Is ek ondervoed?

Research

Theewaterskloof project
June 2014

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Organizations	Genadendal Educare Bereaville Educare Greyton Speelcentrum Vrolike Vinkies Voorstekraal Educare
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PROJECT THEEWATERSKLOOF

Hogeschool van Arnhem en Nijmegen

Genadendal, June 2014

Foreword

This research report is written in the context of the thesis of two 4th year students in completion of the course Nutrition and Dietetics at the HAN University of applied science in Nijmegen. This report is designed for the principal, teachers and staff members of five crèches in the Theewaterskloof district. Other readers that are interested in the subject nutrition by children in South Africa are more than welcome to read this report as well.

This report has been in collaboration with a few people. First of all we would like to thank the employees of the crèches (Genadendal Educare, Bereaville Educare, Voorstekraal Educare, Greyton Speelcentrum and Vrolike vinkies) for giving us the opportunity to be part of their work. We are grateful for their cooperation and giving us information about the South African culture. Secondly we would like to thank our supervisors, Annemarie Nijhof, from the HAN University of applied science in the Netherlands and Elsabé Nel from the UWC in South Africa, for giving us feedback and support during our research.

Furthermore, our thanks goes to our family and friends that were always supporting us. Finally, we would like to thank Lizelle Duminy and Karin Benjamin from the Theewaterskloof project. They told us a lot about the South African culture and they were always ready to help us.

Genadendal, June 2014

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Content

Glossary

BMI	Body Mass Index. The formula for BMI is weight in kilograms divided by height in meters square (Centers for Disease Control and Prevention, 2011)
Food security	Household food security is defined as sustainable access to safe food of sufficient quality and quantity to ensure adequate intake and a healthy life for all members of the family. (Unicef)
Kwashiorkor	A type of protein- energy malnutrition (PEM). Kwashiorkor occurs with fair or adequate calorie intake but inadequate protein and micronutrient intake (vitamins and minerals) (Unicef)
MAM	Moderate acute malnutrition (Unicef)
Marasmus	A type of protein- energy malnutrition (PEM). Marasmus occurs when the diet is inadequate in both calories and proteins (Unicef)
MUAC	Middle Upper Arm Circumference. To measure MUAC, a flexible measuring tape is wrapped around the mid-upper arm between the shoulder and elbow. (Unicef)
NCFS	National Food Consumption Survey. The aim of this survey in South Africa was to determine the nutrient intake and anthropometric status of children aged 1-9 year (Labadarios, et al., NFCS, South Africa 1999, 2005)
Nutrition transition	The nutrition transition refers to changes in dietary patterns and nutrient intakes of individuals, families, groups of people, or whole populations when their food environments and other circumstances change (Temple & Steyn, 2008)
PEM	Protein Energy malnutrition (Unicef)
SAM	Severe acute malnutrition (Unicef)
Stunting	Stunting is an indicator for chronic malnutrition. A child whose height-for-age is below -2 SD is moderate stunted. A child whose height-for-age is below -3 SD is severely stunted. (de Lange, 2010)
Teacher	A preschool educator at the crèches in South Africa
Underweight	Underweight is an indicator for acute malnutrition. A child whose weight for age is below -2 SD, is moderate underweight. A child whose weight for age is below the -3 SD, is severely underweight (de Lange, 2010).
Wasting	Wasting is an indicator for severe acute malnutrition. A child whose weight for height is below -2 SD, is moderate wasted. A child whose weight is below -3 SD, is severely wasted (de Lange, 2010).
WHO	World Health Organization. WHO is the directing and coordinating authority for health within the United Nations system. It is responsible for providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries and monitoring and assessing health trends (WHO, 2014).
Z-score	A z-score is the number of standard deviations (SD) below or above the reference median value.

Abstract

In order to update the data base of the department of health, Elsabe Nel, lecturer at the UWC asked us to research the prevalence of malnutrition at the five crèches in the region of Genadendal. The research question is: *What is the prevalence of malnutrition among the children aged two to five years old at the crèches in Genadendal, Greyton, Bereaville and Voorstekraal, and what are the common classifications (stunting, wasting, underweight)?*

To answer this question a desk and field research has been carried out. There are a lot of parameters that are used for the measurement of malnutrition in South Africa. To classify a child with underweight you can use the Weight-for-Age Chart. To classify whether or not a child is stunted one should use the height-for-age chart and to classify a child with wasting one should use the Mid-Upper Arm Circumference (MUAC) and Weight-for-Height z-score.
A field research has been conducted at the five crèches. The weight, height and MUAC (Middle Upper Arm Circumference) have been measured in 139 children between two and five years old. Besides that we wrote the date birth, birth weight and the birth length of all the children. We entered this date into the 'nutritional survey' of the WHO Anthro program. The outcomes of this program are z-scores of height for age, weight for age, weight for height and MUAC for age.

The results show that in total 83% of the children has a height-for-age below z-score 0. 51% children has a weight-for-height below z-score 0, 44% has a MUAC-for-age below z-score 0 and 73% of the children has a weight-for-age below z-score 0.

With the outcomes it can be concluded that only one in seven children (13%) is classified as stunted, just 1% of the children is classified as wasted and one in seventeen children (6%) is classified as underweight. On the other hand, there are a lot of children between z-score zero and minus two, that are not classified to be stunted, wasted or underweight. These children cannot be classified as stunted, wasted or underweight but they have a mild form of malnutrition which put them in a risk of infections and malnutrition.
In comparison with the WHO classifications for assessing severity malnutrition the prevalence of stunting, wasting and underweight in region Genadendal is low (Temple & Steyn, 2008). Possible explanations of the lower prevalence of malnutrition in region Genadendal are that we may missed a number of children and that urban poverty and under nutrition are increasing faster in comparison with rural poverty and under nutrition (Ruel, Haddad, & Garrett, 1999).

As result of this research a few recommendations can be given. The first one is to conduct a complete nutritional assessment and treatment of the children diagnosed with stunting, wasting and underweight by the dietitian of the clinic of Genadendal. Another recommendation is to start a research focused on the nutritional intake of the children and the food supply at the crèches and shops in region Genadendal. The last recommendation is to start a research focused on the reliability of MUAC-for-age and weight-for-height to determine wasting.

Introduction

We are two Dutch Nutrition and Dietetics students at the HAN University of applied science. To broaden our framework of nutrition, we have chosen to perform our research in South Africa. The HAN University of applied science has been running a project in the municipality Theewaterskloof in collaboration with the UWC for a few years. This project is focused on the social and economical development of the communities in the Theewaterskloof region in South Africa.

The department of nutrition and Dietetics of the UWC and the department of health wants to update the database of rural areas such as the Theewaterskloof district. That is why Elsabe Nel asked us, two students of the study Nutrition and Dietitics of the HAN University of applied science, to do an investigation in rural areas for the UWC. Elsabe Nel is currently a part-time lecturer of the training Nutrition and Dietetics at the UWC. Besides that, she is the coordinator of the students of the training Nutrition and Dietetics of the Theewaterskloof project.
The aim of this research is to determine the prevalence of malnutrition in total and specific of underweight, stunting and wasting at the five crèches in region Genadendal. A research study will be done to assess the anthropometric to investigate the nutritional status. The prevalence of malnutrition in region Genadendal will be compared with the prevalence of malnutrition in South African and the WHO classifications for assessing severity of malnutrition by prevalence ranges.

Malnutrition is a significant factor in approximately one third of the nearly eight million deaths in children who are under five years of age worldwide. The 'National Food Consumption Survey' (NFCS) that was conducted in 1999 showed that stunting is by far the most common nutritional disorder in South Africa, affecting nearly one in five children (Labadarios, et al., NFCS, South Africa 1999, 2005). Besides that, the prevalence of underweight is ascertained at one in ten children and the prevalence of wasting on the national level is one in twenty children. Malnutrition has negative consequences for the health of the children. Health problems, as a consequence of malnutrition, have impact on the social and economic situation in South Africa. The cycle of poverty and malnutrition shows that reduced mental capacity and lower human capital development are results of foetal and early infant and childhood malnutrition because of malnourishment of pregnant women (Vorster, The link between poverty and malnutrition: a South African perspective, 2010). Other consequences are nutritional insults and other poverty-related causes during child development. The reduced human capital is associated with an inability to grow optimally, develop and benefit from education, poor socialization and generally a reduced capacity to lead productive lives that will ensure food security and healthy environments for self and family. So when a child is born in a community where malnutrition and poverty are present it is difficult to escape from the vicious cycle of malnutrition because the poor developmental and educational level of the malnourished child will limit economic productivity in later life.

The structure of this research paper will be as follows: Chapter one starts with a description of the background information, the principal, crèches, boundary conditions and the problem formulation. It also includes the research and sub questions that will answer the main research question. The second chapter provides information about the methodology and results of the desk research. Chapter three gives a description of the method and results of the field research. The conclusions of the desk- and field research can be found in chapter four. The discussion, strengths and weaknesses of the study will be described in chapter five. Finally, recommendations will be given in chapter six.

Chapter 1 Background information

This chapter provides some background information about South Africa, the principal Elsabe Nel, the problem formulation and the crèches. Thereafter, it gives the description of the research, main and sub questions.

1.1 South Africa

South Africa is home to a population that is rich in cultural and ethnic diversity (SouthAfrica.info, 2014). In 2011 it had a total population of 51,8 million people. South Africa has 11 official languages and also a lot unofficial ones. The most spoken language is Afrikaans, while English is the language that is understood throughout the country and is used in business and media.
A total over 500.000 deaths occurred in South Africa in 2010. Tuberculosis (TB) was the leading cause of death. However, during this year the number of deaths caused by TB, influenza and pneumonia and intestinal infectious diseases dropped. In the same period the number of deaths due to diabetes mellitus and HIV disease increased. Besides that, malnutrition is also a problem in South Africa. Malnutrition is a significant factor in approximately one third of the nearly 8 million deaths in children who are under five years of age worldwide (WHO, 2013). Stunting in childhood also increases the risk of overweight later in life (Kimani-Murage, Exploring the paradox: double burden of malnutrition in rural South Africa, 2013).

1.2 Theewaterskloof local Municipality

The research will be conducted in Genadendal, Greyton, Bereaville and Voorstekraal. In 2011, 12.304 people lived in these villages. 950 of these people were between zero and four years old and 957 were between five and nine years old . In 2011, there were 231 pre-school children and now there are 193 pre-school children. The most spoken language is Africans. Furthermore, English and IsiXhosa are commonly used.
These villages are located in a part of the Theewaterskloof municipality. According to Census 2011, Theewaterskloof local municipality has a total population of 108.790 people, of whom 62,9% are colored, 23,4% are black African, and 9,4% are white (Africa, 2011). The other population groups make up the remaining 4,3%. Of those aged 20 years and older, 9,3% had completed primary school, 40,1% had some secondary education, 20,2% had completed matric, and 7,4% had some form of higher education, while 5,0% of them had no form of schooling. 47.644 people are employed or unemployed but looking for working. Of these people 14,9% is unemployed. In the municipality are 28.884 households with an average household size of 3,5 persons. The table below shows the average household incomes. Incomes range from no income to 122.800 rand per month, with an average income of 19.601 – 38.200 Rand per month.

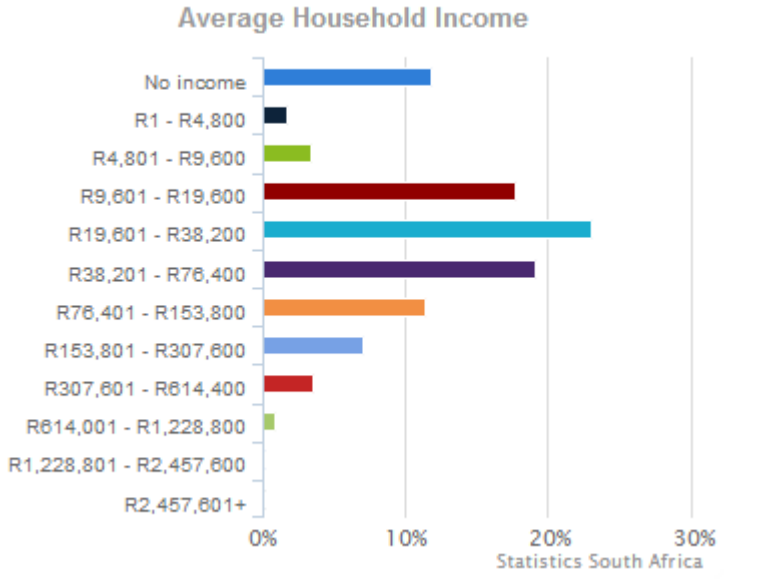

Figure 1 Avarage Household Income (Africa, 2011)

1.3 Involved organizations

In the area of Genadendal there is a collaboration between a number of five crèches:

- Educare Genadendal, in Genadendal
- Educare Bereaville, in Bereaville
- Greyton Speelcentrum, in Greyton
- Vrolike Vinkies, in Greyton
- Voorstekraal Educare, in Voorstekraal

All of these five crèches will be a part in the survey.

In South Africa, a crèche is a preparatory course for primary school. The age of the children varies between two and five years. The crèches are open from Monday till Friday and the teachers at all crèches work according to a time schedule. Breakfast and lunch are prepared and eaten in the crèches. The children take their own drinks and snacks for the recess**.** The number of children and teachers varies from crèche. To finalize, all crèches get financial support from the Social Services Department of the government. The parents are asked for a contribution.

1.4 Research question

What is the prevalence of malnutrition among the children aged two to five years old at the crèches in Genadendal, Greyton, Bereaville and Voorstekraal, and what are the common classifications (stunting, wasting, underweight)?

Sub questions of the desk research:

- What is the definition of malnutrition and what are the different classifications?
- How is malnutrition measured in South Africa?
- What is the prevalence of malnutrition in South African children between two and five years old?
- What are the causes of malnutrition in South African children between two and five years old?
- What are the consequences of malnutrition for the physical and mental health of South African children between two and five years old?

Sub question of the field research:

- What is the anthropometric status (weight, height, growth curve) of children between two and five years old at the crèches in Genadendal, Greyton, Bereaville and Voorstekraal?

Chapter 2 Desk research

Method desk research

Literature study is necessary to collect information about the health state of children in South Africa. Several databases have been searched, such as PupMed, the WHO database and Google. Also websites from organizations such as the World Health Organization (WHO), United Nations Children's Fund (UNICEF) and the Food and Agriculture Organization (FAO) have been consulted to gain information about malnutrition in South Africa. The keywords that were used are “Malnutrition in children”, “Wasting, Stunting and underweight”, “Anthropometry”, “South African” “Growth curves”, “Body Mass Index”, “MUAC", "Protein-Energy Malnutrition", “Pediatrics”, ”diet cost”, ”causes of malnutrition”, “Child”, "Nutritional Assessment”, “Nutritional status” and "Child Nutrition”.
An overview of the search strategy can be found in appendix1.

Results desk research

We’ve applied the desk research to find information about our research question. For each research sub question we did some desk research. These sub questions are described in this chapter.

