Assessment of anthropometry, academic performance and absenteeism in a comprehensive educational programme on the Cape Flats – A cross-sectional survey with a cohort analysis

by

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Declaration

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Abstract

Christel House South Africa (CHSA) is an independent primary and secondary school that offers a comprehensive educational programme that includes two meals and snacks to children from disadvantaged areas known as the Cape Flats. Anthropometric measurements such as weight and height are widely recognised as a reliable way to assess growth and nutritional status of children. Underweight and wasting are indicators of recent and severe malnutrition while stunting is associated with poor socio-economic conditions. Academic performance is associated with many factors including genetics, socio-economic circumstances, parental education and ill-health. However, there is no convincing evidence supporting a direct link between improved academic performance and improvement in nutritional status.

This study aims to evaluate the comprehensive programme that CHSA provides by assessing anthropometric measurements and academic performance as well as absenteeism among the learners over a two year period. In particular, to assess whether those learners who showed improved anthropometry also demonstrated improved academic performance and reduced absenteeism between 2002 and 2004.

The study is a cross-sectional survey with a retrospective cohort analysis. Existing data, part of the school's routine data collection, were used. The data consisted of weight and height measurements, end-of-year grades for English and Mathematics, and absenteeism records, all for 2002 and 2004. After obtaining informed consent from parents and guardians, a sample of 175 learners was established and used for cross-sectional analyses. This represented 65% of all eligible learners in the sample population. The median age was 8.5 years. Sex and age specific anthropometric measurements, expressed as weight-for-age, height-for-age and weight-for-height Z-scores, were created using the Epi Nut software in EPIlnfo6. Due to age and height limits in data that can be entered in this software, a cohort sub-sample of 81 learners, median age 7.2 years, was created and used for cohort analyses. As a result of measurement error with regard to height measurements in 2002, height-for-age and weight-for-height outcomes for 2002 were rendered invalid and excluded from statistical analyses of height-for-age and weight-for-height Z-score change between 2002 and 2004. However, by creating a 'gain' variable that took account of the measurement error, selected comparisons could still be done.

The study found a prevalence of underweight of 8% in 2002 and 1.7% in 2004 (n=175). The reduction in underweight was statistically significant ($P<0.05$). There was a significant improvement in weight-for-age, English performance and Mathematics performance between 2002 and 2004, both in the complete sample (n=175) and the cohort (n=81). These improvements were statistically significant for both sexes, except for weight-for-age among girls in the cohort. There was no significant reduction in absenteeism during this period, either in the complete sample or the cohort.

For 2004, bi-variate analyses showed a modest but significant positive correlation between weight-for-age Z-score and English ($r=0.21$, $P<0.05$) and Math ($r=0.25$, $P<0.05$) performance respectively, and a significant modest negative correlation with absenteeism ($r=-0.18$, $P<0.05$) (n=175). These correlations were not apparent in 2002. Multivariate analyses using logistic regression showed no associations between weight-for-age Z-score gain or height-for-age Z-score gain and improvement in English, Math and absenteeism, respectively (n=81). A negative association (OR=0.3, 95% CI 0.11-0.76) was found between weight-for-height Z-

score gain and improvement in absenteeism. All analyses were adjusted for sex, age and having failed a year in school between 2002 and 2004.

No significant associations were found when assessing improvement in English, Math and absenteeism in relation to quartiles of change in weight-for-age Z-score. A modest positive correlation was found between reduction in absenteeism and improvement in English ($r=0.3$, $P<0.05$) ($n=81$).

Limitations of the study include measurement error in height in 2002, leading to the exclusion of height-for-age and weight-for-height in most of the analyses, and eliminating stunting and wasting as indicators of malnutrition from the overall assessment. Secondly, as a result of the limitations for age and height in the EpiNut software, a cohort was created. Analysis indicated that those included in the cohort were significantly different from those not included in the cohort in terms of age and sex. In particular, selection bias caused the exclusion of older and taller girls from the cohort. As such, findings for the cohort may not be representative of the study population.

In spite of its limitations, this study identified a number of significant findings in respect of academic performance and anthropometric outcomes, suggesting that the programmes as provided by Christel House South Africa benefit their learners. In view of future monitoring and evaluation it is recommended that a protocol for weight and height measurement taking is agreed on, that the same instruments are used consistently, and that these instruments are regularly calibrated. It is also recommended that any future research related to child growth and academic performance at CHSA include data on socio-economic circumstances and parental education. Lastly, it is recommended that CHSA makes an assessment of the quality and nutritional value of the food provided, to ensure that the meals and snacks are healthy, varied and nutritionally balanced.

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List of Acronyms

AIDS:	Acquired Immuno-Deficiency Syndrome
CI:	Confidence Interval
CHSA:	Christel House South Africa
HIV:	Human Immunodeficiency Virus
HST:	Health Systems Trust (HST)
NFCS:	National Food Consumption Survey
NCHS:	National Center for Health Statistics (United States)
PNSP:	South African Primary School Nutrition Programme
P-value:	Probability value
SAVACG:	South African Vitamin A Consultative Group (SAVACG)
SD:	Standard Deviation
SES:	Socio-economic status
UCT:	University of Cape Town
WHO:	World Health Organization

1 Introduction

Christel House South Africa (CHSA) is an independent primary and secondary school that offers comprehensive education from grade 1-10 to 482 children (as per January 2006). Situated in Athlone, Cape Town, the learners are drawn from surrounding areas with low socio-economic status such as Kewtown, Hanover Park, Bokmakierie, Manenberg and Langa, generally referred to as the Cape Flats. The aim of the school is to break the cycle of poverty by providing disadvantaged children with a holistic educational programme that includes food, school uniforms and shoes, school stationery, extra-mural activities, psycho-social services as well as basic health care. The food programme consists of a cereal breakfast in the morning before the children start their lessons, a mid-morning fruit or snack and drink, warm lunch and an afternoon snack or fruit.

In addition, the school provides daily transport between the home area and school, and engages in social outreach towards the learners' families and communities through community workshops on e.g. domestic violence, HIV/AIDS and drug abuse. All services are free of charge to the learners and their families. The school maintains a set of six selection criteria for admission, the main one being economic: a household income of less than R 1500 per month. A full list of the criteria is included in Appendix II.

In order to record baseline information and development over time for every learner, the school conducts routine data collection. This includes a brief medical history at first entry, annual anthropometric measurements, daily absenteeism records and continuous measurement of academic performance.

In this context, this study has explored data on anthropometry, academic performance and absenteeism of learners in order to assess the impact of the school's comprehensive programme on anthropometry, absenteeism and academic performance in English and Mathematics.

2 Literature review

Anthropometric measurements, or measurements of the human body such as weight and height, are widely used and accepted as a reliable way to assess the growth and nutritional status of children.

Underweight, or low weight-for-age, usually occurs after 'a period of recent food shortage' (Walsh et al, 2002, p. 6) and is 'an indicator of acute undernutrition' (Jacobs et al, 1988, p. 432). As such, weight-for-age reflects the immediate nutritional status of a child (Kibel and Wagstaff, 1995). At the same time, using weight-for-age as an indicator of nutritional status may be problematic as 'it assumes that all subjects of a certain age should have the same weight' and it does not take differences in body size into consideration (Steyn et al, 1989, p. 21).

Reduced height-for-age, or stunting, indicates 'a chronic illness, a longstanding growth problem, or a deficiency of growth hormone.' (Kibel and Wagstaff, 1995, p. 29). Stunting usually occurs after a period of chronic undernutrition and height-for-age is therefore a suitable indicator for past nutrition (Walsh et al, 2002; Steyn et al, 1989). Stunting is commonly associated with poor socio-economic conditions (Gorstein et al, 1994; South).

Wasting, or low weight-for-height, usually occurs after a period of recent and severe malnutrition and weight-for-height therefore reflects current nutritional status. As such, 'weight-for-height is the most suitable indicator for the present state of nutrition' (Walsh et al 2002, p. 7; Jacobs et al, 1988).

Underweight, wasting or stunting in a population are commonly determined by calculating a Z-score or percentile score. A Z-score is a score that standardises an anthropometric measure by the number of standard deviations below or above a reference norm, usually the median. For example, if a Z-score is less than -2 standard deviations below the median weight-for-age, a child is said to be underweight (WHO, 2006). Percentile scores reflect 'the rank position of an individual on a given reference distribution, stated in terms of what percentage of the group is equalled or exceeded by the individual' (Vorster et al, 1997, p. 5). A child whose percentile score is below the 5th percentile therefore weighs less than 95% of the children in the reference population, and is also considered underweight. In other words, both -2SD and the 5th percentile are cut-off points for underweight, though the fifth percentile is slightly less strict than -2SD. Sometimes the third percentile is taken as the cut-off point, which is somewhat stricter than -2SD, and which includes only 3% of the reference population.

Malnutrition in children is related to poor physical growth, can predispose to ill health and can be detrimental to cognitive and psychological development (Kibel and Wagstaff, 1995; Dawes and Donald, 1994). Research on children and nutrition has shown that children that are stunted are likely to come from the lowest socio-economic groups in society (Labadarios and Van Middelkoop, 1995; Gorstein et al, 1994). They also tend to perform less well, cognitively, academically and psychologically (Faber and Wenhold, 2007; Dawes and Donald, 1994).

2.1 Anthropometry and nutrition in South Africa

In South Africa, a number of studies of anthropometry and nutritional status of children have been done. These studies often focus on infants or children in early childhood, as underweight and stunting are most likely to occur in infants of 6 -24 months when complementary feeding starts replacing breast milk (Faber and Wenhold, 2007). Research focusing of children of primary school age is somewhat limited and spread over time, with a concentration in the five years following the transition to democracy in 1994. Vorster et al (1997), in their review of the literature on the nutritional status of South Africans, include the findings of the Department of Health's Anthropometric Survey in primary schools of 1994. According to this survey, 13.2% of primary school entrants with an average age of 7.4 years, scored below two standard deviations (<-2SD) of the reference population median score for height-for-age, meaning they were classified as stunted. 9% scored <–2SD for weight-for-age and were classified as underweight, while 2.6% fell <–2 SD for weight-for-height, indicating wasting (Vorster et al, 1997).

The South African Vitamin A Consultative Group (SAVACG) reported a much higher percentage for stunting, with 22.9% scoring <-2 SD of the reference population median height-for-age, though this was among children aged 6 to71 months, i.e. this was a younger population with a maximum age of six years. In this study, being underweight was found in 9.3%, while wasting was measured in 2.6% of the population (Labadarios and Van Middelkoop, 1995). The National Food Consumption Survey (NFCS) in Children aged 1-9 years (Labadarios, 1999), reported stunting in 21% in children 4-6 years old, and 13% in children aged 7-9 years, which corresponds well with the reported percentages for different age groups in the previous two studies. The NFCS reported a prevalence of underweight of 13% in children 4-6 years old, and 8% for children aged 7-9, while wasting was below 4% in all age groups, also in line with the findings of the SAVACG and Department of Health studies cited above[1].

The World Health Organisation (WHO) provides a classification for assessing population based malnutrition in children under age 5 (WHO, 2006). According to the WHO classification, a prevalence of stunting of 40% or above would signify very high prevalence, while 30-39% would constitute high prevalence, 20-29% medium, and below 20% low prevalence. For underweight, a prevalence of 20-29 % in a population is seen as high, while 30% or more is very high, 10-19% is medium and below 10% is low. Wasting has the strictest grading, with a population prevalence equal to or above 15% being classified as very high, 10-14% high, 5-9% medium and below 5% low. In this light, the national figures reported for South Africa do not sound immediately alarming, though Vorster et al (1997) warn that there are areas in South Africa where higher prevalences occur that should warrant concern.

As South Africa is particularly hard hit by the HIV/AIDS epidemic, and HIV is known to affect growth in children (Arpadi, 2005), it is not unlikely that future studies will find more serious prevalences of underweight, stunting and wasting. At the same time, the high death rates among children infected with HIV may obscure this, as 40% of all deaths in children under the age of five are estimated to be associated with HIV (Children's Institute, 2004). It is estimated that in South Africa, 7% of all 2-7 year old children are infected with HIV, and 5% of children aged 10-18. Considering the proportion of these age groups in the total South African population, this would come to about 1 million children infected with HIV. In children with HIV, growth failure is very common and is an independent risk factor for death. A study in the Congo, cited by Arpadi (2005) found stunting in over 60% of HIV infected children surviving to the age of 20 months. Although HIV is not considered as a factor of analysis in this study, it is clearly an issue that merits specific attention, as South Africa is faced with a growing population of children in need of specific nutritional, health and other requirements.

2.2 Anthropometry and nutrition in the Western Cape Province

In the Western Cape Province, a number of relatively small studies have examined anthropometry and nutrition. Steyn et al (1989) looked at the nutritional status of 11-

[1] A follow-up survey to the 1999 NFCS was done in 2005. The results of this were not yet available at the time of this research.

year old children in the Western Cape, with a mixture of urban and rural children, and with the sub-groupings of white, coloured and black[2]. They found the lowest mean heights among coloured boys, and the highest mean heights among white boys. Coloured and black children all scored lower than the median weight-for-age in the reference population. With the cut-off point being the fifth percentile, coloured boys had the highest prevalence of stunting with rates of 20% in urban areas and 33% in rural areas. Among the girls, urban black girls had stunting prevalence of 14% and rural coloured girls a stunting prevalence of 31%. With regard to weight-for-age, rural coloured boys and girls had 27% and 29% prevalence of underweight respectively, while the highest prevalence of low weight-for-age in urban areas was among coloured boys (15%) and black girls (11%). Clearly, rural prevalence on all measures was generally higher (Steyn et al, 1989).

A study by Jacobs et al (1988) assessing nutritional status of crèche and primary school children in Mamre in the Western Cape found that of the 430 primary school children aged 5-11, 10.2% were underweight, while 10.9% were stunted and 4.4% wasted (Jacobs et al, 1988). Significantly more boys than girls scored below the third percentile for weight-for-height, while younger girls (5-7) had a higher prevalence of underweight than older girls (8-10), with 14.6% and 6.3% respectively. In this study, the cut-off point was the third percentile.

A more recent project by Medical Students at the University of Cape Town (UCT) assessed the nutritional status and diet of 117 children in Grade R-4 at a primary school in Philadelphia, a rural settlement not far from Mamre. In comparing their findings with the Mamre study, the students found lower percentages for underweight (6%) and stunting (8%), according to the third percentile cut-off point (Majatladi et al, 2004, unpublished). They found a higher prevalence of wasting, with 14% scoring below the cut-off point for weight-for-height, in comparison to 4.4% in the Mamre study. However, the students acknowledge that selection bias may have influenced the findings, due to the short research period and high absenteeism related to poor weather and presumed illness. The high prevalence of wasting is inconsistent with the Mamre findings, and would normally only occur in time of famine. High

[2] Due to South Africa's history of Apartheid and racial segregation, a distinction was made between racial/ethnic groupings: white, black, coloured and Indian. This racial classification was also used in collection of data on health. The point often made for maintaining these categories, well beyond the expiry of the Apartheid regime, is to monitor disparities in health status and to assess whether change is taking place towards racial equality.

prevalence of illness was postulated as a related factor. This study also found better outcomes among younger children, which is counter to most findings, for instance in the Mamre study and the NFCS (1999) survey.

The Table below summarizes the findings of the national surveys as well as the Western Cape studies discussed above.

