low with slightly elevated levels in the older age groups (figure 17). *Burkholderia cepacia* was not frequently found in our country (figures 18 and 19).

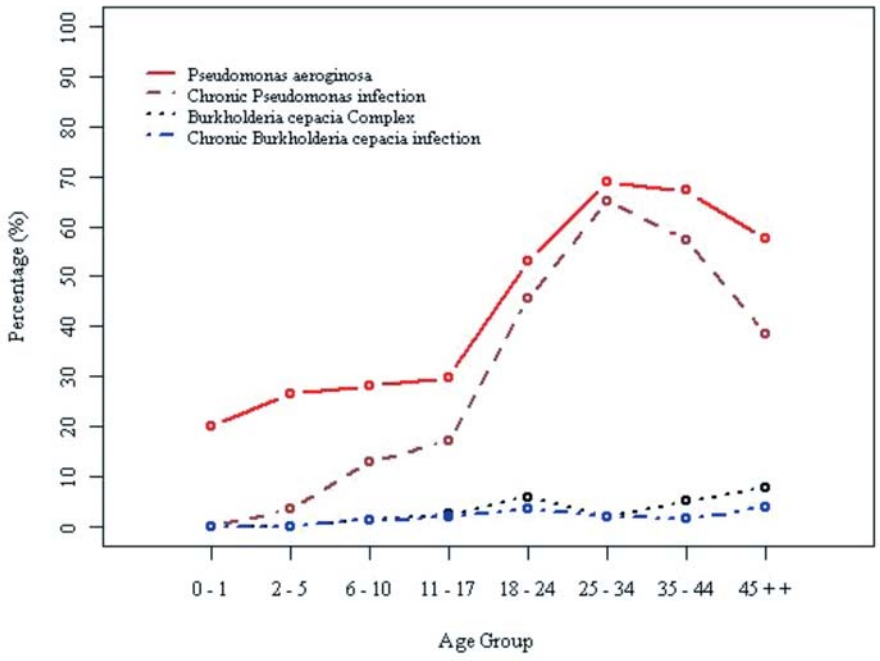


Figure 19 | Annual prevalence and chronic infection with *Pseudomonas aeruginosa* and *Burkholderia cepacia* complex related to age groups in the Belgian population with CF

6 | COMMON COMPLICATIONS

The defective chloride channel in CF causes a range of disturbances within the human body. Chloride channels are needed to regulate fluids within the cells. Complications in CF are mainly found in organs where mucofilms are needed (airways, intestines) and glands which need fluid to excrete their substances (pancreas, testis...). The most frequent complications are detailed here below.

6.1 | Respiratory system complications

Allergic bronchial pulmonary aspergillosis (ABPA).
ABPA is an allergic reaction to *Aspergillus fumigatus*, a fungus that colonizes the airway of people with CF. Diagnosis is not always obvious as many symptoms of ABPA (cough, wheezing, shortness of breath, decline in lung function) are common symptoms of CF lung disease. Diagnosis relies on a combination of the clinical picture, blood tests and chest radiography or CT. If not treated, ABPA can cause bronchiectasies (which are chronic dilatation of the bronchi or bronchioles).

Nasal polyps.
In patients with CF, chronic infections of the upper airways (chronic sinusitis) may cause the formation of nasal polyps which are mucosal overgrowths. They are responsible for nasal obstruction.

Haemoptysis
When the damage whitin the bronchi reaches a blood vessel the patient with CF is coughing blood. Haemoptysis is mild in most cases, but sometimes the bleeding is so severe that a therapeutic embolisation of the bleeding vessel is needed.

A pneumothorax occurs when air reaches the vacuum of the pleural space, mainly caused by destruction of the alveoli causing the leakage of air. This complication is more common in the adults who have more advanced lung disease.

6.2 | Gastro-Intestinal complications

The pancreas needs fluid to excrete enzymes within the duodenum. Those enzymes are needed to digest food (fat and proteins). When this fluid becomes thick in persons with CF it obstructs the exocrine channels. **Pancreatic insufficiency** is the inability of the pancreas to produce and transport enough enzymes to digest fat and proteins resulting in malabsorption with steatorhea (fatty stools), malnutrition and a deficiency in fat-soluble vitamins (ADEK).

