

# *The influence of a multidimensional rehabilitation program on physical and psychosocial health in cancer survivors*

**Abouna Mbaye**

promotor :

Prof. dr. Herbert THIJS, Dr. Raf MEESEN



**University Hasselt  
Center for Statistics**

**The influence of a multidimensional rehabilitation  
program on physical and psychosocial health in cancer  
survivors.**

**By**

**Abouna Aboubakrine MBAYE**

**Internal Supervisor:** Dr. Herbert Thijs

**External Supervisor:** Dr. Raf Meesen

**Thesis submitted in partial fulfillment of the requirements for the  
degree of Master of Science in Applied Statistics.**

**2006-2007**



**University Hasselt  
Center for Statistics**

**The influence of a multidimensional rehabilitation  
program on physical and psychosocial health in cancer  
survivors.**

**By**  
Abouna Aboubakrine Mbaye

Accepted by:

**Internal Supervisor:** Dr. Herbert Thijs

Signature .....

Date .....

**External Supervisor:** Dr. Raf Meesen

Signature ... ..

Date .....

**Thesis submitted in partial fulfillment of the requirements for the  
degree of Master of Science in Applied Statistics**

**2006-2007**

## Acknowledgement

*First and foremost I would like to express my sincere gratitude to my supervisor for his guidance and assistance accorded to me as I worked on this project.*

*Special thanks to all my family members especially my father and mother Mr. and Mrs. Mbaye for their prayers and encouragement my wife, brothers and sisters, friends and class mates who shared ideas, knowledge and time in writing of this project.*

*I do not also forget all my professors.*

*I would thank most of all almighty God for all he has helped me achieve throughout the duration of this project.*

## **Tables of Contents:**

Abstract

### 1. Introduction

1.0 Background

1.1 Objectives of the study

1.2 Structure of the report

### 2. Materials and Methods used

2.1 Data Description

2.1.1 Emplacement and Experimental Settings

2.1.2 Tests Description

2.2 Methodology

2.2.1 Exploratory Data Analysis (E.D.A.)

2.2.2 T test

2.2.3 Linear Mixed Model (L.M.M.)

2.3 Handling Missing Data

### 3. Results

3.1 Exploratory Data Analysis (E.D.A.)

3.1.1 Descriptive statistics

3.1.2 Correlation Structure

3.2 Statistical analysis

3.2.1 T test

3.2.2 Linear Mixed Model (L.M.M.)

### 4. Discussion

### 5. Conclusion and recommendations

### 6. References

### 7. Appendix

## List of Tables:

Table 2.1.1: Data Collection .....	5
Table 2.1.2: Tests Description.....	6
Table 3.1.1 a: Cancer survivor distribution by Age.....	15
Table 3.1.1 b: Cancer survivor distribution by Sex.....	15
Table 3.1.1 c: Cancer survivor distribution by Sex and Diagnosis.....	16
Table 3.1.1 d: Cancer survivor distribution by Therapy.....	16
Table 3.1.1.e: Cancer survivor distribution Marital status.....	17
Table 3.1.2: Spearman Correlation coefficients.....	18
Table 3.2.1.a: Summary statistics obtained on the data set and from each psychosocial test.....	19
Table 3.2.1.a: Summary statistics obtained on the data set and from each physical test...	20
Table 3.2.2.a: Result of the L.M.M. with Age (continuous) and Sex.....	22
Table 3.2.2.b: Result of the L.M.M. with Age (categorical) and Sex.....	22
Table 3.2.2.c: Result of the L.M.M. with Kids.....	23
Table 3.2.2.d: Result of the L.M.M. with Work status.....	23
Table 3.2.2.e: Result of the L.M.M. with Diagnosis.....	23
Table 3.2.2.f: Result of the L.M.M. with Therapy.....	24
Table 3.2.2.g: Result of the L.M.M. with Period.....	24
Table 3.2.2.h: Result of the L.M.M. with Marital status.....	24

## **Abstract**

**Purpose:** To investigate if there is any effect using tests (physical and psychosocial) before and after the rehabilitation for the cancer survivors. We investigate also if there is some influence of the social demographical factors. The main interest is the difference between the two measurements before (M1) and after (M2). The data set used in this analysis was the responses from the Physiotherapy Department of the Virga Jesse hospital at Hasselt.

About 129 patients with any oncological pathology, divided in 10 groups over the past 3 years, participate to this rehabilitation program.

**Methods:** T- test and Linear Mixed Model (L.M.M.) were employed for the data analysis.

**Results:** Under Paired t-test, the physical tests: *3RM (Lateral Pull, Abductor, Abdominals), David Back, Back Muscles; David Back, Abdominals, Jamar Right and Sit and Reach* and also the psychosocial tests: *Physical Functioning, Role Functioning, Emotional Functioning, Cognitive Functioning, Social Functioning, Global Health Status (Quality of Life), Fatigue, Pain, Dyspnea, Sleep disturbance, Financial Impact, FACT Fatigue, Tampa Psychosomatic Questions* were significant and are positively influenced by the difference between the measurement before (M1) and the measurement after (M2).

Linear Mixed Model showed that almost of the tests were associated at *Sex, Age, interaction between Sex and Age, Diagnosis, Therapies (Operation, Chemotherapy, and Radiotherapy)*.

**Conclusions:** Sex, Age, Age\*Sex interaction, Diagnosis and the type of therapy were the main factors that influenced the difference between M1 and M2 for the tests done in the rehabilitation program.

**Key Words:** T test, Linear Mixed Model (L.M.M.), Physical tests, Psychosocial tests, Cancer Survivors, Rehabilitation program.

# 1. Introduction

## 1.0. Background

Cancer is a disease characterized by an abnormal and anarchistic cellular proliferation within a normal fabric of the organization. These cells derive from the same clone, cell initiating of the cancer which acquired certain characteristics enabling him to divide indefinitely. During the evolution of the disease, certain cells can migrate of their place of production and form metastases.

A cancer is a general term for any disease for which certain cells of the human body divide in an uncontrolled way. The new resulting cells can form a malignant tumor (a neoplasm) or be propagated through the body.

We can distinguish cancers in several types:

- \* Carcinomas: cancer of an epithelium, i.e. a surface only made up of cells
- \* Sarcomas: cancer in fabrics of support like the bones.
- \* Cancer hematopoïetic: cancer of the blood cells.

We can also classify them by the bodies which they touch, here some types of cancer:

- \* the breast cancer;
- \* the cancer of the colon: cancer of the colon and, near, that of the rectum;
- \* the cancer of the pancreas;
- \* the multiple myeloma: cancer of osseous marrow;
- \* leukaemias: leukemias;
- \* the sarcoma of Kaposi: cancer of the blood vessels;
- \* Lymphomas: disease of Hodgkin and Lymphoma non-hodgkinien.

In fact, there exist practically as many sources of cancer of tissues in the organization. Some are however more frequent than others.



The choice of a treatment or a combination of particular treatments depends on various factors of which most important are: the type of cancer, the degree of extension of the disease, the age of the person and her general state. In other words, the treatments are adapted individually.

Regular physical activity provides enormous health benefits in human beings. It helps reduce cancer, heart disease and many other diseases and metabolic conditions. Regular fitness exercise is also highly beneficial for weight reduction and weight maintenance, and may improve brain chemistry to reduce depression. By contrast, health studies that have monitored the wellbeing of large groups of people over many years clearly show that inactivity significantly increases the risk of overweight, obesity and chronic diseases. Inactivity consistently influences the state of skeletal muscles in human being. Non physical status leads to the decrease of performance and in case of any effort; the subject gets tired and is subject to body weakness.

The social conditions (married or single person, with or without work, have children or not ...) have an important role in the "curing" of the patients.

### 1.1. Objectives of the study

This study was to compare firstly on a general scale between two measurements. One measurement is done before starting the rehabilitation (pre-test/M1), the patients participate in some physical tests and to answer the questionnaire of the psychosocial test and the second measurement was done after the rehabilitation (post-test/M2) in the same way. The question is if there are any statistical significant differences between M1 and M2, for each test (physical and psychosocial tests).

On a specific note, this study also was to compare the influence of the social demographical factors.

Patients with an oncological disease (neoplasm of the lung cancer) often have a lot of complaints after their treatment with chemotherapy and radiotherapy. The most common physical problems are fatigue, a lack of physical capacity and decreased muscle strength.