Table 1: Summary of selected study findings on child anthropometry in South Africa

Study	Setting	Year	n	Sex	Age	Underweight	Stunting	Wasting
Department of Health, National Survey	Primary school children, South Africa	1994	97790	Both	7.4	9% < -2 SD	13.2% < -2SD	2.6% < -2 SD
South African Vitamin A Consultative Group (SAVACG)	Pre-school children, South Africa	1994	10819 to 11238	Both	6-71 months	9.3% < -2SD	22.9% < -2SD	2.6% < -2SD
National Food Consumption Survey (NFCS)	Pre- and primary school children, South Africa	1999	2894	Both	1-9	10% < -2SD	22% < -2SD	4% < -2 SD
					4-6	13% < -2SD	21% < -2SD	<4% < -2SD
					7-9	8% < -2SD	13% < -2 SD	<4% < -2SD
Steyn et al	Western Cape	1989	872	Both	11			
				Boys *	11	15% < 5th percentile	20% < 5th percentile	1% < 5th percentile
				Girls *	11	12% < 5th percentile	10% < 5th percentile	-
Jacobs et al	Mamre, Western Cape	1988	430	Both	5-10	10.2% < 3rd percentile	10.9 < 3rd percentile	4.4 < 3rd percentile
Majatladi et al	Philadelphia, Western Cape	2004	117	Both	5-10	6% < 3rd percentile	8% < 3rd percentile	14% < 3rd percentile

2.3 Nutrition and academic performance

Poor academic performance may be linked to many factors, including genetics, family circumstances, socio-economic situation, quality of the educational system, poverty, low birth weight, ill health and parental education levels. Even though it is recognised that malnutrition, as expressed through stunting, wasting and being underweight, is also a determinant of poor academic performance, it is hard to establish an independent link between malnutrition and academic performance, as malnutrition is likely to occur in conjunction within a set of detrimental circumstances (Richter et al, 1997; Kleinman et al, 2002). Despite the apparent difficulties in directly linking nutrition with academic performance, a number of studies have tried to ascertain this.

A relatively recent review of studies into breakfast, nutrition, body weight and academic performance in children and adolescents by Rampersaud et al (2005) concludes that still very little can be said with certainty about the link between nutrition and academic achievements, as cognition and academic performance are strongly related to socio-economic indicators such as family income and parental education. The review does make mention of several experimental studies that have shown some significant results in relation to academic performance and school attendance, controlled for socio-economic status (SES). For instance, an intervention study in Peru showed improved school attendance among children who were given a school breakfast for three months, in comparison with the control group that did not receive breakfast (Jacoby et al, 1996, as cited in Rampersaud et al, 1995). Two studies among rural children in Jamaica found improved performance among children who received the intervention, i.e. breakfast, during two semesters or one year (Powell et al, 1998; 1993, as cited in Rampersaud et al, 1995). The second study by Powell et al (1998) was claimed to be the first long term randomised trial in a developing country to test the relation between school breakfast and school achievements. Overall, the trial found 'small but significant improvements in attendance and nutritional status' and to a lesser extent achievements, with especially younger children improving in arithmetic (Powell et al, 1998, p. 876). However, it must be noted that the group rated 'undernourished' at the start of the trial only scored <-1SD of the reference value, as 'this definition of undernutrition was the lowest at which we could identify sufficient numbers of children' (Ibid, p. 874). This is a much less strict cut-off point than -2SD, and may be questioned by some as representing real 'underweight', considering the WHO standard of <-2SD. The authors suggest that 'greater improvements may occur in more undernourished populations', acknowledging that 'the massive problem of poor achievement levels requires integrated programmes including health and educational inputs as well as school meals' (Ibid, p. 873).

A study by Kleinman et al (2002) investigating the effects of a free school breakfast program on academic and psychosocial functioning in inner-city schools in Boston found some significant results after 6 months. Children whose nutritional intake improved had a significant decrease in number of days absent and showed significant improvement in Mathematics grades. However, no significant association was found with the three other subjects examined (reading, social studies and science) or decrease in tardiness. The authors acknowledge the limitations of their study, such as the small sample size (97 children) and the fact that breakfast consumption 'was not specifically examined as distinct from total daily intake' making it hard to determine its actual contribution to the study outcomes (Kleinman et al, 2002, p. 29)

In Nsukka, Nigeria, Abidoye and Eze (2000) assessed the school performance of 285 primary school children of different nutritional and health status. They found that overall nutritional status, expressed through weight-for-age Z-scores, significantly affected school performance, with mean academic performance of the last year serving as the outcome variable. They also found a strong link between maternal education and school performance in children. However, there was only one cross-sectional analysis of performance with nutritional status which was not adjusted for age or sex, while less than 30% of the children scored >-2SD for weight-for-age and over 70% of the sample scored <-2SD for weight-for-age (of which 24% <-3SD) and hence were classified as underweight. The sample may therefore have been biased, or may have been affected by measurement error.

2.3.1 School feeding programmes

Despite the difficulty in finding direct evidence for the link between nutrition and academic performance, school feeding programmes are often regarded as a useful intervention. According to Richter et al (1997), potential benefits of school feeding could translate in more enabling circumstances that in turn can promote better academic results. For instance, school feeding can increase the motivation for school attendance and hence result in lower absenteeism rates. Also, if children come to school hungry, this can reduce their ability to pay attention, and impact on the potential to learn. School breakfast or comprehensive school feeding programmes could counter this (Richter et al, 1997).

An evaluation of the South African Primary School Nutrition Programme (PNSP) by the Health Systems Trust (McCoy et al, 1997) provides more insight in the pros and cons of such programmes. In their literature review and from the experience with the PNSP they find that a vertical, 'feeding only' approach has very limited effects, even though it may address short term hunger if the feeding is a breakfast and children come to school hungry. The evaluation goes as far to state that 'there is no conclusive evidence that school feeding programmes lead to any nutritional benefits (McCoy et al, 1997, p. 12). Some important reasons for this are school feeding programmes 'cannot be expected to make a significant contribution to combating malnutrition among school children because of the multiplicity of factors causing malnutrition' (Ibid, p. 12). Also, a feeding programme can usually only deliver a relatively small part of a child's recommended daily nutritional intake. In addition, if school feeding displaces meals at home, which is not unusual in poor communities, than there will be no gain and perhaps even a decrease in overall nutritional intake. Therefore, the preference is for feeding programmes 1) to be part of comprehensive integrated programmes that include health, nutrition and education aspects, 2) to be well targeted at the most deserving areas, and 3) to have active community involvement.

There are a number of other factors that make feeding programmes often less successful than expected and desired. Some of these are the high cost of such a programme, complex and burdensome logistics and management, food that is of sub-standard quality or has low nutritional value, and irregular supplies (McCoy et al, 1997).

Though this evaluation did not specifically look at the impact of the PNSP on academic performance, nor on nutritional outcomes for that matter, it summarizes outcomes from a number of studies, concluding that results are generally inconsistent. It does however state that 'the composition of school meals has been shown to be a factor in determining a positive educational outcome' (McCoy et al, 1997, p. 17). A study done in Chile is cited as having shown a significant and positive correlation between educational achievement and the consumption of dairy products and the intake of protein and calcium. Rampersaud et al (2005) make similar observations with regard to the nutritional value of different types of breakfast.

2.4 Nutrition and physical growth

Although the link between nutrition and physical growth is more straightforward to assess than the link between nutrition and academic performance, catch-up growth after under-nutrition in the early years of infancy and childhood will not always be realised to full potential by good nutrition later on in childhood. Catch-up growth will mostly occur in terms of weight-for-age and weight-for-height, as weight can respond quickly to better availability of food (Faber and Wenhold, 2007. Yet stunting is less easily reversed by good nutrition later on in childhood. A study by Walsh et al (2001), on effects of a nutrition educational programme on the anthropometric nutritional status of low-income children in South Africa, found that among the stunted children in their study, no significant catch-up growth in height-for-age was achieved. Their intervention included an educational programme and food aid over a two year period. Children in this study did significantly improve their weight-for-age. Walsh et al (2001) argue that as stunting occurs after prolonged malnutrition, unlike underweight which is an indicator of acute under-nutrition, it would take longer for catch-up growth in terms of height to occur, in particular if children remain living in poor socio-economic circumstances. Children who show low weight-for-age and weight-for-height may still improve significantly, as 'weight is the first indicator to respond to nutrition intervention' (Walsh et al, 2001, pp. 7).

This position is also held by Gorstein et al (1994) and Kibel and Wagstaff (1997). According to the latter, 'once stunting has occurred, catch-up growth is difficult to achieve ... it tends to persist until puberty ... when an acceleration in growth occurs' (Kibel and Wagstaff, 1997, p. 100-101). Gorstein et al (1994) argue that children of all ages with low weight-for-age or weight-for-height will respond to (nutrition) interventions but that with regard to height-for-age this would only apply to very young children under 2 years of age and that 'for older children treatment will most probably have little effect on the child's height-for-age status' (Gorstein et al, 1994, p. 275). According to Labadarios and Van Middelkoop (1995, Ch. 4, p. 12), 'the prevalence of stunting can be significantly reduced, but by no means eliminated', even under more favourable circumstances.

One factor to keep in mind with regard to physical growth is puberty. Jacobs et al (1988) excluded children from the age of 11 onwards, as puberty associated growth spurts might bias results.

2.5 Norms and standards

An issue of some debate in the literature on child growth and development is the use of the same norms and standards for weight-for-age and height-for-age in children from different ethnic groups. To date, the North American National Center for Health Statistics (NCHS) values for weight-for-age and height-for-age, specific for age and sex, are used as the reference in South Africa. The NCHS data are based on a number of American surveys dating back over 30 years ago, involving mostly healthy, white middle class children. The NCHS values are endorsed by the World Health Organization (WHO). The study by the South African Vitamin A Consultancy Group (1995) for instance, as well as the National Food Consumption Survey (1999) use the NCHS as reference without further explanation. Yet Walsh et al (2002) and Vorster et al (1997) make reference to this debate.

Some authors as cited by Vorster et al (1997), for instance Walker et al (1978) and Cameron and Kgamphe (1993) express the need for national norms that would reflect the growth patterns of South African black children. The latter argue that when assessing national and long term trends in anthropometric growth and development, one has to compare with international norms, but when monitoring an individual child, it should be compared with its peers living under similar environmental circumstances. Others (Dawes and Donald, 1994) argue that growth measures should be seen as the acknowledgement that all children have equal growth potential, regardless of their background and circumstances.

Internationally, the debate is also ongoing. In April 2006, a new international growth standard for infants and preschool children was adopted by the World Health Organization (WHO). It provided a different approach to child growth, focusing on 'how they should grow rather than how they grew in a particular time and place' (Butte et al, 2007, p. 153). The adoption of this new reference, together with the fast increase in childhood obesity, lead to increased discussion on the relevance of the NCHS standards. Subsequently, meetings were held and in a symposium presentation by Butte et al (2007) entitled 'Evaluation of the feasibility of international growth standards for school-aged children and adolescents' the status of the discussion is reflected on. There is consensus that 'humans follow a similar pattern of growth across ethnic groups and geographic locations' and that 'a single standard can describe universal human growth patterns' (Ibid, p. 155). At the same time, it is acknowledged that 'observed differences in linear growth across ethnic groups reflect true differences in genetic potential rather than the sole influence of environmental factors' (Ibid, p. 155). As a consequence of this, any new standard would have to include 'multi-ethnic sampling strategies designed to capture the variation in human growth pattern' (Ibid, p. 155). This would then merge the diverging South African views that all children have the same growth potential with the recognition that particular genetic differences may cause different growth outcomes. However, in the absence of new norms, the NCHS standards continue to be used as the reference.

3 Rationale

In South Africa, many people living in townships experience urban poverty through high levels of unemployment, low service delivery and poor quality housing. Socio-economic deprivation and low household income may influence the access to and quality of education, as well as the quality and quantity of nutritional intake, which, in time, is presumed to impact on capacity to learn at school. Also, living conditions such as overcrowding and poor sanitation facilities can influence disease susceptibility. As children continue to be part of this environment, it can be detrimental to their social, physical and cognitive development.

In a setting where a comprehensive schooling programme, inclusive of consistent daily nutrition, is provided, this may impact positively on children's physical growth and cognitive development, their capacity to fight off disease and their academic performance.

This study adds to the body of research in South Africa on children from socio-economic deprived circumstances and the value of comprehensive schooling programmes to their anthropometric and academic development.

This study should also be seen in the context of the constitution of South Africa which explicitly states the rights of children to basic nutrition and basic education.

4 Aim and objectives

The aim of the study is to assess the impact of the comprehensive schooling programme provided by CHSA on anthropometry, academic performance in English and Mathematics and absenteeism among the learners over a two year period.

Objective 1: Anthropometry

a) To describe the anthropometric measurements of the first cohort of children entering CHSA in 2002 and again in 2004, stratified by age and by sex.

b) To compare baseline anthropometry in 2002 to anthropometry in 2004.

Objective 2: Academic performance

a) To describe the academic performance of the first cohort of CHSA learners for 2002 and for 2004, by age, sex and grade.

b) To compare baseline academic performance in 2002 with academic performance in 2004.

Objective 3: Absenteeism

a) To describe the frequency and reasons of absenteeism in the first cohort of CHSA learners for 2002 and for 2004, by age, sex and grade.

b) To compare the frequency and reasons for absenteeism in the baseline year with frequency and reasons for absenteeism in 2004

Objective 4: Association between anthropometry, academic performance and absenteeism

a) To assess whether an association can be observed between academic performance, absenteeism and anthropometry in 2002 and in 2004.

b) To assess whether those learners in the 2002 cohort that showed improved anthropometry have demonstrated improved academic performance and reduced absenteeism over the period 2002 to 2004.

For all objectives, part a) represents the cross-sectional element of the study, while part b) represents a cohort analysis.

5 Methods

5.1 Study design

The study is a cross-sectional survey with a retrospective cohort analysis. Measurements were taken at two points in time, approximately two years apart.

The measurements and data used in this study were existing data, part of routine data collection performed by the school in order to record baseline information and development over time for every learner. This includes annual anthropometric measurements, daily absenteeism records and continuous measurement of academic performance. No new data were specifically collected for the purpose of this study.

5.2 Definitions and terms

Z-score: the Z-score system expresses the anthropometric value as a number of standard deviations or Z-scores below or above the reference mean or median value (WHO, 2006):

$$\frac{\text{(observed value)} - \text{(median value of the reference population)}}{\text{standard deviation value of reference population}}$$

The advantages of using the Z-score system are:

(1) The Z-score scale is linear and therefore a fixed interval of Z-scores has a fixed height difference in cm, or weight difference in kg, for all children of the same age. In other words, Z-scores have the same statistical relation to the distribution of the reference around the mean at all ages, which makes results comparable across age groups and indicators.

(2) Z-scores are sex-independent, thus permitting the evaluation of children's growth status by combining sex and age groups.

(3) These characteristics of Z-scores allow further computation of summary statistics such as means, standard deviations, and standard error to classify a population's growth status.

Underweight: when the Z-score is below –2 standard deviations of the median for weight-for-age in the reference population.

Overweight: when the Z-score is above 2 standard deviations of the median for weight-for-age in the reference population.

Stunting: when the Z-score is below -2 standard deviations of the median for height-for-age in the reference population.

Wasting: when Z-score is below -2 standard deviations of the median for weight-for-height in the reference population.

Percentile score: the rank position of an individual on a given reference distribution, stated in terms of what percentage of the group is equalled or exceeded by the individual. A child of a specific age, whose weight falls in the 10^{th} percentile, weighs the same or more than 10% of the reference population of children of the same age (Vorster et al, 1997, p. 5). If a child scores $<5^{th}$ percentile, it means it weighs less than 95% of the children of the same age in the reference population. This score is another definition of underweight. A child whose weight falls in the $>95^{th}$ percentile weighs more than 95% of the children in the reference population. This score is also regarded as overweight.

In this study, -2 standard deviations is used as the primary cut-off point for categorising underweight, wasted or stunted because of the use of the NCHS population data as reference, and to allow comparison with the South African national surveys. However, some analyses were also conducted using percentile scores. When using percentile scores, the fifth percentile or third percentile usually serve as cut-off points. The fifth percentile is less strict than -2SD, while the third percentile is stricter than -2SD. The variation in methodology used in different studies makes comparisons more difficult.