Gastro-oesopahgeal reflux is a condition in which contents of the stomach or small intestine repeatedly move back up into the esophagus. When repeated it causes oesophagitis and it may worsen the respiratory function.

Distal intestinal Obstruction syndrome (DIOS)
The intestinal cells with defective chloride channels produces thick ineffective intestinal mucus which in combination with stools can cause obstruction of the intestines. DIOS is especially found in the terminal ileum and caecum. It can causes acute abdominal pain. DIOS usually responds to medical treatment but in a few cases a surgical intervention may be required.

Liver disease
All patients with CF present a defect CFTR protein in their biliary tract. Nevertheless some persons do develop liver disease leading to cirrhosis (replacement of the liver tissue by fibrosis) and others do not. Because of the growing amount of persons with CF reaching adulthood, monitoring liver disease in this population is now part of the multidisciplinary CF care. Sometimes cirrhosis evolves in portal hypertension and in advanced cases a liver transplant can be proposed.

6.3 | Endocrine complications

CF related Diabetes:
Insulin is a hormone which maintains the balance of sugar in blood. Malfunctioning of the endocrine part of the pancreas leads to an insufficiency of the secretion of insulin leading to diabetes. Diabetes requires insulin administration. CFRD prevalence increases with age. In the BMR-RBM, 1 (0.6%) of the 5–9 year olds, 22 (7.0%) of 10–20 yr olds and 32 (20.5%) patients aged 30 years and above were reported to have CF related diabetes (figure 20).

6.4 | Reproductive system complications

Many men with cystic fibrosis are infertile because of congenital bilateral absence of the vas deferens (which allows the transport of the spermatozoids). However, as the production of spermatozoids is being preserved, techniques of assisted procreation are possible. Although women with cystic fibrosis may be less fertile than other women, it is possible for them to conceive and to have successful pregnancies. Those pregnancies require a higher surveillance.

6.5 | Other complications

Oseopenia and osteoporosis
Osteopenia and osteoporosis which are the result of a progressive loss of the bone mass are more frequent and earlier in cystic fibrosis due to various risk factors like malabsorption of vitamins D, use of glucocorticoids…

Psychiatric disease
Difficult to define and quantify, the psychological repercussions of this pathology are frequent and often involve a bad compliance with the treatment.

In this section we consider the most common complications recorded. The percentage of patients presenting these complications in 2008 are reported in table 5.

	Complications	n patients	% of patients
Respiratory	Allergic bronchopulmonary aspergillosis	61	6.3
	Nasal polyps	108	11.1
	Massive haemoptysis	14	1.4
	Pneumothorax	2	0.2
Gastro-intestinal	Pancreatic insufficiency	829	85.5
	Gastro-oesophageal reflux	178	18.4
	Intestinal obstruction (no surgery)	119	12.3
	Intestinal obstruction (requiring surgery)	7	0.7
	Cirrhosis with portal hypertension	36	3.7
Endocrine	CF related diabetes (CFRD)	111	11.4
Other	Osteopenia / osteoporosis	95	9.8
	CF related arthritis / athropathy	28	2.9
	Psychiatric disease	18	1.9