2.1 What is the definition of malnutrition and what are the different classifications?

Child malnutrition has been defined or described in many ways. One of the definitions of malnutrition is the following: “*Malnutrition is the condition that develops when the body does not get the right amount of vitamins, minerals and other nutrients it needs to maintain healthy tissues and organ function”* (Medical dictionary , 2014).
If the deficiency of micro and macronutrients persists for a while, a child can lose weight and the body will start to digest its own body tissue to supplement the shortage. First, body fat will serve as a primary energy source, followed by the secondary source, muscle tissue. The metabolism becomes disrupted and the major organs will start malfunctioning. So, child malnutrition may be defined as a pathological state resulted from inadequate nutrition, including under nutrition (protein-energy malnutrition) due to insufficient intake of energy and other nutrients (Ge KY1, 2001). Besides that, Malnutrition can also refer to over nutrition. Eating a lot of unhealthy food may also lead to a shortage of micro and macronutrients.

2.1.1 Marasmus and Kwashiorkor

The two types of protein- energy malnutrition (PEM) are Kwashiorkor and Marasmus. The most common type of malnutrition is Marasmus (Unicef). Marasmus occurs when the diet is inadequate in both calories and proteins. Children with Marasmus are extremely thin because they have lost a lot of body fat and muscles. Besides that, children with Marasmus have failure of linear growth. (de Lange, 2010). The time of development of Marasmus has a broad range. It differs from several months to years.

Figure 2 A child with Marasmus (Unicef)

Figure 3: Children with Kwashiorkor (mchinmedicaljournal, 2012)

Kwashiorkor occurs with fair or adequate calorie intake but inadequate protein and micronutrient intake (vitamins and minerals).

Patients with Kwashiorkor suffer the following: retention of sodium, low blood pressure and signs of decreased blood volume (hypovolemia) and infections (de Lange, 2010). Kwashiorkor can be characterized with the following symptoms: swollen abdomen, severe anemia and edema (the feet, legs and arms visibly show fluid retention), skin changes and the hair gets thin, pale and sparse. Children with Kwashiorkor have a well-nourished appearance, even though some tissue wastage and weight loss is present. This is because of the edema. Kwashiorkor can develop rapidly, it may can occur in a few weeks.

There is also a mixed form of severe malnutrition that has features of both Marasmus and Kwashiorkor, including edema. This is called Marasmic Kwashiorkor.

The definition of Marasmus, Kwashiorkor and Marasmic kwashiorkor is based on different measurement. Two of these measurements are the percentage of the expected weight-for-age and the presence or absecence of oedema (Temple & Steyn, 2008).

Marasmus	→	Weight-for-age <60% of the international standard
Kwashiorkor	→	Weight-for-age <80% of the international standard and oedema
Marasmic kwashiorkor	→	Weight-for-age <60% of the international standard and oedema

Besides that, to be able to define Marasmus and Kwashiorkor information about the complete dietary intake and laboratory research is necessary. Due to a lack of time and resources it is not possible to determine this form of malnutrition for the whole target group. That's why we will not pay more attention to these forms of malnutrition in this report.

2.1.2 Acute and chronic malnutrition

Malnutrition can be split in acute and chronic malnutrition. Acute malnutrition can also be split in severe acute malnutrition (SAM) and moderate acute malnutrition (MAM). SAM is common in rapid onset emergencies, chronic emergencies as well as non-emergency situations (Unicef). To identify these different classifications, the following indicators can be used: underweight, wasting and stunting. Underweight can be used to determine acute malnutrition, wasting can be used as indicator to determine severe acute malnutrition and stunting can be used to determine chronic malnutrition (de Lange, 2010).

These indicators can be identified by using a combination of three anthropometric measurements:

Low weight-for-age	→ indicator of underweight
Low weight-for-height	→ indicator of wasting
Low height-for-age	→ indicator of stunting

Underweight

Underweight children suffer from a dietary deficiency that is not very severe and therefore do not produce clinical diseases or symptoms (de Lange, 2010). These children are underweight and undersized, while at the same time they have relatively normal body proportions. When weight and height are not specifically shown on the growth charts, these children can be easily mistaken for healthy children. While in fact this group can also be stunted, wasted or even both.

Wasting

Wasting is indicated as a low weight-for-height, occurring at any age and is used as an indicator for identifying severe acute malnutrition (de Lange, 2010). Wasting is the weight of the sick child compared to that of a normal child of the same height.

Wasting is the term used to describe recent severe fat loss due to illness or severe food restriction. In order to determine the presence of visible severe wasting, you can look at the arms, thighs and buttocks for loss of muscle bulk (LabSpace). Sagging skin and buttocks indicates visible severe wasting.

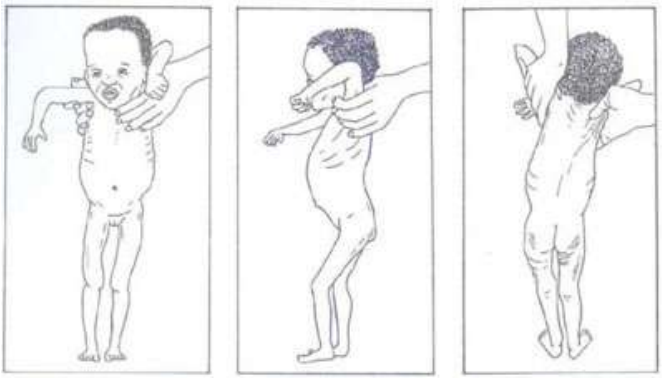

Figure 4: Clinical signs of wasting *(LabSpace)*

Stunting

An indication of stunting is a low height of a child compared to the height of a normal child of the same age (de Lange, 2010). This is an indication of nutritional deficiencies or illness that occurred during times of growth and development. This usually happens to infants and children younger than five years old. It is associated with a number of long-term factors, such as chronic insufficient protein and energy intake, recurrent infections, sustained inappropriate feeding practices and certain micronutrient deficiencies, such as iron and zinc (Temple & Steyn, 2008). Stunting can also be called failure to thrive or growth faltering, which refers to slow weight gain or inadequate growth of the infant or young child. Therefore Stunting is an indicator of chronic malnutrition.

Figure 5 These two girls are the same age but the one on the right is stunted *(Badham, 2012)*

2.2 How is malnutrition measured in South Africa?

There are a lot of parameters that are used for the measurement of malnutrition in South Africa. One of the sources that is used to gain information is the 'Road to Health' book (Department health of the Republic of South Africa). The aim of this medical book is to offer an accurate home-based record of a child's health and development, to promote the relationship between health workers and the parents of the child and to improve the identification of children needing extra care (Directorate Nutrition Department of Health). The intention of the government is that all children in South Africa have this booklet. In this book all health data of children are noted, including Vitamin A supplementation and the anthropometric data. The anthropometric parameters, are based on the following WHO-growth standards: Weight-for-age, height-for-age, weight-for-height and the MUAC are used to measure the nutritional status. Furthermore, Body Mass Index (BMI) can be used to screen for obesity, overweight, healthy weight or underweight (Centers for Disease Control and Prevention, 2011). All of these parameters to determine malnutrition will be explained in the next section.

2.2.1 WHO-Growth Charts

These growth charts are based on the Multicentre Growth Reference Study (MGRS), performed between 1997 and 2003. An overview of different articles about the development, reliability and usefulness of the WHO growth charts is written in the International Journal of Pediatrics (Taylor and Francis group, 2006). This shows that the growth chart is a standard that defines how children should grow. It contains growth figures of children all over the world and links the growth to motor development. That is why the WHO child growth charts are reliable and can be used to assess children everywhere, regardless of ethnicity, socio-economic status and type of feeding. In Figure 6 an example of a growth chart can be found.

Figure 6: An example of a growth chart: Height-for-age boys.

Method
A growth curve is a tool used by health care providers to determine whether a child is growing well. Growth charts consist of a series of percentile curves that illustrate the distribution of selected body measurements of children. To see if there is something special going on with a specific child, the height of weight of the child is compared to the height of weight of other - healthy - children of the same age (WHO child growth standards and the identification of severe acute malnutrition in infants and children, 2009)

All of these growth curves work with a median and z-scores based on the standard deviations. The standard deviation is a rank of the distribution of the height or weight around the average. The standard deviation score, or SDS, is the number of standard deviations above or below the average. A SDS of 0 indicates the average. The numbers 1, 2 and 3 (-1, -2, and -3) that are visible on the help lines are the z-scores. They give information about the size of the deviation from the average. According to the WHO, 68% of the children are between -1 and +1, 95% of the children are between -2 and +2 and 99% of the children are between -3 and +3 (Hayes, 2014).
The following table 1 shows the three different growth-charts, the type of malnutrition that can be measured and associated cut off.

Table 1: The three different growth-charts, the type of malnutrition that can be measured and associated cut off.

Growth-chart	Indicator	Type of malnutrition	Cut off
Height-for-age	Stunting	Chronic malnutrition	A child whose length/height-for-age is below -2 SD is moderate stunted. A child whose length/height-for-age is below -3 SD is severely stunted.
Weight-for-age	Underweight	Acute malnutrition	A child whose weight for age is below -2 SD, is moderate underweight. A child whose weight for age is below the -3 SD, is severely underweight.
Weight-for-height	Wasting	Severe acute malnutrition	A child whose weight for height is: above 3 SD, is obese. above 2 SD, is overweight. above1 SD, shows possible risk of overweight. below -2 SD, is moderate wasted. below -3 SD, is severely wasted. Refer for urgent specialized care.

2.2.2 MUAC

MUAC stands for “Middle Upper Arm Circumference”. In children aged 6 to 60 months, the WHO recommends to use MUAC with simple cut-offs to determine wasting (Mwangome, Fegan, Fulford, Prentice, & Berkley, 2012). It is a band with four colored zones by which the circumference of the upper arm of the child can be measured (Artsen zonder grenzen). If a child loses weight, this is usually muscle mass. To measure the loss of muscle mass, the length of muscles in the arm can be measured.

Method

To measure MUAC, a flexible measuring tape is wrapped around the mid-upper arm between the shoulder and elbow (Unicef). With the left arm bent, it is recommended to use a string to find the midpoint of the arm between the shoulder and the tip of the elbow. Furthermore, the tape should be placed at the midpoint. Finally, the MUAC should be measured on the left upper arm while the arm is down the side of the body and is relaxed. In figure 6 you can see the MUAC tape.

Figure 7: The MUAC-tape (Unicef)

Cutoff

- If the child is in the “Green” zone (above the 13,5 cm), this means that the child is not malnourished.
- If the child is in the “Yellow” zone (between 13.5 and 12.5 cm), this means that this child has a risk to be malnourished.
- If the child is in the “Orange” zone (between 12.5 and 11.5 cm), this means that the child can be moderately malnourished.
- If the child is in the “Red” zone (under 11.5 cm), this means that the child is severe malnourished.

These outcomes can be used to determine the MUAC-for-age z-score. A child whose MUAC-for-age is below -2 SD, is moderate wasted. A child whose MUAC-for-age is below -3 SD, is severely wasted.

Because measurement errors can be made, the MUAC tape is mainly used as a pre-selection measure instrument. Children who are in the “ Yellow”, “Orange” and “ Red” should also be screened with the weight for height measure method to determine whether a child is really wasted. (Artsen zonder grenzen).

2.2.3 BMI

BMI is a number calculated from a child’s weight and height. It does not measure body fat directly, but it can be considered as an alternative for direct measures of body fat (Centers for Disease Control and Prevention, 2011). Besides that, BMI is an low-priced and easy-to-perform method of screening for weight categories that may lead to health problems.
For children and teens, BMI is age- and sex-specific and is often referred to as BMI-for-age. BMI can be used as a screening tool to identify possible weight problems for children. For children BMI is used to screen for obesity, overweight, healthy weight or underweight.

Method

The formula for BMI is weight in kilograms divided by height in meters squared. Since height is commonly measured in centimeters, an alternative calculation formula, dividing the weight in kilograms by the height in centimeters squared, and then multiplying the result by 10.000, can be used. The BMI can also be calculated by using the Child and Teen BMI calculator (Centers for Disease Control and Prevention).

The criteria for interpreting BMI of children are different from those used to interpret BMI for adults. After BMI is calculated for children and teens, the BMI has to be plotted on the growth chart, BMI-for-age for either girls or boys, because BMI is both age-and sex-specific for children and teens (Centers for Disease Control and Prevention, 2011). The amount of body fat changes with age and the amount of body fat differs between girls and boys. The CDC BMI-for-age growth charts for girls and boys take into account these differences and allow translation of a BMI number into a percentile for a child's or

teen's sex and age. The BMI number is plotted on the CDC BMI-for-age growth charts to obtain a percentile ranking. This percentile is used to interpret the BMI number (Center of Disease Control and Prevention).

Cutoff

Table 2: *Relation between the weight status category and the percentile range* (Centers for Disease Control and Prevention)

Weight Status Category	Percentile Range
Underweight	Less than the 5th percentile
Healthy weight	5th percentile till the 85th percentile
Overweight	85th till 95th percentile
Obese	Equal to or higher than the 95th percentile

2.2.4 Conclusion

The aim of this study is to determine the prevalence of malnutrition in the region of Genadendal and the prevalence of the different classifications: wasting, stunting and underweight. As mentioned before, to classify a child with underweight one should use the weight-for-age chart. To classify whether or not a child is stunted one should use the height-for-age chart. And to classify a child with wasting one should use the MUAC and weight-for-height chart.

In conclusion, the nutritional status of children between two and five years old cannot be determined with only one parameter, but several parameters should be used. The various sources show that the WHO growth charts are reliable and useful in all countries, and they can be used to determine different classifications of malnutrition. Besides that, MUAC can also be used in combination with the weight-for-height growth chart to determine wasting in children between 6 to 60 months. On the other hand, the BMI is not always reliable, because the weight is not only determined by fat mass but also by muscle mass. That is why from now on we will use the three different growth-charts and the MUAC to determine the nutritional status of the children.

2.3 What is the prevalence of malnutrition in South African children between two and five years old?

In 1999 the first National Food Consumption Survey (NFCS) in South Africa was carried out by the Department of Health (DOH), with the aim to determine the nutrient intakes and anthropometric status of children (one to nine years old). This survey also considered factors that affect their dietary intake. This was an cross-sectional survey of 2894 children aged between one to nine years old.

The research showed that stunting (height-for-age below -2 SD) is by far the most common nutritional disorder, affecting nearly one in five children (21,6%) (Labadarios, et al., NFCS, South Africa 1999, 2005). The prevalence of severe stunting is 6,5%. This is also shown in figure 7. Besides that, the prevalence of underweight (weight-for-age -2 SD) is ascertained at one in ten children (10,3%). Striking is that children living in informal urban areas were more severely affected compared to those living in formal urban areas. Nationally, less than 1,5% of children suffer from severe underweight (weight-for age below -3 SD). An exception is found on commercial farms, where the prevalence of severe underweight was 5%. The prevalence of wasting (weight-for-height below -2 SD) on the national level is one in twenty children. The prevalence of severe wasting (weight-for-height below – 3 SD) at the national level is below 1%.