5.3 Sample size and response rate

The total number of school entrants at CHSA in year 2002, the first year of operation, was 287, distributed from grade 1 to 5. Between 2002 and 2004, 18 learners withdrew from the school, leaving a sample population of 269 learners. A total of 42 learners were lost to follow-up because anthropometric measurements were missing or incomplete for either 2002 or 2004. The total number of consent forms handed out was 227. Out of the 227, 38 did not respond while 189 learners did return the response slip.

Of the 189 slips returned, 178 reflected consent by the parent(s) while for 11 learners no consent was granted. This represents an overall sample response rate of 70.3%. Upon data cleaning, another 3 learners were excluded due to incomplete data, bringing the final sample size to 175, representing 77.1% of the 227 approached for consent.

A sub-analysis was done on a cohort that had to be restricted to 81 learners due to certain limitations in the statistical software related to age and height. This is further explained under section 5.8 on data management and analysis. Excluded from this cohort were all girls who in 2004 were over the age of 120 months and taller than 137 centimetres, and all boys who in 2004 were older than 138 months and taller than 145 centimetres. Paired comparisons were done for the 81 children in this cohort.

Table 2: Sample size and response rate

	n	% lost	% included
Total number of entrants in 2002	287		
Learners no longer at CHSA by 2004	18		
Sample population	269		100
Lost to follow-up	42	15.6	84.4
Reasons lost to follow-up:			
- Lacking data for 2002	*32*	*11.9*	
- Lacking or incomplete data for 2004	*10*	*3.7*	
Total number requested for consent	227		100 (84.4 of 269)
Response slip not returned	38	16.7	83.3 (70.3 of 269)
Reasons slip not returned:			
- Long term absenteeism	*8*	*3.5*	
- No longer at CHSA (in 2005)	*5*	*2.2*	
- Slip not returned	*25*	*11.0*	
Total number response slips returned	189		100 (83.3 of 227) (70.3 of 269)
No informed consent	11	5.8	94.2
Informed consent	178		94.2 (78.4% of 227) (66.2% of 269)
Lost after data cleaning	3	1.7	
Sample size (cross-sectional analysis)	175		92.6 (of 189) (77.1% of 227) (65.1% of 269)
Excluded from cohort analysis due to age & height limits of the EpiInfo6 EpiNut anthropometry software	94	53.7	
Sub-sample (cohort analysis)	81		46.3 (of 175) (42.9 of 189) (35.7 of 227) (30.1 of 269)

5.4 Demographics of the sample and the cohort

Of the 175 learners included in the study, 103 were female and 72 were male. This is representative of the general school population, where girls are in the majority (personal communication, school administration). Consequently, there are more girls than boys in almost every grade, both in 2002 and 2004.

The age range of the learners was 5.8-12.7 for 2002 and 8.1-14.9 for 2004. Median age was 8.5 and 10.8 respectively. The age difference of 27 instead of 24 months is due to the fact that age was calculated based on the difference between date of birth and date of measurement of weight and height in 2002 and 2004 respectively. As these measurements were done at periods throughout the year, there is no clear 2-year age difference. The 27 month median difference implies that, on average, the measurements taken in 2004 were taken three months later in the year than in 2002.

As the age distributions did not reflect a normal distribution (P>0.05), the median and Inter Quartile Range (IQR) will be reported, as in the Table below.

Age was calculated to 1 decimal point to provide a degree of detail. However, in further analysis, the rounded age in years will be used. Rounding was done by first calculating age in months for every learner, then dividing by 12 and rounding all scores of .5 and above to the next point.

Table 3: Sample demographics, age and grade

	n	Female	Male	
Sample	175	103 (59%)	72 (41%)	
Age in 2002		**Range**	**Median**	**IQR**
Total	175	5.8-12.7	8.5	7.3-10.1
Girls	103	5.8-12.5	8	7.1-9.8
Boys	72	6.3-12.7	8.8	7.8-10.2
Age in 2004				
Total	175	8.1-14.9	10.8	9.4-12.5
Girls	103	8.1-14.9	10.3	9.3-12.4
Boys	72	8.5-14.9	11.1	10-12.7
Grade 2002	**n**	**Female**	**Male**	

Grade 1	46	35	11
grade 2	42	22	20
grade 3	19	10	9
grade 4	21	11	10
grade 5	47	25	22
Total	175	103	72
Grade 2004	**n**		
Grade 2	9	8	1
grade 3	47	32	15
grade 4	33	17	16
grade 5	19	11	8
grade 6	27	11	16
grade 7	40	24	16
Total	175	103	72

In 2002, the 175 learners were distributed over grades 1-5, while in 2004 they were distributed over grades 2-7. A total of 28 learners, or 16%, repeated a year between 2002 and 2004. Of these, 13 were male and 15 were female, representing 18% and 15% of their respective sex sub-set within the sample.

With regard to the cohort of 81 learners, 40 were female and 41 were male. The age range of these learners in years was 5.8-9 for 2002 and 8.1-11.3 for 2004. Median age was 7.2 and 9.3 years respectively.

As the age distributions did not reflect a normal distribution (P<0.05, Shapiro Wilk test), the median, range and Inter Quartile Range (IQR) are reported in the Table below. Categorised age groups are used throughout.

Table 4: Cohort demographics, age and grade

	n	Female	Male	
Cohort	81	40 (49.4%)	41 (50.6%)	
Age in 2002	**n**	**Range (yrs)**	**Median (yrs)**	**IQR (yrs)**
Total	81	5.8-9.0	7.2	6.8-8.1
Girls	40	5.8-7.7	6.9	6.7-7.2
Boys	41	6.3-9.0	8.1	7.2-8.5
Age in 2004				
Total	81	8.1-11.3	9.3	9.0-10.3
Girls	40	8.1-9.8	9.1	8.8-9.3
Boys	41	8.5-11.3	10.3	9.3-10.8

Age group in 2002	n	Female n	Male n
6	4	3	1
7	44	31	13
8	21	6	15
9	12	0	12
Total	81	40	41

Age group in 2004	n	Female n	Male n
8	1	1	0
9	44	32	12
10	18	7	11
11	18	0	18
Total	81	40	41

Grade 2002	n	Female	Male
Grade 1	44	33	11
grade 2	26	6	20
grade 3	9	1	8
grade 4	2	0	2
Total	81	40	41

Grade 2004	n	Female	Male
Grade 2	9	8	1
grade 3	43	28	15
grade 4	19	3	16
grade 5	8	1	7
grade 6	2	0	2
Total	81	40	41

In 2002, the 81 learners were distributed over grades 1-4, while in 2004 they were distributed over grades 2-6. A total of 18 learners, or 22%, repeated a year between 2002 and 2004. Of these, 7 were male and 11 were female, representing 17% and 27% of their respective sub sample. This means that roughly one in four girls in the cohort repeated a year. This difference between boys and girls was not statistically significant (P=0.3, unpaired t-test).

The cohort is a sub-set of the sample of 175. Some tests were done to assess whether those included in the cohort of 81 differed from those who were not included (175-81=94). Significant differences in terms of age, grade and sex were found. In 2002, the mean age difference between the cohort and the sub-sample of 94 was 2.4

(P<0.05, two sample t-test, unpaired). The mean difference in grade was 2.4 (P<0.05, two sample t-test, unpaired). There was also a difference in sex. The cohort had 41 boys and 40 girls, about 50% each. The sub-sample of 94 children had 33% boys and 67% girls. This difference was statistically significant (P<0.05, two sample test of proportion). The cohort was therefore younger and had fewer girls than the rest of the sample, which is consistent with the limitations in the statistical software related to age and height. The fact that the age cut-off point for girls is lower than for boys may be related to the onset of puberty, which is generally at a younger age in girls than in boys.

In analysis of data by grade, e.g. with regard to academic performance or absenteeism, the grade distribution as in 2002 will be used for stratification and not grade distribution in 2004.

5.5 Anthropometry: data collection and measurements

Weight and height measurements were done in 2002 and 2004, on several dates during the year. The age of learners was calculated using their date of birth and the respective dates of measurement. In doing so, actual age at date of measurement would be calculated more precisely and hence the value of the outcome variables be reflected more accurately in the calculation.

In 2002, the measurements for weight were taken with a SECA mechanical scale, (model 750 9999009 2002). The measurement was observed and read out by an assistant and recorded by the school physician. Weight was measured in kilograms and rounded to the nearest kilogram. In 2004, a digital scale (no brand name known) was used and rounding was done to the first decimal point. This means two different measurement tools were used and possibly results in 2004 may have been more precise than those in 2002. As measurements were done throughout the day, it is possible that time of measurement may also have influenced results. For example, children were weighed before or after lunch, which could affect the actual weight measured. It appears justified to say that due to different instruments used, and due to the lack in standardisation in the routine data collection, the circumstances under which children were weighed in 2002 were not the same as in 2004. There is a possibility of observer, instrument and subject variability in the data. However, there is no evidence of systematic bias in the direction of this variation.

For height, the measurements were taken using a wall erected height tape measure (no brand name) fastened at one meter above the floor in an upward direction. Again, the measurements were observed and read out by an assistant and recorded by the school physician. In 2002, the measurements were done in the school doctor's private office. As the floor was carpeted, a firm board (unknown thickness) was placed on the carpet to ensure all children stood at the same level. However, the board may have elevated the children inadvertently towards the 1-meter value and the readings of their height may have been inflated because of this. In 2004, the measurements were done in the school clinic, where there was a flat wooden floor. The same instrument was used. Clearly, the sites and circumstances were different between the two years. As a result, immediate comparability of the two readings may be limited. This will be further explored in the results section. In addition, the assistants used in both years may not have been the same, and may have had different ways of positioning the children, e.g. how they planted their feet and tilted their heads, and reading the measurements. In both 2002 and 2004, measurements were rounded to two decimal points. Unlike the case for weight, there is evidence of a systematic over-reporting of height in 2002.

As these measurements were done by the school as part of routine monitoring of learner development, and not for research purposes, it must be noted that aspects such as reliability of measurements or calibration of instruments were not subject to close scrutiny or quality control. The limitations resulting from these measurement shortcomings are further discussed in section 7.5.

To attempt to address potential bias introduced by instrument variability, a 'gain' value was derived for the various anthropometric measures as the difference between the 2002 and 2004 measurement. Efforts to address bias in the analysis are further described in section 5.8.1 below.

5.6 Academic performance

The measurement of academic performance is done on a continuous basis through tests and exams, in line with the curriculum requirements at CHSA. At the end of the year, an achievement score is given to each learner for each subject.

The scores for the academic subjects English literacy and Mathematics are taken as measures of academic performance. English and Mathematics were chosen as these subjects are compulsory to all learners and are also subjects that the Christel House Foundation uses to compare the progress of their learners in their different schools globally. Mathematics was also a subject for measurement of progress in the study by Kleinman et al (2002) of breakfast and academic performance in children. This study also looked at reading, while the randomised trial of the effects of breakfast in primary school children by Powell et al (1998) looked at reading and arithmetic, among other things.

In 2002, this score ranged from 1-5, with the following meaning:
1= Not achieved
2= Partially achieved but needs assistance
3= Partially achieved but not consistent
4= Achieved
5= Exceeded

In 2004 the achievement score had changed to a 1-4 range:
1= Not achieved
2= Partially achieved
3= Achieved
4= Exceeded

To allow comparison between the 2002 and 2004 scoring range of 1-5 and 1-4 respectively, the meanings of the different scores were compared and scores 2 and 3 (2002) were collapsed into 2, score 4 (2002) transferred to read score 3 and score 5 (2002) transferred to read score 4.

All scores had been captured electronically by the class teachers and entered into the school's MasterC software. This programme is an Access based software package that allows capturing, integration and comparison of all relevant learner information for use and review by school teachers and management. Data for this study on academic performance was drawn from this data source.

5.7 Absenteeism

The daily recording of absenteeism is done manually by the class teachers through taking attendance during the first lesson of the day. Names of absentees and reasons for absenteeism are recorded on a form that is coded according to a set of categories. All class forms are handed in to the school administration, where the forms are collated. The school administrator enters the absenteeism by learner and captures the categories for absenteeism electronically. However, in 2002 the categories were not yet captured electronically but kept on hard copy file. Although categories for absenteeism were the same in 2002 and 2004, the file with reasons for absenteeism in 2002 could not be located. This made a comparison of reasons for absenteeism between 2002 and 2004 impossible.

5.8 Data management and analysis

A dataset was created in Excel including sex, age, grade, weight, height, absenteeism and performance scores in English and Mathematics for 2002 and 2004. These data were drawn from the school's MasterC software and imported to Excel. The height and weight measurements, as well as data on age and sex, were transferred from Excel to Epi Info 6[3] and analysed using the EpiNut Anthropometry[4] module of Epi Info 6. In so doing, the Z-scores and percentile scores for weight and height by sex and age were calculated for 2002 and 2004 respectively. The EpiNut software uses NCHS data as the reference population.

Whilst performing the EpiNut analyses, many of the outcomes were flagged. On further scrutiny, it was established that the analysis had to be restricted to a sample subset according to age and height in line with the age and height range of these variables in the EpiNut module. Hence, all girls who in 2004 were over the age of 120 months and taller than 137 centimetres had to be excluded, as well as all boys who in 2004 were older than 138 months of age and taller than 145 centimetres. The outcomes for all subjects older and/or taller than these limits were flagged as invalid. This resulted in a considerably slimmed down sub-sample of 41 boys and 40 girls. This sub-sample of 81 was used in the cohort analysis for paired comparisons, and will be referred to as the cohort. The original sample of 175 will be referred to as the complete sample.

The outcomes of the Epi Nut analysis were transferred back to Excel and exported to Stata8[5]. In addition, all data relating to absenteeism and academic performance, as

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[3] Epi Info 6 is a data-base, word processing and statistics program for public health that can handle epidemiological data in different formats. It allows many data management and analysis techniques. http://www.cdc.gov/epiinfo/Epi6/ei6.htm.
[4] EpiNut is a module included with Epi Info 6 that calculates and analyzes anthropometric data.
[5] STATA 8 is a statistical software program that provides data management and statistical analysis, including in the field of epidemiology: http://www.stata.com/.

well as the data on age, grade and sex, were transferred to Stata8. In all, two Stata8 datasets were created; one for the complete sample, and one for the cohort.

As indicated before, no new data were collected for the purpose of this research. No information was available regarding possible HIV status of any learners, and the potential effects of HIV on anthropometric development, academic performance or absenteeism levels are not factored into the analysis of the data.

5.8.1 Creation of new variables

With regard to the outcome variables for weight and height, scores below -2SD of the median weight-for-age, height-for-age and weight-for-height in the reference population were recorded as underweight, stunted and wasted, respectively. Scores over 2SD for weight-for-age were recorded as overweight. Categorical variables were created in Stata8 (i.e. "1" is underweight, "0" is not underweight). Similarly, in order to do some cross-referencing, percentile scores were also assessed to determine prevalence of underweight and overweight. Categorical variables were created, using the 5^{th} percentile as cut-off for underweight and the 95^{th} percentile as the cut-off for overweight.

To assess the gain or improvement over time in weight-for-age, height-for-age and weight-for-height, variables were created in Stata8 for weight gain, height gain and weight-for-height gain. In the context of this study, weight gain is taken as a consequence of improved nutritional intake. As the variables for gain are an important part of the data analysis, and because their calculation is quite complex, a detailed explanation is provided on how the gain variables were derived.

- First, a new variable was generated of the actual Z-score change for each learner for weight-for-age, height-for-age and weight-for-height respectively. This was done by subtracting the Z-scores in 2002 from the Z-scores in 2004.
- This resulted in an exact Z-score change per individual. This new variable had its own distribution around the median value.
- Those whose Z-score change was less than or equal to the median Z-score change were categorised as not having improved their weight, height or weight-for-height. Those whose Z-score change was higher than the median Z-score change were categorised as having 'gain' in weight-for-age, height-for-age or weight-for-height. Median Z-score change was taken as the cut-off

point for weight gain, height gain and weight-for-height gain to distinguish 'gainers' from 'non-gainers'.

