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**Factors associated with nutritional status of children aged 0-60 months  
residing in Eastern Cape and KwaZulu-Natal Provinces**

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Dr. M. Faber; Medical Research Council

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## ABSTRACT

**Background:** Poor health, death, reduced human capacity, increased risk of chronic diseases later in life and poverty are the most prominent consequences of child malnutrition.

**Aim:** This study sought to assess the anthropometric status of 0-60 month-old children living in Eastern Cape and KwaZulu-Natal Provinces using the new WHO child growth standards; identify risk factors of child malnutrition. In addition, assess the prevalence and associated factors of the occurrence of a stunted child with a living-in overweight mother (SCOWT).

**Methods:** Secondary analysis was done on household socio-economic data, child health, child feeding practices, and anthropometric measurements for 2485 children and their mothers. Logistic regression was used to determine risk factors of stunting, overweight and underweight taking into account hierarchical relationships between risk factors. The Chi-square test and analysis of variance were used to identify related variables which were significantly different between SCOWT and non-SCOWT mother-child pairs as well as between wasted and non-wasted children.

**Results:** Prevalence of wasting, underweight, stunting and overweight was 3.4%, 7.3%, 28.6% and 16.1% respectively. The WHO child growth standards gave higher rates of stunting and overweight but lower rates of underweight. Risk factors for child stunting were male gender (Odds ratio (OR) =1.233;  $p=0.019$ ) and the fact that the mother thinks her child is growing well (OR=1.346;  $p=0.018$ ). On the other hand, handouts as source of food (OR=0.719;  $p=0.005$ ) and mother making important household decisions (OR=0.760;  $p=0.009$ ) were protective. Underweight was positively associated with child male gender (OR=1.432;  $p=0.021$ ), maternal education (minimum of 5 years of schooling: OR=1.720;  $p=0.002$ ), the fact that the mother thinks her child is growing well (OR=2.526;  $p<0.000$ ), still breastfeeding (in children <24 months: OR=2.022;  $p=0.014$ ) and history of gastrointestinal symptoms (OR=1.527;  $p=0.013$ ). Child overweight on the

other hand was positively associated with household having a regular source of income (OR=1.473;  $p=0.002$ ) but negatively with maternal education (OR=0.595;  $p=0.001$ ) and the fact that the mother thinks her child is growing well (OR=0.361;  $p<0.001$ ). Prevalence of SCOWT was 13.9% and SCOWT mother-child pairs were more likely to be older (both mother and child), have hand-outs as source of food, have used bottle-feeds in the 24 hours preceding survey (children<24months) but less likely to increase fluid intakes during episodes of diarrhoea. The children were more likely to be males.

**Conclusion:** The double burden of malnutrition occurred in these poor communities, households and individual children. Other than the effect of maternal education on the risk of underweight; the most important factors associated with stunting and underweight were child male gender and the fact that the mother thinks her child is growing well. On the other hand overweight was associated with maternal BMI and household having a regular source of income.

**Key words:** Child malnutrition; nutritional status; South Africa; rural; risk factors; stunting; underweight; overweight

## OPSOMMING

**Motivering:** Swak gesondheid, sterfte, verminderde menslike kapasiteit, 'n toename in die risiko vir kroniese siektes later in die lewe en armoede is die mees belangrike gevolge van kinderwanvoeding (beide ondervoeding en oorvoeding).

**Doelwitte:** Hierdie studie poog om risikofaktore vir kinderwanvoeding vir 0-60 maand oue kinders wat in die Oos-Kaap en KwaZulu-Natal provinsies woon, met behulp van die nuwe WGO kinder groeistandaarde, te identifiseer. Bykomend is die prevalensie en geassosieerde faktore op die voorkoms van groei belemmering met 'n inwonende oorgewig moeder (GBIOG) bepaal.

**Metodes:** Sekondêre analises is op huishoudelike sosio-ekonomiese data, kinder gesondheid, kinder voedingspraktyke en op antropometriese metings van 2485 kinders en hul moeders gedoen. Logistiese regressie is gebruik om risiko faktore vir groei belemmering, oorgewig en ondergewig, met in agneming van die hierargiese verwantskap tussen risiko faktore, te bepaal. Die 'Chi-kwadraat' toets en analise van variansie is gebruik om verwante veranderlikes wat betekenisvol tussen GBIOG en nie-GBIOG ma-kind pare verskil het, sowel as tussen uitgeteerde en nie-uitgeteerde kinders, te bepaal.

**Resultate:** Die voorkoms van spieruittering, groeibelemmering en oorgewig was 3.4%, 7.3%, 28.6% en 16.1% onderskeidelik. Die WHO standaard gee 'n hoër voorkoms van groeibelemmering en oorgewig, maar 'n laer voorkoms van ondergewig. Risiko faktore vir kinder groei belemmering was manlike geslag (Kans-verhouding (KV)=1.233;  $p=0.019$ ) en die feit dat die ma dink haar kind volgens wense groei (KV=1.346,  $p=0.018$ ). Aan die anderkant was voedsel wat uitgedeel is as bron van kos (KV=0.719;  $p=0.005$ ) en waar die ma belangrike besluite in die huishouding neem (KV=0.760;  $p=0.009$ ) beskermend. Ondergewig was positief met manlike geslag (KV=1.432;  $p=0.021$ ), moederlike opvoeding (minimum van vyf jaar skoolopleiding: KV=1.720;  $p=0.002$ ), die ma se persepsie oor die groei van haar kind (KV=2.526;  $p<0.001$ ), steeds borsvoedend (in kinders <24 maande: KV=2.022;  $p=0.014$ ) en geskiedenis van 'n

gastrointestinale simptome (KV=1.527;  $p=0.013$ ) geassosieer. Oorgewig kinders was positief geassosieer met 'n gereelde bron van inkomste (KV=1.473;  $p=0.002$ ), maar negatief met moederlike opvoeding (KV=0.595;  $p=0.001$ ) en moederlike persepsie oor die groei van haar kind (KV=0.361;  $p<0.001$ ) geassosieer. Die voorkoms van GBIOG was 13.9% en GBIOG moeder-kind pare was geneig om ouer te wees (beide moeder en kind), het voedsel wat uitgedeel is as bron van kos gehad, bottelvoeding 24 uur voor die opname gekry (kinders <24 maande oud), maar was minder geneig om vloeistofinname tydens diaree episodes te verhoog. Die kinders was ook meer geneig om manlik te wees.

**Gevolgtrekking:** Die dubbele las van wanvoeding was in hierdie arm gemeenskappe, huishoudings en individuele kinders sigbaar. Behalwe vir die effek van moederlike opvoeding op die risiko vir ondergewig, was die belangrikste faktore wat geassosieerd was met groeibemmering en ondergewig 'n kind van manlike geslag en die feit dat die moeder dink haar kind groei goed. Aan die anderkant is oorgewig geassosieerd met moederlike BMI en huishoudings met 'n gereelde bron van inkomste.

**Sleutelwoorde:** Kinderwanvoeding; voedingstatus; Suid-Afrika; landelik; risiko faktore; belemmerde groei; ondergewig; oorgewig.

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## ACRONYMS AND ABBREVIATIONS

AIDS	Acquired immunodeficiency syndrome
BMI	Body Mass Index
CVD	Cardiovascular disease
DALY	Disability-adjusted-life years
DoH	Department of Health
EC	Eastern Cape
GI	Gastrointestinal
HIV	Human immunodeficiency virus
INP	Integrated nutrition program
KZN	KwaZulu-Natal
MRC	Medical Research Council
NCDs	Non communicable diseases
NFCS	National food consumption survey
NFCS:FB-I	National food consumption survey, fortification baseline
NCHS	National Centre for Health Statistics
NGO	Non-governmental organisation
NIRU	Nutrition interventional research unit
SA	South Africa
SAJCN	South African journal of clinical nutrition
SAVACG	South African Vitamin A consultative group
SCOWT	Stunted child with living in overweight mother
SD	Standard deviation
SSA	Sub-Saharan Africa
TB	Tuberculosis
UNICEF	United Nations children fund
USA	United States of America
WHO	World Health Organisation
UN	United Nations

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**CHAPTER 1: INTRODUCTION**

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## 1.1 PROBLEM STATEMENT AND MOTIVATION

Malnutrition, a deviation from the norm in a child's growth and development, can manifest as under or overnutrition. Undernutrition can present itself as underweight (low weight-for-age), wasting (low weight-for-height) and stunting (low height-for-age), while overnutrition may manifest as overweight and obesity (high weight-for-height). Malnutrition is known to have detrimental effects on the child as well as the household and nation at large. Undernutrition is reported to be the underlying cause of up to 50% of the under-five mortality rate worldwide (UNICEF, 2008). Other detrimental effects of undernutrition include susceptibility to acute morbidity (Nannan *et al.*, 2007; Bejon *et al.*, 2008); decreased cognitive development (Grantham-McGregor *et al.*, 2007; Liu *et al.*, 2003); decreased economic productivity (Alderman *et al.*, 2006; Victora *et al.*, 2008) and susceptibility to chronic illnesses later in life (Barker *et al.*, 2002; Painter *et al.*, 2006).

Undernutrition, as a public health problem affects mostly children in developing countries. Between 2000 and 2006 more than a quarter of children younger than five years in developing countries were reported to be moderately or severely underweight or stunted (UNICEF, 2008). In South Africa (SA) undernutrition is reported to be a public health problem with stunting as the most prevalent anthropometric outcome. Among all age groups, children aged 1-3 years are reported to be most affected (Steyn *et al.*, 2005). Data from the South African Vitamin A Consultative Group (SAVACG) study that was done in 1994 showed a prevalence of 9.3% underweight, 22.9% stunting and 2.6% wasting in 6-71 months old children (SAVACG, 1996). The National Food Consumption Survey (NFCS) five years later reported similar results with 8.8% underweight, 19.3% stunting, and 3.3% wasting in 1-9 year-old children (Labadarios *et al.*, 2005). A more recent national survey, NFCS fortification baseline (NFCS:FB-I), that was done in 2005 reported 18% stunting in 1-9 year-old children (Labadarios *et al.*, 2008). Although the studies differed in their study designs these results suggest that the nutritional status of South African children has not changed much over the past 15 years.

South Africa (SA) is believed to be in nutrition transition as evidenced by co-existence of under and overnutrition (Jinabhai *et al.*, 2005; SAHDS, 2003). Secondary analysis of the 1999 NFCS data reported a prevalence of 17.1% combined overweight and obesity in children aged 1-9 years. Children living in formal urban areas were found to be most affected (Steyn *et al.*, 2005). The NFCS:FB-I reported a prevalence of 10% overweight and 4% obesity in children aged 1-9 years (Labadarios *et al.*, 2008). These results show that overweight/obesity is the second most prevalent adverse anthropometric outcome, after stunting, in South African children. This calls for concerted efforts, addressing both forms of malnutrition simultaneously in line with recommendations by international bodies like United Nations Standing Committee on Nutrition and World Bank (Uauy & Solomons, 2006; World Bank, 2006).

Development of childhood malnutrition is believed to be multi-factorial. According to the United Nations Children's Fund (UNICEF) conceptual framework for development of child malnutrition, an interplay of basic (societal issues like cultural, political, economic and societal systems), underlying (household issues like household food security, maternal and child care practices, water and sanitation) and immediate (dietary intake and disease state) factors determine the child's nutritional outcome (UNICEF, 1990). This framework is generally accepted among scientists but with recognition that the effect of each of these factors will differ from region to region.

Considering the high prevalence of poor anthropometric outcomes and their detrimental effects on health, targeted strategies are vital in order to attain optimal health for South African children. An Integrated Nutrition Program (INP) was developed in 1994 to coordinate an inter-sectoral approach to solving nutrition problems in SA (INP, 2004). One of its goals is to reduce the prevalence of malnutrition in children, therefore, ensuring optimal growth of infants and young children. To achieve this, the INP seeks to address underlying socio-economic, environmental, educational and health related causes of malnutrition. The Health Systems Trust (HST), a non-governmental organisation (NGO), embarked on the implementation of a project based on the INP principles in KwaZulu-Natal (KZN) and Eastern Cape (EC) Provinces. The Nutritional Interventional

Research Unit (NIRU) of the Medical Research Council (MRC) then carried out a baseline assessment of the socio-demographic and anthropometric profile of 0-71 month old children and their caregivers at the request of HST. The baseline assessment revealed that undernutrition was low in infancy but more or less doubled in the second year of life. On the contrary, childhood overweight was most prevalent in the first and second years of life. A high percentage of the female caregivers (EC 55%, KZN 45%) of the studied children were, however, overweight/obese (Smuts *et al.*, 2008).

The baseline study used Epi Info 2000 software package which is based on the National Centre for Health Statistics (NCHS)/World Health Organisation (WHO) child growth reference (Hamill *et al.*, 1979) to construct anthropometric indices. This reference, however, is reported to underestimate the prevalence of stunting when compared to the newer WHO child growth standards (De Onis *et al.*, 2006; Nuruddin *et al.*, 2009). The study on the development of the WHO child growth standards followed a prescriptive approach and it is based on healthy breastfed children (De Onis *et al.*, 2004). Re-assessing the anthropometric status of the children in the baseline survey using the newer WHO child growth standards would therefore be beneficial.

## **1.2 RESEARCH AIMS AND OBJECTIVES**

### **1.2.1 Aim**

To determine factors associated with poor nutritional status of 0-60 month old children living in the EC and KZN Provinces as measured anthropometrically.

### **1.2.2 Objectives**

1. To reassess the anthropometric status using the new WHO child growth standards (WHO, 2006) and compare the results with those of the older WHO/NCHS child growth reference (Hamill *et al.*, 1979).
2. To investigate the association between the anthropometric status of the children and socio-economic status, perceived household food availability, maternal and child care practices, environmental factors and child morbidity.

3. To explore the prevalence of coexistence of a stunted child and an overweight mother in the same household and determine factors associated with this paradoxical phenomenon.

### **1.3 STRUCTURE OF MINI-DISSERTATION**

This mini-dissertation is written in article format comprising of four chapters. Chapter one is the introductory chapter consisting of the problem statement, aims, objectives, an articulation on the structure of the mini-dissertation and authors' contributions to the research done. Chapter two is the literature review providing background information on current knowledge about child nutrition and risk factors of child malnutrition to guide interpretation of results. Chapter three is the article "Risk factors of poor anthropometric status in children under 5 years living in rural districts of the Eastern Cape and KwaZulu-Natal Provinces, South Africa". The article will be submitted to the South African Journal of Clinical Nutrition (SAJCN) to be considered for publication. Chapter four gives general conclusions and recommendations. References for each chapter are provided at the end of each chapter. References for chapter three are written in Vancouver style in line with authors instructions for the SAJCN, while all the other references are written according to the North-West University Harvard reference style.

#### 1.4 CONTRIBUTIONS OF THE AUTHORS

This work is an outcome of contributions by a team of researchers whose contributions to the work is detailed in Table 1.1.