Table 5 | Complications

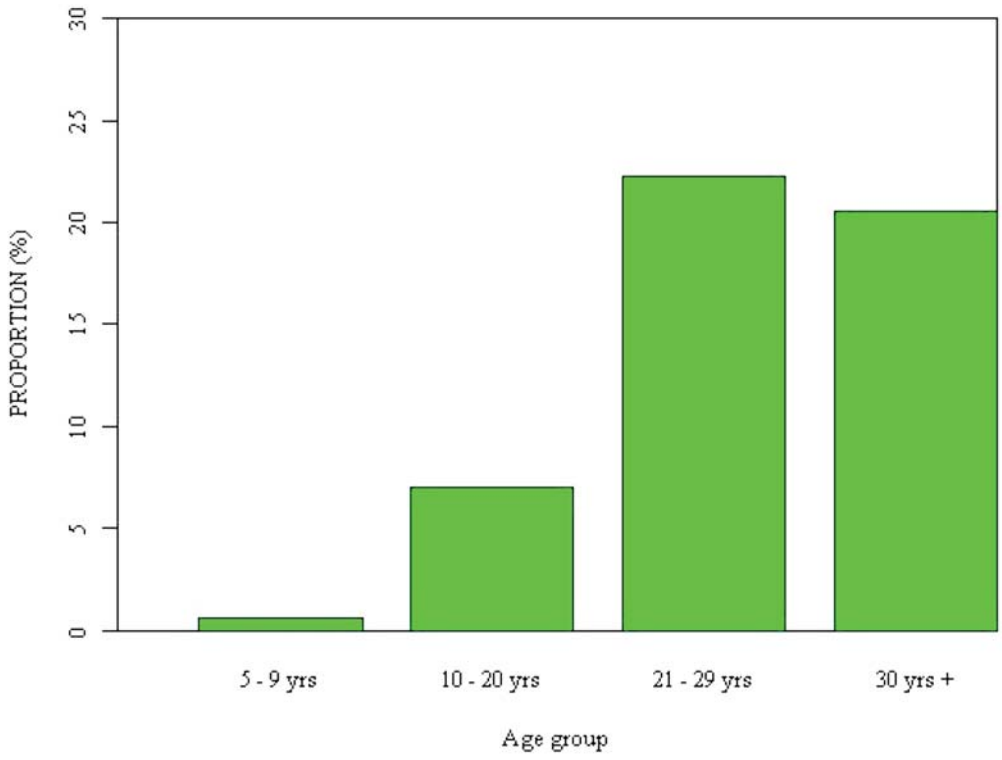


Figure 20 | Proportion of patients with CF related diabetes by age group

Till today no definitive cure for CF exists. The problems of all cystic fibrosis patients are related to defective epithelial function with impaired production of mucus and fluids leading to complications described in the previous section. Treatment of the disease is therefore mostly based on preventing or reducing symptoms and complications.

1 | Prevent and tightly control respiratory respiratory infections

Because mucus is stuck within the bronchi, evacuating mucus is one of the most important interventions. A patient with CF has regular chest physiotherapy sessions. Most of the patients also need autogenic drainage (the patient initiates physiotherapy at his own body).
Maintenance inhaled medications include mucolytics that thin the sticky airway secretions such as RhDNase or hypertonic saline. Bronchodilators are given to open the bronchi. Inhaled antibiotics are used to treat infection, prevent or postpone colonization. In some cases oxygen is needed.

Every year, half of the patients with CF are hospitalized, mostly for the treatment of pulmonary exacerbations caused by an infection requiring intravenous antibiotics.

Inflammation caused by repeated infections plays an important role in the progression of lung injury. This explains the interest in the use of antiinflammatories such as azithromycine or other antiinflammatory drugs as complementary treatment.

2 | Optimizing the nutritional status

Because the nutritional status of a patient is correlated with the disease severity, every person with CF should take a well balanced high-calorie and high-fat diet.
Most individuals with CF are pancreatic insufficient and must take pancreatic enzymes at every meal to digest food correctly. Also supplements of vitamins ADEK are administered routinely. Some people with CF benefit from supplemental feedings given overnight by a tube placed into the stomach (enteral feeding) or given intravenously (parenteral feeding).

3 | Monitoring the onset of other complications followed by appropriate therapeutic interventions

Every patient is regulary examined for possible signs of the onset of known complications of the disease.

When clinical, biological or imaging finding point towards liver disease, ursodeoxycholic acid is started. It is a hydrophilic bile acid normally present in human bile which stimulates the biliary secretion and protect the hepatic cells.

Depending on complications, other medications are prescribed such as insulin therapy when a patient develops CF related diabetes or biphosphonates for osteoporosis.

The treatment burden for CF patients is high. Most CF patients spend a lot of time every day performing therapies. This imposes also a substantial burden on their family.

In this section, we will present data on treatments given to patients as recorded in 2008.