- Hence, categorical variables were created, with "1" being change in Z-score above the median, and "0" being change in Z-score below the median Z-score change. To illustrate this explanation, example cases of variables are reflected in Table 5.

Table 5: Examples of Z-score change in relation to median Z-score change

Weight-for-age		**Z-score 2002**	**Z-score 2004**	**Z-score change**	**Median Z-score change (i.e. cut-off)**	**Gain**
	Example 1	-1.7	-1.89	-.19	0.20	"0"
	Example 2	.64	1.87	1.23	0.20	"1"
Height-for-age						
	Example 1	0.64	1.87	-.73	-.48	"0"
	Example 2	-.01	-.18	-.17	-.48	"1"
Weight-for-height						
	Example 1	-1.3	-.62	0.68	0.96	"0"
	Example 2	-.07	2.12	2.19	0.96	"1"

The overall directions of the Z-score changes were positive for weight-for-age and weight-for-height, i.e. there were median changes of 0.2 and 0.96, respectively. However, the median direction of Z-score change was negative for height-for-age, with a median of -0.48. In this case, 'gain' in height would be represented by a Z-score change >-0.48. For example, a Z-score change of -0.2 would be positive for 'gain', as it is a value larger than -0.48, even though it reflected a nett decline in Z-score change.

This means that the variable 'gain' does not necessarily equate to a true gain. Rather, it distinguishes those above the median for change from 2002 to 2004. This attempts to address the discrepancy that arises from the measurement error for weight and particularly height that occurred in 2002 due to different circumstances of data collection. As indicated before, the data used in this study were routinely collected by the school, and not for the benefit of this study. This means that instruments used may not have been calibrated, or that e.g. staff assisting in data collection may have had different ways of positioning children for height measurement.

Categorical variables were also created for improvements in academic performance in English and Mathematics, and for changes in absenteeism. Improvement in English and Mathematics is measured by the advancement to a next level of achievement and was scored as "1". For example, a child who scored a 2 for academic performance in English in 2002 and a 3 in 2004 has improved its performance (score of "1"). A child who remained at a certain level of performance or declined was scored as "0". For example a child who scored a 2 for academic performance in English in 2002 and a 2 in 2004 scored a "0", as did a child who scored a 3 for Mathematics in 2002 and a 2 in 2004. There was only one case of a child making an advancement of 2 levels, i.e. from 2 to 4. This was recorded as "1".

With regard to absenteeism, improvement is defined as a reduction in days absent in 2004 in comparison to 2002. In other words, a child that was absent for 11 days in 2002 and 6 days in 2004 has shown improved absenteeism (11-6=5), i.e. a score of "1". A child that increased its number of days absent between 2002 and 2004 would have a negative score, for instance 4 days absent in 2002, 12 days absent in 2004: 4-12=-8. This would be a score of "0". A child that retained the same number of days absent and hence had a change of zero was not recorded as improved (score of "0"). So a change in number of days absent smaller than or equal to zero represents a score of "0" (no improvement), while a change in number of days absent larger than zero represents a score of "1", indicating improvement in absenteeism.

5.8.2 Statistical testing

In analysing the data, a number of statistical test were used. Firstly, descriptive statistics were used to calculate and present sample demographics, anthropometric measurements and academic performance, stratified by sex, age and grade where applicable. The Shapiro Wilk test was used to assess the distribution of data (normal or non-normal) and to inform the use of the most appropriate tests for hypothesis testing and measures of association.

The t-test was used to assess statistical significance of hypotheses in normally distributed numerical data (comparison of means). Two-sample paired t-test was done when comparing means between matched samples, for instance mean performance in English by girls in 2002 and 2004. Two-sample unpaired t-test was done when comparing means between unmatched samples, for instance mean performance in English in 2002 between boys and girls.

Wilcoxon's signed rank test for matched pairs was used for testing hypotheses (comparison of medians) in non-normally distributed numerical data. Pearson Chi-square was used for hypothesis testing in categorical data, and Fisher exact test for hypothesis testing in categorical data with small frequencies. The two sample test of proportion was done for hypothesis testing for proportions.

Bi- and multivariate analysis was done using logistic regression, as this allows for the simultaneous adjustment for multiple categorical and numerical variables. Odds Ratios (OR) were used as measures of association while Confidence Intervals (CI) and P-values were used as measures of statistical significance. Collinearity of independent variables was checked prior to inclusion in multivariate models.

Spearman Rank testing was used to look for agreement or correlation between two non-normally distributed variables. This test provides a correlation coefficient (r) and a P-value. A coefficient, either positive or negative, can be modest (.3-.5), moderate (.5-.7) or strong (.7-.9). A coefficient of 1 means perfect correlation whereas a correlation of 0 implies no correlation at all.

6 Results

In this section, results will be presented to first reflect the outcomes of the cross-sectional analyses -parts a) of the objectives- and secondly the outcomes of the cohort analyses -parts b) of the objectives. The cross-sectional descriptive data include all subjects in the sample of 175 learners. The cohort analyses include 81 subjects. This difference between sample and cohort is explained under section 5.6.

In many of the analyses, the comparisons made are based on either age or grade as in 2002. For instance, median weight of all 6-year olds in 2002 (sample of 175) is compared to the median weight for this same group, two years later. Or, mean academic performance in English by grade 3 in 2002 (cohort of 81) is compared to mean English performance for this same group, two years later. In doing so, the summary statistics for the same groups are reflected first for year 2002, then for year 2004.

6.1 Anthropometry

6.1.1 Descriptive cross-sectional analysis

With regard to weight and height measurements, when stratified by age and sex, data for height was normally distributed, hence Mean and Standard Deviation are the reported statistics for height in Table 6. Median and IQR are reported for weight.

Table 6: Weight (median and IQR) and height (mean and SD), by age and sex

Weight (kg)			2002		2004	
	Age group	N	Median	IQR	Median	IQR
Girls	6	3	20.0	12-25	28.3	25.7-30.4
	7	31	21.0	18-25	30.3	25.3-33.5
	8	23	23.0	20-27	32.1	27.8-37.9
	9	13	30.0	26-33	45.4	33.8-50.4
	10	20	30.0	26-35	44.1	38.1-48.0
	11	12	30.5	29-37	46.0	43.5-58.4
	12	0	-	-	-	-
	13	1	50.0	50-50	67.6	67.6-67.6
Total		103	25.0	21-30	34.3	28.8-45.3
Boys	6	1	25.0	25-25	33.3	33.3-33.3
	7	13	21.0	19-23	27.6	24.5-30.2
	8	15	23.0	21-25	30.3	28.2-32.8
	9	14	25.0	23-27	32.8	30.4-34.7
	10	15	26.0	25-29	36.5	33.3-42.5
	11	7	29.0	28-35	40.0	39.4-42.6
	12	6	32.5	29-37	46.7	44.1-55.8
	13	1	29.0	29-29	43.0	43-43
Total		72	25.0	23-29	33.5	29.5-39.9
Height (cm)			**2002**		**2004**	
	Age group	**N**	**Mean**	**SD**	**Mean**	**SD**
Girls	6	3	120.0	3.5	130.0	2.7
	7	31	118.6	4.9	127.6	5.7
	8	23	124.0	4.3	134.7	5.9
	9	13	131.8	6.2	144.8	9.0
	10	20	135.3	7.5	147.8	7.8
	11	12	139.4	6.0	150.6	6.6
	12	0	0	0	0	0

	13	1	147.0	0.0	149.0	0.0
Total		103	127.5	9.7	138.2	11.2
Boys	6	1	124.0	.	135.0	.
	7	13	119.8	5.8	128.8	6.4
	8	15	124.5	6.4	133.6	6.4
	9	14	129.1	4.5	138.6	5.5
	10	15	134.4	6.4	145.1	8.7
	11	7	141.3	6.4	156.1	8.3
	12	6	140.2	8.0	156.2	8.0
	13	1	140.0	.	156.0	.
Total		72	129.7	9.3	140.5	11.6

The median weight in 2002 was 25 kilograms for both girls and boys. In 2004, the median weight was 34.3 kg for girls and 33.5 kg for boys. Mean height for girls in 2002 was 127.5 cm and 138.2 cm in 2004. Boys averaged 129.7 cm in 2002 and 140.5 cm in 2004.

As indicated in section 5.8, data were exported into EpiNut, the anthropometry module in Epi Info 6, to calculate the Z-scores, after which these were added to the data set in STATA for further analysis. As the height and age range in the EpiNut programme were different from the sample, resulting in invalid outcomes for height-for-age Z-score, only Z-score for weight-for-age is reported here for descriptive purposes.

With regard to the Z-scores, the distribution of data was not normal for weight-for-age for the complete sample, hence Median and IQR are reported, as well as Range to illustrate the spread of Z-scores.

Table 7: Z-scores: weight-for-age

		2002			2004				
	N	Median	Range	IQR	Median	Range	IQR	Median change	S signifi
Weight-for-age									
Girls	103	-.22	-3.28-3.97	-1.11-.53	.07	-1.89-3.3	-.70-.74	.32	P<(
Boys	72	-.80	-2.73-2.26	-1.35--.075	-.53	-2.37-2.6	-1.14-.16	.28	P<0.
Total	175	-.49	-3.28-3.97	-1.28-.29	-.12	-2.37-3.3	-.91-.54	.30	P<0.

* Wilcoxon's signed rank test for matched pairs (comparison of medians)

In 2002, at an average age of 8.5 years, the median Z-score for the CHSA learners fell below the median for the reference population, more markedly so in the case of boys. In 2004, at an average age of 10.8 years, the median Z-score for all learners was closer to the median of the reference population. In actual fact, for girls it slightly exceeded the median, while for boys it still lagged behind. The change in median Z-score between 2002 and 2004 was statistically significant for girls, boys and the complete sample.

When stratifying by sex and age, a normal distribution of data was predominant and therefore Mean and SD are reported as summary statistics in Table 8.

Table 8: Z-score means weight-for-age, by sex and age

Weight-for-age		2002			2004			
		n	Mean	SD	Mean	SD	Mean Change	Statistical significance*
	Age group in 2002							
All		175	-.4	1.16	-.1	1.10	+ .3	P<0.05
Girls	6	3	-.7	2.35	.3	.28	+ 1.0	P=0.50
	7	31	-.1	1.43	.1	1.09	+ .1	P=0.19
	8	23	-.3	1.07	-.1	1.12	+ .2	P<0.05
	9	13	.1	1.18	.4	1.27	+ .3	P=0.19
	10	20	-.4	1.15	.0	1.10	+ .4	P<0.05
	11	12	-.5	1.16	.1	1.14	+ .6	P<0.05
	12	0	-	-	-	-	-	-
	13	1	.5	.	1.2	.	+ .6	.
Total girls		103	-.2	1.25	0.1	1.1	+ .3	P<0.05
Boys	6	1	1.1	.	1.3	.	+ .1	.
	7	13	-.5	1.22	-.2	1.14	+ .3	P<0.05
	8	15	-.8	.84	-.5	.81	+ .3	P<0.05
	9	14	-.5	1.11	-.2	1.10	+ .2	P=0.09
	10	15	-1.0	.65	-.7	.73	+ .3	P<0.05
	11	7	-.9	.76	-.5	1.02	+ .3	P<0.05
	12	6	-1.1	.86	-.7	.82	+ .4	P=0.05
	13	1	-2.0	.	-1.6	.	+ .4	.
Total boys		72	-.7	.96	-.4	.96	+ .3	P<0.05

* Paired t-test (comparison of means)

Table 8 tells the same story as Table 7 - the sample in totality, as well as boys and girls, respectively, experienced a statistically significant improvement in their weight-for-age Z-score means between 2002 and 2004-, but shows that this significant change is also apparent in a number of age and sex specific groups.

As Tables 7 and 8 present summary statistics based on non-normality and normality of distribution of data respectively, the statistical tests are different (non-parametric vs. parametric test) but their outcomes show significance in Z-score change for sample and by sex.

Looking at Tables 7 and 8, it appears girls have better outcomes than boys. In Table 9 a comparison is made between the mean Z-scores of boys and girls in 2002 and 2004.

Table 9: Difference in Z-score means (weight-for-age) between boys and girls

Weight-for-age	Mean Z-score girls	Mean Z-score boys	Mean difference	Statistical significance *
2002	-.23	-.72	.49	P<0.05
2004	.09	-.44	.52	P<0.05

* Two sample unpaired t-test (comparison of means)

Table 9 shows that the difference in Z-score means between boys and girls is statistically significant, both in 2002 and 2004. The rate of improvement is almost the same, with the mean difference being roughly 0.5 in both years, meaning boys and girls are seeing a similar change in Z-score. However, boys started and remained at a lower Z-score than girls.

Looking closer at the Z-scores, Table 10 reports the outcomes for those learners whose Z-score fell below the cut-off point of <-2SD or above the cut-off point of >2SD of the reference population median score, indicating whether they can be classified as underweight and overweight, respectively. Percentages are presented to easily see the pattern of change. The statistical test however relates to the hypothesis that the measurements are the same in both years.

Table 10: Under- and Overweight (<-2SD and >2SD), by sex

		2002		2004			
	N	N Yes	% Yes	n Yes	% Yes	% change	Stat. Sign. *
Underweight							
Girls	103	8	7.8	0	0	↓ 7.8	P<0.05
Boys	72	6	8.3	3	4.2	↓ 4.1	P<0.05
Total	175	14	8.0	3	1.7	↓ 6.3	P<0.05
Overweight							
Girls	103	4	3.9	6	5.8	↑ 1.9	P=0.16
Boys	72	2	2.8	1	1.4	↓ 1.4	P=0.32
Total	175	6	3.4	7	4	↑ 0.6	P=0.56

* Wilcoxon's signed rank test for matched pairs, comparing measures for 2002 to 2004.

In 2002, 14 learners out of 175 could be classified as underweight, and six as overweight. In 2004, when the learners' median age was 10.8 years, 1.7% of pupils was underweight and 4% was overweight. The drop in underweight was apparent in boys and girls and the overall sample, and was statistically significant.

Regarding overweight, there was a slight percentage increase for the total sample and among girls and a decrease among boys, but neither increase nor decrease was statistically significant.

The percentage of children who were <- and > 2SDs, (either under- or overweight) in 2002 was 5.9% for girls (7.8+3.9/2), 5.6% (8.3+2.8/2) for boys and 5.7% (8+3.4/2) overall. The percentage of the distribution located outside a 2SD range around the mean of a normal distribution is usually about 5%. The findings are therefore more or less what can be expected, but are clustered at the top of range for girls and at the bottom for boys. However, in 2004 the percentage of children who were <- and > 2SDs, (under- and overweight) was 2.9% for girls and 2.8% for boys, roughly half of what can normally be expected.

6.1.2 Cohort analysis

In all following analyses, the comparison is based on the 2002 cohort of 81 learners.

When the data were age stratified, data for height was normally distributed, hence Mean and Standard Deviation are the reported statistics for height in Table 11. Median and IQR are reported for weight.