**Table 1.1 Qualifications and roles of the research team**

NAME	ROLE IN STUDY
Maemo Lesiapeto (M. Sc student)	Responsible for all aspects of the study: Literature review, data analysis, interpretation and writing up the results
Prof C.M. Smuts (Biochemist)	Project leader; provided supervision of the whole project. He was also supervisor for Maemo Lesiapeto
Dr S.M. Hanekom (Dietician)	Overlooked the financial needs to the study. Also provided guidance in scientific writing and data interpretation
Dr M. Faber (Nutritionist)	Provided guidance on the design, data analysis and interpretation of results. She was also member of the team that collected the original data.

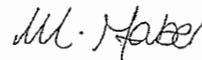
I declare that I have approved the above-mentioned study, that my role in the study is as indicated above is representative of my actual contribution and I hereby give my consent that it be published as part of M. Sc mini-dissertation of Maemo Lesiapeto.



Prof C.M. Smuts



Dr S.M. Hanekom



Dr M. Faber

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## CHAPTER 2: LITERATURE REVIEW

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## 2.1 INTRODUCTION

This chapter will summarize current literature on child growth, nutrition transition and malnutrition in South African children younger than five years. Socio-economic and demographic indicators of SA will also be discussed due to their relevance in child nutrition and health. The information was gathered from a variety of sources like books (to provide background knowledge), peer reviewed publications, communication with experts in the area as well as from websites of relevant organisations like the UNICEF, WHO, Department of Health (DoH) and Statistics South Africa (SSA). For the purpose of this literature review the following definitions will apply.

**Malnutrition** - A deviation from the norm in a child's growth and development. It can manifest as either under or overnutrition (WHO, 1995a). The term malnutrition, however, is often used interchangeably with undernutrition in literature but for the purpose of this review malnutrition will be used to refer to under and overnutrition collectively.

**Undernutrition** - Is an under-nourishing process in which the normal needs of energy and one/more nutrients are continually not met or lost at a greater rate than acquired. It is a cumulative process thus making its measurement difficult. In public health, child undernutrition is usually assessed by anthropometric measurements and it encompasses stunting, underweight and wasting. Micronutrient deficiencies are another form of undernutrition (WHO, 1995a).

**Stunting** - Failure to reach linear growth potential and is measured as height-for-age at least two standard deviations (SD) below the median of a reference population. It is a good indicator of long-term undernutrition among young children. For children <24 months recumbent length is used instead of height (WHO, 1995a).

**Wasting** - Refers to thinness and it is measured as weight-for-height at least 2SD below the median of a reference population. It describes a recent or current severe process leading to significant weight loss; usually a consequence of acute starvation or severe

disease. It is commonly used as an indicator of undernutrition among children in emergency situations such as famine, war displacements and natural disasters (WHO, 1995a).

**Underweight** - Is measured as weight-for-age at least 2SD below the median of a reference population. It may indicate wasting or stunting, but does not differentiate between them. It is the most commonly assessed form of undernutrition in developing countries (WHO, 1995a).

**Obesity** (or energy overnutrition) - Refers to accumulation of excess fat tissue relative to lean body mass. Since measurement of body fatness is difficult and complex, anthropometry is readily used as a proxy for body fatness. In children overweight is measured as body mass index (BMI) or weight-for-height at least 2SD above the median of a reference population, while obesity is at least 3SD above the median (WHO, 1995a).

## **2.2 SOCIO-ECONOMIC AND DEMOGRAPHIC INDICATORS OF SOUTH AFRICA**

### **2.2.1 Geography and population**

South Africa is in the southern region of Africa, according to the United Nations (UN) division of the world. This region is flogged by a number of social ills like poverty, political unrests, wars, infectious disease epidemics and famines. The country is divided into nine provinces with vast demographic and socio-economic differences. The SA population of 48.5 million is heterogeneous comprising mainly of Blacks/Africans (79%), whites (9.5%), coloured/mixed race (9%) and Indian/Asian race (2.6%). Sixty percent of the SA population live in urban areas. The EC and KZN provinces are located in the south-eastern and eastern side of the country respectively. The two provinces take up 21.6% (EC 13.9%; KZN 7.7%) of the SA land and are inhabited by 35% (EC 13.5%; KZN 21.2%) of the population. EC and KZN provinces house 15% and 22% of the SA children aged 0-4 years respectively (SSA, 2007).

### **2.2.2 Selected demographic and socioeconomic indicators**

South Africa is an upper middle income country (WHO, 2009) and in 2007 the country had a gross national income (GNI) per capita (US \$) of 5760 (UNICEF, 2009). In 2005, however, 26% of the South African population lived below the international poverty line of US\$1.25/day (UNICEF, 2009). The SA constitution spells out adequate food and water as a human right for all South Africans (SA, 1994). The country has also ascribed to a number of international declarations with food, nutrition and health components like the Universal declaration of human rights (UN, 1948) and the convention on the rights of the child (UN, 1990b). Article 24 of the human rights declaration advocates for attainment of the highest standard of health and minimized malnutrition and other child health ills. The living conditions of South Africans are reported to have been improving since 1996 (time when the first community and household survey was carried out). About 80% have electricity in their homes while 88% have access to improved drinking water sources (SSA, 2007). Services and facilities, however, are generally better in urban than in rural areas (SSA, 2007; UNICEF, 2009). Housing, sanitation, access to electricity and access to improved drinking water were below the national average in EC and KZN provinces in 2007. Also, in these two provinces only 54% (EC) and 60% (KZN) of the people live in formal dwellings (SSA, 2007).

The population of SA grew at an annual rate of 1.7% between 1990 and 2007 with total fertility rate of 2.5 births per woman, crude birth rate of 21.7 per 1000 and crude death rate of 14.3 per 1000. In 2007 under-five mortality rate was reported to be 59 per 1000 live births (SSA, 2007; UNICEF, 2009). The percentage share of the population aged 0-14 years has been gradually declining while that of 15-64 years has been increasing since 1996 (SSA, 2007).

## 2.3 CHILD GROWTH

### 2.3.1 Infant and young child growth patterns

In human life, the foetal stage represents a period during which growth is at its highest rate followed by infancy. During infancy most children will double their birth weight by 5-6 months and triple it by one year, while they will increase their body length by 55% and head circumference by 40%. In the second year of life an average child grows by about 12 cm and gains about 3.5 kg. Following that, growth rate slows down to nearly a constant at the beginning of 4-5 years with average annual weight and height increments of about 2 kg and 6 cm respectively. The rate of growth will continue to be constant during middle childhood but some gender differences will begin to appear in height, while in weight only minimal differences will be observed. During adolescence, growth rate continues to be constant until at the onset of puberty where the growth spurt commences and secondary sexual characteristics appear. After this, growth rate decelerates until adulthood (Sun, 2006:19).

Nutritional demands during childhood, especially infancy, are high relative to those of adults. This is a consequence of children's relatively high growth rate, high proportion of metabolically active tissues (like the brain) and frequent occurrence of childhood illnesses. Attainment of these high nutritional needs can be hindered by physiological factors (like immaturity of the gastrointestinal and excretory systems), developmental stage (inability to search for food and eat), neurological impairment, psychological disorders and social and educational disadvantage. A notion that children are just small adults has long been dismissed with recognition that children are growing individuals and exhibit developmental changes at different stages of their lives. These include developmental changes in the gastrointestinal (GI) system to enhance the efficacy of nutrient absorption, while the kidneys and liver progressively increase ability to adapt to changes in under or over-supply of nutrients. More importantly is the children's neurological maturity from being completely dependent on adults in infancy to seeking out for food and later selecting food supply as they continue to grow and develop (Williams, 2005:378).

Child growth, however, follows a certain rhythm which can be disturbed by nutritional deficits, excesses or childhood illnesses. This highlights the importance of monitoring child growth and development (Williams, 2005:378). Anthropometric measurements are simple, cheap and cost-effective in assessing the nutritional status of children and those most commonly measured include weight, height and head circumference. Measurements like skin fold thickness, waist circumference and mid-upper arm circumference may, however, also be assessed. These anthropometric measurements can then be assessed against those of a reference population to identify growth deficits or excesses. To achieve this, the anthropometric measurements can be plotted against those of a reference population to observe graphically child growth patterns or they can be transformed into age-specific anthropometric indices like height-for-age, weight-for-age, weight-for-height and BMI (Sun, 2006:19; WHO, 1995a). Anthropometric indices can then be expressed as z-scores (SD-scores), percentiles or percent of median. Use of SD-scores (or z-scores) is the preferred method for reporting anthropometric data in public health nutrition since it allows for statistical calculations like mean values (WHO, 1995a).

### **2.3.2 The history of child growth references**

Child growth references are used internationally in both public health and clinical practice. In public health they are often used as early warning signals where emergencies related to food and nutrition are predicted, in evaluation of child care practices and in nutrition screening to identify population groups at risk of malnutrition. In clinical settings child growth references are used for growth monitoring and promotion as well as identification of abnormal deviations of growth (WHO, 1995a). The first international child growth reference was developed by the NCHS of the United States of America (USA) (Hamill *et al.*, 1979). To develop this reference two distinct data sets which were collected at different time periods were combined; the Ohio Fels Research Institute Longitudinal Study (for children 0-24 months) and the United States (US) Health Examination Survey (for children over 24 months). The Fels Research Institute Longitudinal Study sample consisted of infants predominantly formula fed, of a homogenous genetic, geographic and socio-economic status. The US Health Examination Survey was a national cross-sectional survey. The studies followed a descriptive

approach (describing how the children grew) and the children were measured once every three months (Hamill *et al.*, 1979). The WHO endorsed the reference for international use which helped with identification of child malnutrition and also allowed for international comparisons.

Over time, however, the adequacy of the NCHS/WHO reference in assessing child growth was questioned due to observations that healthy breastfed infants living in environments supporting achievement of genetic growth potential grew less rapidly and deviated significantly from the reference. Weight-for-age and weight-for-height z-scores of breastfed infants were found to deviate from that of the reference population from two to three months of age (Agostoni *et al.*, 1999; Victora *et al.*, 1998; WHO, 1995b). The limitations of the NCHS/WHO reference were attributed to the fact that infants were measured once every three months (thus failed to capture the rapid changing growth pattern of this age group), the sample population was small and homogenous, infants were predominantly formula fed and the analytical methods available at that time were inadequate for developing an international child growth reference. This deviation of the growth patterns of healthy breastfed children was considered to be sufficient to lead health workers to faulty decisions like premature introduction of complementary feeds or supplementation with other milks (Victora *et al.*, 1998; WHO, 1995b). In poverty-stricken communities where the burden of infectious diseases is high the consequences of such practices could be life threatening.

To address the limitations of the NCHS/WHO reference the World Health Assembly resolved that a new international child growth reference be developed. The new WHO child growth standards were then developed following a multi-country study which was specifically designed to develop child growth standards (De Onis *et al.*, 2004a; Garza & De Onis, 1999). The study followed a prescriptive approach where a large sample of breastfed children living in environments which did not hinder their genetic growth potential was studied. A longitudinal study design was employed for children younger than two years and a cross-sectional study design for children 18–71 months of age. In the longitudinal study children were measured every two weeks in the first two months of life and then monthly until 12 months old and thereafter every two months (De Onis *et*

*al.*, 2004a; Garza, 2006). Studies comparing growth patterns of children based on the NCHS/WHO reference and the new WHO child growth standards found that healthy breastfed infants tracked along the WHO standards while appearing to falter on the NCHS/WHO reference. It was further observed that stunting and obesity increased for all age groups when assessed by the new WHO standards, while underweight reduced mainly in infancy (De Onis *et al.*, 2006; Nuruddin *et al.*, 2009).

### **2.3.3 Relevance of child growth in human health**

Among all age groups children are especially vulnerable as demonstrated by the high number (11 million a year worldwide) of them dying in the first five years of life (Black *et al.*, 2008; UNICEF, 2008). As alluded to in Section 2.2.1, child growth can be disrupted by nutritional deficits/excesses and illnesses, making monitoring of child growth an important aspect of ensuring good health. Although growth attainment on its own is not sufficient to evaluate the health of an individual child adequately, it does provide a good indication of attainment of well-being (WHO, 1995b). Since children and infants are particularly vulnerable to ill-health and poverty, nutrition assessment of their growth provides a 'sentinel' indicator of the health and socio-economic development or status of the communities in which they live. An example of this is the use of child underweight as an indicator for attainment of the first Millennium Development Goal (MDG1) which is to reduce extreme poverty and hunger by half by 2015 (UN, 1990a). The prenatal period and early childhood are increasingly recognized as critical stages for development of undernutrition (Maleta *et al.*, 2003; Shrimpton *et al.*, 2001) and obesity (Chomtho *et al.*, 2008; Dietz, 1994). The World Bank highlights the 'window of opportunity' (period between prenatal through to two years of life) as a crucial period in which efforts to reduce child malnutrition are most likely to be effective (World Bank, 2006).

## 2.4 THE NUTRITION TRANSITION

Nutrition transition refers to major changes in dietary composition and physical activity levels in societies resulting in changes in the nutritional profile (stature and body composition) of the human populations (Popkin, 2006). The nutrition transition is reported to follow two other important shifts, namely the demographic and the epidemiological transition. The demographic transition denotes a shift from a state of high birth and death-rates to a state where birth and death-rates are low (Omran, 2005). Epidemiological transition on the other hand refers to a shift from a pattern where diseases associated with undernutrition, poor sanitation, famines and unsafe environment are prevalent to one where noncommunicable diseases (NCDs) like obesity, cardiovascular diseases and diabetes mellitus are more prevalent (Olshansky & Ault, 1986). Factors associated with the nutrition transition include urbanization, economic growth, improved technology, population growth and acculturation. Popkin (2006) described the historical patterns of the nutrition transition as:-

- Pattern 1      **Collecting food**; characterised by hunter-gatherer populations who ate diets high in carbohydrate and fibre but low in fat
- Pattern 2      **Famine**; periods where acute hunger, starvation were prevalent with minimal variety in the diet
- Pattern 3      **Receding famine**; characterised by increased consumption of fruits and vegetables and reduced dependency on staple foods
- Pattern 4      **Degenerative diseases**; where there is increased availability of cheap foods which are high in fat and refined carbohydrates but low in fibre
- Pattern 5      **Behavioural changes**; health awareness resulting in adoption of healthier eating patterns and physical activity leading to successful aging.

What is of concern, however, is the rapid shift from receding famine (Pattern 3) to a pattern characterized by degenerative diseases (Pattern 4) resulting in a state where obesity and NCDs become national public health problems while undernutrition-related infections remain at unacceptably high levels in developing countries (Popkin, 2002;

Popkin & Gordon-Larsen, 2004). These societies are said to suffer with the double burden of morbidity and mortality. In SA, this state of the double burden of morbidity and mortality is further worsened by the Human Immunodeficiency Virus/Acquired Immuno Deficiency Syndrome (HIV/AIDS) pandemic and related infections (Zwang *et al.*, 2007; Welz *et al.*, 2007). South Africans, especially those in urban areas, are found to be shifting from their traditional plant-based diets to more energy dense Western diets as well as adopting more sedentary lifestyles (Kruger *et al.*, 2005; Steyn *et al.*, 2006).