There are also a lot of psychosocial problems. For example, the patients may have depressive thoughts and feelings, a lack of social contact and problems with resumption of work. All these symptoms may lead to a vicious circle, and this may have a negative influence on the quality of life (Q.L.).

There are a lot of researchers who have made a study about the influence of physical and psychosocial rehabilitation on these items. Our research is not to improve a lot of new items, but is more to be a supplement to these studies. This study brings a view in the progression of the physical possibilities of cancer survivors and their psychosocial status by means of a 12-week rehabilitation program 'Herstel en Balans'.

## 1.2 Structure of the report

The report begins with an introduction in which some information is given on multidimensional rehabilitation program in the background section. This section also includes information on the contribution of physical and psychosocial condition of cancer survivors. This is then followed by the objective of the study. In the second section of the report, we give a brief description of the data set and of the experimental settings. The third section contains the methodology utilized to carry out investigation on the data set. The results of the investigation are shown in the fourth section of our report. The report ends with the fifth part with the discussions and conclusions and also some recommendations. Lastly we have the references follow by the appendix. We used S-plus and SAS software.

## 2. Materials and Methods used

### 2.1 Data Description

#### 2.1.1 Emplacement and Experimental Settings

The data set used in this analysis was the responses from the Physiotherapy Department of the Virga Jesse hospital at Hasselt.

About 129 patients with any oncological pathology, divided in 10 groups over the past 3 years, participate to this rehabilitation program. These patients are 23 years or older, must have finished their medical treatment at least 3 months ago and must have a life expectancy of more than 1 year. Some patients didn't finish the total program from different reasons. These patients are drop out patients.

Before starting the rehabilitation (pre-test/M1), the patients need to participate in some physical tests: a symptom limited effort test on a bicycle ergo-meter, strength tests of the arms, trunk and legs and an agility test. Their psychosocial status is stipulated by standardized questionnaires. After the rehabilitation (post-test/M2), the same physical tests and psychosocial questionnaires will be retested.

The rehabilitation program consists of physical exercises and psychosocial education. The physical exercises are individually and in group, both accompanied by a group of physical therapists. The psychosocial education is participated in group, accompanied by a group specialised experts.

All the data we collect will be presented in EXCEL spreadsheets.

The meaning of this data acquisition is to find a significant difference between:

- the physical tests from pre-test (M1) and post-test (M2),
- the psychosocial tests from pre-test (M1) and post-test (M2).

The dataset results from a longitudinal observation because of repeated measures carried on each patient (2 times). It consists of 258 observations obtained from 129 cancer survivors. For the second part, we have some additional variables (the socio-demographical factors) coded as a binary indicator, 1= Yes and 0 = No. We also have as variable, the variable scores which a categorical variable determining the period between the last therapy and start of the rehabilitation, fluctuating between 0-6, and the variable age of the patients (0 to 4).

**Data collection:**

**Table 2.1.1: data collection**

Group	1	2	3	4	5	6	7	8	9	10	Test	Number of participants
											EORTC QLQ C30	97
											FACT Fatigue	98
											TAMPA Scale	94
											Lateral pull (3 RM)	61
											Abductor (3 RM)	61
											Abdominals (3 RM)	62
											David Back: Back muscles & Abdominals	27
											Gymnex: Relative & Absolute	29
											Jamar: Left & Right	35
											Sit and Reach	97

In total, there are 30 tests to check if they are significant or not. Within some tests, we have more than one sub-test to do. For example for Gymnex we have 4 sub-tests: *Gymnex Absolute extension 180°/s, Absolute extension 60°/s, Relative extension 180°/s, Relative extension 60°/s.*

For EORTC, we have 15 tests to do: *PF, RF, EF, CF, QL, Fatigue, Nausea, Dyspnea, Pain, Vomiting,...*

For Tampa: 2 tests, *Psychosomatic Questions and Denying activities.*

## 2.1.2 Test Description

**Table 2.1.2: Test description**

<b>Physical Tests name</b>	<b>Description</b>
David Back: 2 tests	Strength of the back muscles and abdominals
Gymnex: 4 tests	Strength of the leg muscles
Jamar hand dynamometer: 2 tests	Grip strength of the hands Left and Right
Sit and Reach: 1 test	Flexibility of the leg muscles
3 RM measurement: 3 tests	Strength test of Lateral pull, Abductor and Abdominals

<b>Psychosocial Tests name</b>	<b>Questionnaire description</b>
EORTC QLQ C 30: 15 tests	Ask the patients about their physical functioning (PF), their role function (RF), their emotional functioning (EF), their cognitive functioning (CF), their social functioning (SF), their global health status or Quality of Life (QL) and some physical discomforts like Nausea, vomiting, sleep disturbance, appetite loss,.
TAMPA SCALE: 2 tests	Ask the patients how they experience their disease; their physical activity avoidance and their psychosomatic focus.
FACT FATIGUE; 1 test	Ask the patients about their fatigue feelings

For the social demographic part we have 15 variables:

<b>Variable</b>	<b>Information</b>	<b>Codes/Unit</b>
GROUPNR	Group identifier	1 to 10
PATIENTNR	Patients identifier	1 to 17
AGE	Age of the patients	0 to 4
SEX	Sex of the patients	0/1
MAR/LIVTOG	Married or Living together	0/1
KIDS	Patient has kids or not	0/1
KIDSHOM	Kids at home	0/1
WORKED BEFORE	Worked before	0/1
STILLWOR	Still working	0/1
DIAG	Diagnosis: Breast cancer = 1 and Other = 0	0/1
THERAPY: 4 variables	Hormone therapy - Chemotherapy- Operation – Radiotherapy.	0/1
PERIOD	Period between last therapy and start of the rehabilitation	0 to 6

## 2.2 Methodology

Each patient is measured two times, after and before the rehabilitation. The principal variable of interest (difference between the measurement before and the measurement after for each test), the responses variables, are repeated only two times.

For the first part of this study, we want to know if there are any statistical significant differences between two measurements (M2 and M1), for each test (physical and psychosocial). We use *t-test* for investigating this issue.

For the second part of the study, we want to see if there is any influence of the social demographical variables in the difference between the measurements before and after. Each patient is measured two times.

A longitudinal study is defined as a study in which the response for each experimental unit in the study is observed on two or more occasions. The defining feature of a longitudinal data set is repeated observations on experimental units over time. Longitudinal data require special statistical methods because the set of observations on each subject tends to be correlated. These correlations must be taken into account to draw valid inferences. One of the statistical methods commonly known to handle this type of data, for normal responses, is the Linear Mixed-effects Models (LMM). Proc mixed is done for each test.

### 2.2.1 Exploratory Data Analysis (E.D.A.)

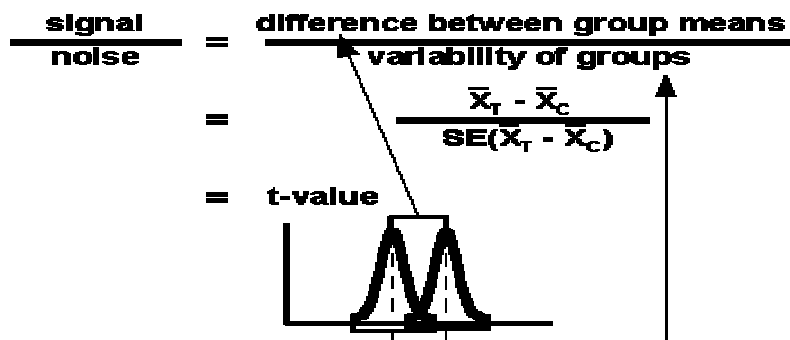
It is usually very useful as a first step in analysis, to do some data exploration in order to get an insight of the data. In this step, various tables were used to explore the distributions of Sex, Age, Therapy, Marital status, etc... Exploratory Data Analysis was done to investigate the associations between the difference and the covariates. The relation between the covariates was also investigated. This was further investigated by looking at the trends between the test and the also the other covariates such a Marital status, AGE and Kids. Pearson correlation coefficient helped us to have an idea of the relation between the principal response of interest, and the covariates.

## 2.2.2 T-test

The t-test assesses whether the means of two groups are *statistically* different from each other. This analysis is appropriate whenever you want to compare the means of two groups, and especially appropriate as the analysis for the posttest-only two-group randomized experimental design.

The formula for the t-test is a ratio. The top part of the ratio is just the difference between the two means or averages. The bottom part is a measure of the variability or dispersion of the scores.

The next figure shows the formula for the t-test and how the numerator and denominator are related to the distributions.



Formula for the t-test.