Table 11: Weight (median and IQR) and height (mean and SD), by age group and sex. Cohort comparison

				2002		2004	
Weight (kg)		Age group	n	Median	IQR	Median	IQR
	All	6	4	22.5	16-25	29.4	27-31.9
		7	44	21.0	18.5-25	28.7	25.3-32.8
		8	21	23.0	20-24	29.1	26.1-32.1
		9	12	25.0	23.5-27	32.8	30.5-39.9
	Total		81	23.0	20-25	30.2	26.1-33.1

				2002		2004	
Height (cm)		Age group	n	Mean	SD	Mean	SD
	All	6	4	121.0	3.5	131.0	3.3
		7	44	119.0	5.1	128.0	5.9
		8	21	123.0	6.2	132.0	6.3
		9	12	129.0	4.4	139.0	5.5
	Total		81	121.0	6.3	131.0	6.9

				2002		2004	
Weight (kg)		Age group	n	Median	IQR	Median	IQR
	Girls	6	3	20.0	12-25	28.3	25.7-30.4
		7	31	21.0	18-25	30.3	25.3-33.5
		8	6	19.5	18-23	27.0	23.9-29.3
	Total		40	20.5	18-25	28.6	25.5-32.3
	Boys	6	1	25.0	25-25	33.3	33.3-33.3
		7	13	21.0	19-23	27.6	24.5-30.2
		8	15	23.0	21-25	30.3	28.2-32.8
		9	12	25.0	23-27	32.8	30.5-39.9
	Total		41	23.0	21-25	30.3	27.6-33.3

				2002		2004	
Height (cm)		Age group	n	Mean	SD	Mean	SD
	Girls	6	3	120.0	3.5	130.0	2.6
		7	31	118.6	5.0	127.6	5.7
		8	6	119.2	3.4	128.7	5.0
	Total		40	118.8	4.6	128.0	5.4
	Boys	6	1	124.0	-	135.0	-
		7	13	119.8	5.8	128.8	6.4
		8	15	124.5	6.4	133.6	6.4
		9	12	129.1	4.4	138.7	5.5
	Total		41	124.3	6.6	133.6	7.1

With regard to the Z-scores, the distribution of data was predominantly normal for all outcomes, with a few exceptions. Hence, median, IQR and range are reported together with mean and SD.

Table 12: Z-scores: weight-for-age, height-for-age and weight-for-height, by sex. Cohort comparison.

Weight-for-age				**2002**					**2004**		
	n	**Median**	**Range**	**IQR**	**Mean**	**SD**	**Median**	**Range**	**IQR**	**Mean**	**SD**
Girls	40	-.3	-3.3-4.0	-1.4-.7	-.3	1.4	.0	-1.9-3.1	-.8-.6	-.1	1
Boys	41	-.5	-2.8-2.3	-1.3-.0	-.5	1.1	-.3	-2.4-2.6	-1-.2	-.2	1
Total	81	-.5	-3.3-4.0	-1.3-.2	-.4	1.3	-.1	-2.4-3.1	-1-.3	-.2	1

Height-for-age				**2002**					**2004**		
	n	**Median**	**Range**	**IQR**	**Mean**	**SD**	**Median**	**Range**	**IQR**	**Mean**	**SD**
Girls	40	-.2	-1.7-1.6	-1.0-.4	-.2	.9	-.7	-2.2-.6	-1.5--.1	-.8	.9
Boys	41	-.3	-3.1-1.3	-1.2-.2	-.3	1	-.5	-3.3-1	-1.4-.0	-.7	1
Total	81	-.3	-3.1-1.6	-1.0--.3	-.3	1	-.6	-3.3:1	-1.4--.0	-.7	.9

Weight-for-height				**2002**					**2004**		
	n	**Median**	**Range**	**IQR**	**Mean**	**SD**	**Median**	**Range**	**IQR**	**Mean**	**SD**
Girls	40	-.1	-5-3	-1.2-.5	-.3	1.5	.7	-1.1-3.3	.1-1.5	.8	1.0
Boys	41	-.6	-2.3-2.9	-1-.2	-.4	1.0	.5	-1.9-3.2	-.2-.9	.4	1.1
Total	81	-.5	-5-3	-1.1-.4	-.3	1.3	.6	-1.9-3.3	-.0-1.1	.6	1.0

The information in Table 12 shows that there was improvement in weight-for-age and weight-for-height for boys and girls respectively. However, the outcomes regarding height-for-age seem to indicate the opposite, i.e. a decline, as if more children have low height-for-age in 2004 than in 2002. Although it is not impossible that children grew at sub-normal rates, and hence scored lower in relation to the reference population, this does appear to be a rather unlikely trend. Though there appears to be reliability of the measurements, this does suggest that a more likely explanation is measurement error in the dataset. The difference in the circumstances under which the children were measured, and the error this may have introduced, has been previously explained in section 5.8.

For this reason, although Table 13 presents data for Z-scores for height in 2002 and 2004, no statistical testing is done comparing results for 2002 to those for 2004 for height-for-age.

As height is the denominator in the calculation of weight-for-height, any measurement error in height will have affected the outcomes of weight-for-height, rendering them largely invalid. Similarly, though Table 13 presents data for Z-score for weight-for-height in 2002 and 2004, no statistical testing is done comparing results for 2002 to those for 2004 for weight-for-height. As both the outcome variables height-for-age and weight-for-height have lost their relevance, the remainder of this paper will focus on weight-for-age.

When stratifying by age, distribution of data was predominantly normal and therefore Mean and SD are reported as summary statistics in Table 13.

Table 13: Z-score means, mean difference and statistical significance, by age and sex. Cohort comparison

Weight-for-age			**2002**		**2004**			
	Age group in 2002	**n**	**Mean**	**SD**	**Mean**	**SD**	**Mean difference**	**Statistical significance (P<0.05)***
All								
	6	4	-.2	2.1	.5	.5	.7	P=0.4
	7	44	-.2	1.4	-.0	1.1	.2	**P<0.05**
	8	21	-.8	.8	-.6	.8	.2	**P<0.05**
	9	12	-.4	1.1	-.1	1.1	.3	P=0.1
Total		81	-.4	1.3	-.2	1	.2	**P<0.05**
Girls	6	3	-.7	2.3	.3	.3	1	P=0.5
	7	31	-.1	1.4	.0	1.1	.1	P=0.2
	8	6	-1	.9	-.9	.7	.1	P=0.5
Total		40	-.3	1.4	-.1	1.1	.2	P=0.1
Boys	6	1	1.2	-	1.3	-	.1	-
	7	13	-.5	1.2	-.2	1.1	.3	**P<0.05**
	8	15	-.8	.8	-.5	.8	.3	**P<0.05**
	9	12	-.4	1.1	-.1	1.1	.3	P=0.1
Total		41	-.5	1.1	-.2	1.0	.3	**P<0.05**

Height-for-age			**2002**		**2004**		
	Age group in 2002	**n**	**Mean**	**SD**	**Mean**	**SD**	**Mean difference**
All							
	6	4	.9	.6	.4	.6	-.5
	7	44	-.2	.9	-.7	.9	-.5

	8	21	-.6	1	-.9	.9	-.3
	9	12	-.3	.8	-.6	.8	-.4
Total		81	-.3	1	-.7	.9	-.5
Girls	6	3	.8	.6	.2	.5	-.6
	7	31	-.2	.9	-.8	.9	-.5
	8	6	-.8	.6	-1.2	.7	-.4
Total		40	-.2	.9	-.7	.9	-.5
Boys	6	1	1.2	-	1	-	-.2
	7	13	-.3	1	-.8	1	-.4
	8	15	-.5	1	-.8	1	-.3
	9	12	-.3	.8	-.6	.8	-.4
Total		41	-.3	1	-.7	1	-.4
Weight-for-height			**2002**		**2004**		
	Age group in 2002	**n**	**Mean**	**SD**	**Mean**	**SD**	**Mean difference**
All		81	-.3	1.3	.6	1.0	1
Girls	6	3	-1.7	3	.3	.5	2
	7	31	-.0	1.4	1.0	1	1
	8	6	-.8	.8	.1	.7	.9
Total		40	-.3	1.5	.8	1	1
Boys	6	1	.4	-	.9	-	.5
	7	13	-.4	1.1	.6	.9	1
	8	15	-.6	-8	.2	.9	.8
	9	12	-.2	1.3	.6	1.4	.8
Total		41	-.4	1	.4	1	.8

* Paired t-test (comparison of means)

From Table 13, it follows that the cohort in totality, as well as the boys in the cohort, experienced a statistically significant improvement in their weight-for-age Z-score. An improvement is apparent among the girls but it is not statistically significant either in the different age groups or amongst all girls in the cohort. In the sex and age specific groups the improvement is most evident among 7 and 8 year old boys, in spite of the small sample subset.

Looking at height-for-age, the observations made in Table 12 are confirmed, in the sense that there is a decline in height-for-age Z-score means for all boys and girls, possibly reflecting measurement error in 2002.

In Table 14, the median percentile scores for weight-for-age and the statistical significance of the changes in those scores are reported.

Table 14: Percentile scores weight-for-age, by sex, statistical significance. Cohort comparison (comparison of medians)

Weight-for-age		2002		2004		Statistical significance (P<0.05)*
	n	**Median**	**IQR**	**Median**	**IQR**	
Total	81	32.2	9-58	45.1	17.6-91.8	**P<0.05**
Girls	40	39.0	8.3-75.8	51.6	20.2-73.4	P=0.08
Boys	41	31.0	10.3-50.8	37.5	17.6-58.3	**P<0.05**

* Wilcoxon's signed rank test for matched pairs (comparison of medians) comparing measures for 2002 to 2004.

There was a significant difference between the medians for weight-for-age percentile scores in 2002 and 2004 for the sample as a whole and boys respectively. For girls, although the direction was the same, the difference was of marginal statistical significance (P=0.08). Overall, the changes in median percentile scores mirror the changes in Z-score (Table 7).

Table 15 reports the outcomes for those learners who's Z-score fell below the lower cut-off point of -2SD and above the higher cut-off point of 2SD of the reference population median score. They are classified as underweight and overweight respectively. For comparison, the percentage of children scoring <5^{th} and >95^{th} percentile are also reported. Percentages are presented to easily see the pattern of change. The statistical test however relates to the hypothesis that the measurements are the same in both years.

Table 15: Underweight and overweight, Z-score and percentile score change: cohort comparison. Cohort comparison

Underweight		**2002**	**2004**			**2002**	**2004**		
	N	**%<-2SD**	**%<-2SD**	**% change**	**Stat sign.***	**% <5^{th} percentile**	**% <5^{th} percentile**	**% change**	**Stat sign. ***
Girls	40	12.5	0	12.5 ↓	P<0.05	15.0	7.5	7.5 ↓	P=0.08
Boys	41	4.9	2.4	2.5 ↓	P=0.32	9.8	4.9	4.9 ↓	P=0.16
Total	81	8.6	1.2	7.4 ↓	P<0.05	12.4	6.2	6.2 ↓	P<0.05
Overweight		**2002**	**2004**			**2002**	**2004**		
	N	**%>2SD**	**%>2SD**	**% change**	**Stat sign.***	**%>95^{th} percentile**	**%>95^{th} percentile**	**% change**	**Stat sign.***

Girls	40	2.5	2.5	0	-	5.0	5.0	0	P=1.00
Boys	41	4.8	2.4	2.4 ↓	P=0.32	4.9	7.3	2.4 ↑	P=0.30
Total	81	3.7	2.5	1.2 ↓	P=0.32	4.9	6.2	1.3 ↑	P=0.56

* Wilcoxon's signed rank test for matched pairs, comparing measures for 2002 to 2004.

Table 15 illustrates that by 2004 fewer children in the cohort had very low weight-for-age. The direction of change is the same and statistically significant for the cohort with both cut-off points (-2SD and the 5th percentile), and also for girls in the cohort with regard to their -2SD scores. Interestingly, as the 95th percentile score is a less strict cut-off point than >2SD Z-score, the number of children having a high percentile score increased while the percentage of children scoring a >2SD Z-score decreased. In effect, in 2002 three children scored >2SD and four children scored >95th percentile. In 2004, two children scored >2SD while five scored >95th percentile. Both decrease and increase are not statistically significant.

6.2 Academic Performance

6.2.1 Descriptive cross-sectional analysis

In 2002, all 175 learners in the sample had a mean score of 2.3 for both English and Mathematics. In 2004, the overall mean for both subjects was higher by approximately 0.4 points.

Table 16: Academic performance, by grade, by sex, by age group (mean and SD, mean difference, statistical significance)

			2002		2004			
		n	**Mean**	**SD**	**Mean**	**SD**	**Mean difference**	**Statistical significance * (P<0.05)**
All	**English**	175	2.3	.57	2.7	.57	+ .42	P<0.05
	Math	175	2.3	.50	2.7	.64	+ .38	P<0.05
Grade in 2002								
	English	**n**	**Mean**	**SD**	**Mean**	**SD**	**Mean difference**	**Statistical significance * (P<0.05)**
1		46	2.8	.59	2.9	.51	+ .13	P=0.22
2		42	2.1	.47	2.6	.74	+ .43	P<0.05
3		19	2.2	.63	2.7	.58	+ .47	P<0.05
4		21	2.5	.51	2.8	.40	+ .33	P<0.05
5		47	2.0	.20	2.7	.47	+ .72	P<0.05
	Total	175						

Math	n	Mean	SD	Mean	SD	Mean difference	Statistical significance * (P<0.05)
1	46	2.7	.48	3.0	.60	+ .35	P<0.05
2	42	2.1	.45	2.7	.69	+ .55	P<0.05
3	19	2.4	.51	2.8	.54	+ .37	P<0.05
4	21	2.5	.51	2.6	.50	+ .10	P=0.33
5	47	2.1	.36	2.5	.65	+ .38	P<0.05
Total	175						

Sex

English	n	Mean	SD	Mean	SD	Mean difference	Statistical significance * (P<0.05)
Girls	103	2.4	.60	2.9	.52	+ .50	P<0.05
Boys	72	2.2	.53	2.5	.58	+ .32	P<0.05
Math							
Girls	103	2.3	.50	2.8	.60	+ .46	P<0.05
Boys	72	2.4	.51	2.6	.68	+ .26	P<0.05

Age group in 2002

	English	n	Mean	SD	Mean	SD	Mean difference	Statistical significance * (P<0.05)
Girls	6	3	2.7	1.16	3.0	.00	.33	P=0.67
	7	31	2.7	.65	2.8	.58	.16	P=0.13
	8	23	2.3	.54	2.9	.67	.65	P<0.05
	9	13	2.5	.66	2.8	.60	.23	P=0.08
	10	20	2.3	.37	3.0	.00	.85	P<0.05
	11	12	2.0	.00	2.8	.45	.75	P<0.05
	12	0	-	-	-	-	-	-
	13	1	2.0	.	3.0	.	-	-
	total	103						

	English	n	Mean	SD	Mean	SD	Mean difference	Statistical significance * (P<0.05)
Boys	6	1	4.0	.	3.0	.	-	-
	7	13	2.6	.51	2.9	.64	.31	P=0.17
	8	15	2.2	.46	2.2	.56	.13	P=0.43
	9	14	2.1	.36	2.5	.52	.36	P<0.05
	10	15	2.3	.46	2.5	.52	.27	P<0.05
	11	7	2.0	.00	2.4	.54	.43	P=0.08
	12	6	1.8	.41	2.7	.52	.83	P<0.05

	13	1	1.0	.	2.0	.	-	-
	Total	72						

Age group in 2002								
	Math	**n**	**Mean**	**SD**	**Mean**	**SD**	**Mean difference**	**Statistical significance * (P<0.05)**
Girls	6	3	2.3	.58	3.0	.00	.67	P=0.18
	7	31	2.7	.49	3.0	.61	.32	P<0.05
	8	23	2.2	.49	2.8	.67	.61	P<0.05
	9	13	2.4	.51	2.8	.60	.38	P<0.05
	10	20	2.2	.41	2.8	.52	.60	P<0.05
	11	12	2.1	.29	2.4	.52	.33	P<0.05
	12	0	-	-	-	-	-	-
	13	1	2.0	.	2.0	.	0	-
	Total	103						
	Math	**n**	**Mean**	**SD**	**Mean**	**SD**	**Mean difference**	**Statistical significance * (P<0.05)**
Boys	6	1	3.0	.	4.0	.	1.00	-
	7	13	2.5	.66	3.1	.28	.62	P<0.05
	8	15	2.3	.46	2.4	.83	.13	P=0.55
	9	14	2.3	.47	2.6	.51	.29	P<0.05
	10	15	2.5	.52	2.6	.63	.07	P=0.58
	11	7	2.1	.38	2.4	.79	.29	P=0.36
	12	6	2.3	.52	2.5	.84	.16	P=0.36
	13	1	2.0	.	2.0	.	0	-
	Total	72						

* Paired t-test (comparison of means), of measures for 2002 to 2004.