## **2.5 NUTRITIONAL STATUS OF PRESCHOOL CHILDREN**

### **2.5.1 Introduction**

This section will review literature on the global and national prevalence of anthropometric child malnutrition (wasting, underweight, stunting and overweight/obesity). Another form of child malnutrition of public health concern is hidden hunger, which refers to micronutrient deficiencies. Those of great public health concern include iron, vitamin A, iodine, folic acid, calcium and zinc deficiencies. Most undernourished children in developing countries, including SA, would suffer from a combination of micronutrient and macronutrient deficiencies (Black *et al.*, 2008; Sanghvi *et al.*, 2007). For the purposes of this literature review hidden hunger will not be discussed further.

### **2.5.2 Prevalence of childhood malnutrition**

#### **2.5.2.1 Global Prevalence**

Globally, undernutrition was known to affect mostly children in developing countries while overweight and obesity affected mostly children in developed countries. There has been a gradual decrease in childhood undernutrition (anthropometric) worldwide though this decrease was not consistent in all UN regions and sub-regions (De Onis *et al.*, 2000). It was estimated that 33% of children younger than five years in developing countries were stunted in 2000. This was a decrease by 40 million children from a prevalence of

47.1% in 1980 (De Onis *et al.*, 2000). Of all the developing regions Africa was estimated to have the highest prevalence of childhood stunting (35.2%) though there were some sub-regional variations with Western Africa having the highest (34.9%) and North Africa having the lowest (20.2%) prevalence (De Onis *et al.*, 2000). In terms of numbers, South Asia had the largest number of stunted children. In another study De Onis *et al.* (2004b) estimated that globally childhood underweight will reduce from 26.5% in 1990 to 17.6% in 2015, a reduction of 50.4 million children aged younger than five years. Childhood underweight was, however, estimated to increase in Africa from 24.0% to 26.8% by the year 2015. The prevalence of childhood underweight was estimated to be 0.9% and 19.3% in developed and developing countries respectively in 2015 reflecting a big gap between the developed and developing world (De Onis *et al.*, 2004b).

Establishment of the WHO global database on child growth and development as a method to estimate global trends in child malnutrition have facilitated tracking of the nutritional status of children (De Onis & Blössner, 2003; Svedberg, 2006). These two studies reported comparable changes in child stunting (from 34% to 24%) and underweight (from 27% to 21%) globally between 1990 and 2005 (De Onis *et al.*, 2004b; Svedberg, 2006). Table 2.1 shows recent estimates of child undernutrition based on the new WHO child growth standards in 2005. About 32% (178 million) of children younger than five years in developing countries were stunted (Black *et al.*, 2008). Though this estimate suggests an increase in stunting this may be an artefact of the change in the reference population used. Globally 36 countries accounted for 90% of all stunted children, SA included (Black *et al.*, 2008). In Sub-Saharan Africa male preschool children are found to be more likely to be stunted when compared with their female counterparts. This was found to be more pronounced in children of the lowest socio-economic status group (Wamani *et al.*, 2007).

Table 2.1 Global estimates of childhood undernutrition based on the World Health Organisation child growth standards (Adapted from Black *et al.*, 2008)

	Children <5 years in millions	Percentage stunted (95% CI)	Percentage severely wasted (95 % CI)	Percentage underweight (95 % CI)
Africa	141 914	40.1 (36.8–43.4)	3.9 (2.2–5.7)	21.9 (19.8–24.0)
Eastern	48 807	50.0 (42.3–57.9)	3.6 (1.5–8.4)	28.0 (23.6–32.9)
Middle	20 197	41.5 (38.3–44.8)	5.0 (2.0–12.0)	22.5 (19.2–26.1)
Northern	22 171	24.5 (17.3–33.9)	3.3 (1.2–8.9)	6.8 (2.8–15.3)
Southern	6 075	30.2 (25.4–35.6)	2.7 (1.0–6.8)	11.4 (8.0–15.7)
Western	44 663	37.7 (33.5–42.1)	4.3 (1.8–9.6)	23.9 (21.0–26.9)
Asia	356 879	31.3 (27.5–35.1)	3.7 (1.2–6.2)	22.0 (18.5–25.6)
Eastern	95 070	14.5 (13.5–15.5)	0.7 (0.3–1.6)	5.1 (4.8–5.4)
South-central	181 481	40.7 (34.2–47.7)	5.7 (2.4–12.8)	33.1 (26.6–40.3)
South-eastern	54 970	34.3 (26.5–43.5)	3.6 (1.4–8.8)	20.7 (17.2–24.6)
Western	25 358	20.6 (10.0–38.8)	1.6 (0.4–5.8)	8.9 (2.8–24.2)
Latin America	56 936	16.1 (9.4–22.8)	0.6 (0.2–1.0)	4.8 (3.1–6.4)
Developing regions	555 729	32.0 (29.3–34.6)	3.5 (1.8–5.1)	20.2 (17.9–22.6)

CI: confidence interval

Variations in the definition of childhood obesity in epidemiological studies have led to difficulties in international comparisons (Ng & Lai, 2004; Lobstein *et al.*, 2004). Prior to 2006, two different international criteria were used to define child obesity and overweight; weight-for-height assessed against the NCHS/WHO reference and BMI for age assessed against the International Obesity Taskforce reference which was developed following concerns with the NCHS/WHO reference (Cole *et al.*, 2000). The new WHO child growth standards are also now available for use (WHO, 2006a).

Childhood obesity was originally known to be a problem of developed countries where children are continually reported to be above their expected weight-for-height (Dehghan *et al.*, 2005; Hedley *et al.*, 2004; Wang & Lobstein, 2006). Martorell and colleagues (2000) found overweight and obesity (defined as weight-for-height >1 SD and >2 SD respectively) in preschool children to be low in some developing countries in Asia and SSA. Childhood overweight and obesity were, however, found to be high in some

developing countries in Latin America, the Caribbean, Middle East and North Africa at levels comparable to those found in the USA. In another study De Onis and Blössner (2000) found childhood overweight (weight-for-height >2 SDs) to be 3.3% (17.5 million preschool children) in developing countries, while wasting was 2.5-3.5 times higher than overweight rates. In this study, however, obesity was found to be higher (6.5%) in Southern Africa compared to other studied African UN sub-regions, an observation attributed to the influence of higher child overweight rates in South African children (De Onis & Blössner, 2000).

The WHO (WHO, 2009a) estimated that in 2007 22 million children under the age of five years were overweight worldwide, of which more than 75% lived in low and middle-income countries. Another observation of concern is that in low and medium-income countries obesity is increasing at rates more rapid than it did in high-income countries (Dieu *et al.*, 2009; Popkin & Gordon-Larsen, 2004). In developed countries children of lower socio-economic status (Cecil *et al.*, 2005; Kleiser *et al.*, 2009) and certain ethnic groups like African-American and Hispanic children in the USA (Lobstein *et al.*, 2004; Ogden *et al.*, 2006) are reported to be most affected. In developing countries on the other hand, childhood obesity is most prevalent among the rich and in urban areas (Lobstein *et al.*, 2004; Sakamoto *et al.*, 2001). In older children girls are found to be at higher risk of childhood obesity than boys (Lobstein *et al.*, 2004; Irigoyen *et al.*, 2008), but results are inconsistent in preschoolers (Blomquist *et al.*, 2007; Jinabhai *et al.*, 2007).

#### **2.5.2.2 Prevalence in South Africa**

Table 2.2 shows the prevalence of child malnutrition in South African children. National data suggest that the anthropometric status of the children has changed minimally over the past 15 years. Though the studies differed in study design, stunting is reported as the most prevalent adverse anthropometric outcome followed by combined overweight and obesity in children younger than nine years (SAVACG, 1996; Labadarios *et al.*, 2005a; Labadarios *et al.*, 2008). Based on the WHO criteria for assessment of severity of undernutrition in a population (Gorstein *et al.*, 1994), the most recent report of 18% stunting, 9.3% underweight and 4.5% wasting implies that nationally undernutrition is of

low severity. There is currently no criterion for assessment of severity of childhood overweight or obesity in populations. National prevalence of child malnutrition, however, masks the variations in the nutritional status of the children by age group and area of residence. Children aged 1-3 years are consistently found to be most affected by both forms of malnutrition (Figure 2.1). Children living in rural areas, especially rural formal areas, are most affected by undernutrition. Overweight and obesity are more prevalent in children living in urban areas (Labadarios *et al.*, 2008).

Table 2.2 Prevalence of child malnutrition in South African children over the past 15 years (SAVACG, 1996; Labadarios *et al.*, 2005a; Labadarios *et al.*, 2008)

ANTHROPOMETRIC PARAMETER	SAVACG <sup>†</sup> (1994)	NFCS † (1999)	NFCS:FB-I† (2005)
<b>Height-for-age</b>			
< 2 SDs	22.9 %	21.6%	18.0%
< 3 SDs	6.6%	6.5%	5.1%
<b>Weight-for-age</b>			
< 2 SDs	9.3%	10.3%	9.3%
< 3 SDs	1.4%	1.4%	1.0%
<b>Weight-for-height</b>			
< 2 SDs	2.6%	3.7%	4.5%
< 3 SDs	0.4%	0.8%	1.0%
<b>Body mass index</b>			
25-30 kg/m <sup>2</sup>	Not reported	12.1% <sup>**</sup>	10.0%#
≤ 30	Not reported	5.0% <sup>**</sup>	4.0%#

SD: Standard deviation;

SAVACG: South African vitamin A consultative group

NFCS: National food consumption survey

NFCS: FB-I: National food consumption survey fortification baseline

<sup>†</sup> Results for children aged 6-71 months

\*Results for children aged 1-8 years

†Results for children aged 1-9 years

Results for children aged 12-71 months

#Results from Steyn *et al.*, 2005

Small scale studies in various parts of SA generally report results which are different from the national prevalence in both under and overnutrition. In a study of preschool children living in an informal settlement in Bloemfontein undernutrition was above the

national prevalence with stunting, underweight and wasting affecting 22-29%, 19-20% and 4-7% of the preschool children respectively (Dannhauser *et al.*, 2000). On following a cohort of Black infants in rural Limpopo Province, Mamabolo and researchers (2004) reported that 9.6%, 48.9% and 7.3% of the children were stunted, underweight and wasted respectively at birth. By three years of age 48%, 9%, 1%, 18% and 24% were stunted, underweight, wasted, overweight and obese respectively (Mamabolo *et al.*, 2005). Faber *et al.* (2001) observed results similar to national prevalence of undernutrition but not obesity in 2-5 year olds living in a rural area in KZN Province. In a large sample of preschool children of the poorest areas of KZN and EC Provinces, Smuts *et al.* (2008) found stunting to be of concern especially in children over 12 months while obesity was highest in infants.

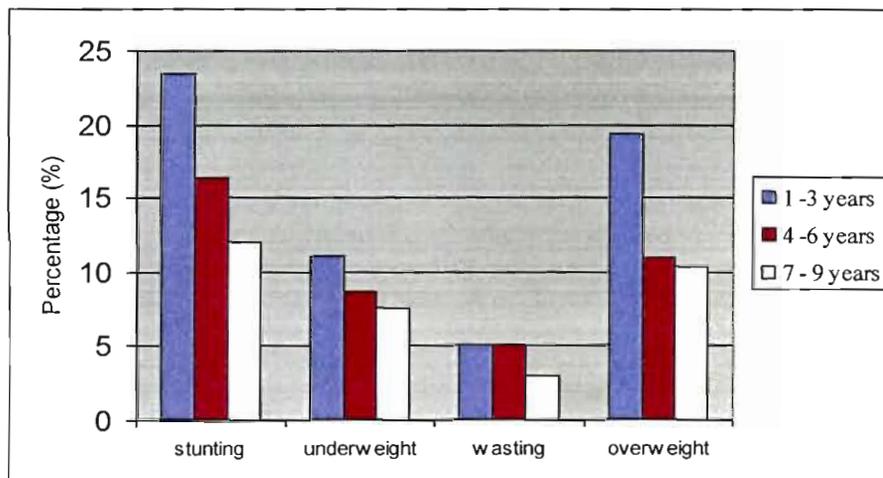


Figure 2.1 Anthropometric status of South African children aged 1-9 years by age group (Labadarios *et al.*, 2008)

This literature review highlights that undernutrition coexists with overnutrition in South African children. Jinabhai *et al.* (2005) reported similar observations in children aged 2-11 years residing in KZN province; an increase in overweight and obesity while stunting remained high over a period of five years. This observed state of coexistence of under and overnutrition is termed 'the double burden of malnutrition' or the nutrition paradox and it is believed to be one of the consequences of the nutrition transition. National data

from other middle and upper-low-income countries like China (Doak *et al.*, 2002), Brazil (Monterio *et al.*, 2004) and Pakistan (Jafar *et al.*, 2008) also reported this paradox.

Epidemiological studies globally also report observations of this double burden of malnutrition in the same household where any two members of the household (Doak *et al.*, 2002; Doak *et al.*, 2005) or mother-child-pairs (Barquera *et al.*, 2007; Garrett & Ruel 2005; Jehn & Brewis 2009) suffer with opposite forms of malnutrition. There is currently no national data on this occurrence in SA. Both forms of malnutrition can occur in the same child (Fernald & Neufeld, 2007; Mamabolo *et al.*, 2005) and stunted children are found to be especially at risk of obesity (Hoffman *et al.*, 2007; Kruger *et al.*, 2004). The mechanisms of why stunted children are at risk of overweight/obesity are still largely unknown, but early life metabolic programming and impaired fat oxidation are suggested (Hoffman *et al.*, 2000; Wells, 2007). What is of interest is that, globally, in poor countries the double burden affects mostly people in the upper quintile of the socio-economic status while in middle-income countries and high-income countries the poorest of those societies are most affected by the double burden of malnutrition (Monterio *et al.*, 2004; Armstrong & Reilly., 2003).

## **2.6 CONSEQUENCES OF CHILD MALNUTRITION**

### **2.6.1 Introduction**

The detrimental effects of child malnutrition include short-term consequences like increased risk of mortality and morbidity as well as more long-term consequences like reduced economic productivity and increased risk of NCDs later in life (Black *et al.*, 2008). Most research on the consequences of childhood undernutrition was done in developing populations while at the time of writing this review, research on childhood overweight and obesity was mostly done in developed countries.

### **2.6.2 Increased risk of morbidity**

The relationship between nutrition and immunity has long been recognized and as research evolved both under and overnutrition are now reported to relate with immunity

in a vicious cycle (Keusch, 2003; Solomons, 2007). Undernutrition (anthropometric) may increase the incidence and severity of infections like diarrhoea, malaria, HIV and respiratory disease by impairing the immune function (Bejon *et al.*, 2008; Fillol *et al.*, 2009). Increased infections will in-turn worsen undernutrition by increasing nutritional needs and nutrient loss, and reducing nutrient intake (Garza, 2005). Black *et al.* (2008) estimated that percentage of disability-adjusted life-years (DALYs) lost in children younger than five years due to anthropometric undernutrition is 52.1% (18.7% underweight, 12.6% stunting, 14.8% wasting). Of the percentage of DALYs lost due to wasting 6% was due to severe wasting. In SA protein and energy malnutrition in children aged 0-4 years was estimated to contribute 44.7% of the total disease burden in 2000 (Nannan *et al.*, 2007).