The top part of the formula is easy to compute - just find the difference between the means. The bottom part is called the standard error of the difference (Std Err or SE). To compute it, we take the variance (Var) for each group and divide it by the number of people in that group (n). We add these two values and then take their square root. The specific formula is given below:

$$SE(\bar{X}_T - \bar{X}_C) = \sqrt{\frac{\text{var}_T}{n_T} + \frac{\text{var}_C}{n_C}}$$

Formula for the Standard error of the difference between the means.

Remember, that the variance is simply the square of the standard deviation (Std Dev).

The final formula for the t-test is shown below:

$$t = \frac{\bar{X}_T - \bar{X}_C}{\sqrt{\frac{\text{var}_T}{n_T} + \frac{\text{var}_C}{n_C}}}$$

Formula for the t-test

Once we compute the t-value we have to look it up in a table of significance to test whether the ratio is large enough to say that the difference between the groups is not likely to have been a chance finding. To test the significance, we need to set a risk level (called the alpha level). In most social research, the "rule of thumb" is to set the alpha level at 0.05. This means that five times out of a hundred we would find a statistically significant difference between the means even if there was none (i.e., by "chance"). We also need to determine the degrees of freedom (DF) for the test. In the t-test, the degrees of freedom are the sum of the persons in both groups minus 1. Given the alpha level, the DF, and the t-value, we can look the t-value up of significance to determine whether the t-value is large enough to be significant. If it is, we can conclude that the difference between the means for the two groups or measurements (M2 and M1) is different (even given the variability). Fortunately, statistical computer programs like SAS routinely print the significance test results and save us the trouble of looking them up in a table.

The regular t-test cannot be used here since the measurements are no longer independent. A variety of the t-test referred to as a paired t-test is used instead. The differences between the measurement before and the measurement after are computed for each cancer survivor. The paired t-test essentially computes a mean and standard error of the differences and determines the probability that the absolute value of the mean difference was greater than zero by chance alone.

The SAS system does not include a paired t-test as part of PROC TTEST. We will need to compute the difference scores ourselves and then use PROC MEANS to compute the probability that the difference is significantly different from zero.



### 2.2.3 Linear Mixed Model (L.M.M.)

Many statistical techniques are encountered and are used in the statistical world to handle data set we can name techniques like; Analysis of Variance (ANOVA), Regression, Principal components, Multivariate Analysis of Variance...The principal assumptions of these techniques is that the observations are independent; they don't take into account the correlated aspect of observations. The Linear Mixed Models (LMM) is an exceptional case in this direction. They consider the correlation among observations; there fore they appear to be recommendable to handle the present data set which is a longitudinal data set. In this model the measures on the 2 time points, before and after were taken into account and the correlation between the observations as well.

The linear Mixed models (LMM) when modeling uses the response and all covariates in the data set.

The general formula of the linear Mixed models (LMM) has the following structure;

$$Y_i = X_i\beta + Z_i b_i + \varepsilon_i$$

$Y_i$  is a vector of repeated measures

$X_i$  is a matrix of covariates

$\beta$  is a vector of regression parameters

$Z_i = n_i \times r$  design matrix for random effect

$b_i$  is the vector of the subject specific regression parameters,  $b_i \sim N(0, D)$

$\varepsilon_i$  is vector of error components,  $\varepsilon_i \sim N(0, \Sigma)$

$b_i, \dots, b_N, \varepsilon_1, \dots, \varepsilon_N$  are independent

Our main interest in this study is on the population level, we are interested on the evolution of the population over time (before and after). The individual evolution of each patient in the two measurements is not of primary interest. The implication of this is that the above Linear Mixed Models (LMM) will be reduced to the following model;

$$Y_i = X_i\beta + \varepsilon_i \quad (\text{I})$$

$Y_i$  is a vector of repeated measures

$X_i$  is a matrix of covariates

$\beta$  is a vector of regression parameters

$\varepsilon_i$  is vector of error components,  $\varepsilon_i \sim N(0, \Sigma)$ .

The relationship between a response variable and one or more continuous covariates is often curved. Also attempts to represent curvature in single or multiple regression models are usually made by means of polynomials of the covariates, typically quadratics. However, low order polynomials offer a limited family of shapes, and high order polynomials may fit poorly at the extreme values of the covariates. Fractional polynomial was proposed as a solution to this ambiguous situation by Royston and Altman (1994).

Fractional polynomial is a family of curves, whose power terms are restricted to a small predefined set of integer and non-integer values. The powers are selected so that conventional polynomials are a subset of the family. Regression models using fractional polynomials appear to show to have considerable flexibility and are straightforward to fit using standard methods.

Formally, Royston and Altman (1994) define a fractional polynomial as any function of the form:

$$f(u) = \phi_0 + \sum_{k=1}^m \phi_k x^{(pk)}$$

Where the degree  $m$  is a positive integer, where  $p_1 < \dots < p_m$  are real prespecified powers, and where  $\phi_0$  and  $\phi_1, \dots, \phi_m$  are real-valued regression coefficients. Finally,  $x^{(pk)}$  is defined as:

$$x^{(pk)} = \begin{cases} x^{pk} & \text{if } pk \neq 0 \\ \ln(x) & \text{if } pk = 0 \end{cases}$$

Thus, not only the conventional powers  $x, x^2, \dots$  are allowable, also,  $\ln(x)$ ,  $\sqrt{x}$  (for  $pk = 0.5$ ),  $\frac{1}{x}$  (for  $pk = -1$ ), etc.

A fractional polynomial approach was used to determine  $X_i$  in the above relation (I)

To generate  $pk$  represented here by  $X_i$  we used a macro of fractional polynomials then later, we fitted a mixed model with repeated statement with these fractional polynomials.

## 2.3 Handling Missing Data

Non-response or incomplete data is a common problem in sample surveys, such as health surveys. Several recently published articles illustrate how such non response can yield information with large potential bias. Many studies delete incomplete data prior to model estimation, resulting in less efficient and potentially biased parameter estimates.

Since the occurrence of the missing data may bias the final results, they should receive careful attention during the design of a health survey. Also, an investigation of the influence on the results should be undertaken.

Missing information of concern in this paper consists of item non-response, defined as a refusal to respond or simply a lack of response to a particular survey question. Some patients are very reluctant to respond to survey questions, particularly regarding age and income... The proportion of householders who decline to answer questions on income can be significant, with item non-response ranging from 15 percent to more than 20 percent of the complete sample (*Gronhaug 1988, Bell 1983*). The manner in which researchers choose to deal with incomplete information can significantly affect parameter estimates and standard error (Schafer 1997). Simply deleting incomplete observations is acceptable in some cases, but not all, circumstances.

### What to do about missing data?

Deleting records with missing values is a common practice for dealing with item non-response. This practice produces a reduced-size dataset of complete cases in which all the variables are fully observed. Reducing the dataset to complete cases has its *advantages*: it offers simplicity, since standard statistical packages can now be easily applied, and comparability, as all calculations proceed from a common base (*Little and Rubin, 2002*). List-wise deletion is simple and may be perfectly appropriate in numerous situations, particularly if the number of deleted incomplete cases is relatively small or if the deleted cases are very similar to the complete case.

In many situations, however, discarding incomplete cases creates *disadvantages*. First, estimates based on complete cases are biased if the deleted cases differ from the complete

cases. Second, the precision of model estimates will be lower due to the smaller sample size. It is possible that the extent of the bias and loss of precision will be small; rules of thumb are difficult to formulate, however, since the degree of bias depends not only on the proportion of incomplete cases but also on the differences between complete and incomplete cases and pattern of missing data. (*Little and Rubin, 2002*).

The missing data mechanism is said to be *missing at random* (MAR) if the probability of missingness depends on the complete data but not the missing data. If the data are MAR, then the probability that an item is missing can be related to the values of observed items alone, not the missing items.

A special case of MAR is *missing completely at random* (MCAR). If the missingness pattern is MCAR, then the probability of missingness cannot be related to the observed data; missing data occur as if randomly distributed throughout the dataset.

The Multiple Imputation can be used also for handling missing data

#### *Multiple Imputations (MI):*

Instead of generating just one estimate for a missing value as is the case in single imputation. MI produces several estimates for each missing value; the variation of the estimates measures the uncertainty of imputation, an improvement compared with single imputation. Others techniques for estimating missing data have serious shortcomings. Replacing the missing values by the mean of the variable biases the variance and covariance toward zero, for example. Using regression models to estimate missing data also is problematic, since the correlation of the estimates and explanatory variables are biased away from zero. Weighting is proper to adjust for missing cases when all values of an observation are missing. Using weight to adjust for item non-response is equivalent to assuming that the missing data are similar to the complete data, an assumption that may not be true.