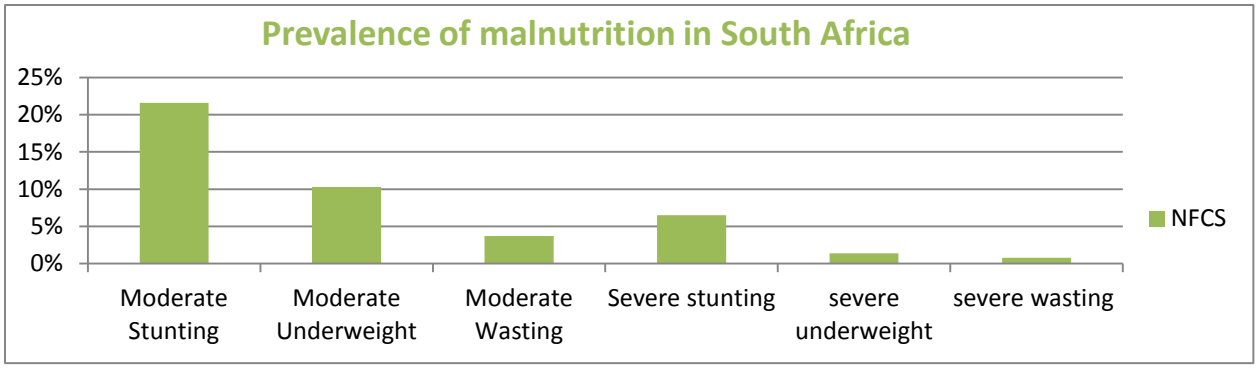

Figure 8: Percentage of the total children with malnutrition in South Africa according to the different classifications of malnutrition

In 2005, another national survey took place. This was an continuation of the National Food Consumption Survey (NFCS) in 1999. This survey showed positive and negative developments. One positive effect was an apparent improvement in the anthropometric status (stunting) of children between one to nine years old, as showed in Figure 9. Other positive effects were positive knowledge, attitude and behavior among the respondents about food fortification (Global Alliance for Improved Nutrition , 2005).

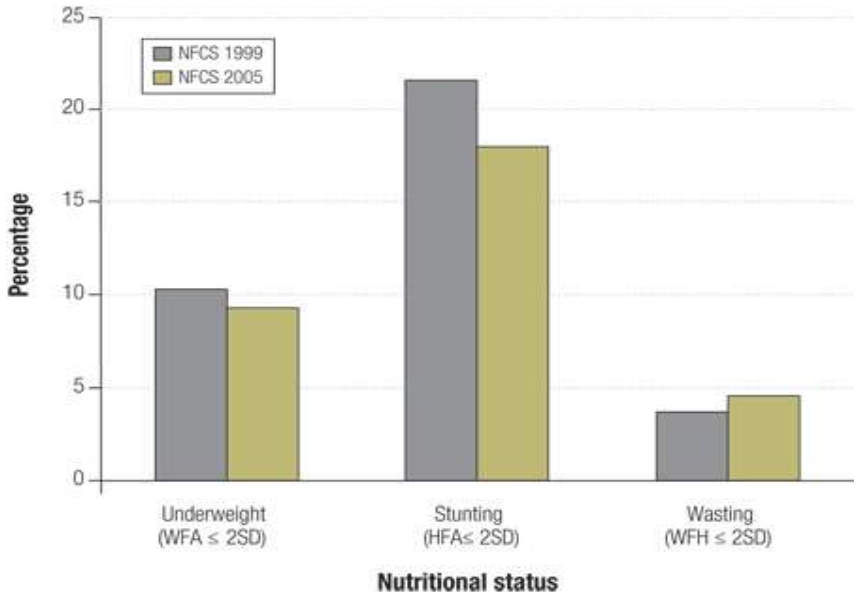

Figure 9: Changes in the prevalence of the different classifications of malnutrition *(Labadarios, et al., Food security in South Africa: a review of national surveys, 2011)*

2.4 What are the causes of malnutrition in South African children between two and five years old?

Under nutrition has many causes, these are not solely related to food. To be able to understand and to identify under nutrition, an analysis of all possible causes is necessary. United Nations Children's Fund (UNICEF) has developed a conceptual framework which makes a distinction between three different categories of causes (Unicef). These include immediate causes, underlying causes and basic causes. The framework can be found in Figure 10.

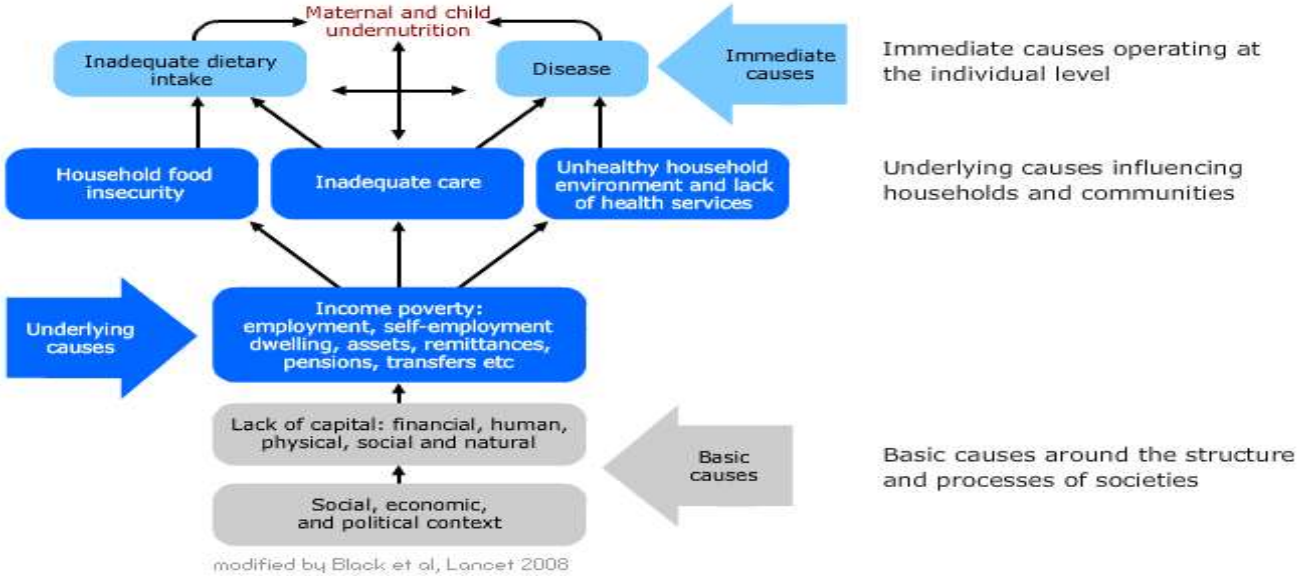

Figure 10: The conceptual framework (Unicef)

2.4.1 Immediate causes

The immediate causes of malnutrition are due to an imbalance between the amount of nutrients absorbed by the body and the amount of nutrients required by the body (Unicef). A combination of disease and inadequate intake may also occur. In practice inadequate dietary intake and infection often occur at the same time, because one can lead to another. Infection can result in loss of appetite, decreased nutrient intake and decreased absorption of nutrients consumed. Besides that a poor nutrition can result in reduced immunity to infection. This is called the infection-malnutrition cycle.

2.4.1.1 Inadequate dietary intake

One of the immediate causes of malnutrition is an inadequate dietary intake. In 1999, the dietary intake of South African children was less than 67% of the Recommended Dietary Allowances: energy, calcium, iron, zinc, selenium, vitamins A, C, D, and E, riboflavin, niacin, vitamin B6 and folic acid (Labadarios, et al., NFCS, South Africa 1999, 2005). In 2005, another national survey took place. This was an continuation of the National Food Consumption Survey (NFCS) in 1999. This survey showed positive and negative developments. However there appeared to be a deterioration in the vitamin A and iron status of children between one and five years old, a high prevalence of poor zinc status among children between one and nine years old and the persistence and possible worsening of the prevalence of hunger.
Furthermore, According to Faber (Faber, Laurie, Ball, & Andrade, 2013) the diet of South African children is low in animals food, vegetables and fruit, resulting in approximately half of the children eating less than 50% of the required amount of various micronutrients.

2.4.1.2 Disease

The other immediate cause is disease. An infection can increase the need for nutrients and prevent the body form absorbing those consumed. According to the conceptual framework (Unicef), diarrhea, acute respiratory infection, measles and malaria are the most common diseases worldwide that have an effect on the nutritional status in children. Furthermore, nearly all children suffer from diarrhea in devolving countries (National academy of sciences, 1985). Preschool children suffer from diarrhea about 10% to 20% of the time: about 35 to 70 days a year. Finally in South Africa the prevalence of HIV in children is high. According to Elizabeth W. Kimani-Murage (2013) HIV also increases

vulnerability to malnutrition (Kimani-Murage, Exploring the paradox: double burden of malnutrition in rural South Africa, 2013).

Diarrhea

Among the common infectious diseases, diarrheal diseases are the most common contributors to malnutrition. For a malnourished child, even a brief episode of diarrhea can seriously affect the nutritional status of children (Whitney, 2013). The relation between malnutrition and diarrhea is bidirectional. Malnourished children are more susceptible to a greater incidence and duration of diarrhea, and malnutrition can be triggered or worsened by significant diarrhea (Manary, Iannotti, Trehan, & Weisz, 2012). Diarrhea contributes to malnutrition due to reduced absorption of carbohydrates, protein, potassium, zinc and other nutrients. Besides that it has important adverse affects on the nutritional status of a child as a result of losing water and electrolytes. Significant water losses from diarrhea can lead to dehydration, electrolyte imbalance, shock, decreased mental status and ultimately death. Episodes of prolonged diarrhea are also associated with increased morbidity and mortality from other diseases, adverse neurodevelopment and growth stunting.

HIV

In South Africa, 30 to 40 percent of pediatric admissions are infected with HIV (Simoes, Cherian, Chow, Shahid-Salles, Laxminarayan, & John, 2006). HIV directly increases vulnerability to malnutrition for the infected child, or indirectly, particularly due to decreased food security associated with lowered productivity or death of the parents (Kimani-Murage, Exploring the paradox: double burden of malnutrition in rural South Africa, 2013). In 2011 there were about 2,01 million orphans due to HIV. Based on estimation, 1,06 million adults and more than 100.000 children received antiretroviral treatment in 2010 (SouthAfrica.info, 2012). Furthermore the HIV on nutritional status, the socioeconomic consequences of HIV/AIDS are devastating, as it promotes the vicious cycle of poverty and malnutrition (Vorster, The link between poverty and malnutrition: A South African perspective , 2010). Because HIV is mainly sexually transmitted in economically active young to middle-aged adults. This turns uneducated children into breadwinners and grandparents into child caretakers.
Furthermore, the combination of HIV with low birth-weight is also associated with malnutrition. Women with HIV mostly give birth to children with a low birth-weight. According to 'Disease Control Priorities in Developing Countries' (Jamison, et al., 2006) low birth- weight is a possible key reason why younger children are more likely to be stunted or underweighted. Low birth-weight is due to the health and nutritional status of the mother, which may be influenced by factors such as food security at the household or community level. Finally, there is a relation between HIV and diarrhea. The presence of diarrhea among HIV infected patients is estimated to be about 30% to 70%.

2.4.2 Underlying causes

The dietary intake and risk of disease have several causes. These underlying causes are grouped in three categories:

- Household food insecurity
- Inadequate care
- Unhealthy household environment and lack of health services

In practice there is significant overlap in these three groups of underlying causes.

2.4.2.1 Household food insecurity

Household food security is defined as sustainable access to safe food of sufficient quality and quantity to ensure adequate intake and a healthy life for all members of the family (Unicef). Food security is said to exist in accordance with its internal definition, when in a society all people at all times have enough food or an active healthy life (Labadarios, et al., Food security in South Africa: a review of national surveys, 2011). Food security includes: the availability of food that is nutritious and safe and an assured ability to procure and acquire food of good quality in a socially acceptable way. In contrast, food insecurity exists when food is not easily accessible and household have difficulty securing adequate food. According to the 2004 report of the Food and Agriculture Organization (FAO) on the state of food insecurity in the world, more than 814 million people in developing countries are undernourished. Of these people, 204 million live in countries of sub-Saharan Africa, including South Africa.

As mentioned before, the dietary intake of South African children is less than 67% of the recommended dietary allowances (Labadarios, et al., NFCS, South Africa 1999, 2005). These data were supported by the findings that on a national level one out of two households (52%) experienced

hunger, one in four (23%) were at risk of hunger and only one in four households (25%) appeared food-secure. In 2005, another national survey took place. This survey shows a persistence and possibly a worsening of the prevalence of hunger. On the other hand the food insecurity has decreased over the past ten years in South Africa. This can also be found in **Fout! Verwijzingsbron niet gevonden.**.

Table 3: Access to food as reflected in scores for food security, risk of hunger and experience of hunger (food insecurity) (Labadarios, et al., Food security in South Africa: a review of national surveys, 2011)

Question	NFCS 1999 (*n* = 2 735) %	NFCS 2005 (*n* = 2 413) %	SASAS 2008 (*n* = 1 150) %
Food security[b]	25	19.8	48
At risk of hunger[c]	23	27.9	25
Experiencing hunger[d]	52.3	52	25.9

People from South Africa with a low income may select a relatively less healthy diet because energy-dense foods are relatively cheap sources of energy, but have a low nutrient density (Temple & Steyn, 2011). Some foods, such as oats, beans, carrots, and apples are relatively cheap sources of energy and are healthy. They have a low energy density and are rich in various nutrients. However, such foods are likely to be less desired by the people than other foods, such as candy, cookies, jam and chocolate, that have a similar cost, but are less healthy. According to the same study, on average, the healthier diet is about 69% more expensive, but this estimate depends a lot of the food choices. A family whose householder wage exceeds the average income by one third, has a relatively higher expenditure on food, 30% of the total householder income. Overall, a healthy food intake is unaffordable for most of the households in South Africa.

According to the expenditure survey, (IES) that was conducted in 2010-2011, one out of every two Rand spent by South African households was on housing and food items. According to the NFCS 1999, households that enjoyed food security consumed an average 16 different food items in 24 hours. However, three out of four children live in poor, insecure households (75%) in South Africa (de Lange, 2010). These poorer households spent less money on food and consumed less than 8 different food items (Labadarios, et al., Food security in South Africa: a review of national surveys, 2011). This causes low or inadequate food intake and sometimes disease, which causes the development of PEM and death.

Furthermore, studies in the USA and other countries found that low-income areas often lack a supermarket with a wide selection of healthy food (Norman, Temple, Nelias, & Steyn, 2011). Instead, people often have little choice, because they have to shop in small food stores with higher prices and limited availability of healthier food choices. Genadendal also has small food stores where there is limited availability of vegetables, fruit and animal products. Because most people from Genadendal make regular trips to a nearby town, they do have access to a supermarket. However, most people are likely to find it hard to transport lots of groceries in a vehicle to their houses and then store the goods for 1 or 2 weeks. For that reason, even when residents of small towns are willing to buy healthy foods, they will need to put a lot of effort in it to do so, unless these foods are available locally. There are also people who do not have transportation. These people usually walk from one village to another in order to be able to shop. Other people just stay in their village and do not have another dietary selection.

2.4.2.2 Inadequate care

Inadequate care is also an underlying cause of malnutrition because caring practices, hygiene and health seeking behavior supports good nutrition. A lack of education may contribute to malnutrition (Bain, et al., 2013). First of all, people may know little about vitamins and other nutrients. They fail to eat even the cheap and available ones. Children living in an informal housing have the highest prevalence of malnutrition and the lowest is seen in children whose mothers are well educated. In South Africa the prevalence of stunting was the highest for children living in traditional or an informal housing, with poorly educated mothers.