Though the complications of childhood obesity are anticipated to be more pronounced in later life there are observations of increased risk of hypertension, dyslipidaemia and hyperinsulinemia in obese children, in some as early as 3-5 years (Belfort *et al.*, 2007; Burke *et al.*, 2005a; Weiss *et al.*, 2004). There is an alarming increase in type 2 diabetes mellitus in children concurrent with increase in childhood obesity (Craig & Huang, 2009; Sinha *et al.*, 2002). Epidemiological studies reported an association between asthma and obesity in children though it has been difficult to determine the temporal order of the association (To *et al.*, 2004; Von Mutius *et al.*, 2001). Carroll *et al.* (2007) reported an increased risk of hospital admissions due to asthma exacerbations in obese children compared to those of normal weight. Another pulmonary complication of obesity is apnoea/disordered breathing (Redline *et al.*, 1999; Sulit *et al.*, 2005). Obese children are often reported to have poor quality of life and in a study of obese American children and adolescents the participants rated the quality of their lives to be low at levels comparable with that of children with cancer (Schwimmer *et al.*, 2003). Other complications of childhood obesity include glomerulosclerosis (Adelman *et al.*, 2001), Blount's disease (Parsons *et al.*, 2007) and gallstones (Friesen & Roberts, 1989).

### **2.6.3 Susceptibility to noncommunicable diseases later in adulthood**

There is growing evidence that development of obesity and a number of NCDs start in early childhood. Over the past two to three decades research has reported that poor growth in utero and/or accelerated early childhood weight gain is associated with changes in metabolism resulting in increased risk of adult obesity (Chomtho *et al.*, 2008; Jones-Smith *et al.*, 2007; Sayer *et al.*, 2004), type 2 diabetes (Wang & Lobstein *et al.*, 2006; Yajnik, 2009), high blood pressure (Law *et al.*, 2002; Sesso *et al.*, 2004) and cardiovascular disease (CVD) (Burke *et al.*, 2005a; Painter *et al.*, 2006). This is known as early programming (Barker *et al.*, 1993). Childhood obesity is reported to track into adolescence and adulthood in some individuals (Burke *et al.*, 2005a; Whitaker *et al.*, 1997), while stunted children are especially at higher risk of obesity in later life (Popkin *et al.*, 1996; Sawaya *et al.*, 2004).

Research on how early life nutrition affects adult risk of NCDs is ongoing but some primary pathways have been suggested. The first one is that poor growth during foetal and infancy permanently constrain lean mass resulting in impairment in metabolic capacity to tolerate high energy/fat diets later in life. The second pathway is that rapid weight gain in early life may divert energy disproportionately to the adipose tissue preferably abdominal, resulting in increased metabolic load. Lastly an oversupply of nutrients in utero can impair appetite and energy metabolism in the child resulting in increased obesity and subsequent NCDs in later life (Wells, 2007).

### **2.6.4 Increased risk of mortality**

Risks of mortality due to under- and overnutrition vary in terms of timing and cause of death. Since standardization of methodology estimating contribution of undernutrition to mortality by Pelletier *et al.* (1994), undernutrition is found to potentiate 50-60% of childhood deaths. These deaths are mostly due to mild-to-moderate undernutrition since these are the most numerous when compared to severe cases of undernutrition (Caulfield *et al.*, 2004; Garenne *et al.*, 2006). This contribution of undernutrition to child mortality was found by Bejon *et al.* (2008) to be similar with that seen caused by diseases like

gastroenteritis, HIV/AIDS, severe malaria and invasive bacterial disease. Black *et al.* (2008) estimated that child undernutrition (underweight, stunting and wasting) was responsible for five million (48.1%) childhood deaths in 2005 worldwide. Of the three adverse anthropometric outcomes underweight was found to be responsible for the largest disease burden. In SA Nannan *et al.* (2007) reported that just under 12 000 (12.3%) deaths in children aged below four years was attributable to underweight.

Childhood mortality due to the potentiating effect of obesity is not known. Overweight/obesity, however, contribute significantly to the increased adult mortality due to cardiovascular disease and other NCDs (Dietz, 1998; Gunnell *et al.*, 1998). Cardiovascular disease, a cluster of diseases, has always been a major killer in most developed countries but it is now found in unacceptably high levels in developing countries. In SA, NCDs were reported as prominent causes of death in middle-aged adults during the pre-HIV era (Tollman *et al.*, 2008). Despite the observed rise in mortality due to HIV/AIDS, tuberculosis (TB) and related infections, mortality from NCDs remain evident in SA adult population (Tollman *et al.*, 2008).

### **2.6.5 Decreased economic productivity**

Child undernutrition can affect human capital in three main ways namely, by impairing cognitive development, reducing lean body mass and/or short stature and increasing costs due to health and social support services. About 200 million children in developing countries fail to attain their full development potential due to undernutrition (Grantham-McGregor *et al.*, 2007). Undernourished children are reported to either enrol late at school or not enrol at all (Beasley *et al.*, 2000; Brooker *et al.*, 1999), have a lower intelligence quotient (Emond *et al.*, 2007; Liu *et al.*, 2003) and attain lower academic grades for their age (Mendez & Adair, 1999; Themane *et al.*, 2003). Stunting between 1-3 years could result in lower school grade attainment in adulthood and reduced life time earnings (Victora *et al.*, 2008).

Poor anthropometric outcome, especially stunting, may result in reduced productivity in labour intense jobs resulting in reduced earnings later in adulthood (Haas, 2006; Victora

*et al.*, 2008). As alluded to in the previous section undernourished children are at increased risk of morbidity resulting in increased medical costs. If a high proportion of children fail to achieve their maximum developmental potential and are undernourished (anthropometrically, especially stunted) the loss in human capital can adversely affect the national economic development seriously (Alderman *et al.*, 2006; Victora *et al.*, 2008). On the other hand nutrition interventions have been associated with improved economic income. Nutrition intervention before three years of life was found to be associated with a higher hourly income later in life in adult Guatemalan men (Hoddinott *et al.*, 2008).

Like undernutrition, child obesity can affect economic productivity through reduced human capital and through increased costs (health and social). In school-age children research reports adverse school performance and achievement in obese children (Daniels, 2006; Datar & Sturm, 2006) and reduced earnings in later life (Gortmaker *et al.*, 1993; Sargent & Blanchflower, 1994). Factors which could contribute to poor school performance include increased absenteeism due to poor health (Van Gent *et al.*, 2007; Schwimmer *et al.*, 2003), increased daytime sleepiness due to apnoea (Daniels, 2006; Taras & Potts-Datema, 2005) and psychosocial/behavioural problems (Kim & Park, 2009). What is striking, however, is reports that overweight adolescents considered themselves to be poor students and that they are more likely to quit school (Falkner *et al.*, 2001) while young obese women reported no aspiration for further education though they were dissatisfied by their careers, study and work (Ball *et al.*, 2004). Another way in which obesity affects economic status is through increased health and social costs (Lobstein *et al.*, 2004; Wang & Dietz, 2002). Abegunde and colleagues (2007) estimated that if nothing is done to reduce chronic diseases, an estimated US\$ 84 billion economic production will be lost due to CVD and diabetes alone in 23 developing countries between 2006 and 2015.

## 2.7 RISK FACTORS FOR CHILD MALNUTRITION

### 2.7.1 Introduction

Research has shown that children from different countries and regions grow similarly regardless of their race or genetic make-up, if exposed to environments which support optimal growth and development (Bhandari *et al.*, 2002; WHO, 2006b). Anthropometric status is, however, controlled to some extent by genetic makeup. An example of genetic contribution to child nutritional status is the identification of a mutation in the gene encoding leptin resulting in impaired nutrient metabolism leading to obesity in some individuals (Nishimura *et al.*, 2007; Venner *et al.*, 2006). Another example is the association between parent stature and that of their off-spring (Victora *et al.*, 2008; Knight *et al.*, 2005). Though an individual child might be predisposed to malnutrition, non-genetic factors contribute significantly to the development of adverse anthropometric outcome (Bouchard, 2009; Hebebrand & Hinney 2009). Discussion on risk factors for development of child malnutrition will be based on the UNICEF conceptual framework for development of child malnutrition (UNICEF, 1990).

### 2.7.2 The UNICEF Conceptual Framework for development of child malnutrition

Prior to 1970 protein deficiency was the main area of interest in child malnutrition. This was due to an earlier identification of kwashiorkor which was believed to be caused by protein deficiency (Waterlow, 1992:2). As research evolved and new evidence attained, this focus changed and child malnutrition is now recognised as multi-factorial. The UNICEF conceptual framework for development of child malnutrition was developed to interlink causes of malnutrition and guide interventions. The framework (Figure 2.2) recognizes that malnutrition is a biological manifestation of the poor dietary intake and health status of an individual child which are deeply rooted in a set of underlying and basic factors (UNICEF, 1990).

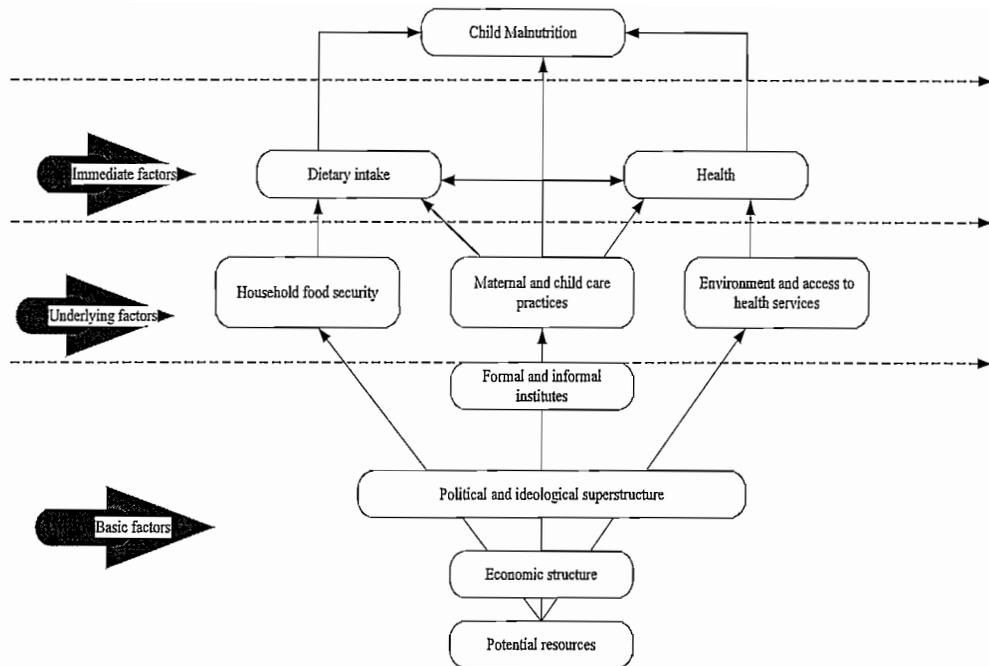


Figure 2.2 United Nations Children Fund conceptual framework for development of childhood malnutrition (UNICEF, 1990).

### 2.7.2.1 Immediate factors

Diet and health are recognised as the most significant proximate risk factors of child malnutrition. They may, however, interact with one another often making it difficult to discern their independent role in development child malnutrition.

*Diet:* To attain good nutritional status one has to consume a diet adequate in all nutrients to meet their nutritional needs. The 1999 NFCS revealed that nearly half of South African children aged 1-9 years did not meet 67% of their energy and micronutrient (calcium, iron, zinc, selenium and several vitamins) needs (Labadarios *et al.*, 2005a). In terms of quality, diets of SA children living in rural areas are found to be monotonous and of poor quality (high in carbohydrates, low in fat and micronutrients) (Faber *et al.*, 2001; Faber & Benadé, 2007). Micronutrients known to be important in child growth include zinc, calcium and iron though currently only zinc interventions have been associated with increases in child linear growth (Bhutta *et al.*, 2008). The limited

research on the association between diet and stunting in South African children has, however, failed to find an association (Mamabolo *et al.*, 2006; Theron *et al.*, 2007). This could be an artefact of difficulties with dietary assessment, complex interactions between nutrients and/or lack of variability in dietary intakes within study samples (Onyango, 2003; Theron *et al.*, 2007).

Obesity occurs when the body continually receives more energy than it expends over a long time. Attainment of a westernized diet (a diet high in animal fat, refined carbohydrates but low in fibre, fruits, and vegetables) accompanied by reduced physical activity are associated with obesity (Rey-Lopez *et al.*, 2008; Robertson & Cullen., 1999). In preschool children high intake of sugar-containing beverages might be an important factor since it can increase total energy intake significantly (Dubois *et al.*, 2007; Ó Connor *et al.*, 2006). Increase in fast food consumption has been associated with increased energy intake and body weight in adults and adolescents (Colapinto *et al.*, 2007; Pereira *et al.*, 2005). As alluded to earlier, the few studies on dietary intakes of South African children living in rural areas reveal that they are of poor quality: high in carbohydrates, low in fats and micronutrients. The contribution of diet to obesity in these children still remains to be determined (Mamabolo *et al.*, 2006).

Health: Illnesses can alter nutrient needs, use, loss and storage. Diarrhoea, especially if prolonged or recurrent, is associated with increased risk of child stunting (Assis *et al.*, 2005; Checkley *et al.*, 2008) through increased nutrient losses and/or resultant poor appetite. Parasitic infections like malaria and intestinal parasites may increase nutrient losses and needs (Assis *et al.*, 2004; Villamor *et al.*, 2004) while tuberculosis (TB) and HIV/AIDS may impair protein, carbohydrate, fat and micronutrient intake and/or metabolism (Fergusson & Tomkins, 2009; Paton *et al.*, 2003). Communicable diseases like TB, HIV/AIDS and diarrhoea are still a major health problem in South African communities (Tollman *et al.*, 2008; Welz *et al.*, 2007). Child undernutrition commonly starts appearing around the time when complementary feeds are initiated. Other than receiving diets poor in nutritional content this period is associated with increased exposure to infections associated with taking other fluids (non-

breast milk) and/or solids as well as ingestion of contaminated materials as the child starts exploring their environment (Stephensen, 1999).

In developed countries, where undernutrition is not common, children are exposed to fewer infectious diseases when compared to those living in developing countries (Ezzati *et al.*, 2002). On the other hand there are some medical conditions which may impair nutrient intake, metabolism or energy expenditure resulting in increased risk of obesity in children. These include but are not limited to: Cushing's syndrome, hypothyroidism and Prader-Willi syndrome (Theodoro *et al.*, 2006; Van Mil *et al.*, 2001). Improved treatment in developed settings, where most of these cases are found, may help treat/control these conditions which may or may not result in improvements in body composition (Eiholzer & I'Allemand, 2000; Savage *et al.*, 2008).

#### 2.7.2.2 *Underlying factors*

These factors include food security, maternal and child-care practices, environment factors and access to health services. They affect child nutrition either directly and/or indirectly (through proximal factors) but are themselves deeply rooted in basic factors.