MI offers a comprehensive method of simultaneously estimating missing values, Marginal associations among variables are preserved, and missing value uncertainty is estimated. MI produces stochastic estimates for missing values, drawing from the

predictive distribution of missing values given the observed data (*S-Plus Manual*). In multiple imputations, the analyst specifies an imputation model; the model incorporates information about the relationships among the observed data, using this estimates how much the variance of an estimator has increased due to imputed values.

All tests were considered at 0.05 level of significance. The analysis was performed with SAS version 9.1 and S-plus version 6.0. Some of the graphics were also done with Ms Excel.

### 3. Results

#### 3.1 Exploratory Data Analysis

##### 3.1.1 Descriptive statistics

The first part of the work is exploratory data analysis (EDA) on the data. Simple statistical techniques such as measures of central tendency, frequency tables, and correlation matrix and box plots were employed in order to gain an insight into the dataset and also to grasp some idea of the distribution shape and location of the data so as to identify pattern and to have a rough idea about the outline of the continuous variables.

Analysis of variance techniques was used to check if there is significant difference in the measurements (M1 and M2). At 0.05, we obtained significant result.

##### a) Cancer survivor distribution by Age

Table 3.1.1 a: Cancer survivor distribution by Age

AGE	21-30 years	31-40 years	41-50 years	51-60 years	61 -70 years	Total
Number	4	17	45	52	11	129
Frequence	3.10%	13.18%	34.88%	40.31%	8.52%	100%

These results show that the number of survivors of cancer increases with the age. It exists little of people reached of cancer between 21 and 40 years, (16.27%) only. For the people who are 40 years old and more, the number of people increase (83.71%).

##### b) Cancer survivor distribution by Sex

Table 3.1.1.b: Cancer survivor distribution by Sex

SEX	Female	Male	Total
Number	115	14	129
Frequence	89.14%	10.86%	100%

This table 3.1.1.b show that there is much more case of cancer survivor in the study among women (89.14%) than among men (10.86%).

**c) Cancer survivor distribution by Sex and Diagnosis.**

**Table 3.1.1.c: Cancer survivor distribution by Sex and by Diagnosis.**

DIAGNOSIS	Breast Cancer	Other	Total
	<b>84</b>	<b>45</b>	<b>129</b>
Female	84	31	115
Male	-	14	14
Total	84	45	129

These results confirm that it has more women in this study (89.14%), which is due to the fact that there are more breast cancer (65.12%) than others (34.88%).

**d) Cancer survivor distribution by therapy**

**Table 3.1.1.d: Cancer survivor distribution by therapy**

THERAPY	Yes	No	Total
Operation	113	16	129
Radiotherapy	91	38	129
Chemotherapy	95	34	129
Hormone therapy	54	62	116

Number of Patient who have done any therapy	03
Number of Patient who have done only 1 therapy	14
Number of Patient who have done 2 therapies	29
Number of Patient who have done 3 therapies	51
Number of Patient who have done all the 4 therapies	32
Total	129

These 2 tables show that, there are three or four principal methods of treatment of cancers which can only be carried out or in association: the surgical operation, the radiotherapy, the chemotherapy and the hormone therapy. The immunotherapy is also used to treat certain cancers.

Certain patients need more than one method for their treatment.

The treatments suggested take into account recommendations good clinical practice which corresponds to the most effective treatments known and depend on the state of the disease.

These tables also show that there are much more patients who resorted to the surgical operation (113 out of 129), this depends thus of the progress of their disease, the type of cancer.

#### e) Cancer survivor distribution by marital status

**Table 3.1.1.e: Cancer survivor distribution by marital status**

Married or living together	Yes	No	Total
Number	109	20	129
Frequence	84.50 %	15.50 %	100 %

More than 84.50% are married or are living together.

#### f) Cancer survivor distribution by Kids

**Table 3.1.1.f: Cancer survivor distribution by Kids**

Kid	Without Kid	Have Kid	Kid at home	Missing	Total
Number	18	39	71	01	129
Frequence	13.95 %	30.23 %	55.04 %	0.78 %	100 %

This table shows that more than a half of the patients have children at the home and only less than 15% do not have any at all.



### 3.1.2 Correlation Structure

Spearman correlation was used to determine the possible linear relationship between the covariates of the data set (table 3.1.2).

**Table 3.1.2: Spearman Correlation Coefficients**

	SEX	AGE	MAR/L	KIDS	KIDSH	WORKB	DIAG	STILL	OPER	RTHE	CTHE	HTHE	PERI
SEX	1.00												
AGE	-0.5	1.00											
MAR/LIVT	0.62	-0.46	1.00										
KIDS	0.018	0.001	0.16	1.00									
KIDSHOME	-0.21	-0.5	0.32	0.418	1.00								
WORKBEF	-0.01	-0.21	-0.07	-0.05	0.24	1.00							
DIAG	-0.14	0.34	-0.35	0.004	-0.12	-0.04	1.0						
STILLWOR	0.286	-0.25	0.23	-0.06	0.05	0.316	-0.14	1					
OPERATIO	-0.10	0.19	-0.15	-0.09	-0.06	0.04	0.36	-0.11	1				
R THERAP	0.208	-0.06	0.024	-0.07	0.09	-0.13	0.27	0.044	0.32	1			
CTHERAP	0.062	-0.01	0.024	-0.07	-0.05	-0.09	0.04	-0.16	0.15	0.12	1		
HTHERA	0.31	-0.04	0.193	-0.04	0.05	-0.00	0.30	0.082	0.22	0.23	-0.1	1	
PERIOD	-0.25	0.196	-0.14	0.129	-0.09	-0.14	-0.03	-0.00	0.09	-0.1	-0.1	0.02	1

It was found that the variable *Married or living together* and *Age* have a negative relationship (- 0.46). The variable *Age* and the variable *Operation* are correlated (0.19). The variable *Married or Living together* and variable *Kids* have a moderate coefficient of correlation (0.32). While a relatively big correlation between *Sex* and *Married or living together* variable (0.62). The type of *therapy* (Operation, Chemotherapy, Radiotherapy, Hormone therapy) and the variable *Diagnosis* are often correlated. All the types of *therapies* are also correlated between them. A relationship between the variable *Still working* and the variable *Worked before* is noted as 0.31. The variable *Age* and the variable *Diagnosis* are also correlated (0.34).

## 3.2 Statistical Analysis

Based on the insight from the EDA results and the structure of the data, we fitted both *Paired T test* for the first part and *Linear Mixed Model (L.M.M.)* for investigate the second part. The details are discussed in the following sections.

### 3.2.1 *T test* statistic

*T test* is used to determine if there are any statistical significant differences between M1, the measurement before and M2, the measurement after. Proc t test is used and all tests were considered at 0.05 level of significance and we compare this to the p value obtained. We reject Ho (null hypothesis), if  $P_{Ho} \leq 0.05$  and we do not reject if  $P_{Ho} \geq 0.05$ .

**Table 3.2.1.a: Summary statistics obtained on the entire dataset and also from each psychosocial test.**

Psychosocial Tests	Variable	N	Mean	Std Dev	Std Err	Min	Max	DF	t value	Pr >  t
Eortc PF (Physical Functioning)	M2_M1	97	11.13	17.313	1.757	-40	60	96	6.33	<.0001**
Eortc RF (Role Functioning)	M2_M1	97	13.74	20.973	2.129	-50	66.7	96	6.45	<.0001**
Eortc EF (Emotional Functioning)	M2_M1	97	7.302	24.658	2.503	-50	66.7	96	2.92	0.0044**
Eortc CF (Cognitive Functioning)	M2_M1	97	7.732	25.916	2.631	-83	83.3	96	2.94	0.0041**
Eortc SF (Social Functioning)	M2_M1	97	17.01	24.054	2.442	-33	100	96	6.96	<.0001**
QL (Quality of Life )	M2_M1	97	11.42	18.569	1.885	-33	58.3	96	6.06	<.0001**
Fatigue	M2_M1	97	-13.4	23.015	2.337	-67	55.6	96	-5.74	<.0001**
Nausea	M2_M1	97	2.577	15.279	1.551	-50	66.7	96	1.66	0.0999
Pain	M2_M1	97	-6.35	24.348	2.472	-83	50	96	-2.57	0.0117**
Dyspnea	M2_M1	97	-13.1	26.596	2.700	-67	66.7	96	-4.84	<.0001**
Sleep disturbance	M2_M1	97	-11.7	32.29	3.278	-100	66.7	96	-3.56	0.0006**
Appetite loss	M2_M1	97	-2.75	22.908	2.326	-100	66.7	96	-1.18	0.2401
Constipation	M2_M1	97	0.343	25.683	2.607	-100	100	96	0.13	0.8954
Diarrhea	M2_M1	97	-1.72	15.494	1.573	-67	66.7	96	-1.09	0.2775
Financial Impact	M2_M1	97	-4.13	18.793	1.908	-67	33.3	96	-2.16	0.0332**
FACT Fatigue	M2_M1	98	-6.58	9.351	0.945	-30	20	97	-6.97	<.0001**
Psychosomatic Questions	M2_M1	94	-0.81	2.537	0.262	-10	5	93	-3.09	0.0026**
Denying Activities	M2_M1	94	-0.47	3.519	0.363	-12	8	93	-1.29	0.2003

\*\* : means significant.