Table 6 | Main therapies

Treatment	% of patients receiving the treatment
Respiratory therapies	
Regular chest physiotherapy	91.0
Inhalation therapy (antibiotics excluded)	
RhDNase	55.9
Hypertonic saline	28.5
Other mucolytics	52.7
Bronchodilators	67.9
Corticosteroids	51.0
Oral antiinflammatories	
Azithromycin	37.6
Systemic corticosteroids	4.6
NSAID	6.0
Oxygen therapy	2.4
Antibiotics	
Oral or IV antibiotics	90.6
Inhaled antibiotics	54.8
Tobramycine 300 mg (Tobi®)	16.6
Digestive and nutritional therapies	
Pancreatic enzymes	85.9
Fat soluble vitamins (ADEK)	82.2
Ursodeoxychloic acid	25.5
Enteral feeding	2.3
Parenteral feeding	2.4
Proton pomp inhibitor + H2 receptor blocker	34.1
Other treatments	
Insulin therapy	11.0
Oral therapy for diabetes	1.8

7.1 | Respiratory therapies

About 91 % of the patients were reported to follow regular chest physiotherapy. Ninety one percent of the patients took on a daily basis at least one mucolytic (RhDNase, hypertonic saline or other mucolytic). Inhaled bronchodilators were the most frequent additional drugs (68%). Among anti-inflammatory drugs, azithromycin was given to a third of the patients while systemic corticosteroids and NSAID's were given to only a small proportion of the patients.

7.2 | Antibiotics

The proportion of patients using inhaled antibiotics was about 55 %. Over 90 % of the patients received one form of oral or intravenous antibiotic therapy. Half of the patients received oral antibiotics. The need for intravenous antibiotics increases with age. About 30% of the children and half of the adults received at least one treatment with intravenous antibiotics during the year 2008 (figure 21). Adolescents and adults received more days of intravenous antibiotics than children. The children had a median (Inter Quartile Range (IQR)) of 14 (12 - 28) days of IV antibiotics while adults had a median of 24 (14 - 43) days.

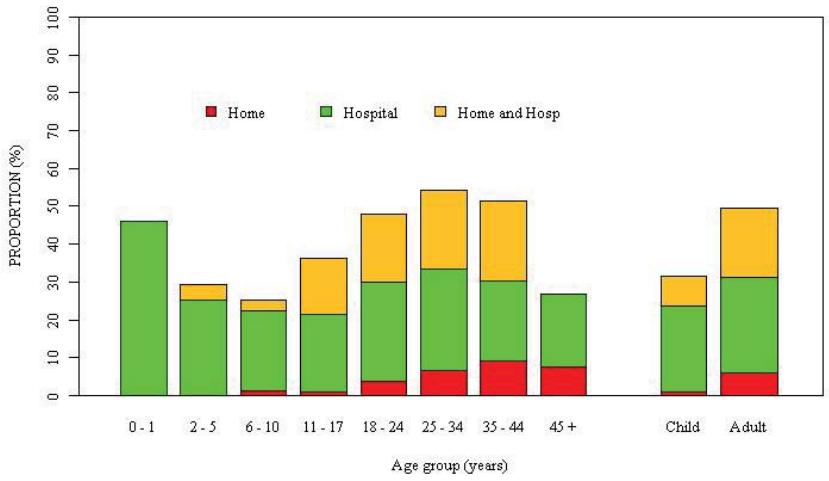


Figure 21 | Proportion of patients using IV antibiotics by age

7.3 | Digestive and nutritional therapies

Pancreatic enzymes replacement therapy were taken by 85.9 % of the patients; a supplement of fat-soluble vitamins ADEK by 82.2% of them. Ursodeoxycholic acid was given in a quarter of the patients.

7.4 | Other therapies

Eleven percent of all patients, i.e. 3 % of the children and 21 % of the adults, were treated with insulin.

7.5 | Outpatient visits and hospitalizations

The median (IQR) number of outpatients visits of the patients with CF was 5 (4 - 7). 46.6 % of the patients were hospitalized in 2008 with a median (IQR) number of 11 (4 – 21) days.