Food security: The United States Aid for International Development (USAID) defines food security as, 'when all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life' (USAID, 1992). The 1999 NFCS reported that  $\approx 52\%$  of South African households experienced hunger with EC Province having the highest percentage ( $\approx 80\%$ ) (Labadarios *et al.*, 2005a). In the most recent national survey, NFCS:FB-I, household food insecurity at national level was found to be at the same level as in the 1999 NFCS and EC Province was still among the most affected provinces (Labadarios *et al.*, 2008). Household food security in KZN Province is among the highest in the country (Labadarios *et al.*, 2005a; Labadarios *et al.*, 2008). Adoption of strategies which might be detrimental to nutritional status like reducing meal frequencies, portion sizes and variety has been reported in some food insecure households in other parts of SA (Oldewage-Theron *et al.*, 2006).

Food security is associated with both under and over-nutrition since it is a precondition for dietary intake though it does not always translate into attainment of a good nutritional status (Rose & Bodor, 2006; Tanumihardjo *et al.*, 2007). Food insecure households living in high and medium-income countries are often reported to be at increased risk of obesity (Bhattacharya *et al.*, 2004; Dubois *et al.*, 2006; Gundersen *et al.*, 2008). This is believed to be associated with procurement and consumption of energy-dense poor quality diets supporting obesity but limited in nutrients to support child growth (Tanumihardjo *et al.*, 2007). In low-income countries household food insecurity is associated with frank lack of food resulting in child undernutrition (Gray *et al.*, 2006; Hackett *et al.*, 2009).

Maternal and child-care practices: Provision of adequate care is crucial for attainment of good nutritional status and may even reduce the effects of poverty and poor maternal education on the nutritional status of children (Ruel *et al.*, 1999). The WHO recommends that children be exclusively breastfed for the first six months (initially it was 4-6 months) followed by timely introduction of nutritious complementary foods at six months with continued breastfeeding up to two years and beyond (WHO, 2003). Although breastfeeding is a common practice in South African communities, exclusive breastfeeding rates are low and children are introduced to complementary foods of poor nutritional quality before the time recommended by the WHO (Mamabolo *et al.*, 2004, SADHS, 2003). Ironically, some studies observed increased risk of child undernutrition with prolonged breastfeeding (Caulfield *et al.*, 1996; Ntab *et al.*, 2005). Reverse causality (a state of delaying complementary feeds beyond the recommended period in children perceived as weak, not growing well or sickly by mothers) has been implicated for this unexpected observation (Marquis *et al.*, 1997; Simondon *et al.*, 2001).

The relationship between infection and type of feeding has long been recognised with observations of reduced incidences of infections in breastfed children when compared to non-breastfed children (Dewey *et al.*, 1995). Other than being sterile, breast-milk contains some inherent factors like antibodies, bifidus factors, lactoferrin, growth factor and the enzyme lipase known to be protective against infection. Bottle-feeding on the other hand may increase the risk of feed contamination (by using unsafe water for milk preparations and/or using inadequately sterilising feeding utensils) resulting in increased

risk of infections and malnutrition (Dorrosko & Rollins, 2003; Sánchez-Carrillo *et al.*, 2009). Debate on the protective effect of breastfeeding against obesity is continuing. Some studies have reported protective effects (Burke *et al.*, 2005; Novotny *et al.*, 2007) while others did not find this protective effects (Araújo *et al.*, 2006; Owen *et al.*, 2005). Mechanisms on how breastfeeding protects children from obesity are not well known but two main pathways are postulated. The first mechanism being that breastfeeding limits caregivers from overriding the innate mechanisms of regulating energy intake in their children. The second mechanism is that breastfeeding results in lower plasma insulin concentrations when compared to formula feeding resulting in reduced fat deposition and early development of fat cells (Arenz *et al.*, 2004).

Maternal undernutrition during pregnancy is associated with intrauterine growth retardation leading to increased risk of delivering a low-birth-weight (< 2500 grams) infant (De Bernabé *et al.*, 2004; Ehrenberg *et al.*, 2003). Low-birth-weight infants are more likely to be underweight if they continue not meeting their nutritional needs (Espo *et al.*, 2002; Schmidt *et al.*, 2002). On the other hand, high-birth-weight is associated with increased risk of obesity (Huus *et al.*, 2007; Kleiser *et al.*, 2009). Maternal obesity during pregnancy is postulated to increase nutrient transfer across the placenta to the foetus resulting in permanent changes in appetite and energy metabolism in the unborn baby thus pre-disposing them to obesity in later life (Wells, 2007). Fifty-nine percent of South African women older than 15 years are either overweight or obese (SADHS, 2003).

Environmental factors and access to health services: Living in a clean, and healthy environment and having access to clean water reduces the risk of contracting infectious diseases. Access to adequate health services provides a point of contact for education on child nutrition and health as well as to provide treatment during episodes of ill health. Living conditions of South Africans are reported to have been gradually improving since 1996. On average 90% have a toilet, 89% access to piped water, 67% electricity for cooking and 60% a reliable refuse disposal system. Services are generally better in urban than in rural settings while at provincial level, living conditions in EC and KZN Provinces are among the poorest. About 70% and 79% of households in EC and KZN

Provinces have access to piped water respectively whilst 45% in EC and 61% in KZN households use electricity for cooking (SSA; 2007).

In a large study of 36 developing countries Smith *et al.* (2005) did not find safe environment, access to health facilities or access to clean safe water to be associated with the undernutrition disparities between urban and rural settings. Smith and colleagues (2005), nonetheless, reported that availability of these services did improve maternal and child-care practices. In another study Fay *et al.* (2005) found availability of adequate, affordable and universal health services to be associated with improved child health and nutrition. De Villiers & Senekal (2002) did not find environmental conditions and health service utilization to be determinants of growth failure (stunting or underweight) in 12-24 month old children living in an urban slum community in SA. These highlight some of the challenges in singling out associations in complex interactions like in development of child malnutrition. A recent study reported that mothers living in East London, SA, perceive services at the local primary health care (PHC) clinics as unsatisfactory; a factor which hinders them from using such services (De Villiers *et al.*, 2005). Local research on the role of access to adequate services of risk of child obesity is still to be determined.

Environmental factors which can affect food availability and/or procurement, physical activity and energy balance may increase the risk of obesity. Association between environmental factors and obesity in children younger than five years is less studied when compared to older children and adults. Food availability and cost influences people's ability to procure and follow a prudent diet (Popkin *et al.*, 2005). The SA adult population is reported to be shifting from their traditional diets to more westernized diets; a shift associated with the nutrition transition (Kruger *et al.*, 2005). Such a shift in the diets of SA children, especially those living in rural areas, is still not known. Environmental factors found to increase calorie and/or fat intake with subsequent obesity include accessibility to fast food outlets and advertising of obesogenic foods (Lobstein & Dobb, 2005; Popkin *et al.*, 2005). Access to safe places for exercise (Burdette & Whitaker, 2005; Roemmich *et al.*, 2006) and changes in mode of transport (Davison *et al.*, 2008; Pont *et al.*, 2009) may affect physical activity levels. Unlike adults, children,

especially preschoolers, have limited control over what they eat; the mode of transport they use and they also have limited ability to understand the consequences of their food and exercise choices on health.

Maternal formal education and nutrition knowledge are crucial as they influence preparation, procurement and selection of nutritious foods for themselves and their children. Several studies, including the last two national surveys (NFCS; NFCS -FB:I) found child undernutrition to decrease with increasing maternal education while child obesity increased (Kruger *et al.*, 2008; Labadarios *et al.*, 2005a). Armar-Klemusu *et al.* (2000) found poor maternal education to be a limiting factor in good child practices, health seeking behaviour and hygiene in Ghana. Community-based growth promotion programs may provide education and/or counselling on maternal and child-care practices and growth monitoring. This would help empower the caregivers to provide better care for themselves and their children and have been found to be effective in improving child nutrition (Adelman, 2007; Walsh *et al.*, 2001). Maternal formal education may also contribute to child nutrition indirectly by increasing household income (Frost *et al.*, 2005), but if this would lead to inadequate child care through use of alternative helpers these benefits may be reversed (Ukwuani & Suchindran, 2003).

### **2.7.2.3 Basic Factors**

Basic determinants of child malnutrition include available resources for the community or the country and may affect child nutrition directly or indirectly (through immediate and underlying factors). Accessibility of these resources may be limited by the presiding natural environment, access to technology and the quality of human resources. Political, economic and cultural ideologies influence distribution and utilisation of these resources within the country or community. Banerjee and Duflo (2007) in their extensive review of how poor people live highlights the fact that the poor buy less food and invest little in their health and education; practices which influence health and nutrition. Child undernutrition, especially stunting, is most common in children living in poor settings (Black *et al.*, 2008; Van de Poel *et al.*, 2007) and improvements in national income can reduce significantly child undernutrition (Alderman *et al.*, 2006; Haddad *et al.*, 2003). Childhood obesity is most prevalent in children living in the 'rich' countries though

highest among the poor of those countries (Lobstein *et al*, 2004; Cecil *et al.*, 2005). South Africa is an upper-middle-income country (WHO, 2009a) but 26% of the population lived below the international poverty line, \$1/day, in 2007 (UNICEF, 2009). The SA constitution spells out access to safe food and water as a right for all South Africans (SA, 1994). Economic inequality has nonetheless influenced the observed variation in the nutritional status of SA children; high undernutrition in poor rural settings and high overweight/obesity in wealthy formal communities (Zere E & McIntyre 2003).

In 1995, the DoH developed the INP with the aim of improving the nutritional status of the nutritionally vulnerable groups like pregnant and lactating women, and children less than five years as well as preventing increases in mortality due to NCDs (INP, 2004). A review of the INP has reported that there is good progress in some of the set targets, though its effect on the nutrition and health of targeted groups (like children) is not yet known (Labadarios *et al.*, 2005b). Nongovernmental organisations (NGOs), research institutes and other partners like HST and MRC support government in its efforts of ensuring optimal nutrition for all South Africans.

## **2.8 CHILD MALNUTRITION IN EASTERN CAPE AND KWAZULU-NATAL PROVINCES**

The nutrition and health status of children living in EC and KZN provinces contributes significantly to that of SA since they house about 37% of the SA 0-4 year olds (SSA, 2007). Children living in EC and KZN provinces live in poor conditions (SSA, 2007; UNICEF, 2009) with increased risk of food insecurity. Other than for the national surveys there is currently little research done in the EC province. The HST under its district support and community development cluster undertook to support the implementation of the INP program in selected districts in EC and KZN provinces in 2002 (HST, 2009). To facilitate this, the NIRU of the MRC carried out a baseline assessment of the socio-demographic and anthropometric profile of children aged 0-71 months and their caregivers. Child undernutrition was of low severity in the first 12 months of life but almost doubled at 12-24 months. Stunting was highest after 12 months of life ranging

between 22-25% and 22-30% at 12-24 months and 24-60 months of age respectively. Overweight followed an opposite direction with 16-18% of the infants being overweight during infancy and gradually decreasing to about 5% in children over two years (Smuts *et al.*, 2008). Identifying risk factors of child malnutrition in these children will, therefore, help inform the DoH and other interested parties in developing interventions which are evidence based and targeted as advised by the World Bank (World Bank, 2006).

Another important observation in the baseline survey was that maternal overweight/obesity was high (55% EC; 45% KZN) in the caregivers of these children (Smuts *et al.*, 2008). This suggests that there may be mother-child pairs suffering with opposite forms of malnutrition in the study sample, a paradox which may complicate nutrition interventions as attempts to improve child undernutrition may worsen obesity in the caregivers. To help guide interventions this study attempts to estimate the frequency of an occurrence where a stunted child having a living-in overweight mother (SCOWT) in this study sample and identify associated factors.

The baseline study, however, used the Epi Info 2000 software package to assess the anthropometric status of the children (Smuts *et al.*, 2008). This package is based on the NCHS/WHO reference, based on a small study population, predominantly formula fed and of European decendency living in the USA. The newer WHO child growth standards on the other hand are based on a large sample of breastfed children from six countries, including one African country, living in conditions supporting attainment of optimal growth. Re-assessment of the anthropometric status of the children using the newer WHO child growth standards would be appropriate since they show how healthy children should grow (both breastfed and formula fed).

## **2.9 SUMMARY**

Undernutrition coexists with overnutrition in SA children. Eastern Cape and KZN provinces need to be given special attention because they house a large proportion of the SA population. Both forms of malnutrition significantly increase the risk of morbidity,

mortality, poor cognitive function and the risk of NCDs later in life. These would result in increased health and social support costs and reduced human capital; leading to what is known as the vicious cycle between causes and consequences of malnutrition, propelling poverty from one generation to another (Figure 2.3). The high prevalence of both forms of malnutrition in SA could adversely affect the economy of the country and it is likely to perpetuate poverty for many generations to come if the cycle is not interrupted. Special attention has to be given to the girl child, whose nutritional status, cognitive development, and level of education determine the quality of the next generation.

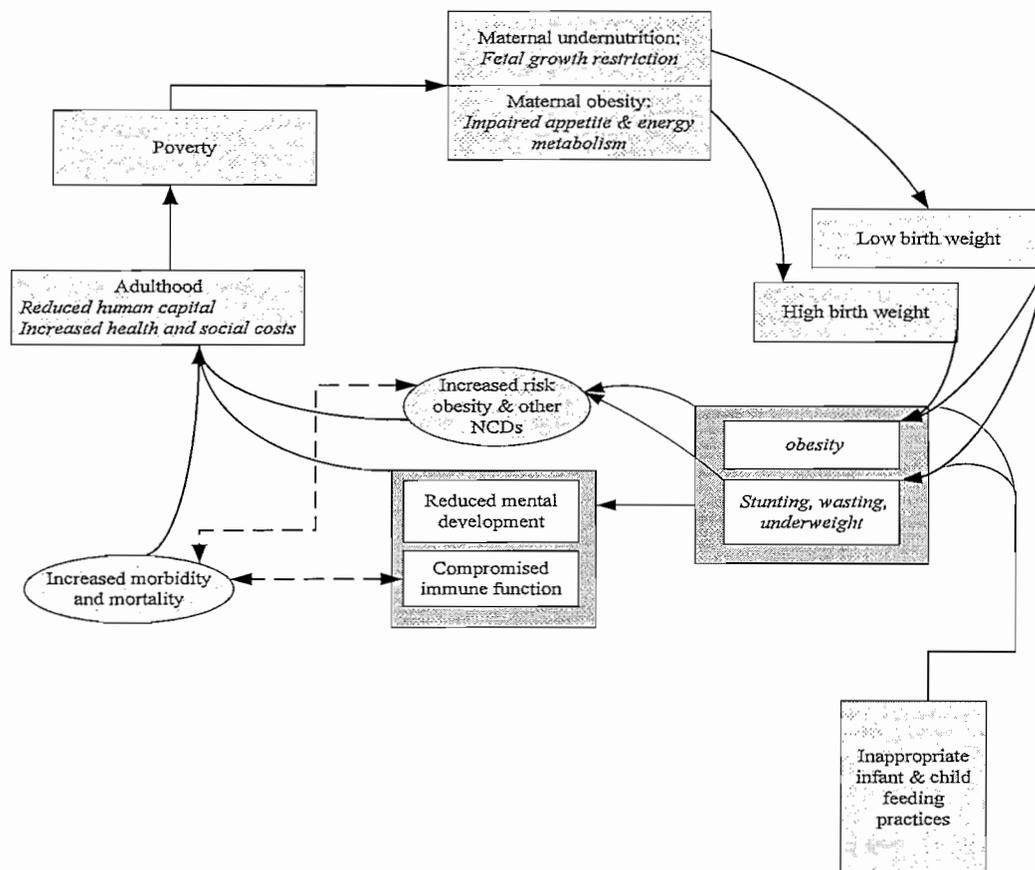


Figure 2.3 The intergenerational vicious cycle of malnutrition showing that the consequences of malnutrition often aggravate the causes (Adapted from Vorster & Gibney, 2009:354).