### **Psychosocial tests:**

The results revealed a borderline significant effect of some tests:

*Eortc Physical Functioning* (p= 0.0001), *Eortc Role Functioning* (p= 0.0001), *Eortc Emotional Functioning* (p=0.0044), *Eortc Cognitive Functioning* (p= 0.0041), *Eortc Social Functioning* (p= 0.0001), *QL: Global Health Status* (p= 0.0001), *Fatigue* (p= 0.0001), *Pain* (p=0.0117), *Dyspnea* (p= 0.0001), *Sleep disturbance* (p=0.0006), *Financial Impact* (p=0.0332), *FACT Fatigue* (p= 0.0001), *Tampa Psychosomatic Questions* (p=0.0026).

Since the p-value is less than 0.05, reject Ho means that the response is significant.

Measurements after and before for these tests are different. We have effect for these tests.

All the significant tests are in general dependent. The majority rest on the physical efforts. The experiment of the disease (*Tampa scale* test) and the *Fact Fatigue* test are both based on questions about tiredness, the weakness, the complaints, the risk of injury, the pain, their sleep, etc ... The survivors of cancer always think that from one moment to another, they could be relapsed. That is psychological. These influence also their *quality of life*.

**Table 3.2.1.b: Summary statistics obtained on the entire dataset and also from each Physical test.**

Physical Tests	Variable	N	Mean	Std Dev	Std Err	Min	Max	DF	t value	Pr >  t
3RM Lateral Pull	M2_M1	61	5.4508	5.4081	0.6924	-2	25	60	7.87	<.0001**
3RM Abductor	M2_M1	61	2.0656	1.537	0.1968	-2	6	60	10.5	<.0001**
3RM Abdominals	M2_M1	62	39.694	27.156	3.4488	2	120	61	11.51	<.0001**
David Back, Back muscles	M2_M1	27	24.444	26.179	5.0381	-16	81	26	4.85	<.0001**
David Back, Abdominals	M2_M1	27	8.4444	12.735	2.4508	-9	34	26	3.45	0.0019**
Gymnex Absolute Extension 180°/s	M2_M1	29	1.7586	12.85	2.3862	-22	33	28	0.74	0.4672
Gymnex Absolute Extension 60°/s	M2_M1	29	2.8966	21.261	3.948	-41	65	28	0.73	0.4693
Gymnex Relative Extension 180°/s	M2_M1	29	2.6207	20.97	3.894	-38	49	28	0.67	0.5065
Gymnex Relative Extens.60°/s	M2_M1	29	4.3103	32.001	5.9425	-51	92	28	0.73	0.4743
Jamar Left	M2_M1	35	3.7714	14.132	2.3887	-19	63	34	1.58	0.1236
Jamar Right	M2_M1	35	3.6857	10.383	1.7551	-22	27	34	2.1	0.0432**
Sit & reach	M2_M1	97	3.5979	4.2172	0.4282	-7	26	96	8.4	<.0001**

\*\* : means significant.

### **Physical tests:**

The results revealed a borderline significant effect of some tests:

**3RM (Lateral Pull, Abductor, Abdominals)**,  $p=0.0001$ ; **David Back, Back Muscles**  $p=0.0001$ ; **David Back, Abdominals**,  $p=0.0019$ ; **Jamar Right**,  $p=0.0432$ ; **Sit and Reach**,  $p=0.0001$ .

Since the p-value is less than 0.05, reject  $H_0$  means that the response is highly significant.

Measurements after and before for these tests are different. We have effect for these tests.

Many cancer survivors suffer from a loss of their muscular strength. Their muscular weakness includes in a total field of fatigue or "syndrome of asthenic".

The cancer survivors always think that from one moment to another, they could be relapsed or could be hurt them or got injury. That's why they are afraid to do some exercises or unnecessary movements.

**Conclusion:** It is precisely recommended to the majority of the cancerous people to make physical exercise, by however consulting their practitioner attending who will be able to advice them up to what point and with which frequency. They do not be afraid to do some fitness. Too much rest can weaken the general health. To cancerous people, the physical activity has not only a favorable effect on the physical state, but contributes moreover to improve their psychosocial wellbeing and their *Quality of live*. An increased rest is obviously necessary in certain phases of the disease.

### 3.2.2 Linear Mixed Model

#### a) Model with Age (continuous) and Sex

**Table 3.2.2.a: Result of Linear Mixed Model for the model with Age (continuous) and Sex**

Test	Effect	Num DF	Den DF	F value	ProbF
3RM Abductors	AGE	1	57	6.03	0.0172**
3RM Abductors	SEX	1	57	8.99	0.0040**
3RM Abductors	AGE*SEX	1	57	7.92	0.0067**
Diarrhea	SEX	1	93	4.03	0.0477*
Emotional Functioning	AGE	1	93	4.36	0.0394**
Jamar Hand dynamometer	AGE	1	31	4.55	0.0409*
Jamar Hand dynamometer	SEX	1	31	5.15	0.0304**
Jamar Hand dynamometer	SEX*AGE	1	31	4.55	0.0410**
Physical Functioning	AGE	1	93	4.97	0.0283**
Sit and Reach	AGE	1	93	9.23	0.0031**
Sit and Reach	SEX	1	93	6.32	0.0136**
Sit and Reach	AGE*SEX	1	93	6.05	0.0157**

Table 3.2.2.a presents the result of L.M.M. fitted to the data set for only the model with Age (continuous) and Sex.

#### b) Model with Age (categorical) and Sex

**Table 3.2.2.b: Result of Linear Mixed Model for the model with Age (categorical) and Sex**

Test	Effect	Num DF	Den DF	F value	ProbF
3RM Abductors	AGE1	1	55	6.31	0.0149**
3RM Abductors	SEX	1	55	6.68	0.0124**
3RM Abductors	SEX*AGE1	1	55	7.45	0.0085**
David Back: Back Muscles	SEX	1	20	5.39	0.0309**
Financial Impact	AGE1	4	87	4.43	0.0026**
Financial Impact	SEX	1	87	4.69	0.0331**
Jamar Hand dynamometer	AGE1	1	28	4.65	0.0398**
Jamar Hand dynamometer	SEX*AGE1	1	28	6.60	0.0158**
3RM Lateral pull	AGE1	2	54	9.17	0.0004**
3RM Lateral pull	SEX*AGE1	1	54	13.91	0.0005**
Sit and Reach	AGE1	3	88	14.77	<.0001**
Sit and Reach	SEX	1	88	4.13	0.0452**
Sit and Reach	SEX*AGE1	3	88	10.96	<.0001**
Tampa Scale: Psychosomatic	AGE1	4	84	4.97	0.0012**

Table 3.2.2.b, presents the result of L.M.M. fitted to the data set for only the model with Age (categorical) and Sex.

**c) Model with Kids**

**Table 3.2.2.c: Result of Linear Mixed Model for the model with Kids**

Test	Effect	Num DF	Den DF	F value	ProbF
Global Functioning	KIDS_AT_HOME	1	93	4.97	0.0283**
Jamar Hand dynamometer	KIDS	1	32	5.22	0.0292**
3RM Lateral pull	KIDS	1	57	4.77	0.0331**
Physical Functioning	KIDS_AT_HOME	1	93	5.78	0.0182**
Sit and Reach	KIDS	1	93	4.96	0.0284**

Table 3.2.2.c, presents the result of L.M.M. fitted to the data set for the model with Kids. Here we combine having Kids and Kids at home in one variable like Kids.