8 | LUNG AND OTHER TRANSPLANTATIONS

When a patient with CF develops severe and progressive lung disease, lung transplantation may become an option. However, like other major surgeries, lung transplantation involves significant risks. A lung transplant is indicated only for patients who have a severe disease and who have exhausted all other forms of conventional medical treatment. For these patients, lung transplantation may offer prolonged survival and an improved quality of life; in some cases even a 'new' life. The success rate of lung transplantation for CF patients is steadily improving. At present the actuarial survival rate is > 60 % at 3 years and > 40 % at 10 years after surgery (6). The longest surviving patients had their transplant operations now more than 20 years ago.

The first (heart)-lung transplant in a Belgian patient with CF was performed in 1988. Since this time more than 160 patients with CF (149 reported in the CF Registry) have received a (heart)-lung transplant in Belgium and approximately 10 lung transplants per year are now performed for CF. Some patients with CF will need other types of transplantations such as liver transplantation for end-stage CF-related liver cirrhosis or renal transplantation for end-stage renal disease because of diabetes, antibiotic toxicity or the toxicity of immunosuppressive drugs required after lung transplantation.

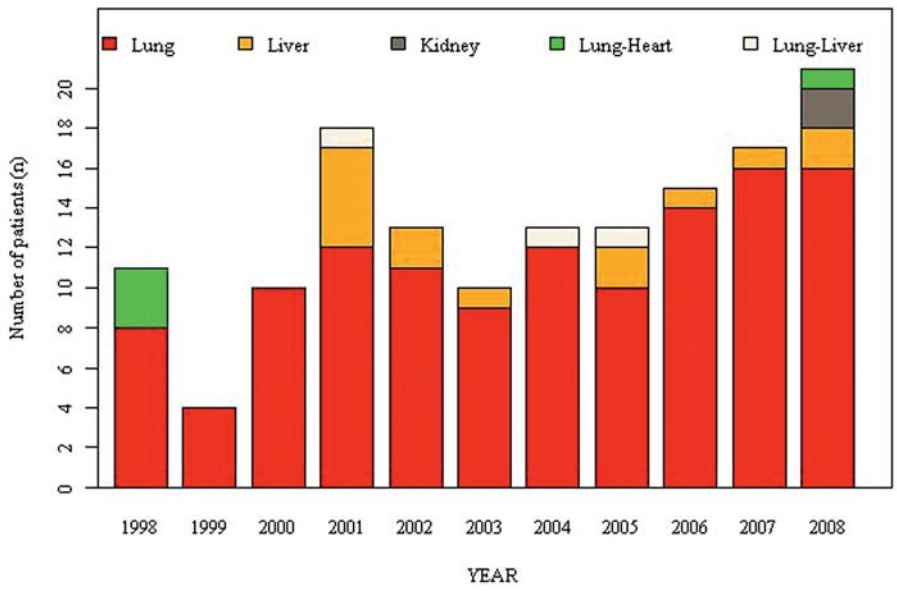


Figure 22 | Number of transplants by year reported in the BMR-RBM

9| Conclusions

This edition of the public report of the Belgian CF Registry (BMR-RBM) includes data that compares to previous years from a selection of parameters of interest. It is the hope that the provision of this information will continue to enlighten the public in general and people with interest in CF about this life threatening hereditary chronic disease.

Continuous efforts have been made throughout the past years by everyone involved in the Belgian CF Registry (physicians, nurses and staff from the CF reference centres, database managers, scientific collaborators …) to improve the quality of the data and provide a useful database for monitoring the natural evolution of the disease and for use as a research instrument in generating and addressing various research hypotheses.

The number of patients enrolled in the Registry has continued to rise and has doubled since 1998. CF is now no longer only a disease of childhood, as the number of patients aged 18 years and above has steadily risen from 39.2% to about 50.2% in 2008.

Based on the data collected each year, a national scientific report dedicated to the CF centres is published annually. Since 2006, centre reports are also provided to the centres. From 2008 onwards, a feedback report is being provided with analyses that compare the results from each centre with data from the other centres in order to improve the quality of care provided to the patients with CF in their respective centres through benchmarking.

Physicians from the centres and researchers have continued to submit research questions to the BMR-RBM, and currently a number of research questions are being analyzed. Several abstracts have been presented at international conferences (7-9) and a publication made in an international Journal (10).

Finally, we are greatly indebted to the patients and their families or care-givers who agreed to contribute data to this Registry and have made the various research issues including this report possible.

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