Besides that, their ignorance about causes of disease and its consequences can also lead to an unhealthy lifestyle. Some people might be ignorant on how to care for their children as they might undervalue healthy practices like breastfeeding, offering vitamins and other micronutrient rich foods to their children. Fetal growth restriction and suboptimum breastfeeding together cause more than 1,3 million deaths a year which is 19,4% of all deaths of children younger than five years, representing 43,5% of all nutrition-related deaths (Lancet, 2013).

2.4.2.3 Unhealthy household environment and Lack of health services

Poor public health includes factors related to the health environment, exposure to disease and access to basic health services. According to the WHO an estimated 23% of all deaths in South Africa are a result of avoidable environmental hazards such as contaminated water, poor hygiene, inadequate sanitation and poor water resource management (CSIR, 2010). Lack of access to safe, clean drinking-water and basic sanitation, as well as poor hygiene, causes nearly 19% of all deaths from diarrhea, mainly in children (WHO, 2014). Water, sanitation and hygiene interventions prevent intestinal parasitic infections alongside diarrhea, and these infections also have effects with malnutrition. Various studies have documented how access to safe water, sanitations and adequate hygiene can predict child growth and malnutrition.

The health care in South Africa varies from the most basic primary health care, offered for free by the state, to the specialized health care services available in the public and private sector (SouthAfrica.info, 2012). According to this website the institutions in the public sector have suffered from poor management, underfunding and deteriorating infrastructure. People who have no money to pay for health care and social facility cannot get optimal health care. Furthermore, the situation is compounded by public health challenges, including the burden of diseases such as HIV and tuberculosis (TB), and a shortage of key medical personnel. There are long waiting lists for people from small villages, because there is a shortage in medical personnel. Like mentioned before children with diseases such as HIV and diarrhea are more vulnerability of malnutrition.

2.4.3 Basic causes

Political, legal and cultural factors fall under the basic causes that may defeat the best efforts of households to attain good nutrition (Unicef). Other factors that are basic causes are economic, environmental, degradation, poor agriculture, war, urbanization, population growth, distribution, conflicts, trade agreements, natural disaster and cultural factors (de Lange, 2010).
Firstly, the level of corruption is high in South Africa, with resources concentrated in the hands of few (Bain, et al., 2013). Recent years, the fight against this has resulted in very poor results. Misappropriation of state funds corruption have led to division amongst people.

2.4.4 Conclusion

Corruption is one of the causes of poverty in South Africa, but the root causes of poverty are multifaceted. Poverty, combined with other socioeconomic and political problems, create the bulk of food insecurity in our world.
One of the consequences of poverty is malnutrition. Malnutrition leads to sub optimal intellectual development. Knowing that children are the future of any society, an unproductive generation shall therefore be prone to be poor. Completing the poverty malnutrition chain, malnourished women usually bear children with a low birth-weight. Consequently these children will grow into physically and mentally stunted children. Stunted adults imply low human capital, low incomes and poverty.

2.5 What are the consequences of malnutrition on the physical and mental health of South African children between two and five years old?

In addition to determining the prevalence of malnutrition, it is important to describe the consequences of undernourishment. The effects of malnutrition in children are devastating. It affects every system in the body and always results in an increment of complications and in very extreme cases even death. It is estimated that in South Africa stunting, severe wasting, and growth restriction together were responsible for 2,2 million deaths and 21% of disability-adjusted life-years (DALYs) for children younger than five years of age (Lancet, 2008).
Distinction can be made between short-term consequences and long-term consequences. Short-term effects can be given in terms of deaths and disease burden, as measured by DALYs. The long-term consequences also include the long-term educational and associations with adult chronic diseases. These consequences can also have an influence on the next generation. This is illustrated with the

cycle of despair for the poor (Figure 11). This cycle shows that malnutrition and hunger lead to lower resistance and diseases whereby people are weak and often sick and have little energy to work (Culbertson, 2014). After that, less food will be produced and there will be not enough food to feed the family. Here, the circle starts again with malnutrition. For those in poverty, this cycle is simply the way of life.

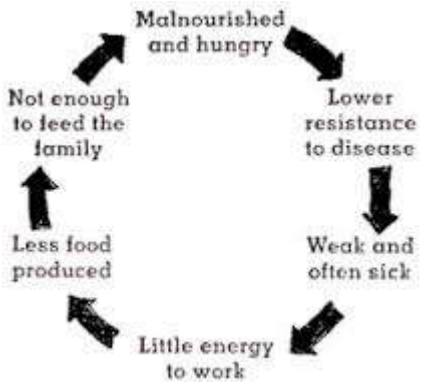

Figure 11: Cycle of despair. (Culbertson, 2014)

2.5.1 Short-term consequences

2.5.1.1 Macro- and micro nutrient deficiencies

Micronutrient deficiencies are still seen as the major public health problem. As mentioned before, the dietary intake for South African children is less than 67% of the Recommended Dietary Allowances. On the other hand vitamin B, C and D deficiencies have decreased recent years (de Lange, 2010). A lack of one micronutrient may lead to deficiencies of another. For example, a low lipid intake can affect the absorption of important fat soluble vitamins such as vitamin A and D. Besides that, a deficiency in iron, magnesium and zinc can cause anorexia and thereby result in reduced intake of important nutrients such as protein (Orphan nutrition , 2014).

The deficiency of several macro en micro nutrients have several negative effects on the body and the immune system. The most common consequences will be explained below.

Muscle

The most common sign of malnutrition is weight loss due to depletion of fat and muscle mass, including organ mass. Muscle functions decline before changes in muscle mass occur (Whitney, 2013).

Underweight and wasting

Wasting, or low weight-for-height is the result of acute significant food shortage and/or disease. Wasting is a strong predictor of mortality among children under five. Other consequences of underweight and wasting can be reversible (Unicef).

Immune complications

The immune system plays an important role in the ability of the body to fight infections and reduce the risk of tumors, auto-immune and degenerative diseases (Chandra S, 1986). Nutritional deficiencies and excess of nutrition affect different components of the immune system. There are several studies that show the effects of general protein- energy malnutrition on immunity, especially among children in developing countries (Chandra, 1993). Deficiencies of some proteins, amino acids, vitamins A, E, B6 and folic acid are associated with reduced immune competence. The most consistent effects of nutritional deprivation are on cell-mediated immunity, lymphocyte subsets, complement system, phagocyte function, secretory antibody response and antibody affinity. In contrast, excessive intake of fat, in particular polyunsaturated fatty acids (e.g., linoleic acid and arachidonic acid), vitamin E and iron are immunosuppressive. Trace elements modulate immune response through their crucial role in enzyme activity. The relationship between poor nutrition and reduced immunity can be found in the infection-malnutrition cycle (Unicef). Poor nutrition can result in reduced immunity to infection. And

infection can result in loss of appetite, decreased nutrient intake and decreased absorption of nutrients consumed.

2.5.2 Long-term consequences

2.5.2.1 Stunting

Stunting, or low height-for-age, is caused by long-term insufficient nutrient intake and frequent infections. Stunting generally occurs with children younger than two years old and the effects are hardly reversible (Unicef).

2.5.2.2 Mental Development

Most organs grow rapidly in the first years of childhood (de Lange, 2010). This results in high metabolic demands. Brain growth is almost completed in the early years of childhood. Severe nutrient deficiency for a long time may result in lifelong functional deficits. For this reason malnutrition is often associated with poor school results. Because children with malnutrition usually start school later, they do not complete all grades and do not perform as well as children of the same age. Furthermore, deficiencies of essential vitamins and minerals are widespread and have substantial adverse effects on child survival and development. Deficiencies of vitamin A and zinc adversely affect child health and survival, and deficiencies of iodine and iron, together with stunting, result in children not reaching their developmental potential.

2.5.2.3 Nutrition-related chronic diseases of lifestyle

According to Barker (Barker, Osmond, Winter, Margetts, & Simmonds, 1989) low birth weight, thinness and short body length at birth are associated with markedly increased rates of cardiovascular disease and non-insulin dependent diabetes in adult life. The fetal programming hypothesis proposes that these diseases originate through adaptation which the fetus makes when it is undernourished. These adaptations may be vascular, metabolic or endocrine. They permanently change the function and the structure of the body in adult life.
Another research examines the relation between stunting and overweight status for children aged three to six and seven to nine years in nationally representative surveys in Russia, Brazil, and the Republic of South Africa and a large nationwide survey in China. This research showed a significant association between stunting and overweight status for children in all of these countries (Popkin, Richards, & Montiero, 1996). Clearly, there is an important association between stunting and a weight-for-height in a variety of ethnic environmental and social backgrounds.
To conclude, the ‘early origins of adult disease’ hypothesis is now better understood and accepted (Temple & Steyn, 2008). So, it seems that individuals who were previously exposed to under nutrition during fetal life or infancy have an increased risk or extra vulnerability to the nutrition-related chronic diseases of lifestyle when they eat western diets as adults.

In South Africa more and more people eat western diets caused by the nutrition transition. The nutrition transition refers to changes in dietary patterns and nutrient intakes of individuals, families, groups of people, or whole populations when their food environments and other circumstances change (Temple & Steyn, 2008). Rapidly urbanizing development countries are generally moving from stage 3 towards stage 4 of the transition, with the co-existence of malnutrition and obesity, which disproportionately affects the poor. In stage 3 there is a lot of starchy, low fat and high-fibre food, with a low variety. (Crush, Frayne, & McLachlan, 2011). On the other hand, in stage 4 there is an increasing of fat, sugar and processed foods. The rapid urbanization and changing diets in development countries are now causing over nutrition and obesity.
In South Africa, the movement from receding famine to a dietary pattern of nutrition-related chronic diseases of lifestyle is rapidly taking place before the battle against under nutrition has been won (Temple & Steyn, 2008). The consequence is that we are experiencing a double burden of morbidity and mortality: both infectious diseases related to under nutrition as well as chronic diseases of lifestyle related to over nutrition. This nutrition transition and the associated ‘double burden’ of disease is caused by the massive rural-urban migration and rapid urbanization in South Africa (Crush, Frayne, & McLachlan, 2011).

Chapter 3 Field research

In chapter 2 desk research information about definition, classifications, measurements, prevalence, causes and consequences of malnutrition in South Africa is described. But there was hardly data found about the anthropometric state of children in the region of Genadendal. To collect this data, a field research should be performed. The method and results of the field research are described in this chapter.

3.1 Method

3.1.1 Design

The design of the study is a descriptive and observational study and the method of the field research is based on the results of the desk research. In this field research, a situation will be mapped, which is the prevalence and classifications of malnutrition in the region Genadendal. Furthermore, this is a quantitative research. The anthropometric data of a lot of children will be determined. Children will be measured at the crèches for a high response rate.
The aim of this research is to answer the research question: *What is the prevalence of malnutrition among the children aged two to five years old at the crèches in Genadendal, Greyton, Bereaville and Voorstekraal, and what are the common classifications (stunting, wasting, underweight)?*
As concluded in the previous chapter, this will be done by using height, weight, MUAC and related growth charts. In this way, the prevalence of malnutrition and specifically the prevalence of the different classifications of malnutrition (wasting, stunting and underweight) can be determined.

As described in the previous chapter, the intention is that all children in South Africa have a medical book. In this book all the health data of children are noted, including vitamin A suppletion and the anthropometric data. The first period of two years the weight and height of the children should be measured every month. After that this should be measured once in three months. This results in 36 sessions in the first five years.

3.1.2 Study population

Children of the five crèches:

- Educare Genadendal: 70 children
- Educare Bereaville: 34 children
- Greyton Speelcentrum: 31 children
- Vrolike Vinkies Greyton: 28 children
- Voorstekraal Educare: 30 children

Total population: 139 children

There won't be taken a sample, but the whole population will be involved. In this way all children will be measured and this offers prospects to future individual treatments. Table 4 shows the inclusion and exclusion critera.

Table 4: inclusion and exclusion criteria

Inclusion criteria	**Exclusion criteria**
Nationality: South African	Other nationalities
Age: 2-5 years	Age: < 2 years en > 5 years
Disciple of one of the five selected crèches	No disciple of one of the five selected crèches
Gender: boy or girl	-

There are no exclusion and inclusion criteria relating to health perspective. The health status of children is checked by asking the principals and our own clinical perspective. In total there is just one child with alcohol syndrome, the other children are seemingly healthy.

3.1.3 Anthropometric research

Informed consent

A letter has been written to the parents of the children to inform them about the research. They are asked to give the 'clinical cart' to the crèche. Furthermore this letter mentioned that when parents don't want their child to cooperate in the research, it can be indicated at the crèche. This letter can be found at Appendix 3 Letter for the parents. Furthermore, the informed consent was signed by the principals

of the five crèches. The informed consents can be found at Appendix 2 Informed Consent. In all crèches an appointment has been made on which date the research will be carried out. The teachers of the crèches will collect the 'clinical carts' the children before this date.

Parameters
As described in the desk research, the growth charts of WHO (Weight-for-age, height-for-age and weight-for-height) and MUAC are good ways to determine malnutrition in children and specifically underweight, stunting and wasting. The variables that have to be measured are:
- Height
- Weight
- MUAC

Other important data that can be determined by using the 'clinic cart' are:
- Date of birth
- Gender
- Birth weight
- Conduct of height and weight

Materials
- Digital scale. The accuracy of the scale is ±0,05 kg.
- Measuring tape. The accuracy of the measuring tape is ±0,1 cm.
- MUAC tape. The accuracy of the measuring tape is ±0,1 cm
- Schema with names and surnames of the children of the five crèches
- 'Clinical carts' of the children of the five crèches
- Calculator
- Laptop with WHO Anthro
- Copy machine / printer

Budget
All costs, such as fuel, paper, printing costs, watermelon etc. will be paid by the students themselves.

3.1.4 Performing field research

Each crèche will be visited on a different day to carry out the measurements. The anthropometric will be measured at the following dates:
- Genadendal Educare: 24th of March
- Voorstekraal Educare: 25th of March
- Bereaville Educare: 7th of April
- Vrolike vinkies Greyton: 9th of April
- Greyton Speelcentrum: 10th of April

The measurements will be implemented according to the following procedure. The measurement of height and weight will be in accordance with the procedure of 'Het Diëtistisch Consult' (Becker-Woudstra, Havinga, van Kuijeren, & Linden-Wouters, 2006). The measurement of the MUAC will be performed with the procedure of Unicef (Unicef).
- At each crèche a separate room will be arranged in order to perform the measurements.
- The researchers will introduce themselves by age group and explain the procedure of the measurements.
- Each child will be picked up separately.
- The procedure of measurement will be explained again.
- Measuring height: The children will be asked to take off their shoes. After that the child will be asked to stand straight with the back of their heels, bottom and head against the wall, and to look in front of him. In this way the height can be read and be noted.
- Measuring weight: The children will be asked to take of their coat/jacket and to remove heavy items from the pockets. Then they will be asked to take place in the middle of the scale en to look in front of him. In this way the weight can be read en be noted.
- Measuring MUAC: The children will be asked to bent the left arm in 90 degrees. With the left arm bent, it is recommended to use a string to find the midpoint of the arm between the shoulder and the tip of the elbow. MUAC should then be measured on the left upper arm while the arm is hanging down the side of the body and relaxed.

- After the measurement the child will be asked to put their clothes and shoes on again, and the children will get a piece of watermelon.

After performing all the measurements important information such as date of birth, gender, birth weight and birth length of the 'clinical carts' will be written down.