Overall, it appears significant improvement in academic performance had taken place between 2002 and 2004. This applies to the complete sample and both sexes. Looking at the sub-samples of age group and grade, stratified by sex, academic improvement was still significant for most grades, and in roughly half of the age groups. Girls in particular improved significantly in Math, and overall girls seem to show bigger jumps in performance gain. The direction of improvement was however the same across the board and failure to show a significant effect may have been due to the small size of certain sub-samples.

Table 17 illustrates that the difference in academic performance between the sexes was only statistically significant for English performance in 2004.

Table 17: Comparison of mean performance scores between boys and girls

	n	Girls, mean score	Boys, mean score	Difference in performance	Statistical significance*
English, 2002	175	2.4	2.2	.17	P=0.05
English, 2004	175	2.9	2.5	.35	P<0.05
Math, 2002	175	2.3	2.4	.20	P=0.78
Math, 2004	175	2.8	2.6	.17	P=0.08

* Two sample (unpaired) t-test (comparison of means), comparing girls to boys in each year and subject.

6.2.2 Cohort analysis

Turning to the cohort of 81 learners, the trend of overall improvement is equally apparent and statistical testing shows that advances made are mostly significant.

Table 18: Academic performance, by grade, by sex, by age group. Cohort comparison (mean and SD, mean difference, median and IQR, statistical significance)

			2002		2004			
All		**n**	**Mean**	**SD**	**Mean**	**SD**	**Mean difference**	**Stat. sign. (p<0.05)***
	English	81	2.4	.6	2.7	.6	+.23	P<0.05
	Math	81	2.5	.5	2.8	.6	+.34	P<0.05
Grade in 2002			**2002**		**2004**			
	English	**n**	**Median**	**IQR**	**Median**	**IQR**	**Mean difference**	**Stat. sign. (P<0.05)#**
1		44	3	2-3	3	3-3	+.16	P=0.10
2		26	2	2-2	2	2-3	+.23	P=0.10
3		9	2	2-2	3	3-3	+.67	P<0.05
4		2	2	2-2	2	2-2	-	-
	Total	81						
	Math	**n**	**Median**	**IQR**	**Median**	**IQR**	**Mean difference**	**Stat. sign. (P<0.05)#**
1		44	3	2-3	3	3-3	+.36	P<0.05
2		26	2	2-2	3	2-3	+.42	P<0.05
3		9	3	2-3	3	3-3	+.11	P=0.30
4		2	2	2-2	2	2-2	-	-
	Total	81						
Sex			**2002**		**2004**		**Mean difference**	**Stat. sign. (P<0.05)***
	English	**n**	**Mean**	**SD**	**Mean**	**SD**		

	Girls	40	2.6	.7	2.8	.6	+.25	P<0.05
	Boys	41	2.3	.6	2.5	.6	+.22	P<0.05
	Math							
	Girls	40	2.6	.5	2.9	.6	+.35	P<0.05
	Boys	41	2.4	.5	2.7	.7	+.34	P<0.05
Age group in 2002			**2002**		**2004**			
	English	**n**	**Median**	**IQR**	**Median**	**IQR**	**Mean difference**	**Stat. sign. (P<0.05)#**
6		4	3	2-4	3	3-3	0	P=1.00
7		44	3	2-3	3	3-3	+.20	P<0.05
8		21	2	2-2	2	2-3	+.29	P=0.09
9		12	2	2-2	2.5	2-3	+.33	P=0.05
	Total	81						
	Math	**n**	**Median**	**IQR**	**Median**	**IQR**	**Mean difference**	**Stat. sign. (P<0.05)#**
6		4	2.5	2-3	3	3-3.5	+.75	P=0.08
7		44	3	2-3	3	3-3	+.41	P<0.05
8		21	2	2-2	3	2-3	+.19	P=0.33
9		12	2	2-3	3	2-3	+.25	P=0.08
	Total	81						

* Paired t-test (comparison of means), comparing measures for 2002 to 2004.
# Wilcoxon's signed rank test for matched pairs (comparison of medians), comparing measures for 2002 to 2004.

Overall, the improvement in Mathematics and English between 2002 and 2004 was evident for the whole cohort and it was statistically significant for girls and boys, for 7-year olds, as well as for grades 1 and 2 for Math, and grade 3 for English.

From eyeballing the results, it appears that girls generally demonstrated better academic improvement. This is similar to Table 16 above for the complete sample.

Table 19: Comparison of mean performance scores between boys and girls. Cohort comparison

	n	Girls, mean score	Boys, mean score	Difference in performance	Statistical significance*
English, 2002	81	2.6	2.3	.26	P=0.06
English, 2004	81	2.8	2.5	.29	P<0.05
Math, 2002	81	2.6	2.4	.18	P=0.12
Math, 2004	81	2.9	2.7	.19	P=0.19

* Two sample, unpaired t-test (comparison of means)

Table 19 shows that difference in performance between boys and girls was only statistically significant for English in 2004, with girls performing better. The difference in improvement between Math and English, regardless of sex, was not statistically significant (P=0.6, two sample t-test, unpaired), even though in Table 18 it appears that more improvement was gained in Mathematics.

Although it is clear that academic improvement occurred, it must also be taken into account that 18 children in the cohort failed and had to repeat a year. In the case of performance in English, there is an association between failing a year and improvement in English, with those children who failed a year being 3.8 times as likely to have improved in English (OR=3.8, P<0.05, logistic regression, adjusted for sex and age).

6.3 Absenteeism

Part of the objective on absenteeism was to describe and compare reasons for absenteeism. However, the 2002 records with reasons for absenteeism could not be located. Therefore, comparison from 2002 to 2004 will focus on frequency of absenteeism only.

6.3.1 Descriptive cross-sectional analysis

In 2002, the sample's overall absenteeism was 857 days. In 2004, the total was 862 days. In 2002, the 103 girls had a total of 540 days and in 2004 545 days, while the 72 boys had totals of 317 for both years. The range in days absent was 0-31 in 2002 and 0-30 in 2004.

Table 20: Absenteeism, by sex

	N	year	Days total	Median	Range	IQR
Sample	175	2002	857	4	0-31	1-7
	175	2004	862	3	0-30	1-7
Girls	103	2002	540	4	0-31	1-7
	103	2004	545	4	0.-30	2-8
Boys	72	2002	317	3.5	0-18	1.5-6
	72	2004	317	3	0-27	2-8

The change in median days absent between 2002 and 2004 for girls and boys respectively was not statistically significant (P=1 for both, Wilcoxon's signed rank test for paired samples, comparison of medians). Also, although it appears that girls were absent more, the difference between the sexes in both years was not statistically significant (P=0.24 in 2002, P=0.25 in 2004, t-test for unpaired samples).

Although 64% of learners was absent for 5 days or less during 2002, the 12.6% that was absent for more than 10 days was responsible for 317 days of absenteeism – 37% of the total days absent. In 2004, 110 learners, or almost 63%, were absent for 5 days or less, while the 24 who recorded over 10 days each were absent 348 days in total. This represents 40% of the total number of days absent.

Table 21: Number of days absent

	0 days	**%**	**1-5 days**	**%**	**6-10 days**	**%**	**>10 days**	**%**
2002	17	9.7%	95	54.3%	41	23.4%	22	12.6%
2004	26	14.9%	84	48.0%	41	23.4%	24	13.7%

There was no significant difference in the number of children having zero days absenteeism between 2002 (9.7%) and 2004 (14.9%) (P=0.1, two sample test of proportion), or in the number of children who had over 10 days absent (P=0.7, two sample test of proportion). This means that overall, no significant improvements were achieved with regard to absenteeism between 2002 and 2004.

6.3.2 Cohort analysis

For the cohort of 81, the total number of days absent in 2002 was 456, while in 2004 it came to 461 days. The 40 girls had a total of 234 days in 2002 and 241 days in 2004, while the 41 boys had a total of 222 and 220 in 2002 and 2004 respectively. The range in days absent was 0-19 in 2002 and 0-27 in 2004. In 2002, four children had 0 days absent while in 2004, nine children did not miss any days. This difference was not statistically significant (P=0.1, two sample test of proportion). Also, in 2002 13 children (16.0%) reported over 10 days absent, while in 2004 this was 16 children (19.8%), including three who were absent for 20 or more days. This difference was not statistically significant (P=0.6, two sample test of proportion). The findings for the cohort with regard to frequency of absenteeism appeared similar to the whole sample.

Table 22: Absenteeism, by sex, grade and age group. Cohort comparison

		2002			2004			
	N	**Median**	**Range**	**IQR**	**Median**	**Range**	**IQR**	**Statistical Significance (P<0.05)***
Cohort	81	5	0-19	2-7	4	0-27	1-9	P=0.8
Girls	40	5.5	0-19	2-8	5.5	0-20	2-9.5	P=1.0
Boys	41	4	0-18	2-7	3	0-27	1-8	P=0.7

		2002			2004			
Grade in 2002	**N**	**Median**	**Range**	**IQR**	**Median**	**Range**	**IQR**	**Statistical Significance (P<0.05)***
1	44	5.5	0-19	2.5-7.5	4.5	0-27	2-9	P=0.7
2	26	5	0-18	1-7	4.5	0-22	1-11	P=0.7
3	9	4	0-13	2-12	2	0-8	0-3	P=0.2
4	2	2	2-2	2-2	5	4-6	4-6	P=0.2
Total	81							

		2002			2004			
Age group in 2002	**N**	**Median**	**Range**	**IQR**	**Median**	**Range**	**IQR**	**Statistical Significance (P<0.05)***
6	4	5	4-6	4-6	2.5	1-12	1.5-7.5	P=0.7
7	44	4	0-19	2-6.5	3.5	0-27	1-9	P=0.9
8	21	7	0-18	4-10	5	0-12	1-10	P=0.2
9	12	3	0-13	2-7.5	5	0-22	1.5-10	P=0.4
Total	81							

* Wilcoxon's signed rank test for matched pairs (comparison of medians)

As Table 22 shows, there is a decrease in median number of days absent for the sample in total and all boys, as well as across most of the grades and age groups over the two years. However, the drop is never statistically significant.

Though the boys in the cohort tend to have fewer days absent than the girls, this difference is not statistically significant (P=0.7 in 2002, P=0.6 in 2004, two-sample t-test).

With regard to the *reasons* for absenteeism, a brief overview of reasons as recorded for 2004 is provided as this may still serve to highlight the main reasons for absenteeism in this year. There are 20 categories to capture the reason why a child is absent.

Table 23: Reasons for absenteeism (for 175 learners), 2004			
Reason	**%**	**Reason**	**%**
Illness	34	Holiday/vacation	2
Missed the bus	13	Domestic need	2
Appointments	12	Unstable home	2
Death/funeral	7	Transport	1
Other	5	Learning camp	1
Serious/long illness	5	School uniform	1
Injuries	4	Relocated	1
Social services	3	Suspension	0
Time with family	3	Transferred	0
Religious	3	Surgery	0
Hospitalised	2	**Total**	100

From Table 23 it is clear that illness was the main reason for absenteeism in 2004. Together with missing the school bus, they account for almost 50% of all missed days.

6.4 Multivariate analyses: anthropometry, academic performance and absenteeism

The fourth objective of this study is, again, twofold. Firstly, to assess whether in 2002 and 2004 respectively, an association can be found between anthropometry, academic performance and absenteeism in the sample of 175 learners. Secondly, to assess whether those learners in the cohort of 81 that showed improved anthropometry in 2004, in comparison to 2002, show improved academic performance and decreased absenteeism.

6.4.1 Cross-sectional analysis

In order to explore the hypothesised relation between the variables, Table 24 reports the correlation between Z-scores for weight-for-age and performance in English and Mathematics as well as absenteeism in 2002 and 2004, respectively. The same is done for correlation between absenteeism and academic performance, and lastly, for correlation in performance between English and Mathematics.

Table 24: Cross-sectional analysis of correlation between variables					
		2002		**2004**	
Weight-for age Z-score	**n**	**Correlation Coefficient r***	**Stat sign***	**Correlation coefficient r***	**Stat sign***
English	175	0.08	P=0.28	**0.21**	**P<0.05**
Mathematics	175	0.04	P=0.54	**0.25**	**P<0.05**
Absenteeism	175	-0.12	P=0.11	**-0.18**	**P<0.05**
Absenteeism					
English	175	0.14	P=0.06	-0.06	P=0.45
Mathematics	175	0.13	P=0.08	-0.00	P=1.00
English					
Mathematics	175	**0.70**	**P<0.05**	**0.58**	**P<0.05**

* Spearman Rank Correlation

Table 24 shows that in 2002, there was a strong positive correlation between performance in English and Mathematics and that this correlation was statistically significant. This correlation persisted, quite strongly, in 2004. In 2004, a modest yet statistically significant positive correlation is found between weight-for-age Z-score and performance in English and Math, while a weak but significant negative correlation exists between Z-score and absenteeism. Absenteeism does not show a correlation with academic performance.

6.4.2 Cohort analysis

In section 6.1.2 it was established that:

- Improvement in weight-for-age between 2002 and 2004 was statistically significant for the cohort of 81 and all boys in the cohort, but not for girls.

- With regard to academic performance, there was a statistically significant improvement in both Mathematics and English in the cohort and among girls and boys respectively.

- Lastly, although there was a decline in median days absent in the cohort and among the boys in the cohort, this decrease was not statistically significant.

In section 6.1 the argument was made that the absolute height measurements for 2002 and 2004 lack comparability and therefore comparisons for height-for-age and weight-for-height are not valid. However, the variables weight gain, height gain and weight-for-height gain are based on dichotomising the Z-score **changes** from 2002 to 2004, as explained in detail in section 5.8. In creating the categorical variables for weight gain, height gain and weight-for-height gain the median Z-score change for each anthropometric measure was taken as the cut-off point. In this way, the fact that the absolute measures for height are not comparable is removed from the picture because the dichotomisation in the change in weight-for-age, height-for-age and weight-for-height (i.e. dichotomised gain variables) can still be used to assess whether they are associated with improvement in academic performance and absenteeism.

Table 25: Median Z-score change from 2002 to 2004 (cohort)

Weight-for-age	0.20
Height-for-age	-.48
Weight-for-height	0.96

Table 26 reflects the results of the multivariate logistic regression modelling, alternately, improvement in English, improvement in Math and improvement in absenteeism on, firstly weight gain, secondly height gain and thirdly, weight-for-height gain, all analyses adjusted for sex and age. Adjustments made for sex and age mean that any association found has been controlled for these variables. All analyses are also adjusted for having failed a year in school between 2002 and 2004, as this is strongly associated with improvement in English performance. Odds Ratios, confidence intervals and P-values are presented for the hypothesised associations between weight gain, height gain and weight-for-height gain in relation to improved performance in English and Mathematics, and improved absenteeism respectively. As age in 2002 and grade in 2002 were highly correlated (r=0.8, P<0.05, Spearman Rank Correlation), grade was not included in the analysis.

Table 26: Multivariate logistic regression, modelling cohort improvement in English, Math and absenteeism on anthropometric gain variables, adjusted for age, sex and having failed a year in school between 2002 and 2004

	n	Odds Ratio*	Statistical significance (P<0.05)*	Confidence Interval*
Weight gain, adjusted for sex, age and failing a year				
Improvement in English	81	0.4	P=0.05	0.13-0.99
Improvement in Math	81	1.0	P=0.93	0.41-2.66
Improvement in absenteeism	81	0.4	P=0.08	0.18-1.10

	n	Odds Ratio*	Statistical significance (P<0.05)*	Confidence Interval*
Height gain, adjusted for sex, age and failing a year				
Improvement in English	81	1.6	P=0.35	0.60-4.32
Improvement in Math	81	1.9	P=0.18	0.73-5.12
Improvement in absenteeism	81	0.5	P=0.14	0.20-1.26
	n	**Odds Ratio***	**Statistical significance (P<0.05)***	**Confidence Interval***
Weight-for-height gain, adjusted for sex, age and failing a year				
Improvement in English	81	0.5	P=0.21	0.19-1.42
Improvement in Math	81	1.1	P=0.78	0.44-2.98
Improvement in absenteeism	81	**0.3**	**P<0.05**	**0.11-0.76**

* Multivariate logistic regression of binomial variables, with Odds Ratios as measure of association and P-values and confidence intervals to indicate statistical significance.