**d) Model with Work status**

**Table 3.2.2.d: Result of Linear Mixed Model for the model with Work status**

Test	Effect	Num DF	Den DF	F value	ProbF
Pain	WORKED_BEFORE	1	92	9.55	0.0026**
Pain	STILL_WORKING	1	92	7.84	0.0062**

Table 3.2.2.d, presents the result of L.M.M. fitted to the data set for the model with Work status. We had combined in one variable Worked before and still working.

**e) Model with Diagnosis**

**Table 3.2.2.e: Result of Linear Mixed Model for the model with Diagnosis**

Test	Effect	Num DF	Den DF	F value	ProbF
Nausea	DIAGNOSIS	1	95	6.87	0.0102**
Tampa scale: Denying	DIAGNOSIS	1	92	5.30	0.0236**

Table 3.2.2.e, presents the result of L.M.M. fitted to the data set for only the model with Diagnosis.

### f) Model with Therapy

**Table 3.2.2.f: Result of Linear Mixed Model for the model with Therapy**

Test	Effect	Num DF	Den DF	F value	ProbF
Dyspnea	CHEMOTHERAPY	1	84	6.14	0.0152**
Extension 60 (Absolute)	OPERATION	1	14	5.79	0.0305**
Extension 60 (Absolute)	RADIOTHERAPY	1	14	4.67	0.0486**
Tampa scale: Denying	RADIOTHERAPY	1	81	5.29	0.0240**

Table 3.2.2.f, presents the result of L.M.M. fitted to the data set for only the model with Therapy. The variable Therapy is the sum of Radiotherapy, Chemotherapy, Operation and Hormone therapy.

### g) Model with Period

**Table 3.2.2.g: Result of Linear Mixed Model for the model with Period**

Test	Effect	Num DF	Den DF	F value	ProbF
Fatigue	PERIOD	6	90	2.53	0.0262**
Loss of Appetite	PERIOD	6	90	2.22	0.0477**

Table 3.2.2.g, presents the result of L.M.M. fitted to the data set for only the model with Period, means period between last therapy and start of rehabilitation.

### h) Model with Marital status

**Table 3.2.2.h: Result of Linear Mixed Model for the model with Marital status**

Test	Effect	Num DF	Den DF	F value	ProbF
David Back: abdominals	MARRIED_LIVING _TOGETER	1	23	11.14	0.0029**

Table 3.2.2.h, presents the result of L.M.M. fitted to the data set for the model with Marital status (Married or living with together).

For the physical tests, the results revealed a significant effect of *Age*, *Sex* and the *interaction between Age and Sex* for almost all significant tests obtained at the *paired t-test* (3RM Lateral pull, 3RM Abductors, David Back: Abdominals, David Back: Back muscles, Jamar Hand dynamometer, Sit and Reach). These confirm the EDA part.

For the psychosocial tests, the results of LMM revealed a significant effect of *Diagnosis*, *Therapy*, *Age*, *Period*, *Work status*, *sex*, *Kids* and *Marital status*. This confirm the Spearman correlation Coefficient,



## 4. Discussion

In our attempt to answer the research question which was globally to state if there was difference between the two measurements M1 (before the program) and M2 (after the program). We implemented statistical methodology dealing with this type of data (longitudinal data) and with respect of the just mentioned characteristics; we used the PROC T Test and PROC MIXED statements in SAS. One of the main characteristics of the PROC MIXED is: it assumes normality and it is robust against non normality and more also there were small number of patients participating in the experiment (129 cancer survivors) and will not be rewarding making inference base on the analysis of such data set.

The study was carried during 12 weeks and during this we had common tests where in both treatments. Since our interest was to determine if there are any difference between the measurement before and the measurement after for each test.

The research question was to investigate the effect of the socio demographical factors on the difference between the two measurements for each tests doing by the cancer survivors. This was done by investigating on a general note the effect of physical training and the psychosocial being. We found that according to the p-value, there seems to be a difference between the two measurements for some tests. These observations were confirmed by the results of the L.M.M., which suggest there is difference between the measurements on a general scale.

Cancer survivors have most common physical problems like fatigue, lack of physical capacity and decrease muscles strength and also a lack of psychosocial problems, like social contact, depressive thoughts and feelings.

After the statistical analysis, we can say that in almost tests, Age, Sex, interaction between Age and Sex, the type of therapy and the type of cancer are always significant. All the symptoms may lead to a vicious circle, and this may have a negative influence on the Quality of life.

This explain why we have the approximately the same results in T test and in L.M.M.

## 5. Conclusion and recommendations

It is precisely recommended to the majority of the cancerous people to make physical exercise. Too much rest can weaken the general health. At the cancerous people, the activity has not only one effect favorable on the physical state, but contributes moreover to improve their psychosocial wellbeing. An increased rest is obviously necessary in certain phases of the disease.

A regular physical activity can contribute to prevent cancer and stimulates the immunizing system of defense (system indeed). Practiced regularly, the physical exercise probably makes it possible to prevent certain cancers, in particular the cancer of the endometrium and that of the colon. It may be also that a regular physical activity makes it possible to avoid or slow down the development of and certain shape breast cancer of lung cancers, as - although one does not have any certainty yet on this subject - cancer of the prostate and ovaries.

Compared to the majority of the other countries, the Belgians practice not enough much physical activities. Nearly 1 adult out of 2 admits doing little physical exercise during his leisure and hardly 1 out of 3 devotes to a tiring physical activity once per week. Damage, because it is proven that the regular physical activity is beneficial for body and psychosocial health, like for the wellbeing; it in addition contributes to prevent many diseases, to accelerate their process of cure or to stabilize them.

Concurrently to these three specific treatments of cancer (surgical operation, radiotherapy and chemotherapy), other treatments will be proposed to the patient aiming at ensuring the best quality of possible life to him while meeting its needs as regards pain, tiredness, problems nutritional, turbid digestive, respiratory, odontological, social difficulties, psychic suffering and accompaniment of the end of lifetime.

The survivors of cancer currently make mention of a great number of side effects due to the followed treatment, which interferes with their quality of life. More than one over three of the survivors of the cancer treated by chemotherapy mentions a decline in their capacities of reflection.

Some research project like project of Dr Bernstein studies the possible effects of chemotherapy on the cognitive functions and will particularly examine the coherence of their capacities of reflection and their level of fatigue.

## 6. References

- Molenberghs, G. & Verbeke, G. (2005). *Models for Discrete Longitudinal Data*. Springer Series in statistics. New-York: Springer-verlag
- Verbeke, G. and Molenberghs, G. (2006) *Lecture Notes in Correlated and Multivariate data*, for Applied Statistics U Hasselt press.
- G. Verbeke, G. Molenberghs (2000) *Linear Mixed Model for Longitudinal Data Springer Series in Statistics*. New York: Springer-Verlag.
- [www.socialresearchmethods.net](http://www.socialresearchmethods.net)
- [www.cancer.be](http://www.cancer.be)
- [www.icr.ac.uk](http://www.icr.ac.uk)
- [www.cancerhelp.org.uk](http://www.cancerhelp.org.uk)
- [www.cancerresearch.org](http://www.cancerresearch.org)