Children under five years are recognised as a vulnerable group by the INP and the international nutrition community. To achieve optimal nutrition for these children interventions need be targeted and evidence-based thus requiring that causal pathways be determined in a systematic way. It is generally accepted among scientists that the UNICEF conceptual framework for development of child malnutrition provides a systematic way for determining risk factors of child malnutrition, but with recognition that factors will differ from region to region requiring identification of specific determinants in each region, country or community.

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**CHAPTER 3:** Risk factors of poor anthropometric status in children under 5 years living in rural districts of the Eastern Cape and KwaZulu-Natal Provinces, South Africa

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**Key words:** Child malnutrition; South Africa; risk factors; stunting; underweight; overweight.

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Written according to the South African journal of clinical nutrition authors guidelines (Appendix A)

## Abstract

**Objectives:** To identify factors associated with childhood malnutrition as assessed anthropometrically. In addition, the prevalence and associated factors of the occurrence of a stunted child with a living-in overweight mother (SCOWT) were assessed.

**Design:** Cross-sectional survey.

**Setting:** Eastern Cape and KwaZulu-Natal Provinces.

**Subjects:** 0-60 months old children (n=2485) and their mothers.

**Methods:** Secondary data analysis of a questionnaire and anthropometric survey. Logistic regression taking into account hierarchical relationships of risk factors was used to determine the odds of a child being stunted, underweight or overweight. Chi-Square test and analysis of variance were used to identify related variables which differed significantly between SCOWT and non-SCOWT pairs.

**Results:** Stunting, wasting, underweight and overweight rates were 28.6%, 3.4%, 7.3% and 16.1% respectively. The WHO child growth standards gave higher rates of stunting and overweight but lower rates of underweight. Risk factors for child stunting were male gender (Odds ratio (OR) =1.233;  $p=0.019$ ) and the fact that the mother thinks her child is growing well (OR=1.346;  $p=0.018$ ). On the other hand handouts as source of food (OR=0.719;  $p=0.005$ ) and mother making important household decisions (OR=0.760;  $p=0.009$ ) were protective. Underweight was positively associated with child male gender (OR=1.432;  $p=0.021$ ), maternal education (minimum of 5 years of schooling: OR=1.720;  $p=0.002$ ), the fact that the mother thinks her child is growing well (OR=2.526;  $p<0.001$ ), still breastfeeding (in children <24 months: OR=2.022;  $p=0.014$ ) and history of a gastrointestinal symptom (OR=1.527;  $p=0.013$ ). Child overweight on the other hand was positively associated with household having a regular source of income (OR=1.473;  $p=0.002$ ) but negatively with maternal education (OR=0.595;  $p=0.001$ ) and the fact that the mother thinks her child is growing well (OR=0.361;  $p=0.000$ ). Prevalence of SCOWT was 13.9% and SCOWT mother-child pairs were more likely to be older (both mother and child), have hand-outs as source of food, have used bottle-feeds in the 24 hours preceding survey (children <24 months) but less likely to increase fluid intakes during episodes of diarrhoea.

**Conclusion:** The double burden of malnutrition occurred in these poor communities,

households and individual children. Child male gender and the fact that the mother thinks her child is growing well increased the risk of both stunting and underweight while maternal education also increased risk of underweight. Having a regular source of income and maternal BMI increased the risk of child overweight/obesity.

## Introduction

Child malnutrition, both under and overnutrition, is associated with undesirable health<sup>1,2</sup> and socio-economic outcomes.<sup>3</sup> The nutritional status of South African children younger than nine years has not changed much over the past 15 years as reflected by comparable rates reported by three national surveys.<sup>4,5,6</sup> The most recent national study reported 18% stunting, 9.3% underweight, 4.5% wasting and 14% combined overweight and obesity.<sup>6</sup> At these rates, undernutrition is of low severity in South African children based on the World Health Organisation (WHO) criteria for assessment of severity of child undernutrition in populations.<sup>7</sup> There is currently no criteria for assessing severity of child overweight/obesity in populations.

Diet and health are the most significant proximate risk factors of child malnutrition but are, themselves, rooted in underlying (household issues like household food security, maternal and child care practices, water and sanitation) and basic (societal issues like cultural, political, economic and societal systems) factors.<sup>8</sup> To attain optimal nutrition risk factors of child malnutrition need to be identified and evidence based interventions, policies and programs be implemented. Emergence of the double-burden of malnutrition, a paradox associated with nutrition transition, may complicate interventions.

South Africa (SA) is an upper middle income country, though 26% of its population lived below the international poverty line in 2007.<sup>9</sup> The Eastern Cape (EC) and KwaZulu-Natal (KZN) Provinces, housing about 35% of the population, are among the poorest in the country.<sup>10</sup> In 1995, the Department of Health developed an integrated nutrition program (INP) to coordinate an inter-sectoral approach to solving nutrition problems affecting nutritionally vulnerable groups like pregnant and lactating women, and children less than

five years as well as preventing increases in mortality due to non communicable diseases (NCDs).<sup>11</sup> To achieve this, the INP seeks to address underlying socio-economic, environmental, educational and health related causes of malnutrition. In its efforts to assist government in improving the nutritional status of South Africans the Health System Trust (HST), a non-governmental organisation (NGO), undertook to implement a project that fits into the focus areas of the INP in selected areas of the EC and KZN provinces.<sup>12</sup> Baseline assessment on children 0-71 months and their caregivers found stunting to be a public health problem in the children while overweight and obesity were high in the caregivers.<sup>13</sup>

The aim of the current study was to identify socio-economic, maternal and child factors associated with malnutrition in children aged 0-60 months living in EC and KZN provinces through secondary data analysis of the above-mentioned baseline assessment. Anthropometric status of the children was reassessed using the WHO growth standards.

## **Methods**

This study forms part of the baseline study that was conducted in OR Tambo and Alfred Nzo districts of the EC Province and Umkhanyakude and Zululand districts of the KZN Province during 2003. Details of the study design, sampling and data collection of the baseline survey are published elsewhere.<sup>13</sup> A cross-sectional study design was employed targeting 0-71 month old children and their caregivers. A stratified random sample of 4000 children (1000 per district) was drawn using the health facilities as strata. Anthropometric measurements were taken by trained field workers following standard anthropometric protocols. Data on socio-demographic indicators, dietary intake, child morbidity, child care practices and maternal health were collected using a structured questionnaire in the caregiver's local language. The study was approved by the ethics committee of the Medical Research Council and mothers gave written consent once the purpose and the nature of the study was explained to them.

For the current study, children were selected from the existing data set using the following inclusion criteria: children aged 0–60 months; complete data on gender, date of birth, weight and height measurements; and child accompanied by their mother for measurements and completion of the questionnaire. Data on household socio-economic and demographic indicators, child-care practices, perceived household food availability, child health, anthropometric measurements and child feeding practices were extracted from the existing data set. A household wealth index was constructed from data on living conditions (access to electricity, main source of drinking water, type of toilet facility) and asset ownership (ownership of fridge, coal stove, electric stove, electric hot plate, gas stove, paraffin stove, television set, radio, kettle, motor car and cell phone). Categorical principal component analysis was then used to develop the wealth index for each of the households.

## **Data analysis**

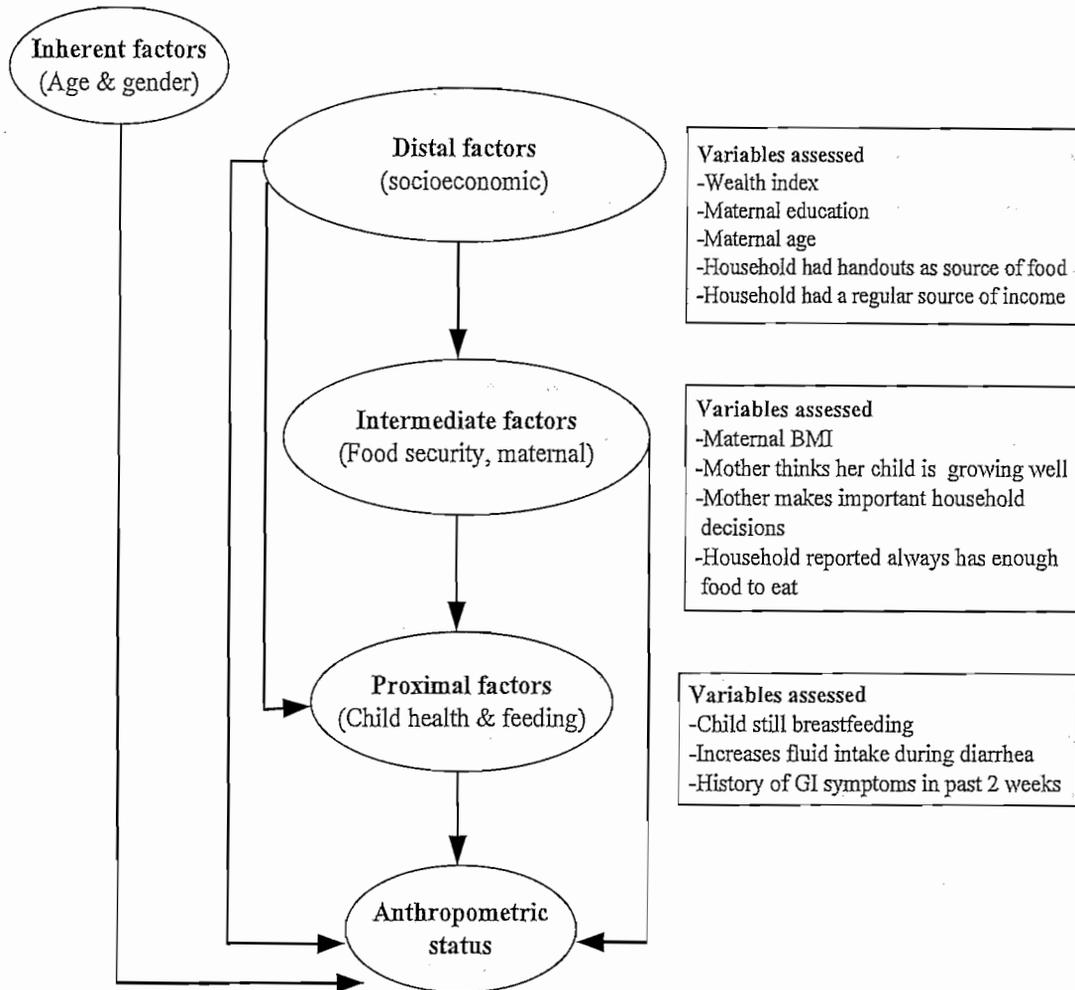
The anthropometric data of the children was assessed using the WHO Anthro software version two<sup>®14</sup> and expressed as z-scores for each of the anthropometric indices of malnutrition against both the new WHO child growth standards and the older National Centre for Health Statistics (NCHS)/WHO reference. A child was defined as stunted, underweight or wasted if their height-for-age, weight-for-age or weight-for-height z-score was more than two standard deviations (SDs) below the reference median, respectively. A child was defined as overweight if their weight-for-height z-score or body mass index for age z-score (BAZ) was at least 2SDs above the reference median. Body mass index for age was only calculated for assessment of child overweight against the WHO child growth standards. Maternal body mass index (BMI) was calculated as weight (kg)/[height (m)]<sup>2</sup>. The WHO criteria was then used to classify mothers as underweight (BMI < 18.5); normal weight (18.5 ≤ BMI < 25); and overweight and obesity (BMI ≥ 25).<sup>15</sup>

A mother-child pair was considered to be suffering with the double burden of malnutrition if a stunted child had a living-in overweight mother (SCOWT). Bivariate analysis was used to identify factors which differed significantly between SCOWT and

non-SCOWT pairs. Analysis of variance (for continuous variables) and Chi-square test (for categorical data) were used to test for any statistically significant difference between the two groups.

To assess risk factors of child stunting, overweight and underweight the multivariate analysis was performed using SPSS Version 17. The odds ratios (OR) and their 95% confidence intervals (CI) were calculated using logistic regression. Wealth index, maternal age, child age and maternal BMI were assessed as continuous variables while all the other variables were assessed as categorical variables. The multivariate analysis took into account the hierarchical relationships between risk factors of malnutrition (Figure 1). The framework was built during the preliminary assessments and in line with current international literature on child malnutrition. According to the framework, distal factors such as socio-economic status may influence child nutritional status directly and/or indirectly (through their effect on intermediate and proximal factors). In the same way intermediate factors such as food security may influence child growth directly and/or indirectly through proximal factors. Proximal factors on the other hand exert direct influence on nutritional status while inherent factors (age and gender) are not influenced by any of the other risk factors.

In the first step of the multivariate analyses, age and gender were entered simultaneously and analysed using unconditional logistic regression. While keeping age and gender in the model all distal factors were analysed using SPSS backwards conditional logistic regression. Factors were excluded from the model at a significance level of  $p > 0.1$ . The same analyses were repeated for intermediate and proximal factors. In the results OR from the equation corresponding to the level at which the risk factor was first entered into the model is reported in line with hierarchical association assumptions of such models.<sup>16,17</sup>



**Figure 1** Conceptual framework of the multivariate analysis, taking into account the hierarchical relationship of the proposed risk factors for poor anthropometric status

Adapted from Wamani et al.<sup>16</sup> and Chopra et al.<sup>17</sup>

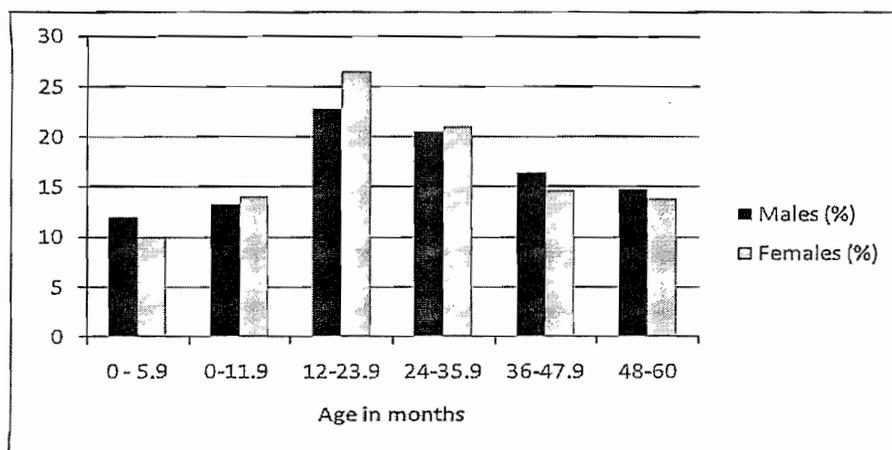
## Results

From the 3782 children in the original data set, 2680 children met the study criteria. The program, WHO Anthro version 2<sup>®</sup> recommends that all flagged z-score in a nutrition survey analysis be excluded from further analysis.<sup>18</sup> One hundred and ninety-five children were, therefore, excluded from further data analysis. Results for 2485 children

are therefore reported. There was no statistically significant difference in the anthropometric status of the children by province. Results are, therefore, reported for the two provinces combined. Results for anthropometric outcomes are those assessed against the WHO child growth standards. The NCHS/WHO reference was only used to compare with the WHO standards in prevalence of child malnutrition.