3.2 Results

In this paragraph the outcomes of the field research will be described. In total we measured 139 children at the five crèches, 81 boys and 58 girls. For various reasons the number of children is less than the expected number of 193. Firstly, there were some children younger than two years and older than five years. These children do not fulfill the inclusion criteria of this research. Besides that, some children that are on the list that we get from the principals, are not members of the crèche anymore. The list is not up to date. Some other children were not at the crèche on the day of measurements, some because they were sick and some because of the rain. In order to be able to measure many children as possible we went twice to all crèches.

We measured the weight, the height and the MUAC of all the 139 children. Besides that we wrote the date birth, birth weight and the birth length of all the children. We entered this date into the 'nutritional survey' of the WHO Anthro program. We also entered the name of all the children, because in this way it is possible to recognize a child that is in need of individual treatment. The outcomes of this program are z-scores of height-for-age, weight-for-age, weight-for-height and MUAC-for-age. All these outcomes can be found in Appendix 5 Results of the Z-scores. In this appendix all the results are shown in a table with eight categories: < -3 SD, -3 to -2 SD, -2 to -1 SD, -1 to 0 SD, 0 to +1 SD, +1 to +2 SD, +2 to +3 SD and > +3 SD. These outcomes are shown per crèche and of all children together. The results of all the crèches in total will be described below.

3.2.1 Weight-for-height

51% of the children has a z-score weight-for-height below zero. 34% of the children has a z-score between 0 and -1, 16% has a z-score between -1 and -2 and over 1% has a z-score between -2 and -3. None of the children has a z-score lower than -3. 49% of the children has a z-score higher than 0. In the graphic below, the total of the z-scores of weight-for-height are illustrated.

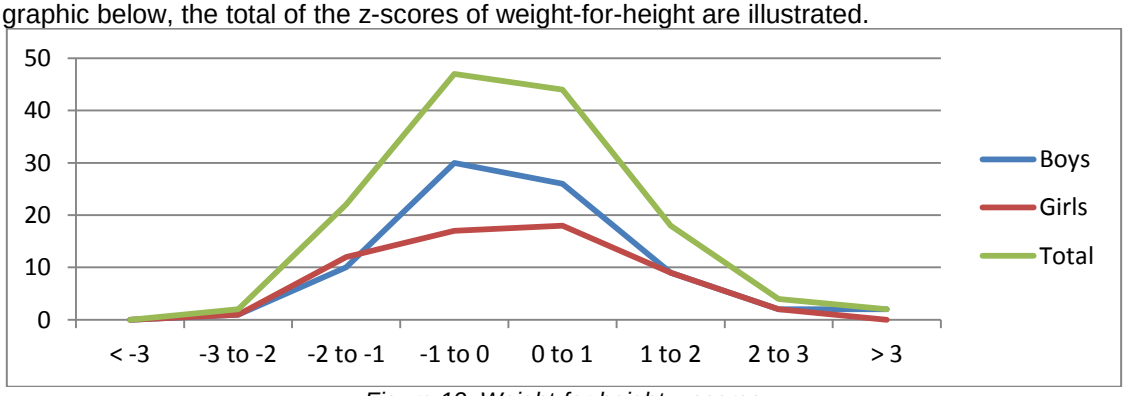

Figure 12: Weight-for-height z-scores

3.2.2 Weight-for-age

73% of the children have a z-score weight-for-age below zero. 45% of the children has a z-score between 0 and -1. 23% has a z-score between -1 and -2. 5% has a z-score between -2 and -3 and less than 1% of the children has a z-score lower than -3. 27% of the children has a z-score higher than 0. In the graphic below, the total of the z-scores of weight-for-age are illustrated.

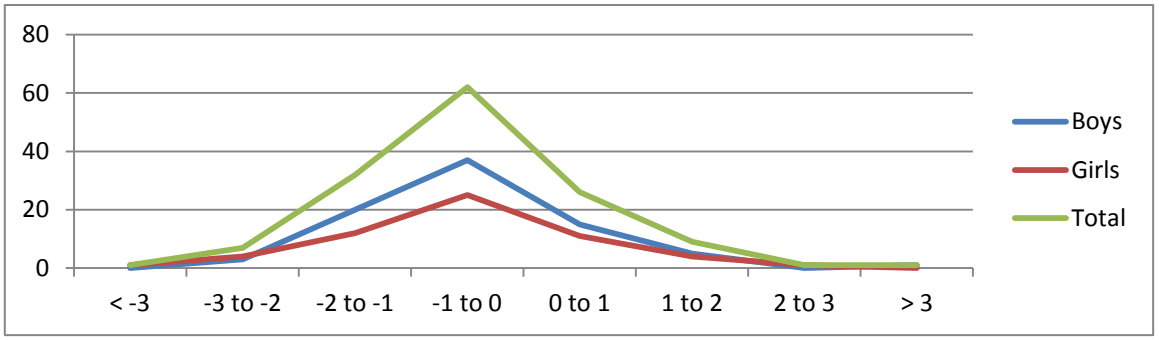

Figure 13 Weight-for-age z-scores

3.2.3 Height-for-age

83% of the children have a z-score weight-for-age below zero. 40% of the children has a z-score between 0 and -1. 30% has a z-score between -1 and -2. 12% has a z-score between -2 and -3 and 2% of the children has a z-score lower than -3. 17% of the children has a z-score higher than 0. In the graphic below, the total of the z-scores of weight for age are illustrated. Besides that, there is a distinction between boys and girls.

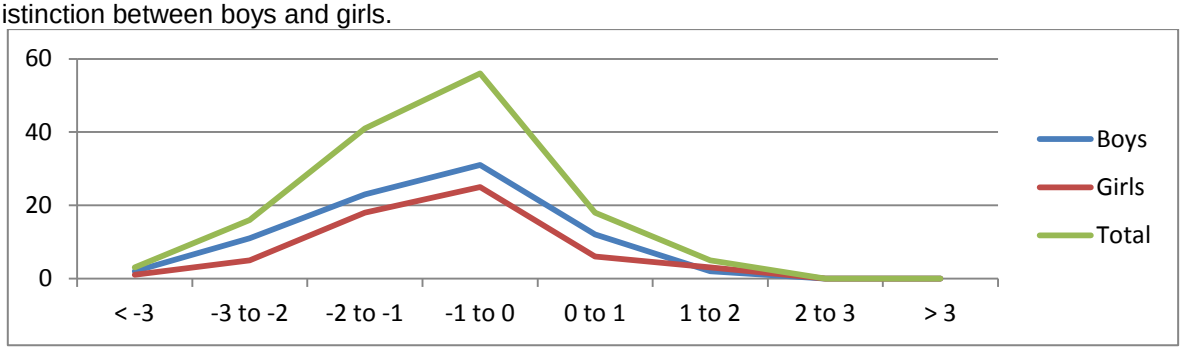

Figure 14 Height-for-age z-scores

3.2.4 MUAC-for-age

45% of the children have a z-score MUAC-for-age below 0. 32% of the children has a z-score between 0 and -1. 11% has a z-score between -1 and -2 and over 1% has a z-score between -2 and -3. None of the children has a z-score lower than -3 SD. 55% of the children has a z-score higher than 0. In the graphic below, the total of the z-scores of MUAC-for-age are illustrated.

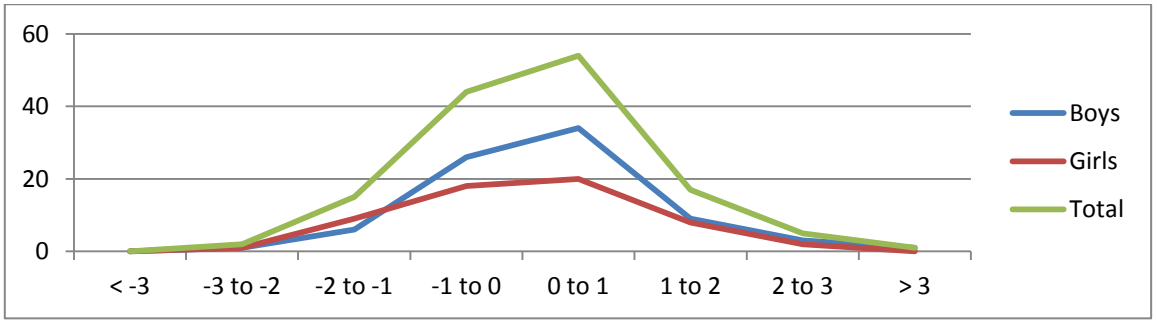

Figure 15: MUAC-for-age z-scores

Chapter 4 Conclusion desk and field research

In this chapter the previous described outcomes will be interpreted. To answer the main question it is determined how many children are stunted, underweight or wasted. After that, the severity of malnutrition will be determined by prevalence rangers of the WHO.

4.1 Stunting

As mentioned in chapter 2, stunting can be determined by using the growth chart height-for-age. When the height-for-age of a child is below -2 SD, this is child is moderate stunted and when the height-for-age of a child is below -3 SD, this child is severely stunted.
It can be concluded that sixteen children are moderate stunted and three children are severely stunted. In total, nineteen children (14%) are stunted, because their height is not appropriate for their age. The final outcomes can be found in Table 5 below.

Table 5 prevalence stunting

	Male (N = 81)	**Female (N = 58)**	**Total (N =139)**
Moderate Stunting	11 (14%)	5 (9%)	16 (12%)
Severe stunting	2 (2%)	1 (1%)	3 (2%)
Total	**13 (16%)**	**6 (10%)**	**19 (14%)**

4.2 Wasting

As mentioned in chapter 2, wasting can be determined by using the growth chart weight-for-height and the MUAC-for-age. When the weight-for-height or the MUAC-for-age of a child is below -2 SD, this child is moderate wasted and when the weight-for-height or MUAC-for-age of a child is below -3 SD, this child is severe wasted.

By using the growth chart weight-for-height it can be concluded that two children are moderate wasted and that none of the children is severe wasted. In total, two children (1%) are wasted, because their weight is not appropriate for their height.
By using the MUAC-for-age, it can be concluded that two children are moderate wasted because they have z-score blow -2 SD. None of the children is severe wasted. The final outcomes can be found in Table 6 below.

Table 6: prevalence wasting

	Male (N = 81)	**Female (N = 58)**	**Total (N =139)**
Moderate Wasting	1 (1%)	1 (2%)	2 (1%)
Severe Wasting	0 (0%)	0 (0%)	0 (0%)
Total	**1 (1%)**	**1 (2%)**	**2 (1%)**

4.3 Underweight

As mentioned in chapter 2, underweight can be determined by using the growth chart weight-for-age. When the weight-for-age of a child is below -2 SD, this is child is moderate underweight and when the weight-for-age of a child is below -3 SD, this child is severe underweight.
It can be concluded that seven children are moderate underweight and one child is severe underweight. In total, eight children (6%) are underweight, because their weight is too low for their age. The final outcomes can be found in Table 7.

Table 7: prevalence underweight

	Male (N = 81)	**Female (N = 58)**	**Total (N =139)**
Moderate underweight	3 (3,70%)	4 (6,90%)	7 (5,04%)
Severe underweight	0 (0%)	1 (1,72%)	1 (0,72%)
Total	**3 (3,70%)**	**5 (8,62%)**	**8 (5,76%)**

4.4 Conclusion

With the data of the field research, the main question can be answered: *What is the prevalence of malnutrition in children aged two to five years at the crèches in Genadendal, Greyton, Bereaville and Voorstekraal, and what are the common classifications (stunting, wasting, underweight)?*

It can be concluded that 83% of the children has a z-score below 0, so a low height-for-their age. But only one in seven children (13%) is classified as stunted. Besides that, 51% of the children in region Genadendal has weight-for-height below z-score 0. Just 1% of the children is classified as wasted. Finally, 73% of the children has a low weight for their age. One in seventeen children (6%) is classified as underweight.

In order to conclude if the severity is low, normal or high the WHO classifications for assessing severity of malnutrition by prevalence ranges among children under five years of age can be used (Temple & Steyn, 2008). Table 8 below shows the guidelines used by WHO to classify levels of stunting, underweight and wasting.

Table 8: Classification for assessing severity of malnutrition of malnutrition by prevalence ranges among children under 5 years of age

Indicator	Low	Medium	High	Very high
Stunting	<20	20-29	30-39	>40
Underweight	<10	10-19	20-29	>30
Wasting	<5	5-9	10-14	>15

Since the prevalence of stunting in the region Genadendal is 14%, the severity of stunting is low for it is below 20%. The prevalence of underweight in region Genadendal is 6%. This also shows that the severity of underweight is low. The prevalence of wasting in the region Genadendal is 1%. This also falls in the lowest classification. It can be concluded that the severity of malnutrition by children between two and five years old in the region Genadendal is low.

On the other hand, there are a lot of children between z-score zero and minus two, that are not classified to be stunted, wasted or underweight. These children cannot be classified as stunted, wasted or underweight but they have a big risk of malnutrition. These children have a mild form of malnutrition which put them in a risk of infections and malnutrition.

According to the outcomes of the height-for-age growth chart, 79 children (70%) are between 0 and -2 SD. Secondly, 94 children (68%) are between 0 and -2 SD on the growth chart weight-for-age. According to the weight-for-height growth chart outcomes 69 children (50%) are between 0 and -2 SD. Finally, according to MUAC-for-age 59 children (42%) are between 0 and -2 SD. This is also shown in Figure 16 below.

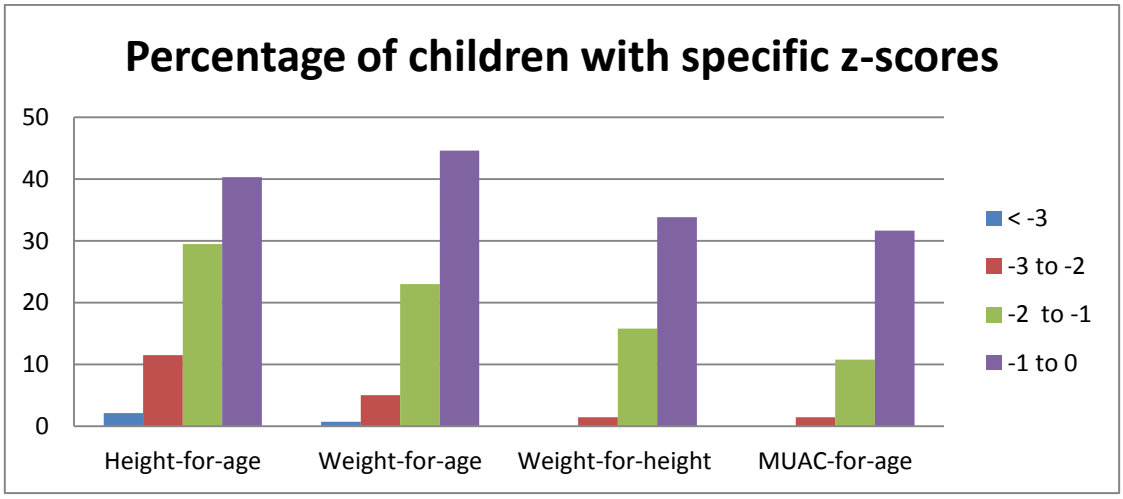

Figure 16 percentage of children with specific z-scores

Chapter 5 Discussion

In this chapter the prevalence of malnutrition in the region Genadendal will be compared with the prevalence of malnutrition in entirely South Africa. Furthermore, other topics of discussion will be mentioned.