## 7. Appendix

### Appendix A

```
proc print data=sasuser.abouna;
run;
proc sort data=sasuser.abouna;
by test;
run;
proc ttest data=sasuser.abouna;
var m2_m1;
by test;
run;
proc sort data=sasuser.abouna;
by patientnr test;
run;
data mixed; set sasuser.abouna;
testcl=test;
run;
proc mixed data=mixed;
class test testcl group_nr patientsnr;
model m2_m1=test group_nr/solution;
repeated testcl/type=cs subject=patientsnr r rcorr;
run;
#####;
##### Mean Structure #####;
proc sort data=sasuser.abouna;
by group_nr test;
run;

proc means data=sasuser.abouna;
var m2_m1;
by group_nr test;
output out=nana mean=mean;
run;

symbol1 v=none i=j ;
symbol2 v=none i=j ;
symbol3 v=none i=j ;
symbol4 v=none i=j ;
symbol5 v=none i=j ;
symbol6 v=none i=j ;
symbol7 v=none i=j ;
symbol8 v=none i=j ;
symbol9 v=none i=j ;
symbol10 v=none i=j;
proc gplot data=nana;
plot mean*test/overlay;
run;

proc gplot data=nana;
plot mean*test;
run;
```

```

#####
##### Sociodemographic #####
data TMP1.DATA;
set TMP1.DATA;
if PATID = . then delete;
TAMPAPSYCH = TAMPAPSYCH2 - TAMPAPSYCH1;
TAMPADENAYING = TAMPADENAYING2 - TAMPADENAYING1;
LATPULL = LATPULL2 - LATPULL1;
ABDUCT = ABDUCT2 - ABDUCT1;
ABDOM = ABDOM2 - ABDOM1;
SITREACH = SITREACH2 - SITREACH1;
JAMARLEFT = JAMARLEFT2 - JAMARLEFT1;
JAMARRIGHT = JAMARRIGHT2 - JAMARRIGHT1;
EXTABS180 = EXTABS1802 - EXTABS1801;
EXTABS60 = EXTABS602 - EXTABS601;
EXTREL180 = EXTREL1802 - EXTREL1801;
EXTREL60 = EXTREL602 - EXTREL601;
BACKMUSCTEST = BACKMUSCTEST2 - BACKMUSCTEST1;
BACKMUSCNORM = BACKMUSCNORM2 - BACKMUSCNORM1;
ABDOMTEST = ABDOMTEST2 - ABDOMTEST1;
ABDOMNORM = ABDOMNORM2 - ABDOMNORM1;
PERIOD = PERIOD_BETWEEN_LAST_THERAPY_AND_;
drop TAMPAPSYCH2 TAMPAPSYCH1 TAMPADENAYING2 TAMPADENAYING1 LATPULL2
LATPULL1 ABDUCT2 ABDUCT1
ABDOM2 ABDOM1 SITREACH2 SITREACH1 JAMARRIGHT2 JAMARRIGHT1
JAMARLEFT2 JAMARLEFT1
EXTABS1802 EXTABS1801 EXTABS602 EXTABS601 EXTREL1802 EXTREL1801
EXTREL602 EXTREL601
BACKMUSCTEST2 BACKMUSCTEST1 BACKMUSCNORM2 BACKMUSCNORM1
ABDOMTEST2 ABDOMTEST1 ABDOMNORM2 ABDOMNORM1
PERIOD_BETWEEN_LAST_THERAPY_AND_;
run;

data DATA1;
set TMP1.DATA;
DIFF = PF;
TEST = 'Physical Functioning';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA2;
set TMP1.DATA;
DIFF = RF;
TEST = 'Role Functioning';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA3;
set TMP1.DATA;
DIFF = EF;
TEST = 'Emotional Functioning';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA4;
set TMP1.DATA;

```

```

DIFF = CF;
TEST = 'Cognitive Functioning';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA5;
set TMP1.DATA;
DIFF = SF;
TEST = 'Social Functioning';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA6;
set TMP1.DATA;
DIFF = QL;
TEST = 'Global Functioning';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA7;
set TMP1.DATA;
DIFF = Fatigue;
TEST = 'Fatigue';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA8;
set TMP1.DATA;
DIFF = Nausea;
TEST = 'Nausea';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA9;
set TMP1.DATA;
DIFF = Pain;
TEST = 'Pain';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA10;
set TMP1.DATA;
DIFF = Dyspnea;
TEST = 'Dyspnea';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA11;
set TMP1.DATA;
DIFF = Sleep;
TEST = 'Sleep Disturbance';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA12;
set TMP1.DATA;

```

```

DIFF = Appetite;
TEST = 'Loss of Appetite';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA13;
set TMP1.DATA;
DIFF = Constipation;
TEST = 'Constipation';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA14;
set TMP1.DATA;
DIFF = Diarrhea;
TEST = 'Diarrhea';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA15;
set TMP1.DATA;
DIFF = Financial;
TEST = 'Financial impact';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA16;
set TMP1.DATA;
DIFF = FACTFAT;
TEST = 'Fact Fatigue';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA17;
set TMP1.DATA;
DIFF = JAMARLEFT;
TEST = 'Jamar Handdynamometer (Left)';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA18;
set TMP1.DATA;
DIFF = JAMARRIGHT;
TEST = 'Jamar Handdynamometer (Right)';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA19;
set TMP1.DATA;
DIFF = LATPULL;
TEST = 'Lateral pull';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA20;
set TMP1.DATA;

```



```

DIFF = TAMPAPSYCH;
TEST = 'Tampa scale: psychosomatic questions';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA21;
set TMP1.DATA;
DIFF = TAMPADENAYING;
TEST = 'Tampa scale: Denying activities';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA22;
set TMP1.DATA;
DIFF = ABDUCT;
TEST = 'Abductors';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA23;
set TMP1.DATA;
DIFF = ABDOM;
TEST = 'Abdominals';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA24;
set TMP1.DATA;
DIFF = SITREACH;
TEST = 'Sit and reach test';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA25;
set TMP1.DATA;
DIFF = EXTABS180;
TEST = 'Extension 180 (Absolute)';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA26;
set TMP1.DATA;
DIFF = EXTABS60;
TEST = 'Extension 60 (Absolute)';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA27;
set TMP1.DATA;
DIFF = EXTREL180;
TEST = 'Extension 180 (Relative)';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA28;
set TMP1.DATA;

```

```

DIFF = EXTREL60;
TEST = 'Extension 60 (Relative)';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA29;
set TMP1.DATA;
DIFF = BACKMUSCTEST;
TEST = 'David Back: Back Muscles';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA30;
set TMP1.DATA;
DIFF = BACKMUSCNORM;
TEST = 'David Back: Back muscles (Difference to normal in %)';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA31;
set TMP1.DATA;
DIFF = ABDOMTEST;
TEST = 'David Back: abdominals';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data DATA32;
set TMP1.DATA;
DIFF = ABDOMNORM;
TEST = 'David Back: abdominals (Difference to normal in %)';
keep DIFF TEST PATID SEX AGE AGE1 MARRIED_LIVING_TOGETHER KIDS KIDS_AT_HOME
WORKED_BEFORE STILL_WORKING DIAGNOSIS OPERATION
RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY PERIOD;
data TMP1.DATA;
merge DATA1 DATA2 DATA3 DATA4 DATA5 DATA6 DATA7 DATA8 DATA9 DATA10 DATA11
DATA12 DATA13 DATA14 DATA15 DATA16 DATA17 DATA18 DATA19
DATA20 DATA21 DATA22 DATA23 DATA24 DATA25 DATA26 DATA27 DATA28 DATA29
DATA30 DATA31 DATA32;
by TEST;
proc sort data = TMP1.DATA;
by TEST;
proc print data = TMP1.DATA;
run;

/*****
***/
/* SOCIODEMOGRAPHIC VARIABLES IN THE DATASET
/*
/* SEX
/* 1 = female
/* 0 = male
/*
/* AGE
/*
/* AGE1
/* 0 = 21-30

```

```

/* 1 = 31-40
/* 2 = 41-50
/* 3 = 51-60
/* 4 = 61-70
/*
/* MARRIED/LIVING TOGETHER
/* 1 = yes
/* 0 = no
/*
/* KIDS
/* 1 = yes
/* 0 = no
/*
/* KIDS AT HOME
/* 1 = yes
/* 0 = no
/*
/* WORKED BEFORE
/* 1 = yes
/* 0 = no
/*
/* STILL WORKING
/* 1 = yes
/* 0 = no
/*
/* DIAGNOSIS
/* 1 = breast
/* 0 = other cancer
/*
/* OPERATION
/* 1 = yes
/* 0 = no
/*
/* RADIOTHERAPY
/* 1 = yes
/* 0 = no
/*
/* CHEAMOTHERAPIE
/* 1 = yes
/* 0 = no
/*
/* HORMONETHERAPY
/* 1 = yes
/* 0 = no
/*
/* PERIOD BETWEEN LAST THERAPY AND START OF THE REHABILITATION
/* 0 = 3 months
/* 1 = 4 - 6 months
/* 2 = 7 - 9 months
/* 3 = 10 - 12 months
/* 4 = 12 - 24 months
/* 5 = > 24 months
/* 6 = missing
/*
/******
***/

```

```

proc mixed data = TMP1.DATA;
title 'MODEL WITH AGE (CONTINUOUS) AND SEX';
class PERIOD AGE1 ;
model DIFF = AGE SEX AGE*SEX;
by TEST;
ods output TESTS3 = AGE_CON_TEST;
proc print data = AGE_CON_TEST;
run;