### *Characteristics of the study population*

Figure 2 shows the age and gender distribution for the study sample. There were only slightly more females (51.5%) than males (48.5%) and children aged 12.0-35.9 months were most represented in the study sample. The socio-economic characteristics of the households are summarized in Table 1. The median number of people per household was six (range: 2-18) and while that of number of children younger than six years was one (range: 1-6). Sixty-one percent of the households had a toilet (mostly pit toilet), 25% used safe drinking water (tap/borehole) the day before the survey and 26% had electricity in the home (though only 5% used it in cooking) respectively.



**Figure 2: Age and gender distribution of the study sample**

Almost one-third of the households depended on grant/welfare (30.2%) and child support/maintenance (26.5%) as source of cash income. These sources of cash income (grant/welfare and child support/maintenance), however, contributed significantly to the 72% of households having some kind of regular source of income. Shops were the main

source of food though 19% of households reported handouts (gifts, begged, borrowed, food aid/welfare) as a source of food the month preceding the survey. Only 11% of the surveyed households reported that they always had enough food to eat. About 64% and 61% of the households reported ownership of livestock and a home garden respectively. Whereas a paraffin stove and radio were common commodities, a much smaller number of households reported ownership of a refrigerator (15.5%), coal stove (11.4%), electric stove/hotplate (14.7%), gas stove (13.6%), television set (18.3%) and a motorcar (7.1%).

**Table 1: Socioeconomic characteristics of the studied households (n=2485)**

Variable name		Variable Name	
Toilet present <sup>a</sup> (%)	61.1%	Household ownership of	
Have access to safe drinking water <sup>b</sup>	25.2%	Fridge	15.5%
Have electricity in the house	25.9%	Coal stove	11.4%
Use electricity for cooking	5.0%	Electric stove	5.0%
Has regular source of income	72.2%	Hotplate	9.7%
Household attained its food from		Gas stove	13.6%
Shops	78.6%	Paraffin stove	64.9%
Handouts	19.0%	Electric kettle	11.2%
Livestock or home garden	19.9%	Television set	18.3%
Mother has been schooled for > 5 years	74.8%	Radio	67.6%
Mother is married	43.4%	Motor car	7.1 %
Number of people per household (median)	6	Cell phone	27.2%
Number of children <6 years per household (median)	1	Ownership of livestock	63.6%
Household reportedly always had enough food to eat	11.0%	Ownership of home garden	61.1%

<sup>a</sup> Pit toilet 60.9%; flush toilet 0.2%

<sup>b</sup> Own tap water 9.8%; public tap 10.4%; borehole 5%.

### *Anthropometric status of the children*

Table 2 shows the prevalence of child malnutrition by age group as assessed against the WHO child growth standards as well as the NCHS/WHO reference. The WHO child growth standards generally gave higher prevalence of child malnutrition when compared to the NCHS reference. This was especially so in undernutrition rates for children younger than six months. Using the WHO child growth standards, stunting was the most

prevalent (28.6%) adverse anthropometric outcome followed by combined overweight and obesity (16.1%). Of the stunted children (n=711), 18.6% were underweight while 23.6% were overweight (BAZ>2SD). Furthermore, 20% and 61% of the wasted children (n=85) were also stunted and underweight respectively. Undernutrition was lowest whilst overnutrition highest in the 0-5 month-old group. Using the WHO child growth standards and WHO criteria for assessing severity of undernutrition<sup>7</sup> in populations stunting is of high severity in all the different age groups except during infancy, while underweight and wasting were of low severity in all the age groups. There is currently no criterion for assessing severity of child obesity in populations.

**Table 2: Prevalence of child malnutrition based on the World Health Organisation (WHO) growth standards and the National Centre for Health Statistics reference (NCHS)**

AGE IN MONTHS	PREVALENCE (%)								
	Stunting		Wasting		Underweight		Overweight		
	NCHS	WHO	NCHS	WHO	NCHS	WHO	NCHS	WHO <sup>a</sup>	WHO <sup>b</sup>
0-5.9 (N=271)	5.9	11.4	1.5	4.4	0.4	3.0	19.2	20.3	17.3
6-12 (N= 341)	16.7	20.5	2.3	3.8	8.5	7.9	14.7	15	15.2
12-23.9 (N= 614)	28.0	30.9	4.4	3.1	11.6	7.3	11.2	14.0	20.4
24-60 (N= 1259)	26.8	33.4	3.1	3.3	10.9	8.0	5.2	10.8	14.1
All (N=2485)	23.5	28.6	3.2	3.4	9.6	7.3	9.5	13.1	16.1

Stunting: height-for-age z-score < -2SD of the median of the reference population

Underweight: weight-for-age z-score < -2SD of the median of the reference population

Wasting: weight-for-age z-score < -2SD of the reference population

Overweight: weight-for-height z-score or body mass index for age >2SD of the median of the reference population

WHO<sup>a</sup>: Prevalence of overweight based on weight-for-height z-score and the WHO standards

WHO<sup>b</sup>: Prevalence of overweight based on body mass index-for-age z-score and the WHO standards

Criteria for assessing severity of malnutrition in a population<sup>7</sup>:

Stunting: low (<20%), medium (20-29.9%), high (30-39.9%), very high (≥40%)

Wasting: low (<5%), medium (5-9.9%), high (10-14.9%), very high (≥15%)

Underweight: low (<10%), medium (10-19.9%), high (20-29.9%), very high (≥30%)

### Risk factors of child malnutrition

Only 85 children (61.2% males; 38.8% females) were found to be wasted hence multivariate analysis for determination of risk factors for child wasting was not done. The mean age for the wasted children was 24.5 months. Only maternal age, maternal education and the fact that the mother thinks her child was growing well differed significantly ( $p < 0.05$ ) between wasted and non-wasted children. Wasted children tended to have slightly older mothers (mean age  $32.2 \pm 10.1$  vs  $30.2 \pm 8.51$  years); mothers who have not schooled for a minimum of five years (40% vs 24.6%) while their mothers were less likely to think their child is growing well (73% vs 83%). Risk factors associated with child stunting, underweight and overweight after multivariate analysis are as shown in Tables 3, 4 and 5 respectively.

### Risk factors for stunting

Stunting was positively associated with male gender (OR=1.233, 95% CI=1.035-1.470), child age (OR=1.015; 95% CI=1.010–1.021) and the fact that the mother thinks the child is growing well (OR=1.346; 95% CI=1.051-1.722). On the other hand household wealth index (OR= 0.864; 95% CI=0.803-0.929), handouts as source of food during the month preceding the survey (OR=0.719; 95% CI=0.571-0.906), increasing fluids during diarrhoea (OR=0.826; 95% CI=0.682-0.999) and mother making important household decisions (OR=0.760; 95% CI=0.618-0.934) seemed protective against stunting. Provincial variations were observed in the practice of increasing fluids during episodes of diarrhoea (EC, 10.7%; KZN 76.5%).

**Table 3: Multivariate analysis of risk factors for child stunting (HAZ<-2SD) based on the World Health Organisation child growth standards**

Variable	Odds Ratio (OR)	95% confidence intervals	p-value
Male gender	1.233	1.035-1.470	0.019
Child age	1.015	1.010-1.021	<0.001
Wealth index	0.864	0.803-0.929	<0.001
Household had handouts as source food	0.719	0.571-0.906	0.005
Mother thinks the child is growing well	1.346	1.051-1.722	0.018
Household reportedly always enough food to eat	1.356	0.972-1.892	0.073
Mother makes important decisions	0.760	0.618-0.934	0.009
Increases fluid intake during diarrhoea	0.826	0.682-0.999	0.049

### Risk factors for underweight

Factors positively associated with underweight included male gender (OR=1.432; 95% CI=1.055-1.945), child age (OR=1.012; 95% CI=1.003-1.022), mother attaining a minimum of five years of schooling (OR=1.720; 95% CI=1.215-2.434), the fact that the mother thinks the child is growing well (OR=2.526; 95% CI=1.743-3.660), still breastfeeding (in children <24 months) (OR=2.022; 95% CI=1.155-3.538) and history of a gastrointestinal (GI) symptom in the two weeks preceding survey (OR=1.527; 95% CI=1.095-2.128). Gastrointestinal symptoms assessed included history of diarrhoea, vomiting and poor appetite in the two weeks preceding the survey. Frequencies of the GI symptoms by province were 61% EC and 43% KZN Province. Household wealth index (OR=0.870; 95% CI=0.760-0.994) was associated with a lower risk of being underweight.

**Table 4: Multivariate analysis of risk factors for child underweight (WAZ<-2SD) based on the World Health Organisation child growth standards**

Variable	Odds Ratio (OR)	95% confidence intervals	p-value
Male gender	1.432	1.055-1.945	0.021
Child age	1.012	1.003-1.022	0.008
Wealth index	0.870	0.760-0.994	0.041
Mother had minimum five years education	1.720	1.215-2.434	0.002
Household had a regular source of income	1.399	0.993-1.970	0.055
Maternal BMI	0.970	0.937-1.006	0.098
Mother thinks her child is growing well	2.526	1.743-3.660	<0.001
Child had GI symptoms in past two weeks	1.527	1.095 - 2.128	0.013
Child still breastfeeding*	2.022	1.155-3.538	0.014

GI: Gastrointestinal

Gastrointestinal symptoms assessed were diarrhoea, vomiting and poor appetite

BMI: Body mass index

\* Only assessed in children  $\leq$ 24 months

### Risk factors for overweight

Child age (OR=0.985; 95% CI=0.979-0.992), attainment of a minimum of five years of formal schooling by the mother (OR=0.595; 95% CI=0.437-0.809) and the fact that the mother thinks the child is growing well were negatively associated with overweight (OR=0.361; 95% CI=0.234-0.557). Higher maternal BMI (OR=1.044; 95% CI=1.023-

1.067) and having a regular source of income on the other hand were positively associated with child overweight (OR=1.473; 95% CI=1.150-1.886).

**Table 5: Multivariate analysis of risk factors for child overweight (BAZ>2SD) based on the World Health Organisation child growth standards**

Variable	Odds Ratio (OR)	95% confidence intervals	p-value
Male gender	1.172	0.945-1.453	0.149
Child age	0.985	0.979-0.992	<0.001
Wealth index	1.086	0.999-1.179	0.053
Mother had a minimum of 5 years education	0.595	0.437-0.809	0.001
Household had a regular source of income	1.473	1.150-1.886	0.002
Maternal BMI	1.044	1.023-1.067	<0.001
Mother thinks the child is growing well	0.361	0.234-0.557	<0.001
Child had GI symptoms in past 2 weeks	1.232	0.978-1.522	0.077

GI: Gastrointestinal

Gastrointestinal symptoms assessed were diarrhoea, vomiting and poor appetite

BMI: Body mass index

### Characteristics of mother-child pairs suffering with opposite forms of malnutrition

Table 6 details the characteristics of the mothers of the children included in this study sample. The mean age and BMI of the mothers were 30.2 ( $\pm$ 8.6) years and 25.9 ( $\pm$ 5.2) kg/m<sup>2</sup> respectively. Maternal underweight was uncommon (2.6%) in the whole study sample while overweight affected almost half of the mothers (49.1%). However, of the few (n=63) underweight mothers studied, 16 (25.4%) had children who were stunted while 343 (28.9%) of the mothers with normal BMI (n=1186) had a stunted child.

**Table 6 Anthropometric status of the mothers (N=2462)**

Anthropometric status of the mothers	
Mean (SD) age (years)	30.2 (8.6)
Mean (SD) height (meters)	1.58 (0.07)
Mean (SD) weight (kg)	64.8 (13.3)
Mean (SD) BMI (kg/m <sup>2</sup> )	25.9 (5.2)
Maternal underweight	2.6%
Maternal normal weight	48.3%
Maternal overweight*	49.1%

BMI: Body mass index

SD: Standard deviation

\* BMI  $\geq$  25kg/m<sup>2</sup>

In this study 13.9% of the mother child pairs suffered with opposite forms of malnutrition (stunted child; overweight mother). Of the 711 stunted children 345 (48.5%) had a living-in overweight mother. Twenty-nine percent of the overweight mothers in this study sample had a stunted child. Though the presence of SCOWT pairs was observed in all child age groups, 69.1% of all the SCOWT pairs included children in the 12-48 months age group. Table 7 details the observed differences in the studied factors between SCOWT and non-SCOWT pairs. On average SCOWT pairs were more likely to be of older age (both mother and child), had hand-outs as source of food the month preceding the survey, less likely to increase fluid intakes for their children during episodes of diarrhoea while the children were more likely to be males. Children from SCOWT pairs were less likely to have received bottle feeds in the 24 hours preceding the survey in children younger than 24 months.

**Table 7: Differences in related factors by coexistence of a stunted child with a living in overweight mother**

Variable	NON SCOWT (N= 2117)	SCOWT (N=345)	p-value*
Mean (SD) child age in months	25.6 (16.5)	31.5 (15.3)	<0.001
Mean (SD) maternal age in years	29.9 (8.6)	31.8 (8.3)	<0.001
Child gender			
Male	47.8%	53.6	0.043
Female	52.2	46.4	
Household received handouts as source of food			
No	81.8	75.4	0.005
Yes	18.2	24.6	
Mother increase fluids for the child during episodes of diarrhoea			
No	58	67.2	0.002
Yes	42	32.8	
Child received bottle feeds 24 hours preceding survey#			
No	43.4	59.4	0.002
Yes	56.6	40.6	

\* Analysis of variance was used for continuous data and Pearson's Chi-square test for categorical data

# Only assessed in children <24 months

SD: Standard deviation

SCOWT: Mother-child pairs where the child is stunted and has a living in overweight mother

Non-SCOWT: All other mother-child pairs

## Discussion

These results indicate that stunting and underweight were associated with socio-economic, maternal and child factors while wasting was mainly associated with maternal factors in the under-fives living in the studied rural communities of EC and KZN Provinces. Except for having regular source of income, overweight was also mainly influenced by maternal factors. Child malnutrition rates were similar to those reported by national surveys;<sup>6,19</sup> double-burden of malnutrition with stunting (though higher than national prevalence) being the most prevalent followed by combined overweight and obesity while acute undernutrition levels were low. Stunting was of high severity (>30%) in age groups 12-60 months but low to medium in children younger than 12 months, while underweight and wasting were of low severity, <10% and <5% respectively in all age groups. The WHO child growth standards gave higher rates of child stunting, overweight and wasting when compared to the NCHS reference in line with global reports.<sup>20,21</sup>

Being male was associated with increased risk of stunting and underweight but not overweight. Several studies in Sub-Saharan Africa have found male preschoolers to be at increased risk of stunting when compared with their female counterparts.<sup>22,23</sup> The mechanism behind this is unknown. No association was found between child gender and overweight in the current study. Research on older children often found girls to be at increased risk of overweight<sup>24</sup> while in preschoolers conflicting gender differences are observed.<sup>25,26</sup> The observed increased risk of stunting and underweight with increase in age is similar to reports by other local researchers<sup>17,27</sup> but different from the results of the national food consumption survey.<sup>5</sup> This is also in line with observations by Shrimpton et al.<sup>28</sup> that growth faltering starts occurring shortly after birth, progressing until two years of age, an observation which led to recognition and adoption of ‘window of opportunity’ (period from prenatal through to 2 years) as a crucial period in prevention of child undernutrition.<sup>29,30</sup> Child overweight on the other hand was highest in children younger than 24 months.