In Table 26, one hypothesised association was found to be statistically significant, though not in the direction one would perhaps have anticipated. Those learners who had improved weight-for-height outcomes were 0.3 times as likely to have improved their absenteeism levels, in comparison to those who did not improve weight-for-height but were of the same sex or age and regardless of having failed a year. In other words, improved weight-for-height was not positively associated with better absenteeism records.

As weight-for-age has been the variable of focus regarding anthropometric outcomes, Table 27 examines the possible association between weight-for-age Z-score change and academic performance and absenteeism more closely by looking at the four quartiles of actual Z-score change.

Table 27: Multivariate logistic regression, modelling cohort improvement in English, Math and absenteeism on change in weight-for-age Z-score, by quartile, adjusted for sex, age and having failed a year in school

Improvement in English	n	Odds ratio*	Statistical significance (P<0.05)*	Confidence interval*
Weight-for-age Z-score change # (<.03)	20	1.0		
Weight-for-age Z-score change # (>-.03 <.2)	20	0.6	P=0.46	.14-2.47
Weight-for-age Z-score change # (≥.2 ≤.47)	21	0.3	P=0.15	.08-1.49

Weight-for-age Z-score change # (> .47)	20	0.3	P=0.12	.07-1.35
Improvement in Mathematics	**n**	**Odds ratio***	**Statistical significance (P<0.05)***	**Confidence interval***
Weight-for-age Z-score change # (<.03)	20	1.0		
Weight-for-age Z-score change # (>-.03 <.2)	20	0.4	P=0.27	.09-1.96
Weight-for-age Z-score change # (≥.2 ≤.47)	21	0.5	P=0.34	.12-2.09
Weight-for-age Z-score change # (> .47)	20	1.2	P=0.75	.33-4.72
Improvement in absenteeism	**n**	**Odds ratio***	**Statistical significance (P<0.05)***	**Confidence interval***
Weight-for-age Z-score change # (<.03)	20	1.0		
Weight-for-age Z-score change # (>-.03 <.2}	20	0.4	P=0.23	.10-1.71
Weight-for-age Z-score change # (≥.2 ≤.47)	21	0.2	P=0.05	.06-1.02
Weight-for-age Z-score change # (> .47)	20	0.4	P=0.15	.10-1.41

* Multivariate Logistic Regression, reporting Odds Ratio, Confidence Interval and P-value
# Adjusted for sex, age and having failed a year in school between 2002 and 2004

From this, it follows is that those who experienced a weight-for-age Z-score change ≥.2 ≤.47 were .2 times as likely to have improved absenteeism as compared to those who experienced a weight-for-age Z-score change < .03 but who were of the same age, sex and regardless of whether they had failed a year. However, this association is only marginally significant, while the confidence interval includes the null value.

When taking a closer look at absenteeism, Table 25 shows that reduction in absenteeism was positively and significantly correlated with improvement in English in the cohort and among boys in the cohort. This link was not apparent between improvement in absenteeism and Math. It may be noted that when excluding the children who had failed a year from the variable on English improvement, the correlation still remained, at same strength (r=0.3, P<0.05, Spearman Rank Correlation) and was then also apparent for girls in the cohort (r=3, P<0.05, Spearman Rank Correlation).

In creating the variable for improvement in absenteeism, the variable reflecting the actual change in days per learner between 2002 and 2004 was retained. To see whether there was any relation between a smaller or larger change in days absent and academic improvement, change in absenteeism was ordered in quartiles. It appears that the quartile that showed the worst change in absenteeism, with an increase of more than two days between 2002 and 2004, showed a modest negative correlation with improvement in English.

Table 28: Correlation between improvement & quartiles of change in absenteeism and academic improvement (cohort)

		Improvement in English	
Improvement in absenteeism	**N**	**Correlation Coefficient r***	**Stat sign (P<0.05)***
All	81	**0.3**	**P<0.05**
Girls	40	0.3	P=0.10
Boys	41	**0.3**	**P<0.05**
		Improvement in English	
Change in absenteeism (actual days 2004-2002)	**N**	**Correlation Coefficient r***	**Stat sign (P<0.05)***
<25% (2)	20	-0.2	P=0.41
>25% <50% (0)	20	0.0	P=0.97
>50% <75% (-2)	13	0.5	P=0.06
>75% (-2)	28	**-0.4**	**P<0.05**
		Improvement in Mathematics	
Improvement in absenteeism	**N**	**Correlation Coefficient r***	**Stat sign (P<0.05)***
All	81	0.1	P=0.32
Girls	40	0.2	P=0.34
Boys	41	0.1	P=0.67
		Improvement in Mathematics	
Change in absenteeism (actual days 2004-2002)	**N**	**Correlation Coefficient r***	**Stat sign (P<0.05)***
<25% (2)	20	0.3	P=0.25
>25% <50% (0)	20	-0.2	P=0.37
>50% <75% (-2)	13	0.2	P=0.47
>75% (-2)	28	-0.3	P=0.17

* Spearman Rank Correlation

Lastly, although it may seem obvious, there is a positive correlation between improvement in English and Mathematics respectively (r=0.3, P<0.05, Spearman rank correlation). This correlation remains and is actually stronger when excluding from both variables those who failed a year (r=0.4, P<0.05, Spearman rank correlation).

7 Discussion

7.1 Anthropometry

Anthropometric data can serve as an indicator of nutritional status. The purpose of Christel House South Africa is to offer children from disadvantaged backgrounds a comprehensive educational programme that includes daily nutrition.

During the first year of the school's operations, the anthropometry of the children in terms of weight-for-age showed similarity with other studies done in South Africa. For instance, the National Survey done by the Department of Health in 1994 found a national underweight prevalence of 9% (<-2SD), at an average age of 7.4 years. The 1999 National Food Consumption Survey found 8% <-2SD for weight-for-age in the age group 7-9 year old. At Christel House, in 2002, 8% of the sample of 175 children, at a median age of 8.5 years, was underweight, as they scored <-2SD for weight-for-age. For girls and boys respectively, the prevalence of underweight was 7.8 and 8.3%.

The weight-for-age Z-scores improved for both boys and girls in the sample and was statistically significant for both sexes.

Two years into the programme, underweight had reduced significantly from 8% to 1.7% in the sample overall, from 7.8% to 0% for girls and from 8.3% to 4.2% for boys, who roughly halved their prevalence of underweight. Though overweight increased in the sample and among girls, this increase was not statistically significant.

These improvements are noteworthy when compared to estimates of underweight in national studies. After two years of regular nutrition provided by the school – breakfast, lunch and two snacks, which would include fruit- girls showed a median weight-for-age very close to the median of the reference population, while boys had made a similar amount of progress in the same direction. These results are an indication that the programme offered by Christel House South Africa may be having a positive impact on anthropometric outcomes.

7.1.2 Anthropometry: sample versus cohort and issues of validity

The results of the cohort analysis are largely similar to the outcomes for the sample based on the cross-sectional analysis. For instance, when looking at the improvement in Z-score for weight-for-age in the cohort of 81 children, the improvement is statistically significant for the overall cohort and boys. For girls, the direction is the same, though not statistically significant. The overall increase was .2 for girls and .3 for boys. Lack of statistical significance, such as for weight-for-age Z-score change for girls, could be due to the power of the cohort, with n=81, being less than half the power of the sample (n=175).

In 2002, 12.5% of girls in the cohort were underweight compared to 4.9% of the boys. By 2004, no girls were underweight and among boys it had dropped to 2.4%, reductions very similar to those for the sample. As the actual number of underweight children was relatively small, the improvement in those children may not have greatly affected the mean Z-score change.

There are some differences between the sample and the cohort, and between the outcomes among boys and girls respectively that merit further discussion. Firstly, with regard to differences between girls and boys, girls in the sample and the cohort have better baseline outcomes for weight-for-age than boys. The reason for this is not immediately apparent. Boys are older than girls in both the sample and the cohort. Yet the weight-for-age scores, as based on the NCHS reference population, are age and sex specific. Possibly, differential misclassification underestimated weight in boys or overestimated weight in girls in both years. Yet this misclassification must have happened with much precision, as improvement rates in weight-for-age are very similar among boys and girls. Other explanations could be related to environmental or living circumstances. Perhaps boys engage more in sports and other physical activities than girls and hence burn more calories, resulting in generally lower weight. Conversely, as girls stay indoors more, for instance because they are expected to assist with domestic chores or are kept indoors because of safety concerns, they would have slightly more sedentary lifestyles and hence burn fewer calories.

Secondly, with regard to differences between sample and cohort, the cohort of 81 was created due to certain limitations with regard to age and height in the EpiNut software. The mean height for girls in the sample was higher than the height limitation, meaning that more girls had a height above the sex-specific cut-off point in the software in comparison to boys. As a result, more and relatively tall girls were systematically excluded from the cohort. This brought selection bias into the cohort, as girls in the cohort are not representative of girls in the sample. This brings into question the validity of the cohort outcomes due to systematic error in the selection of girls into the cohort.

The reverse selection bias may have occurred for boys: their height was relatively low in comparison to the cut-off for height in the software, and their median age was lower than the cut-off age for boys. As a result, fewer boys were excluded from the cohort while the boys selected into cohort had slightly better weight-for-age Z-scores, indicating that the tallest excluded boys were also the thinnest boys. Even though the boys in the cohort still started at a disadvantage to girls with a mean Z-score for weight-for-age of -.5 versus -.3 respectively in 2002, the boys were able to experience more catch up growth.

Though it appears the selection bias was introduced by the limitations for height and age in the EpiNut software, it is also possible that measurement bias in the height measurements taken in 2004, systematically overestimating height in girls and underestimating height in boys, caused differential misclassification. However, when discussing the data measurement process in section 5.5, there was cause to assume systematic over-estimation of height in 2002 but not in 2004. Also, the reliability in measurement seems to render no support to the hypothesis that height of girls was overestimated: the difference in mean height between girls and boys in the sample of 175 was 2.2 centimetres in 2002 and 2.3 centimetres in 2004. Although for the cohort the difference was bigger -5.5 centimetres difference between girls and boys in 2002 and 5.6 centimetres in 2004- this is most likely due to the fact that there was a bigger age difference between girls and boys in the cohort in comparison to the sample.

7.2 Academic performance

When looking at academic performance in English and Mathematics, both the sample and cohort made significant improvement between 2002 and 2004. The cohort had better mean scores in 2002, in comparison with the sample. The sample in totality made bigger jumps forward: e.g. .42 points for English, in comparison with .23 for English in the cohort. It appears that those who were at a bigger disadvantage were able to improve more. The improvement is significant for boys and girls, both in sample and cohort. The girls tend to make bigger jumps forward than boys, yet the difference in actual performance between the sexes is only significant for English in 2004, for both the cohort and the sample. The improvement in Mathematics for boys is more pronounced in the cohort than in the sample.

Looking at the cohort, it shows that improvement in performance is significant even at grade and age level, for instance for both subjects among 7-year olds. Lack of statistical significance among the other age groups may be due to the small size of the sub-sets. It must be taken into account that in the cohort, 22% of all children failed and repeated a year between 2002 and 2004, and that failing a year and improving English performance are strongly associated. This is not surprising, as dealing with the same subject matter for two years may be expected to lead to improvement.

It is evident that when looking at academic performance on its own, significant results are being obtained. However, these results must be interpreted in context and with a degree of caution. The sample used in cross-sectional analysis (n=175) represents 65% of the original sample population (n=269). Non-response and drop-out may have brought bias into the sample, and the outcomes are only representative of the 175 learners in the sample used in cross-sectional analysis. The fact that within this group there was significant academic improvement may simply be due to a cohort effect, or the fact that the children enjoyed a regular and structured school life. Nonetheless, it is equally likely that the comprehensive programme provided by Christel House has contributed to the academic improvement demonstrated by its learners.

The outcomes are consistent with findings by other studies (Kleinman et al, 2002; Powell et all, 1998) of improvements in Math and arithmetic following the introduction of a free school breakfast, although those were experimental studies with shorter time frames than this retrospective study (six months and one year, respectively, versus two years).

7.3 Absenteeism

There are no significant positive outcomes with regard to absenteeism. A slight trend, though not significant, towards a decrease in days absent is apparent among boys as they decrease their median days absent in both sample and cohort. Boys also have fewer days absent than girls overall, even though the difference between the sexes is not significant. For girls, median number of days absent does not change between 2002 and 2004, in both sample and cohort. The increase in the number of children that had zero days of absenteeism in the sample between 2002 and 2004 from 9.7% to 14.9% was not statistically significant.

The cohort had a higher median number of days absent than the sample in both years, also by sex, except among boys in 2004, where the median was the same for sample and cohort. Age could be a factor in explaining this difference, as the cohort is significantly younger. Yet when looking at absenteeism levels in different age groups, both in sample and cohort, there is no obvious trend related to age. Another possible explanation could be that the cohort had more children who were ill, as illness is by far the most reported reason for absenteeism.

The experimental studies by Kleinman et al (2002) and Powell et al (1998) found small but significant decreases in absenteeism among children exposed to the feeding intervention. However, these studies were not done in South Africa and reasons for absenteeism in socio-economic deprived areas in South Africa may be very different from reasons for absenteeism elsewhere. As the reasons for absenteeism can be numerous, it is possible that the CHSA programme is not yet seeing an effect on absenteeism levels after two years, or that consistent nutrition in itself is not a sufficient intervention to influence absenteeism levels in the context of the CHSA learners.

7.4 Multivariate analyses: anthropometry, academic performance and absenteeism

For the sample, in 2002, the only correlation that was apparent was between performance in Math and English, suggesting that those who were good at one subject would also perform well in the other. No correlation was observed for weight-for-age Z-score and academic performance or absenteeism. Seeing 2002 was the first year of operation of the school, the children performed to their abilities under the circumstances. Two years into the programme, the analysis does show a positive correlation between weight-for-age Z-score and academic performance and a negative association between weight-for-age Z-score and absenteeism. So two years into the programme, an effect is being seen. These findings are consistent with the notion that well nourished children do better at school (Kleinman et al, 2002; Powell et al 1998; McCoy et al 1997).

In 2004, the correlation between performance in English and Mathematics remains but is less strong. It seems that among the 175 children coming into the school in 2002 with their various educational backgrounds and disadvantages, those who had better academic abilities were able to perform well in English and Math.

A possible explanation for the difference in correlation outcomes between 2002 and 2004, other than 2002 being the first year of operation and the programme not yet having been able to have effect, could be error in weight measurements taken in 2002. Due to random error, measurements taken for weight in 2002 were perhaps so imprecise that children were misclassified. Consequently, the association between weight-for-age and academic performance and absenteeism respectively that would have been expected was not demonstrated. This implies that the weight measurements taken in 2004 were more precise and no misclassification took place, resulting in a visible association. However, it is not possible to conclusively attribute the difference to measurement error and the true reason for the lack of correlation in 2002 between weight-for-age and academic performance and absenteeism respectively cannot be provided.

When looking at the cohort, the picture is complex. Although uni-variate analyses have shown a significant improvement in academic performance and weight-for-age Z-score change between 2002 and 2004, the expected associations or directions of associations between those variables do not present themselves in multivariate analyses. It is not the children with the best anthropometric outcomes who show the most improvement academically, or reduction in absenteeism.

It was explained that Z-score changes for weight-for-age, height-for-age and weight-for-height could all be translated into 'gain' variables, in spite of the suspected measurement error for height in 2002. What multivariate analyses involving the 'gain' variables revealed were a negative association between weight-for-height gain and improvement in absenteeism. Other associations were not significant and tended to be negative, going against expectation. For instance, those who had experienced weight gain were 0.4 time as likely to have improved in English or to have reduced absenteeism as those who did not experience weight gain. This indicates that those children who experienced little or low weight gain showed better academic improvement and reduced absenteeism than children who experienced high weight gain. Various explanations may be explored to clarify this seemingly anomalous situation.