5.1 Prevalence of malnutrition in region Genadendal versus entirely South Africa

In the previous chapter is concluded that the severity of malnutrition in the region Genadendal is low in comparison with the WHO classifications for assessing severity of malnutrition. These classifications are made for the entire world, but it is also important to make a comparison with the prevalence of malnutrition in South Africa. To do the comparison we used the data of the National Food Consumption Survey (Labadarios, et al., NFCS, South Africa 1999, 2005).

This comparison shows that the prevalence of all classifications and the severity of malnutrition in region Genadendal is lower than in South Africa. The biggest difference can be found in the prevalence of moderate stunting. A striking point is that in both outcomes of the field research and the NFCS the prevalence of stunting is the highest, the prevalence of underweight is at the second place and the prevalence of wasting is the lowest. *Figure 17* shows the comparison of all types of classifications of malnutrition.

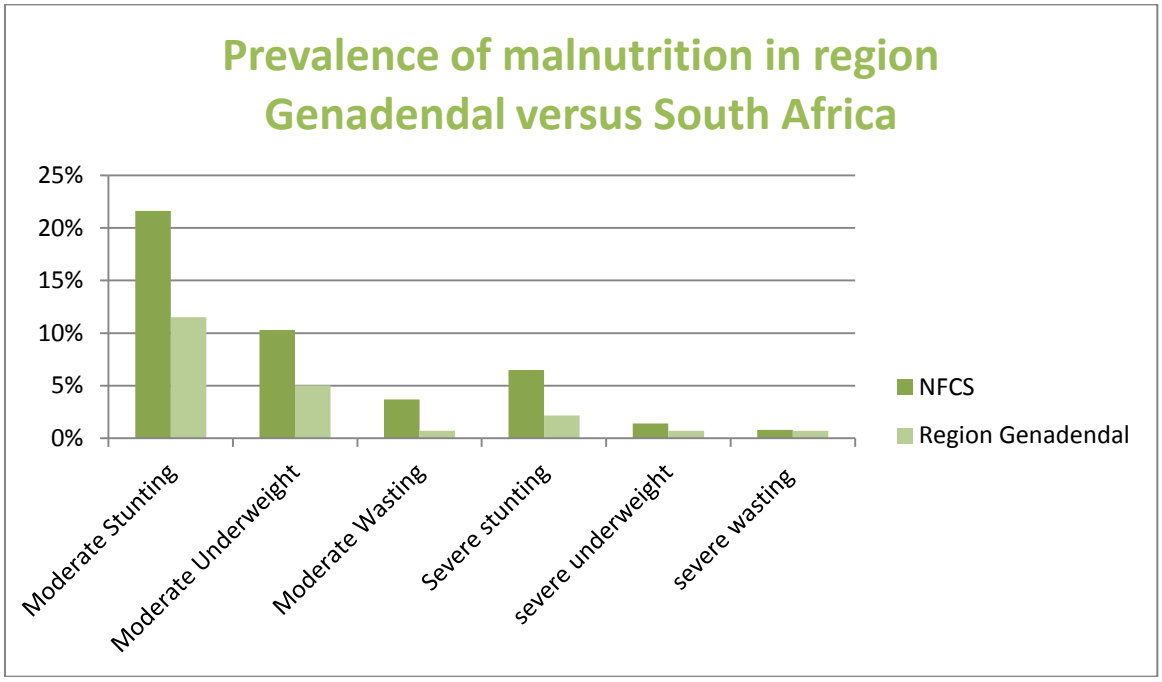

Figure 17: Prevalence of malnutrition in region Genadendal versus South Africa shows the comparison of all types of classifications of malnutrition.

5.1.1 Weight maybe not completely reliable

A first possible explanation for the lower prevalence of malnutrition in the region Genadendal is that the outcomes of weight are maybe not completely reliable. For the anthropometric research, the children have been measured while wearing clothes and had their breakfast. This may have an influence on the outcomes of their real weight.

5.1.2 Generalisability

Another possible explanation for the lower prevalence of malnutrition in the region Genadendal is that the children that were measured cannot give a completely realistic view of all children in the region Genadendal. The main question of our research is to determine the prevalence of malnutrition at the five crèches. Not all the children in the region Genadendal go to one of the five crèches. It is likely that children who do not go to the crèche have a poor home situation. Besides that, it was not possible to measure all children of the crèches, because some of them were sick. Probably children that are

malnourished have more risk to be sick. To summarize, it is possible that we missed a number of children that are malnourished.

5.1.3 Prevalence of malnutrition in urban and rural areas

Finally, another possible reason why the prevalence of malnutrition measured in the NFCS is higher than in the region Genadendal can be explained by the article of Ruel, Haddad & Garret (Ruel, Haddad, & Garrett, 1999). According to this article, urban poverty and under nutrition are increasing and are doing so at a faster rate than rural poverty and under nutrition. The most significant difference between food access in urban and rural areas is that rural people can often produce their own food, whereas urban people are more dependent on food purchases. Furthermore, women in urban areas work often long hours in the streets or in an office. The consequences of this are reduced child care and less time for food preparation. Women's time constraints in urban areas also result in a shift from traditional staple diets towards purchasing and consuming processed or prepared foods or the purchase of food from street vendors, the so-called "street foods." Finally, water borne diarrheal diseases are known to be highly prevalent in urban areas, mainly as a result of contaminated water and food, limited access to water, and poor food and household hygiene. Prevalence of diarrhea among young children in urban areas is often as high as in rural areas. Diarrhea contributes to malnutrition due to reduced absorption of carbohydrates, protein, potassium, zinc and other nutrients. Besides that it has important adverse affects on the nutritional status of a child as a result of losing water and electrolytes.
As mentioned before, in a community where malnutrition and poverty are present it is difficult to escape from the vicious cycle of malnutrition, because the poor developmental and educational level of the malnourished child will limit economic productivity in later life. Thus, the expectation of the prevalence of malnutrition in urban areas will increase more.

5.2 Others discussion points

5.2.1 Incomplete nutritional assessment

To be able to determine malnutrition nutritional assessment can be used. This research does not contain all the parts of nutritional assessment. We paid no attention to the food consumption of the children because it takes a lot of time and effort to get a clear view of the whole food consumption of all the children. It is not possible to ask the children about their own food consumption because they are too young, so the parents should be involved. To conduct this food consumption survey we need more manpower and time. According to the WHO (Hayes, 2014), it is possible to determine the nutritional status with only anthropometric data.

5.2.2 No individual diagnoses

The main goal of this research is to determine the prevalence of malnutrition among children of the five crèches. This research does not focus on individual diagnoses. The focus is on the amount of children that suffer from a specific type of malnutrition. It is possible that a child has more than one type of malnutrition, but this does not appear in the conclusion. To have an individual diagnosis it is necessary to look at the different anthropometric data of this child. The individual anthropometric data can be requested by one of the investigators or the principal of the crèche.

5.2.3 Reliability of MUAC-for-age and weight-for-height

We used MUAC-for-age and weight-for-weight to determine wasting. These two parameters gave us the same results This results showed that two children, one boy and one girl, are moderate wasted and that none of the children are severe wasted. But when we looked to the individual results of these children, we find out that just one child with a MUAC-for-age below -2 SD has also a weight-for-height below -2 SD. The other child with a MUAC-for-age below -2 SD does not have a weight-for-age below -2 SD but has a SD of -1,38. Besides that, just one of the two children with a weight-for-height below -2 SD has also a MUAC-for-age below – 2 SD. That is the reason why we doubt on the reliability of these parameters. According to Artsen zonder grenzen, measurement errors can be made by using MUAC, the MUAC tape is mainly used as a pre-selection measure instrument. Children who are in the " Yellow", "Orange" and " Red" should also be screened with the weight for height measure method to determine whether a child is really wasted. (Artsen zonder grenzen). That is why we think that the weight-for-weight growth curve is a better parameter to determine wasting.

5.2.4 Only one measuring moment

We measured weight, height and MUAC of all the children just one time to determine the z-scores and we did not look at the previous measurements. With only one measurement it is not possible to determine the trend of all the individual growth curves. Every child grows according to their own line, which could be different from the line of z-score 0. As long as the growth continue on the same line there is no problem. There is only cause for concern when children deviate from their own growth line, for example when the line suddenly deflects down.

Chapter 6 Recommendations

This chapter contains recommendations that can be given as result of this research.

6.1 Complete nutritional assessment and treatment by the dietitian

It is possible to provide a list with all the names of the children that are stunted, wasted and/or underweight to the dietitian of the clinic in Genadendal. For this children it is important to conduct a complete nutritional assessment. In this way, the dietitian can give individual advice. It is really important to pay attention to this children because, as mentioned before, malnutrition in young children can have awful consequences for the health, later in adult life. There are also a lot of children that are not determined with a classification of malnutrition, but they have a high risk of malnutrition. The problem is that there is only one dietician operating in region Genadendal, so it is not possible to send all the children to her. But the following recommendations can be useful to help these children.

6.2 Nutritional intake and food supply

In this research report we only paid attention to anthropometric data of the children, but the nutritional intake and food supply are also important. We made a start by investigate and improve the snack consumption of the children at the crèches in our health promotion report 'Kos wat kleuters laat groei'. The following students maybe can start a research to another part of the nutritional intake of the children. Besides that, the food supply at the crèches and in the shops in Genadendal can be investigated and improved if it is needed.

6.3 Research on the reliability of MUAC-for-age and weight-for-height

As mentioned before in the discussion we doubt on the reliability of these parameters, but we think that weight-for-height is more reliable to determine wasting. In this research we determined wasting in only a small number of children. That is why we are not sure which parameter is most reliable. More research is needed to conclude which of these parameters can be recommended to determine wasting.

We hope that this report provide enough information about the anthropometric data of the children in region Genadendal. We hope that other health carers will contribute, since our results show that there is still enough work to improve the nutritional status of the children.

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WHO. (2014). *Water, sanitation and hygiene interventions and the prevention of diarrhoea*. Retrieved 05 15, 2014, from World Healthy Organization: http://www.who.int/elena/titles/bbc/wsh_diarrhoea/en/

Appendix 1: Search Report

This search report provides an overview of the search strategies of literature. We used different methods to get information. Firstly, we used available literature from our previous study years, such as the book “Het diëtistisch consul”’ and “Understanding nutrition”. Besides that, Annemarie Nijhof, our supervisor from the HAN University of applied science in the Netherlands, recommended us to buy the book “Onderzoeksvaardigheden”. Also our supervisor from UWC, Elsabe Nel, recommended us a few sources, such as “The National Food Consumption Survey 1999”, “ The executive summary of National Food Consumption Survey Fortification Baseline” , the “Lancet series”, the “hypothesis of Barker”, the “cycle of despair for the poor” and “Some urban facts of life: implications for research policy”. Besides that, she gave us the book “A crop-based approach to address vitamin A deficiency in South Africa” and she lend us the book “Community nutrition textbook for South Africa: a rights-based approach.” Lastly, we had a few conservations with the dietician that works in the clinic in Genadendal. She gave us an example of a medical book ‘Road to health’ made by the Department of Health.

Additional literature was searched in several databases, such as PupMed and the WHO database. Besides that, we used Google to find information. Also websites from organizations such as the United Nations Children’s Fund (UNICEF), Statistics South Africa and the Food and Agriculture Organization have been used to gain information about malnutrition in South Africa. The table below shows the search strategy for the literature that was found in the several databases and Google. The table shows of each sub question the key words, the database and the limits that has been used. It also shows the date and the result. After finding a source, this was assessed for reliability by publication year and type and organization or journal that has published the information. Some sources that were found to answer one sub question are also used to answer another question.

Keywords	**Database**	**Limits**	**Hits**	**Date**	**Product**
Background information					
culture AND population AND South Africa	Google	-	124.000.000	12-03-2014	South Africa’s population http://www.southafrica.info/about/people/population.htm#.U39iyNJ_vWM
What is the definition of malnutrition and what are the different classifications?					
Malnutrition AND Definition	Google	-	2.960.000	Feb. 2014	Medical dictionary: Malnutrition http://medical-dictionary.thefreedictionary.com/malnutrition
Child Malnutrition AND Definition measurement	Pubmed	Humans	20	Feb. 2014	Definition and measurement of child malnutrition http://www.ncbi.nlm.nih.gov/pubmed/11862608
Factors AND contributing AND malnutrition in children	Google	-	7.970.000	Feb. 2014	Factors contributing to malnutrition in children 0-60 months admitted to hospitals in the northern Cape. http://etd.uovs.ac.za/ETD-db/theses/available/etd-11192010-135204/unrestricted/DeLangeJC.pdf

Wasting AND clinical signs	Google Image	-	-	15-05-2014	Visible severe wasting **http://labspace.open.ac.uk/mod/oucontent/view.php?id=458972&section=1.7.4**
How is malnutrition measured in South Africa?					
Road to health cart AND South Africa	Google	-	31.500.000	13-3-2014	The Road to Health Chart: Guidelines for Health Workers. http://www0.sun.ac.za/ruralhealth/ukwandahome/rudasaresources2009/DOH/11%20-%20healthchart.htm Presentation Kalafong Hospital-University of Pretoria: Road to health chart/booklet https://web.up.ac.za/sitefiles/file/45/1335/877/UPdate%202012_Road%20to%20Health.pdf → References Presentation: Acta Paediatrica. International journal of paediatrics. WHO Child growth standards http://www.who.int/childgrowth/standards/Acta_95_S450.pdf?ua=1
BMI and Children	Google	-	24.700.000	13-3-2014	Healthy Weight - it's not a diet, it's a lifestyle! About BMI for children and teens http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html
Malnutrion AND Measurement AND Child	WHO database	-	867	24-02-2014	Diagnostic performance of visible severe wasting for identifying severe acute malnutrition in children admitted to hospital in Kenya http://www.who.int/bulletin/volumes/89/12/11-091280/en/ Guideline: Updates on the management of severe acute malnutrition in infants and children http://apps.who.int/iris/bitstream/10665/95584/1/9789241506328_eng.pdf?ua=1 WHO Global Database on Child Growth and Malnutrition http://www.who.int/nutgrowthdb/en/
WHO AND groeicurve AND standaarddeviaties	Google	-	1.700	25-02-2014	De nieuwe WHO-groeicurves voor kinderen tot 5 jaar http://www.ouders.nl/artikelen/de-nieuwe-who-groeicurves-voor-kinderen-tot-5-jaar
MUAC	Google	-	967.000	13-03-2014	Artsen zonder grenzen: Hoe stel je ondervoeding vast? http://www.artsenzondergrenzen.nl/over-ons/dossiers/medische-dossiers/dossier-ondervoeding/hoe-stel-je-ondervoeding-vast.aspx