```

```

proc mixed data = TMP1.DATA;
title 'MODEL WITH AGE (CATEGORICAL) AND SEX';
class PERIOD AGE1 ;
model DIFF = AGE1 SEX AGE1*SEX;
by TEST;
ods output TESTS3 = AGE_CAT_TEST;
proc print data = AGE_CAT_TEST;
run;

```

```

proc mixed data = TMP1.DATA;
title 'MODEL WITH MARITAL STATUS';
class PERIOD AGE1 ;
model DIFF = MARRIED_LIVING_TOGETHER;
by TEST;
ods output TESTS3 = MARITAL_TEST;
proc print data = MARITAL_TEST;
run;

```

```

proc mixed data = TMP1.DATA;
title 'MODEL WITH KIDS';
class PERIOD AGE1 ;
model DIFF = KIDS KIDS_AT_HOME;
by TEST;
ods output TESTS3 = KIDS_TEST;
proc print data = KIDS_TEST;
run;

```

```

proc mixed data = TMP1.DATA;
title 'MODEL WITH WORK STATUS';
class PERIOD AGE1 ;
model DIFF = WORKED_BEFORE STILL_WORKING;
by TEST;
ods output TESTS3 = WORK_TEST;
proc print data = WORK_TEST;
run;

```

```

proc mixed data = TMP1.DATA;
title 'MODEL WITH DIAGNOSIS';
class PERIOD AGE1 ;
model DIFF = DIAGNOSIS;
by TEST;
ods output TESTS3 = DIAGNOSIS_TEST;
proc print data = DIAGNOSIS_TEST;
run;

```

```

proc mixed data = TMP1.DATA;
title 'MODEL WITH THERAPY';

```

```
class PERIOD AGE1 ;
model DIFF = OPERATION RADIOTHERAPY CHEAMOTHERAPIE HORMONETHERAPY;
by TEST;
ods output TESTS3 = THERAPY_TEST;
proc print data = THERAPY_TEST;
run;

proc mixed data = TMP1.DATA;
title 'MODEL WITH PERIOD';
class PERIOD AGE1 ;
model DIFF = PERIOD;
by TEST;
ods output TESTS3 = PERIOD_TEST;
proc print data = PERIOD_TEST;
run;
```

## Appendix B

### Explanation used terms in psychosocial questionnaires

---

M1= measurement before rehabilitation, M2 = measurement after rehabilitation.

---

#### **1. EORTC QLQ-30**

This is a questionnaire which asks the patients about their physical functioning (PF), their role function(RF), their emotional functioning (EF), their cognitive functioning (CF), their social functioning (SF), their global health status or Quality of Life (QF) and some physical discomforts like vomiting, sleep disturbance,.....

Questions 1 till 5 can be answered between 1-2, with 1= no and 2= yes

Questions 6 till 28 can be answered between 1-4 with 1= not at all; 2 = a little; 3 =quite; 4 very much

Questions 29 till 32 can be answered between 1- 7 with 1 is very bad and 7 is excellent

1. Do you find it difficult to perform small activities like carrying a suitcase or a grocery bag?
2. Do you find it difficult to make a long walk?
3. Do you find it difficult to make a short walk outside home?
4. Do you have to stay in bed or in a chair most of the day?
5. Do you need help dressing, feeding or going to the toilet?
6. Were you limited in performing daily household tasks or at work?
7. Were you limited in performing your hobbies?
8. Were you short of breath?
9. Did you have pain
10. Did you feel like you had to rest?
11. Did you have trouble sleeping?
12. Did you feel weak?
13. Did you have a lost of appetite?
14. Did you feel sick
15. Did you have to vomit
16. Did you suffer from constipation?
17. Did you suffer from diarrhea

18. Were you tired?
19. Did you experience pain in your daily tasks?
20. Did you have trouble concentrating?
21. Did you feel tense
22. Did you worry a lot?
23. Did you feel agitated or stressed?
24. Did you feel depressed
25. Did you have trouble remembering things?
26. Did your physical condition or medical treatment interfere with your family life?
27. Did your physical condition or medical treatment interfere with your social life?
28. Did your physical condition or medical treatment give you financial problems?
29. How would you describe your health during the last week?
30. How would you describe your general quality of life?
31. How well did you cope with your problems the last week?
32. How successful were you the last week in dealing with stressful situations in your life?

## **2. FACT fatigue**

This is a summation of all these questions.

This is a questionnaire which asks the patients about their fatigued feelings.

The data in M1 and M2 can differ from 0 till 52 (points)

Per question they can fill in 0= not true at all; 1= a little true; 2= roughly true; 3= much true; 4 = very much true.

The minimum is 0 (not tired at all) the maximum is 52 (very tired).

Questions:

1. The tiredness is troubling me.
2. I feel weak over my whole body.
3. I feel listless.
4. I feel tired
5. It costs a lot of effort to do things because I am so tired.
6. It costs a lot of effort to finish things because I am so tired.
7. I feel energetic
8. I can do my normal activities

9. I need to sleep during the day
10. I am too tired to eat
11. I need help to do my daily tasks
12. I'm frustrated because I can't do what I would like
13. I have to limit my social activities because I'm too tired.

### 3. TAMPA scale

This Questionnaire asks the patients how they experience their disease = their physical activity avoidance and their psychosomatic focus.

The data in M1 and M2 can differ for 1 till 4 with 1 = "I disagree", 2 = "I disagree a little", 3 = "I agree a little", 4 = "I agree"

The data in "SOM tampa 17" is the sum of all questions

The data in "SOM tampa 13" is the sum of all questions about her disease experience (Psychosomatic focus and physical activity avoidance).

Questions:

1. I'm afraid to do exercises because it can hurt me.
2. If I would get over my complaints, they would get worse.
3. My body says there is something dangerously wrong.
4. My complaints would probably get better if I perform exercises.
5. Other people don't take my state of health seriously.
6. The rest of my body is in danger because of the cancer.
7. My complaints equal injury.
8. If my complaints get worse, it doesn't mean it's dangerous
9. I'm afraid to get a injury by accident
10. The safest way to prevent my complaints to get worse is to be careful that I don't do any unnecessary movements.
11. I would have lesser complaints if there was nothing wrong with my body.
12. Nevertheless I have these complaints I would be better of if I did some exercise.
13. My complaints tell me when I have to stop exercising to avoid any injury
14. for someone in my condition it is forbidden to do exercise
15. I can't do what healthy people do because I injure rapidly
16. Even if my complaints get worse by doing something, I don't think It's dangerous.
17. I would not have to do exercises when I have complaints.



## **Auteursrechterlijke overeenkomst**

*Opdat de Universiteit Hasselt uw eindverhandeling wereldwijd kan reproduceren, vertalen en distribueren is uw akkoord voor deze overeenkomst noodzakelijk. Gelieve de tijd te nemen om deze overeenkomst door te nemen, de gevraagde informatie in te vullen (en de overeenkomst te ondertekenen en af te geven).*

Ik/wij verlenen het wereldwijde auteursrecht voor de ingediende eindverhandeling:

### **The influence of a multidimensional rehabilitation program on physical and psychosocial health in cancer survivors**

Richting: **Master of science in Applied Statistics**

Jaar: **2007**

in alle mogelijke mediaformaten, - bestaande en in de toekomst te ontwikkelen - , aan de Universiteit Hasselt.

Niet tegenstaand deze toekenning van het auteursrecht aan de Universiteit Hasselt behoud ik als auteur het recht om de eindverhandeling, - in zijn geheel of gedeeltelijk -, vrij te reproduceren, (her)publiceren of distribueren zonder de toelating te moeten verkrijgen van de Universiteit Hasselt.

Ik bevestig dat de eindverhandeling mijn origineel werk is, en dat ik het recht heb om de rechten te verlenen die in deze overeenkomst worden beschreven. Ik verklaar tevens dat de eindverhandeling, naar mijn weten, het auteursrecht van anderen niet overtreedt.

Ik verklaar tevens dat ik voor het materiaal in de eindverhandeling dat beschermd wordt door het auteursrecht, de nodige toelatingen heb verkregen zodat ik deze ook aan de Universiteit Hasselt kan overdragen en dat dit duidelijk in de tekst en inhoud van de eindverhandeling werd genotificeerd.

Universiteit Hasselt zal mij als auteur(s) van de eindverhandeling identificeren en zal geen wijzigingen aanbrengen aan de eindverhandeling, uitgezonderd deze toegelaten door deze overeenkomst.

Ik ga akkoord,

**Abouna Mbaye**

Datum: **27.08.2007**