Firstly, referring back to the literature, one can reiterate that academic performance is linked to a multitude of factors and it is therefore very difficult to establish a clear link or association with one particular factor (Kleinman et al, 2002; Richter et al, 1997). In the case of this study, the children who were most disadvantaged and faced multiple challenges were possibly able to catch up in terms of growth, as weight-for-age is very quick to respond to nutrition interventions, but were not able to show the same improvement in terms of academic performance, or reduction in absenteeism. On the contrary, children who already had better outcomes in 2002 and who did not need to catch up as much growth wise -and hence did not make great improvements in weight-for-age- were able to benefit from the programme differently, by improving cognitively and academically.

Secondly, another possible explanation is that the outcomes of the multivariate analyses do not correspond with the truth – i.e. lack validity. This would imply that systematic error has affected the outcome variables to such an extent that the study lacks internal validity. This occurred, for example, through selection bias of girls into the cohort.

Due to the height limitations in the Epi Nut software, girls who were older and taller were selected out of the cohort. It is possible that exactly those girls would have achieved improved academic performance in correlation with weight gain. The observation that the girls who remained in the cohort were the ones who generally did not perform so well is supported by the fact that 27% of these girls failed a year between 2002 and 2004, representing 11 out of the 18 children who failed. As was shown in section 6.2.2, failing a year is strongly associated with improving in English performance (OR=3.8, $P<0.05$). This would go some way to explain the counter-intuitive finding that children who do not seem to thrive have significant academic improvement since it is the act of repeating the subject, rather than gaining weight, that improves the girls' academic performance in this sub-group.

Lastly, one can suggest the anomalous and somewhat counter-intuitive findings may have occurred because not all children benefited equally. For instance, perhaps not all children consistently ate their meals, or perhaps they took food home. This does seem a little unlikely considering the circumstances under which the meals are taken. The children eat the breakfast and lunch in their classes, and are being served prepared food on plates or in bowls. There is also supervision during mealtimes. It is however more likely that mid-morning and mid-afternoon snacks are taken home as they are mostly pre-packed snacks or whole fruits. One can also not exclude the possibility that because children were fed in school, they would receive less or no evening meal at home. This would to some extent undo the added value of the nutritional intake at school.

Taking this argument further, it must be reiterated that school feeding as an intervention may not be able to fully reverse the effects of malnutrition because of the number of factors contributing to or causing malnutrition. With regard to the potential link of feeding with academic performance, as Rampersaud et al (2005) and McCoy et al (1997) underscore, it is not feeding per se but the nutritional value of the food that is likely to make a difference. In fact, gaining weight because of increased intake of calories with low nutritional value may even result in a transition to overweight.

A more promising finding is the modest but statistically significant positive correlation that occurs in the cohort, and among the boys in the cohort, between improvement in absenteeism and improvement in English performance. The association remains for the cohort when excluding the children who failed a year, as there is a strong association between improvement in English and failing a year in school. Also, children who had an increase in absenteeism of more than two days between 2002 and 2004 showed a modest negative correlation with improvement in English.

7.5 Limitations of the study

It is safe to say this study faces a number of limitations. To start, the data had been routinely collected by the school for information purposes and not specifically for this study. As explained in different sections of this study, the circumstances under which data collection with regard to weight and height took place differed between 2002 and 2004, resulting in possible instrument and observer variability, and in the case of height, measurement bias in 2002. As a result, misclassification may have occurred with regard to height-for-age. Non-differential misclassification occurred as a result of inaccuracy in the data collection process that affected all learners in the sample equally, leading to an underestimation of stunting in 2002. Differential misclassification occurred because of the difference in misclassification between 2002 and 2004. Consequently, height-for-age and weight-for-height had to be dropped as anthropometry related outcome variables in the study, leaving only weight-for-age. This meant that stunting and wasting could not be further examined in the cohort, while stunting is an indicator of chronic malnutrition and weight-for-height is seen as the 'most suitable indicator for present state of nutrition' (Walsh et al, 2002, p. 7; Jacobs et al, 1988).

Even though weight-for-age is an accepted indicator of current nutritional status, it does not take into account body size and frame (Walsh et al, 2002). As such, misclassification may have occurred whereby children were incorrectly classified as underweight or overweight.

As explained earlier, selection bias was introduced into the cohort that was formed as a consequence of height and age limitations in the EpiNut software. As a result, the cohort was not representative of the sample. As selection bias is a form of systematic error, the internal validity of the cohort study is compromised.

With regard to academic performance, it needs to be remembered that the scoring system was changed between 2002 and 2004. In 2002 a learner could get a rating of 1 through to 5. By 2004 this had been adjusted to 1 through to 4. To allow comparison between 2002 and 2004, the 2002 scoring range was adjusted. This meant that scores 2 and 3 were collapsed into score 2. Consequently, scores of 2 may have been overrepresented in 2002. In addition, in 2004, teachers could have been psychologically inclined to upgrade the scores as they would not want to rate too many children below 3, introducing measurement error into the sample. As a result of these of these two factors, academic improvement may have been overestimated and the improvement as observed by the study may not reflect a true improvement.

7.5.1 Achievement of objectives

In terms of achieving its objectives, the previous sections have already described the shortcomings and accomplishments of this study, including the need to create a sub-set of the sample of 175 learners.

With regard to the first objective, the anthropometric measurements, being weight and height, of the children entering CHSA in 2002 have been described, both for 2002 and 2004, and stratified by age and by sex. The comparison of baseline anthropometry to the measurements done in 2004 was problematic due to the much discussed issue of measurement error regarding height in 2002. As a result, only weight-for-age was retained as an outcome indicator for anthropometry. Significant improvement in weight-for-age was observed.

Regarding the second objective, academic performance in English and Mathematics was described for 2002 and 2004. A slight adjustment had to be made to the performance rating for 2002, due to the different rating scales in 2002 and 2004. This may have affected the comparison of academic performance somewhat, by possibly overestimating the rate of improvement. Significant improvement in English and Mathematics performance was observed.

As for the third objective, the records of reasons for absenteeism in 2002 could not be obtained. Even though the categories of absenteeism were the same in both years, the fact that the records containing the actual reasons for absenteeism for a child on a particular day was not available meant that no description of reasons for absenteeism in 2002 could be provided. Hence, no comparison of reasons between 2002 and 2004 was possible. This meant it was not possible to assess whether e.g. illness, the main reason for absenteeism in 2004, had increased or decreased. This would have provided an important indication of improved health among the children, and by extension an indication of the effectiveness of the CHSA programme. Due to these missing data, only frequency of absenteeism in 2002 and 2004 was described, by sex, age and grade, and a comparison was made between the frequencies in both years. No significant decrease in absenteeism was observed.

Lastly, with regard to the suggested association between anthropometry, academic performance and absenteeism in 2002 and in 2004, a number of statistical tests were performed and associations or lack thereof were described. In 2002, the only significant correlation was between performance in English and performance in Mathematics. In 2004, significant positive correlations were found between weight-for-age Z-score and performance in English and Mathematics, respectively, as well as between English and Math, similar to 2002. A significant negative association was found between weight-for-age Z-score and absenteeism.

To assess whether those learners who showed improved anthropometry between 2002 and 2004 also demonstrated improved performance in English, Mathematics and reduced absenteeism, gain variables were created to reflect improvement above the median in weight-for-age, height-for-age and weight-for-height Z-score change. The only significant association following multivariate analysis was negative, between weight-for-height gain and improvement in absenteeism. A bi-variate analysis showed a significant positive association between improvement in absenteeism and improvement in English.

Therefore, although the study was able to find significant improvements in academic performance and weight-for-age, there was no evidence to support the hypothesis that children with improved anthropometry would also demonstrate improved academic performance and reduced absenteeism.

8 Recommendations and conclusion

8.1 Recommendations related to future monitoring and evaluation at CHSA

As Christel House South Africa is a school that operates as a foundation but adheres to certain specific business principles, performance and results are important goals that need to be achieved in order to secure sustained funding. To that end, continued research and analysis of data as presented in this study is highly relevant as it provides evidence based information to both school management and potential funding agencies. Yet in order to do so with credibility, it is recommended that CHSA be vigilant in how information is collected, collated and captured. This applies in particular to the anthropometric measurements and the recording of absenteeism, including the reasons for absenteeism. For instance, it is recommended that a protocol for weight and height measurement taking is agreed on, that the same instruments are used consistently, and that these instruments are regularly calibrated. This would decrease the occurrence of measurement error and variability in instrument and observer.

This study did not factor in socio-economic circumstances of the children or parental education levels. There is much evidence in the literature that especially maternal education is a positive predictor for child growth and development and achievement in school (Rampersaud et al, 2005; Abidoye and Eze, 2000; Kibel and Wagstaff, 1997; Labadarios et al, 1995). It is recommended that any future research related to child growth and academic performance at CHSA include data on socio-economic circumstances and parental education[6]. In that light, it is suggested that CHSA continues to do an annual or bi-annual household survey that includes questions related to socio-economic circumstances and parental education.

8.2 Recommendations related to policy and practice at CHSA

What is currently offered by CHSA to its learners is a comprehensive schooling programme that includes nutrition, daily transport to and from school, school uniforms and shoes, learning support, psycho-social support by a resident social worker and basic health care by a qualified resident nurse. As such, what is offered goes beyond a vertical feeding programme. The feeding itself goes beyond a basic breakfast, as it also includes a warm midday lunch and two snacks during the morning and afternoon break. It is however not exactly clear what the nutritional value and calorific intake of the meals and snacks add up to. It is therefore recommended that CHSA, in collaboration with its catering partner, makes an assessment of the quality and nutritional value of the food provided, and ensures that the meals and snacks are healthy, varied and nutritionally balanced. This recommendation is also in recognition of the notion that the composition of school meals may be related to educational achievements.

CHSA could also decide, based on the recommended daily allowances for protein, starch, fat, vitamins and minerals for children, what percentage of the recommended daily allowances it will provide to the children.

In order to avoid that children are deprived of an evening meal at home, it is recommended that CHSA continuous to engage with parents and guardians regarding the purpose of the school feeding programme. Overall, active engagement

[6] Results of a household survey done by the school in 2004 were available for this research. However, the sample covered by that survey was different from the sample included in this study. As this study already had to engage wlth an internal sub-sample (the cohort of 81), adding yet another and very different sample would have made this study unnecessarily complicated.

by CHSA with parents and guardians and the wider community –as already undertaken by the school- is encouraged.

As noted, illness is reported as the main factor for absenteeism. It is recommended that CHSA makes an inventory of the most common illnesses or the illnesses causing most absenteeism, and investigate whether measures can be taken to address these illnesses, taking into account that many children live in poor housing circumstances that are not conducive to general health.

8.3 Conclusion

In spite of its limitations, this study adds to the body of research in South Africa on the impact of comprehensive schooling programmes on anthropometric development, academic performance and absenteeism levels of children from disadvantaged socio-economic backgrounds.

Though no evidence was found for a direct link between improved anthropometry and improved academic performance or reduced absenteeism, a number of significant findings with respect to academic performance and anthropometric outcomes respectively suggest that the programmes as provided by Christel House South Africa are having a positive impact on their learners.

It is hoped that Christel House South Africa will benefit from the findings of this study.

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Appendix I Letter of consent for parents and guardians

CHRISTEL HOUSE

CHRISTEL HOUSE SOUTH AFRICA
(ASSOCIATION INCORPORATED UNDER SECTION 21)
(Registration Number 2000/012349/08)

38 Bamford Avenue, Athlone
Cape Town, Western Cape, South Africa
☒ P.O. Box 767
Howard Place, 7450
Cape Town, Western Cape, South Africa
☎ **021 - 697 30 37** (International: 27 21 697 30 3
FAX **021 - 697 30 17** (International: 27 21 697 30 1

LETTER OF CONSENT

16 November 2005

Dear Parent / Guardian,

Ms. Froeks Kamminga, who has been a volunteer with Christel House since November 2004, is doing a research study at our school. She is interested to see the effects of the CHSA programme on the learners, for instance: have the children grown physically and has their academic performance in school improved over time. In order to do this, she needs to use information that Christel House has about the children, such as their weight and height, their absenteeism and school performance, and the household survey that CHSA conducts every year. We kindly ask your permission for her to use these data.

Ms. Kamminga will not use any learner's name, and her report will not mention any personal details for any learner or parent. Also, all the information will be kept confidential, and no one else outside the school will have access to the information. In as far as the household survey is concerned, she will only use those interviews that were done in 2004. Again, she will not use names or personal details that could identify the learner or the parent/guardian. This is to ensure confidentiality, and it is a condition for every research project.

Please note that we as the management of Christel House SA think this study is very useful, as it can show us how effective our programmes are and what we can do to improve them. We therefore hope you will agree with our request, but it is your choice. If you choose not to give your consent, this will not affect your child's place at school in any way.

Kindly complete the reply slip below and return it to the school by **Friday 18 November**.

Yours sincerely,

Melvin King
Principal

REPLY SLIP

I, ...Parent/Guardian of .... (name of child) in Grade ..... have read and understand the content of this letter.

I, □ **do give** my written and informed consent
I, □ **do not give** my written and informed consent

to Ms. Froeks Kamminga to use the information about weight, height, absenteeism and performance, and/or the information provided in the CHSA household survey 2004.

I understand this information will only be used for this study, that the study will respect confidentiality and that the study results will not affect the place of my child at CHSA.

Date .... Place......................... Signature.......................................

Appendix II Criteria for admission to Christel House South Africa

1. Area.
We serve the following communities around the school, which include - Athlone, Bokmakierie, Hanover Park, Kewtown, Langa, Mannenberg and Vygieskralal. Only learners from these areas can be considered as they are transported daily to and from the school.

2. Age Appropriateness.
For grade 1 applications, the learner must turn 7 years old in the year of admission. In other grades, they must be with their age cohort.

3. Poverty Level.
Our mission is to work with families who struggling to make ends meet. (Poverty level - R1,500 per household)

4. Movability
A huge investment is made in each learner. We wish to retain them for the full duration of their schooling. (Need to have been in area for min. of 5 years)

5. A semblance of family life
The home is an important part of our triangle - learner, educator and parent. We need the support of the family to meet our mission. (A visit to the home is done to determine worthiness)

6. School Readiness
The learner must be able to cope with our long day and academic programme. (Need to meet min. academic requirements)

Appendix III List of variables

_lageALL_2
_lageALL_3
_lageALL_4
_lwazchange_2
_lwazchange_3
_lwazchange_4
abs02
abs02boy
abs02girl
abs04
abs04boy
abs04girl
Abschange
Absenteeism
Absimprove
Adminno
agegr02
agegr04
ageyrs02
ageyrs04
eng02
eng02boy
eng02girl
eng04
eng04boy
eng04boy
Engchange
Engdeter
Engimprove
English
Fail
Failyear
failyearF
failyearM
Gender
gr02coll
gr04coll
gradeone02
gradethreefour02
gradetwo02
hap02
hap04
haz02
haz04
Height
height02
height04
Heightgain
hfazchange
improveENG
improveMATH
math
math02
math02boy
math02girl
math04
math04boy
math04girl
mathchange
mathdeter
mathimprove
overweight02
overweight04
overwt02
overwt04
percentile
percgain
sex
stunted02
stunted04
underweight02
underweight04
underwt02
underwt04
wap02
wap04
wasted02
wasted04
waz02
waz02A
waz02B
waz02boy
waz02C
waz02D
waz02girl
waz02high
waz02low
waz04
waz04boy
waz04girl
wazchange
wazchangeA
wazchangeB
wazchangeC
wazchangeD
weight
weight02
weight04
weightgain
Weightloss
Wfh
Wfhgain
Wfhzchange
whp02
whp04
whz02
whz04