MUAC	WHO	-	57	29-05-2014	Mid-upper arm circumference at age of routine infant vaccination to identify infants at elevated risk of death: a retrospective cohort study in the Gambia http://www.who.int/bulletin/volumes/90/12/12-109009/en/
What is the prevalence of malnutrition among South African children between two and five years old?					
South Africa AND Food security	WHO database	-	995	13-03-2014	Food security in South Africa: a review of national surveys http://www.who.int/bulletin/volumes/89/12/11-089243/en/
What are the causes of malnutrition among South African children between two and five years old?					
Child Nutrition Disorders AND Causality AND South Africa	Pubmed	-	11	13-03-2014	Exploring the paradox: double burden of malnutrition in rural South Africa http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3556706/ Stunting and obesity in childhood: a reassessment using longitudinal data from South Africa http://ije.oxfordjournals.org/content/41/3/764.long Socio-economic predictors of stunting in preschool children--a population-based study from Johannesburg and Soweto. http://www.thefreelibrary.com/Socio-economic+predictors+of+stunting+in+preschool+children--a...-a0204550768
Diarrhea AND effect on the nutritional intake	Google	-	5.930.000	13-03-2014	Nutritional management of Acute Diarrhea in Infants and Children http://www.nap.edu/openbook.php?record_id=925&page=1
Diarrhea AND severe malnutrition AND Children	WHO	-	516	15-03-2014	Therapeutic feeding of children 6-59 months of age with severe acute malnutrition and acute or persistent diarrhea → Guidelines in references. Systematic review of the care of children with diarrhoea in the community-based management of severe acute malnutrition http://www.who.int/nutrition/publications/guidelines/updates_management_SAM_infantandchildren_review4.pdf

Acute respiratory in children in South Africa	Google	-	844.000	15-03-2014	Disease Control Priorities in Developing Countries. 2nd edition. Chapter 25: Acute Respiratory Infections in Children http://www.ncbi.nlm.nih.gov/books/NBK11786/
Health Care AND South Africa	Google	-	544.000.000	14-04-2014	Health care in South Africa http://www.southafrica.info/about/health/health.htm#.UyF-MD95NoR
Poverty AND malnutrition AND South Africa	Google	-	2.880.000	14-04-2014	The link between poverty and malnutrition: A South African perspective http://www.hsag.co.za/index.php/HSAG/article/view/435/482
Diet cost AND South Africa AND Low income	Pubmed	5 years humans	12	15-03-2014	The cost of a healthy diet: A South African Perspective http://www.ncbi.nlm.nih.gov/pubmed/21074973
causes AND political AND malnutrition AND south africa	Google	-	1.250.000	15-03-2014	Malnutrition in Sub – Saharan Africa: burden, causes and prospects http://www.panafrican-med-journal.com/content/article/15/120/full/
unhealthy household AND environment AND south africa	Google	-	1.270.000	15-04-2014	The impact of an unhealthy environment on human health in South Africa http://www.csir.co.za/nre/docs/Briefing%20Note%20No4%202010_environmental%20health_FINAL.pdf
Water AND hygiene AND diarrhea	WHO	-	1050	15-05-2014	Water, sanitation and hygiene interventions and the prevention of diarrhea http://www.who.int/elena/titles/bbc/wsh_diarrhoea/en/
What are the consequences of malnutrition on the physical and mental health of South African children between two and five years old?					
Impact AND Malnutrition AND health AND malnutrition	Google	-	22.700.000	15-05-2014	Impact of Malnutrition on Health and Development http://www.orphannutrition.org/understanding-malnutrition/impact-of-malnutrition-on-health-and-development/
Nutrition AND malnutrition AND immune response	Google	-	3.590.000	14-03-2014	Nutrition, immune response, and the outcomes http://www.ncbi.nlm.nih.gov/pubmed/3097756

					Symposium on 'Nutrition and immunity in serious illness' http://www.phoenixhealth.me/Clinical%20Studies/Nutrition%20and%20the%20immune%20system.pdf
Stunting AND Children AND overweight	Google	-	318.000	14-03-2014	Stunting is Associated with Overweight in Children of Four Nations That Are undergoing the Nutrition Transition http://jn.nutrition.org/content/126/12/3009.full.pdf+html
nutrition transition AND urbanization AND south africa	Google	-	320.000	15-04-2014	Rapid urbanization and the nutrition transition in Southern Africa http://queensu.ca/samp/afsun/files/AFSUN_7.pdf

Appendix 2 Informed Consent

Informed consent form for the principal

The next three months a research will be conducted to determine the nutritional status of children at the creches in Genadendal, Voorstekraal, Bereaville and Greyton. As a part of this research, on ……. march, there will be a measurement at the crèche **Genadendal Educare**. The goal of this research is to determine the anthropometric status of the children, namely underweight, normal weight, overweight or obesity. Height, weight and middle upper arm circumreference will be measured. For these measurements the children will be asked to take off their shoes, jacket and heavy items.

For additional information, we would like the children to bring their medical book, on day of the measurement. We will use this book to gather more information about the height and weight history of the children.

I declare to be informed about the research. I know, the data and results from this research, will be published anonymously. My questions are answered to my satisfaction.

I understand that movie, photo and video will only be used by analysis and / of scientific presentations.

I voluntary agree that the children of the crèche will be a part of this research. While I reserve the right to terminate the participation at any time in this study, without giving reasons.

Name: _____

Date: _____

Place: _____

Signature: _____

Appendix 3 Letter for the parents

Dear parents,

In this letter we would like to get your attention for an upcoming research at several crèches in Genadendal and surrounding regions. This research gives an unique opportunity to gather information about the health status of the children. ‘Soos almal weet, gesondheid van kinders is belangrijk. Hulle is ons toekomst’. If it is necessary we want to develop a health education program for the children so we can improve their nutritional status.

We are two Dutch students of the course Nutrition & Dietetics and we are going to do an investigation at the crèches in Genadendal, Bereaville, Voorstekraal and Greyton.

We want to measure the height ,weight and mid upper arm of all the children of **Genadendal Educare**, on the following date: 24-03-2014

For these measurements, we will ask the children to take off their shoes and heavy clothing. The goal of this research is to determine the body composition of the children, namely underweight, normal weight, overweight or obesity.

For additional information, we would like the children **to bring their clinic cart**, on the day of the measurement. We will use this book to gather more information about the height and weight history of the children.

If you do not want your child participate in this study, please indicate this at the teacher of the crèche.

Thank you in advance,

Carina de Kort and Vaitiare Jansen

Appendix 4 Results of the measurements

Genadendal Educare:

Name	ID	Male/ Female	Date of birth	Height	Weight	MUAC	Birth weight	Birth length	Weight for height	Weight for age	Height for age	MUAC for age
Jaynick Noble	1	M	17-02-2010	99,3	14,70	16,5	3460	56	-0,38	-0,93	-1,10	0,24
Avlin Constable	35	M	13-08-2010	99,9	15,00	16,4			-0,27	-0,31	-0,20	0,31
Jo-anne Matthijsen	2	F	25-01-2010	16,10	100,0	17,0	3630	48	0,61	-0,14	-0,88	0,44
Ash-Ray Smith	3	M	27-09-2010	102,3	15,35	16,0	3800	52	-0,52	0,01	0,64	0,04
Ruwayne van der Berg	36	F	06-03-2010	96,2	14,70	16,7			0,38	-0,71	-1,60	0,28
Jade-Lee Jantjies	4	F	06-01-2010	100,9	18,65	18,0			1,97	0,84	-0,75	1,05
Likeisha Williams	37	F	25-02-2010	103,1	16,00	16,3			-0,11	-0,11	-0,05	0,00
Jordan Isaacs	38	F	15-03-2010	104,1	14,40	14,8			-1,50	-0,84	-0,26	-1,08
Rosemary Lesch	5	F	20-07-2010	95,8	14,65	16,1			0,43	-0,35	-1,10	0,03
Tino Fourie	6	M	07-03-2010	102,0	14,60	15,6			-1,06	-0,93	-0,39	-0,43
Virgel Taylor	7	M	23-03-2010	97,2	15,55	18,8			0,76	-0,40	-1,46	1,80
Tee-Jay Isaacs	8	M	28-09-2009	110,0	20,45	18,0	3780	53	1,11	1,25	0,78	1,14
Cornay du	39	F	25-04-2009	98,1	13,20	14,9			-1,21	-2,24	-2,29	-1,31

Plessis												
Matthew van Rensburg	9	M	05-09-2009	106,4	22,75	21,0	2100	41	3,05	1,98	-0,13	2,83
T-Jay Hendricks	10		19-07-2009	97,1	15,95	17,9			1,09	-1,04	-2,78	0,92
Chloe Jacobs	40	F	20-11-2009	103,1	16,10	17,2			-0,04	-0,31	-0,46	0,49
Jano Smit	41	M	26-04-2009	102,6	15,60	16,4			-0,39	-1,15	-1,48	-0,06
Usaray Sauls	11	M	28-10-2009	103,2	16,20	16,5			-0,07	-0,44	-0,64	0,15
Brinzleigh Hartzenberg	12	M	25-07-2009	102,4	15,70	15,7	2940	51	-0,27	-0,90	-1,19	-0,51
Joorst Cayla	13	F	24-09-2009	100,5	13,9	14,6			-1,13	-1,51	-1,24	-1,39
Jordin Snijders	14	M	22-08-2009	97,8	14,85	16,9			0,07	-1,27	-2,12	0,38
Domian Mavio	42	M	20-02-2010	100,4	15,55	16,0			0,06	-0,48	-0,84	-0,13
Kieran Peters	15	M	21-12-2010	94,5	14,95	17,5	3480	54	0,86	0,05	-0,92	1,22
Melverick Phillips	16	M	29-08-2010	99,5	15,10	15,9	3780	53	-0,10	-0,20	-0,21	-0.06
Nicolene Jacobs	17	F	14-04-2010	100,7	13,95	15,2	3470	53	-1,13	-1,04	-0,47	-0,76
Zenaydin van der Ross	18	M	14-09-2010	101,4	15,65	16,5			-0,08	0,13	0,35	0,41
Liam Odendal	19	M	12-02-2010	103,9	15,70	17,1	3660	53	-0,60	-0,42	-0,04	0,66
Lesley Louis	20	F	14-12-2010	101,4	16,35	18,8	3160	47	0,49	0,91	1,04	2,00
Micah Zoe	21	F	10-04-2010	101,2	14,70	16,1	3195	49,7	-0,64	-0,61	-0,28	-0,08

Swartz												
Thailor Sauls	43	F	21-05-2010	93,7	14,05	16,1			0,39	-0,84	-1,88	-0,04
Nashrique Hanse	44	M	21-12-2010	88,3	12,85	16,0			0,36	-1,20	-2,55	0,12
Lee-Zanne Louis	22	M	08-06-2009	105,9	15,55	16,2	3020	57	-1,15	-1,07	-0,59	-0,17
Erin Sauls	45	F	24-04-2009	116,3	21,30	18,7			0,04	1,09	1,56	1,14
Regan Pietersen	23	M	25-09-2009	101,5	15,80	15,7			0,01	0,71	-1,16	-0,47
Jay-Lee Hartzenberg	24	M	08-11-2009	101,9	16,90	17,7	3460	52	0,72	-0,09	-0,90	0,98
Miche Losper	25	F	11-05-2009	106,0	14,85	14,5	3045	47	-1,58	-1,33	-0,55	-1,59
Zhoe Jacobs	46	F	20-11-2009	96,1	12,30	15,2			-1,62	-2,32	-2,03	-0,89
Tyrique Sam	47	M	05-08-2009	107,4	16,35	16,4			-0,88	-0,57	-0,04	0,01
Shaznay Beukes	26	F	14-12-2009	100,1	15,95	17,8	2520	47	0,49	-0,31	-1,02	0,90
Jason Johnston	48	M	09-07-2009	95,7	12,80	14,6			-1,34	-2,53	-2,75	-1,40
Ian Klaasen	27	M	25-06-2011	87,9	11,25	15,3	2490	49	-1,21	-1,73	-1,72	-0,26
Deslin Temmers	28	F	12-08-2011	89,6	12,60	14,5			0,05	-0,23	-0,59	-0,73
Jordan Januarie	29	F	16-07-2011	91,5	12,65	15,5			-0,32	-0,30	-0,24	0,04
Raygan Bantom	30	M	27-06-2011	93,5	14,20	16,1	3160	54	0,44	0,23	-0,14	0,39
Keaston Jantjie	31	M	30-11-2011	87,0	12,50	16,8	2820	49	0,33	-0,26	-0,98	1,14

Nolan Booysen	32	M	28-08-2011	92,0	12,65	15,1	3350	50	-0,68	-0,52	-0,16	-0,35
Leticia-Lee Galant	33	F	16-10-2011	85,4	10,80	14,6	2390	48	-0,71	-1,23	-1,34	-0,55
Thurswin Hendricks	34	M	28-07-2011	87,5	13,00	16,5	3245	50	0,69	-0,40	-1,65	0,73

Voorstekraal Educare:

Name	ID	Male/Female	Date of birth	Height	Weight	MUAC	Birth weight	Birth Length	Weight for height	Weight for age	Height for age	MUAC for age
Ruben Morris	1	M	09-06-2010	98,7	15,30	16,5	2550	45	0,24	-0,32	-0,78	0,33
Jessica (Temmers) Marilyn	2	F	04-05-2010	104,6	15,45	17,5	2400	50	-0,82	-0,18	0,62	0,88
Christopher Kroukamp	15	M	16-05-2011	96,5	14,50	16,8	3230	50	0,06	0,25	0,41	0,87
Jean-Pierre Jacobs	3	M	27-11-2010	89,9	12,30	15,5	3380	52	-0,56	-1,62	-2,23	-0,30
Mikayle Oncke	4	F	05-06-2011	92,0	14,75	17,9	3320	53	1,26	0,74	-0,38	1,69
Ismeal Hendricks	5	M	24-05-2010	97,1	15,00	16,1			0,35	-0,52	-1,24	0,02
Gershwin Matthews	6	M	29-11-2010	99,3	15,05	16,1	3170	52	-0,09	0,04	0,20	0,18
Hayden Samuels	7	M	18-06-2009	102,1	16,10	15,6	2900	49	0,10	-0,79	-1,40	-0,61
Sebastian du Toit	16	M	05-06-2009	100,8	16,80	17,3	2100	49	0,90	-0,50	-1,74	0,59
Andrew Britz	8	M	10-07-2009	103,4	16,80	16,6			0,32	-0,42	-1,03	0,14

Tecici April	9	F	05-08-2009	103,9	17,10	18,0			0,44	-0,14	-0,69	0,86
Raymondee Lewis	10	F	15-12-2009	99,9	14,95	16,4	3420	54	-0,18	-0,78	-1,07	-0,01
Joshua Sodoms	11	M	20-10-2009	103,9	15,20	15,7	2950	51	-0,99	-0,95	-0,52	-0,45
Dwayne Willemse	12	M	30-06-2009?	110,7	22,65	19,9			2,06	1,78	0,55	2,18
Jason Jack	13	M	09-11-2009	92,4	13,35	15,1			-0,09	-1,93	-3,08	-0,91
Lizay v.d. Berg	14	F	05-05-2010	92,5	11,45	14,2	2290	45	-1,69	-2,48	-2,22	-1,50

Bereaville Educare:

Name	ID	Male/ Female	Date of birth	Height	Weight	MUAC	Birth weight	Birth length	Weight for height	Weight for age	Height for age	MUAC for age
Lucian Benn	1	Male	02-05-2011	94,4	13,65	16,4	3535	53	-0,24	-0,33	-0,31	0,54
Lushin Butler	2	Male	10-06-2009	109,3	20,20	17,4	2740	44	1,13	0,86	0,11	0,65
Waylon Cupido	3	Male	21-07-2009	98,9	14,35	15,6			-0,59	-1,63	-2,03	-0,60
Brayton Dampies	4	Male	31-05-2009	103,6	15,20	15,8	3040	50	-0,92	-1,30	-1,18	-0,48
Christopher Diedericks	5	Male	03-05-2009	111,9	20,80	18,1	3160	48	0,88	0,98	0,52	1,06
Darren Filander	6	Male	11-11-2009	103,9	16,20	15,4	3060	50	-0,22	-0,44	-0,48	-0,68
Lyle Fillies	7	Male	19-10-2010	94,4	13,50	15,8	2940	54	-0,38	-1,00	-1,32	-0,10
Alexander	8	Male	08-03-2009	110,8	18,35	16,9	2840	?	-0,28	-0,06	0,06	0,24

Flandorp												
Nazier Ismail	9	Male	24-11-2009	101,1	14,75	16,3	3110	52	-0,74	-1,14	-1,07	0,02
Mornay Januarie	10	Male	10-10-2009	102,4	14,10	14,6	2600	49	-1,59	-1,59	-0,95	-1,35
Teacian Matthei	11	Male	18-12-2010	94,3	15,55	18,9	3370	53	1,37	0,32	-1,06	2,13
Ceton Mintoor	12	Male	10-08-2009	100,7	16,40	16,1	2680	46	0,63	-0,56	-1,56	-0,21
CJ Oktober	13	Male	29-07-2009	108,8	17,30	16,9	3320	51	-0,52	-0,18	0,19	0,35
Daniello Pietersen	14	Male	12-11-2010	87,9	10,90	13,7	970	35	-1,62	-2,70	-2,87	-1,88
Uwinn Potberg	15	Male	18-04-2009	97,7	13,35	14,9	1620	37,5	-1,23	-2,38	-2,61	-1,21
Eshwin Sebastiaan	16	Male	21-05-2010	99,9	14,00	14,5	3250	47	-1,12	-1,12	-0,63	-1,29
Denzil Standers	17	Male	06-08-2009	94,2	14,60	16,0	1380	40	0,63	-1,46	-3,02	-0,29
Elzano Timmie	18	Male	21-05-2010	101,1	15,40	15,7	3130	45	-0,21	-0,36	-0,34	-0,30
Junaid Potberg	19	Male	24-03-2010	102,3	15,90	16,9			-0,09	-0,25	-0,31	0,54
Alexa Janecke	20	Female	02-09-2010	92,9	15,35	17,3			1,51	0,08	-1,67	0,89
Elwida Pitcher	21	Female	13-08-2009	99,4	14,95	17,4	2020	47	-0,08	-1,11	-1,69	0,48
Theola Pitcher	22	Female	04-04-2010	101,9	19,55	17,8			2,25	1,36	-0,21	1,02
Teslee Plaatjies	23	Female	28-04-2010	95,5	18,15	19,4	3070	49	2,74	0,92	-1,59	2,00
Janique Smith	24	Female	17-03-2010	100,3	15,50	15,8			0,13	-0,32	-0,65	-0,34

Kaydee Ungwijn	25	Female	28-12-2009	101,5	15,55	16,1	4140	47,5	-0,08	-0,49	-0,71	-0,21
Jay-Lee Witbooi	26	Female	06-03-2010	98,7	17,15	17,4	3760	54	1,54	0,38	-1,07	0,73
Mishca Oktober	27	Female	04-12-2009	101,8	16,50	16,1	3160	52	0,50	-0,13	-0,74	-0,24

Vrolike Vinkies Educare:

Name	ID	Male/ Female	Date of birth	Height	Weight	MUAC	Birth Weight	Birth for length	Weight for height	Weight for age	Height for age	MUAC for age
Angelique Arendse	1	F	22-04-2009	103,1	15,55	15,4			-0,42	-1,07	-1,29	-0,96
Henrico Davids	2	M	21-07-2010	92,4	14,60	16,3			1,01	-0,62	-2,21	0,20
Devaun Europa	3	M	20-09-2009	113,3	15,80	13,8	3180	57	-2,57	-0,76	1,42	-2,06
Junaid Jansen	4	M	11-01-2010	109,1	20,55	18,6	3660	46	1,36	1,53	0,97	1,59
Raydon Josephs	5	M	03-07-2010	100,0	14,95	15,7	3180	32	-0,33	-0,48	-0,43	-0,27
Leonie Prins	6	F	14-01-2010	99,3	13,95	15,2	3250	48	-0,83	-1,26	-1,15	-0,84
Brooklyn Wildschut	7	F	22-11-2009	109,4	17,1	16,4	2780	53	-0,77	0,09	0,90	-0,05
Jody Wildschut	8	F	08-05-2009	107,4	17,65	15,8	3220	52	0,02	-0,15	-0,32	-0,67
Junior Neube	9	M	08-04-2009	108,0	19,75	18,6			1,16	0,54	-0,43	1,34
Priya-leigh Bantom	10	F	11-10-2011	90,1	10,65	13,4	3020	51	-2,02	-1,43	-0,15	-1,64
Inge Delport	11	F	23-02-2012	86,4	11,75	15,0	2940	51	0,00	-0,03	-0,19	0,00

Skylah Govender	12	F	01-05-2011	90,4	10,90	14,4	3320	52	-1,81	-1,85	-1,10	-0,97
Jona-Lee Juries	13	F	03-09-2011	87,9	10,50	14,6			-1,66	-1,70	-1,03	-0,64
Faizel de Koker	14	M	26-01-2011	93,4	12,05	14,7	3100	53	-1,62	-1,66	-1,11	-0,93
Matthew Little	15	M	15-02-2011	95,3	15,05	16,9	2170	40	0,77	0,23	-0,51	0,83
Eden Moners	16	M	29-09-2011	89,90	12,45	16,4	3300	50	-0,41	-0,60	-0,66	0,72
Tarryn Noudt	17	F	07-11-2011	76,1	8,65	13,2	1595	38	-1,04	-3,11	-3,97	-1,79
Shakira Philips	18	F	18-06-2011	93,9	15,80	18,0			1,62	1,25	0,13	1,76
Carmenicia van Dijk	19	F	17-11-2011	82,7	11,40	16,1	2830	50	0,57	-0,71	-2,01	0,67
Jaythan van Niekerk	20	M	28-09-2011	97,4	15,60	17,6	3930	59	0,76	1,31	1,52	1,61
Neo van Staden	21	M	06-01-2012	85,9	11,40	15,5	2800	48	-0,52	-0,97	-1,17	0,14

Greyton Speelcentrum:

Name	ID	Male/ Female	Date of birth	Height	Weight	MUAC	Birth weight	Birth length	Weight for height	Weight for age	Height for age	MUAC for age
Chloe Baadjes	1	F	21-03-2010	101,1	15,50	16,6	4040	55	-0,03	-0,31	-0,47	0,22
Rubylee Adams	2	F	05-11-2009	97,8	16,05	16,8	2680	48	1,02	-0,40	-1,75	0,19
Mercia Cornelius	3	F	05-11-2009	99,1	14,10	14,7	2230	48	-0,67	-1,35	-1,46	-1,29

Shakira Davids	4	F	31-05-2010	94,4	15,45	17,1	3310	51	1,28	-0,15	-1,73	0,64
Sandrewnisia Fourie	5	F	26-01-2010	99,9	16,60	17,7	2770	49	0,96	0,04	-0,97	0,87
Cadee Gilliomee	6	F	13-03-2011	92,7	13,45	15,8	3100	50	0,11	-0,32	-0,78	0,08
Deborah Jackson	7	F	16-12-2010	93,9	15,05	17,5	2710	51	1,10	0,25	-0,93	1,16
Cleo Villet	8	F	06-09-2010	99,	14,60	15,4	3130	45	-0,40	-0,29	-0,01	-0,45
Ava-Lee Stanfield	9	F	10-08-2011	93,2	13,25	15,6	2370	47	-0,16	0,09	0,28	0,13
Cailijn Philips	10	F	07-09-2011	93,5	14,75	17,4	3800	54	0,96	1,03	0,56	1,48
Lakeisha Palmer	11	F	02-05-2010	100,0	13,90	14,1	3330	50	-1,02	-1,01	-0,54	-1,60
Lene Hans	12	F	05-08-2009	115,2	24,45	18,4	2850	52	1,65	2,16	1,70	1,07
Cayreesha du Plessis	13	F	22-04-2009	108,2	18,20	16,5	3740	53	0,17	0,02	-0,21	-0,21
Maylene Jafta	14	F	14-07-2009	94,3	12,15	13,9	2500	49	-1,38	-2,74	-2,90	-2,02
Jayden Jafta	15	M	31-05-2009	100,4	15,50	16,0	2540	48	0,02	-1,15	-1,89	-0,34
Ras-Zion Philips	16	M	15-03-2010	102,8	18,55	17,0	3510	53	1,60	0,91	-0,24	0,60
Lushen Stanfield	17	M	28-06-2009	106,4	28,65	24,0			5,99	3,45	-0,47	4,29
Ras-Chezideck Adendor	18	M	12-12-2009	101,1	18,75	18,0	3460	53	2,10	0,75	-1,02	1,19
Conray Mountz	19	M	01-04-2011	93,5	12,20	14,4			-1,48	-1,37	-0,75	-1,13
Evan Mathews	20	M	10-05-2011	87,6	13,20	16,2	2840	45	0,85	-0,59	-2,14	0,39

Jordan White	21	M	27-11-2009	99,9	14,40	15,8	2260	44	-0,77	-1,32	-1,35	-0,36
Warren Smit	22	M	22-12-2009	96,1	14,80	16,0	3360	51	0,40	-1,05	-2,13	-0,19
Ronaldo Nell	23	M	20-06-2009	106,4	17,25	15,5	2160	47	-0,03	-0,30	-0,50	-0,70
Vondrey Geduld	24	M	08-05-2010	101,8	17,30	17,5	3270	51	1,02	0,52	-0,24	0,99
Juvani Zietsman	25	M	09-01-2010	106,5	18,75	17,0	3240	52	0,91	0,82	0,35	0,55
Alvin Juries	26	M	26-03-2010	99,1	14,55	15,5	3020	49	-0,46	-0,96	-1,07	-0,50
Shawnwill Filander	27	M	11-06-2009	102,3	16,15	16,6	2840	47	0,10	-0,82	-1,44	0,10

Appendix 5 Results of the Z-scores

Genadendal Educare Weight for Height

	N	SD; -4 → -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD > +3
Male	28	0	0	4	11	10	2	0	1
Female	20	0	0	6	5	8	1	0	0
Totaal	48	0	0	10	16	18	3	0	1

Genadendal Educare Weight for Age

	N	SD; -4 → -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD +3 → +4
Male	28	0	1	6	15	4	2	0	0
Female	20	0	2	4	11	2	1	0	0
Totaal	48	0	3	10	26	6	3	0	0

Genadendal Educare Height for age

Genadendal Educare	N	SD; -4 → -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD +3 → +4
Male	28	0	4	7	14	3	0	0	0
Female	20	0	2	6	9	1	2	0	0
Totaal	48	0	6	13	23	4	2	0	0

Genadendal Educare MUAC

Genadendal Educare	N	SD; -4 → -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD +3 → +4
Male	28	0	0	1	9	13	4	1	0
Female	20	0	0	4	6	7	2	1	0
Totaal	48	0	0	5	15	20	6	2	0

Voorstekraal Weight for Height

	N	SD; -4 → -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD +3 → +4
Male	11	0	0	0	4	6	0	1	0
Female	5	0	0	1	2	1	1	0	0
Totaal	16	0	0	1	6	7	1	1	0

Voorstekraal Weight for age

	N	SD; -4 → -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD +3 → +4
Male	11	0	0	2	6	2	1	0	0
Female	5	0	1	0	3	1	0	0	0
Totaal	16	0	1	2	9	3	1	0	0

Voorstekraal Height for age

	N	SD; -4 → -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD +3 → +4
Male	11	1	1	4	2	3	0	0	0
Female	5	0	1	1	2	1	0	0	0
Totaal	16	1	2	5	4	4	0	0	0

Voorstekraal MUAC

	N	SD; -4 → -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD +3 → +4
Male	11	0	0	0	4	6	0	1	0
Female	5	0	0	1	1	2	1	0	0
Totaal	16	0	0	1	5	8	1	1	0

Bereaville Weight for height

	N	SD; -4 → -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD +3 → +4
Male	19	0	0	4	10	3	2	0	0
Female	8	0	0	0	2	2	2	2	0
Totaal	27	0	0	4	12	5	4	2	0

Bereaville Weight for age

	N	SD; -4 → -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD +3 → +4
Male	19	0	2	7	7	3	0	0	0
Female	8	0	0	1	3	3	1	0	0
Totaal	27	0	2	8	10	6	1	0	0

Bereaville Height for age

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	19	1	3	5	6	4	0	0	0
Female	8	0	0	4	4	0	0	0	0
Totaal	27	1	3	9	10	4	0	0	0

Bereaville MUAC

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	19	0	0	4	7	6	1	1	0
Female	8	0	0	0	3	3	1	1	0
Totaal	27	0	0	0	10	9	2	2	0

Vrolike Vinkies Weight for height

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	10	0	1	1	3	2	3	0	0
Female	11	0	1	3	3	3	1	0	0
Totaal	21	0	2	4	6	5	4	0	0

Vrolike Vinkies Weight for age

Genadendal Educare	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	10	0	0	1	5	2	2	0	0
Female	11	1	0	5	3	1	1	0	0
Totaal	21	1	0	6	8	3	3	0	0

Vrolike Vinkies Height for age

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	10	0	1	2	4	1	2	0	0
Female	11	1	1	4	3	2	0	0	0
Totaal	21	1	2	6	7	3	2	0	0

Vrolike Vinkies MUAC

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	10	0	1	0	2	4	3	0	0
Female	11	0	0	2	6	2	1	0	0
Totaal	21	0	1	2	8	6	4	0	0

Greyton Speelcentrum Weight for height

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	13	0	0	1	3	5	2	1	1
Female	14	0	0	2	4	4	4	0	0
Totaal	27	0	0	3	7	9	6	1	1

Greyton Speelcentrum Weight for age

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	13	0	0	4	4	4	0	0	1
Female	14	0	1	2	5	4	1	1	0
Totaal	27	0	1	6	9	8	1	1	1

Greyton Speelcentrum Height for age

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	13	0	2	5	5	1	0	0	0
Female	14	0	1	3	7	2	1	0	0
Totaal	27	0	3	8	12	3	1	0	0

Greyton Speelcentrum MUAC

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	13	0	0	1	5	5	1	0	1
Female	14	0	1	2	2	6	3	0	0
Totaal	27	0	1	3	7	11	4	0	1

Total Weight for height

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	81	0	1	10	30	26	9	2	2
Female	58	0	1	12	17	18	9	2	0
Totaal	139	0	2	22	47	44	18	4	2

Total Weight for age

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	81	0	3	20	37	15	5	0	1
Female	58	1	4	12	25	11	4	1	0
Totaal	139	1	7	32	62	26	9	1	1

Total Height for age

	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	81	2	11	23	31	12	2	0	0
Female	58	1	5	18	25	6	3	0	0
Totaal	139	3	16	41	56	18	5	0	0

Total MUAC

Genadendal Educare	N	SD; > -3	SD; -3 → -2	SD; -2 → -1	SD; -1 → 0	SD 0 → +1	SD 1 → +2	SD 2 → +3	SD >+3
Male	81	0	1	6	26	34	9	3	1
Female	58	0	1	9	18	20	8	2	0
Totaal	139	0	2	15	44	54	17	5	1

Appendix 6 Pictures of the measurements