Household socio-economic status is more often associated with child nutrition<sup>23,31,32</sup> and, therefore, the observed interaction between wealth index and all studied anthropometric outcomes was anticipated. Use of socio-economic status composites like wealth index as a proxy for long-term socioeconomic status provide results consistent with use of the individual variables and may help to make statistical models more prudent.<sup>33</sup> This, however, takes away the opportunity of identifying the specific components of the socio-economic status which are associated with child anthropometric outcome. Principal component analysis has been used in child nutrition studies<sup>34,35</sup> for creation of the wealth index but a recent study questions its appropriateness when many of the variables are of a binary nature.<sup>33</sup> In the current study the components used to develop the wealth index which were found to be significantly ( $p < 0.05$ ) associated with child malnutrition (positively with overweight and negatively with undernutrition) were availability of electricity in the home and ownership of refrigerator, coal stove, electric stove, electric hot plate, gas stove, television set, radio, motor car and cell phone.

At national level, maternal education is associated with reduced risk of stunting and increased risk of obesity in children.<sup>19</sup> In the current study maternal education was not associated with child stunting, but with a lower risk for overweight and a higher risk for underweight. It should be noted that we assessed whether the mother attained a minimum of five years of formal education while national studies used attainment of primary school (seven years in SA). Another study done in KZN Province, however, found maternal schooling for a minimum of five years to be protective against child stunting and underweight.<sup>17</sup> In the current study only 11% of the mothers had not attended school at all while 75% attained a minimum of five years of formal education. The observation that the mother thought her child was growing well was associated with both under and over-nutrition (in opposite directions) although subjective it remains of interest. Also 27%, 5.8%, 17.4% and 2.9% of the mothers of stunted, underweight, overweight and wasted children respectively thought their children were growing well. A study in Mexico reported that in a group of mothers with a minimum of six years schooling, their perception about the growth of their children differed significantly from the measured anthropometric status.<sup>36</sup> This was especially so in stunted children. These highlight the

need to educate and provide mothers with more objective ways of knowing if their child is growing well or not like provision of community growth promotion services with education on child growth.<sup>37,38</sup>

The WHO recommends that children be exclusively breastfed for six months followed by timely introduction of nutritious complementary foods at six months with continued breastfeeding up to two years and beyond.<sup>39</sup> Though suboptimal breastfeeding rates were high in this study population; multivariate analysis for children aged < 24 months showed that current breastfeeding increased the risk of underweight in this study sample. Increased risk of child malnutrition with prolonged breastfeeding has been reported in other studies and is believed to be due to reverse causality (a state of delaying complementary feeds beyond the recommended period in children perceived as sickly, weak or not growing well resulting in development of undernutrition).<sup>40,41</sup>

Just fewer than 90% of the households in the study sample reportedly did not always have enough food to eat, which could be some indication of a high level of food insecurity. The reported lack of enough food to eat within households was, however, not associated with child malnutrition; probably due to lack of variation in the study population (only 11% reportedly had enough food to eat). The literature suggests that food insecurity maybe associated with both forms of child malnutrition.<sup>42</sup> An unexpected association observed in this study was the reduced risk of a child being stunted from those mothers that reported handouts as a source of food in the month preceding the survey. Handouts in this study included food received as gifts, food aid, and welfare or begged and borrowed. Though this cannot be advocated as a long-term strategy for improving child nutrition, it suggests that households in poverty stricken societies like this one, adoption of safe coping strategies like government cash transfer strategies, food aid/welfare and non-governmental organisation (NGO) donations may be beneficial. Food insecure families may adopt coping strategies which may increase the risk of under and overnutrition. A study in North West Province, SA, reported reduction of food portion sizes, meal frequencies and variety in the diet among the food insecure households which may lead to undernutrition.<sup>43</sup> A study of mothers from food insecure households in the United

States of America reported using energy dense foods as a compensatory strategy thus increasing the risk of child obesity.<sup>44</sup> Implementation of poverty alleviation and targeted food provision strategies in these poor communities are, therefore, crucial.

Child having suffered with GI symptoms in the two weeks preceding the survey was associated with increased risk of underweight but not of stunting. Though only underweight was found to be associated with recent of GI in the current study, there is a body of evidence linking stunting, wasting and underweight with childhood infections like diarrhoea.<sup>22, 45,46</sup> Gastrointestinal symptoms assessed in the current study were diarrhoea, vomiting and poor appetite in the two weeks preceding the survey. Fluid intake is especially important during episodes of diarrhoea since it does not only reduce the risk of undernutrition but it would improve child survival.<sup>47</sup> In the current study increasing fluids during periods when the child suffered with diarrhoea was found to be protective against stunting.

The observed prevalence of 13.9% SCOWT occurrence in this study sample is in line with reports by other studies where SCOWT is generally reported to be less than 10% with few exceptions.<sup>48</sup> The observation of SCOWT has been associated with the nutrition transition and is anticipated to complicate interventions as correction of one nutritional state might lead to worsening of the other.<sup>49</sup> Identifying factors that distinguish SCOWT from non-SCOWT mother-child pairs would help guide interventions in this study population. Some of the identified factors are, however, also associated with child stunting highlighting difficulties in delineating factors specifically associated with SCOWT above and beyond those associated with child undernutrition.<sup>50</sup> Caution must be exercised, though, since in the current study we only differentiated SCOWT from non-SCOWT pairs while the double burden of malnutrition may occur in one individual or in any two members of the household not necessarily mother-child pairs.<sup>51,52</sup> Another important factor to note is that in the current study maternal BMI was significantly associated with child overweight.

Use of a hierarchical framework for assessment of risk factors for child malnutrition in this study had two main advantages: balancing statistical significance with biological and social interpretation and reducing interactions between risk factors from the different levels of the framework. Reassessment of the anthropometric status of the children in these predominantly breastfed children is encouraged by the WHO as it is more likely to provide better estimates of child malnutrition levels. Prost et al.<sup>53</sup> found that risk factors determined following use of the WHO child growth standards and the NCHS/WHO reference were comparable although the strength of the association was higher with the WHO standards. Limitations of this study include the fact that the study employed a cross sectional study design which does not allow causality inferences. In the current study birth weight was not recorded but it is consistently reported to be a strong predictor of both under and overnutrition.<sup>17,27</sup> Another noteworthy limitation of this study was that many variables entered into the multivariate analysis were binary variables and were assessed using only one question.

## **Conclusion**

Stunting and underweight resulted from an interaction of risk factors from all the levels of the hierarchical model. Except for the effect of having regular income on overweight, both wasting and overweight were mainly associated with maternal factors; namely maternal age, maternal education, maternal BMI, household having a regular source of cash income and the fact that the mother thinks her child is growing well. For attainment of optimal nutrition in these children targeted short-term strategies addressing underlying risk factors (like food availability in households, maternal nutritional status (i.e. BMI), status of women, maternal knowledge of child growth) and more long-term poverty alleviation strategies may be needed. However, caution must be exercised since child obesity and maternal obesity co-exist with child undernutrition in these communities.

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**CHAPTER 4: CONCLUSIONS AND RECOMMENDATIONS**

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## 4.1 INTRODUCTION

The aim of this study was to determine risk factors of child malnutrition as assessed anthropometrically. To achieve this, secondary analysis of socio-demographic indicators, child-care practices, health status and anthropometric measurements of the children and their mothers was undertaken. Anthropometric measurements of the children were re-assessed using the WHO child growth standards. Risk factors of stunting, overweight and underweight were determined using multivariate analysis which took into account the hierarchical interactions between risk factors. Coexistence of malnutrition within the same child and within mother-child pairs was also assessed since interventions to reduce child malnutrition need not result in increased risk of overweight/obesity.

The purpose of the current chapter is to draw general conclusions and give recommendations for program developers and implementers on possible ways of improving the nutritional status of the children living in the studied rural areas and similar communities.

## 4.2 MAIN FINDINGS

Under and overnutrition coexist with stunting being the most prevalent adverse anthropometric outcome followed by child overweight. The WHO child growth standards gave higher rates of stunting and overweight but lower rates of underweight when compared to the NCHS/WHO reference. Maternal overweight was high; and was positively associated with child obesity while 13.9% of the study sample was SCOWT mother-child pairs. Child male gender and the fact that the mother thinks her child is growing well were positively associated with stunting while handouts as source of food and mother making important household decisions were protective. On the other hand child male gender, maternal education, the fact that the mother thinks her child is growing well and history of GI symptoms increased risk of underweight while wealth index was protective. In children aged <24 months still breastfeeding was associated with increased risk of underweight, possibly due to reverse causality. Child overweight was

positively associated with household having a regular source of income and maternal BMI but negatively with maternal education and the fact that the mother thinks her child is growing well. On average SCOWT pairs were more likely to be of older age (both mother and child), have hand-outs as source of food, less likely to increase fluid intakes for their children during episodes of diarrhoea while the children were more likely to be males. Children from SCOWT pairs were less likely to have received bottle feeds in the 24 hours preceding the survey in children younger than 24 months.

### **4.3 CONCLUSIONS**

The double burden of malnutrition occurred in these poor communities, households and individual children. Child male gender and the fact that the mother thinks her child is growing well increased the risk of both stunting and underweight while maternal education also increased risk of underweight. Having a regular source of income and maternal BMI increased the risk of child overweight/obesity. Further research and adoption of positive deviance might strengthen interventions.

### **4.3 GENERAL RECOMMENDATIONS**

In view of the above summarised results and in line with current local and international research the following recommendations are therefore made:

#### **1. Adopt the WHO child growth standards for anthropometric assessment**

The WHO child growth standards were developed using a large internationally representative sample in terms of ethnicity, living in conditions supporting optimal growth and used breastfeeding as the standard (De Onis *et al.*, 2004) so assessing child growth against these standards is most appropriate.

#### **2. Addressing both under- and over-nutrition with one common agenda**

Under and overnutrition coexist in these children and carry significant health and economic consequences. International bodies recommend that the two nutrition states

be addressed with one common agenda (Uauy & Solomons, 2006; World Bank, 2006). In the current study wealth index was negatively associated with stunting and underweight but positively with overweight (though it did not reach significant levels with overweight) suggesting that they both stem from the economic status of the household among other factors. Childhood undernutrition is suspected to be the root cause of the high obesity and NCDs rates observed in the SA adult population (Vorster & Kruger, 2007). Currently only weight is measured in government clinics and underweight rates determined. Measuring height would help in identifying children at risk of stunting and overweight for early interventions.

### **3. Short-term food provision strategies**

About 90% of the mothers considered their household food availability to be inadequate while children from households which received handouts like food aid and welfare were at reduced risk of stunting. Provision of supplement with or without education has been associated with up to 25% improvement in child growth in food insecure areas (Bhutta *et al.*, 2008). To improve household food availability strategies like targeted food aid (either through adjusting the safety nets or by increasing public awareness about programs already in place) or by increasing agricultural produce could be used. A review of the child grant found that the poorest households were less likely to apply for such programs suggesting the need to remove possible barriers of uptake of targeted child nutrition programs (Twine *et al.*, 2007). Possible strategies to increase local food production include development of homestead gardens and strengthening/supporting improved animal husbandry; practices common in these communities. Strategies should, however, take cognisance of the fact that 16% of the children and 49% of the mothers were overweight.

### **4. Implement poverty alleviation strategies**

Wealth index was associated with both forms of malnutrition in the current study and the literature reports a vicious cycle between poverty, causes and consequences of malnutrition (Vorster & Gibney, 2009). This signals the critical importance of poverty alleviation strategies and the value of investing in child nutrition if the economy of the

country is to be improved, but care must be taken since increase in wealth can increase child obesity.

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**ADDENDUM**

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## **Appendix A      Authors guidelines: South African journal of clinical nutrition**

### **Copyright**

Material submitted for publication in the South African Journal of Clinical Nutrition (SAJCN) is accepted provided it has not been published elsewhere. Copyright forms will be sent with acknowledgement of receipt and the SAJCN reserves copyright of the material published.

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### **Authorship**

All named authors must give consent to publication. Authorship should be based only on substantial contribution to: (i) conception, design, analysis and interpretation of data; (ii) drafting the article or revising it critically for important intellectual content; (iii) final approval of the version to be published. All three of these conditions must be met (Uniform requirements for manuscripts submitted to biomedical journals; [www.icmje.org/index.html](http://www.icmje.org/index.html)).

### **Conflict of interest**

Authors must declare all sources of support for the research and any association with the product or subject that may constitute conflict of interest.

### **Protection of patient's rights to privacy**

Identifying information should not be published in written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) gives informed written consent for publication. Informed consent for this purpose requires that the patient be shown the manuscript to be published. ([www.icmje.org](http://www.icmje.org))

### **Ethnic classification**

Work that is based on or contains reference to ethnic classification must indicate the rationale for this.

### **Manuscripts**

Short items are more likely to appeal to our readers and therefore to be accepted for publication. Manuscript should not exceed 4000 words in total all contents inclusive.

*Original articles* of 4 000 words or less, with up to 6 tables or illustrations, should normally report observations or research of relevance to the field of nutrition. References should preferably be limited to no more than 25.

*Short reports or scientific letters*, which include case reports, side effects of nutrient supplements/drugs and brief or negative research findings should be 1000 words or less, with 1 table or illustration and no more than 6 references.

*Editorials, Opinions, Issues in the field of nutrition.* should be about 1000 words and are welcome, but unless invited, will be subjected to the SAJCN peer review process.

*Review articles* are rarely accepted unless invited.

*Letters to the editor*, if intended for the correspondence column, should be marked 'for publication', signed by all authors and presented in triple spacing. Letters should be no longer than 400 words with only one illustration or table.

*Obituaries* should not exceed 400 words and may be accompanied by a photograph.

### **Manuscript preparation**

Please submit your manuscript electronically at [www.sajcn.co.za](http://www.sajcn.co.za)

- Research articles should have a structured abstract not exceeding 250 words (50 for short reports) comprising: Objectives, Design, Setting, Subjects, Outcome measures, Results and Conclusions.

- Refer to articles in recent issues for guidance on the presentation of headings and subheadings.
- Abbreviations should be spelt out when first used in the text and thereafter used consistently.
- Scientific measurements should be expressed in SI units except: blood pressure should be given in mmHg and haemoglobin values in g/dl.

If in doubt, refer to [www.icmje.org/index.html](http://www.icmje.org/index.html)

### **Illustrations**

1. Figures consist of all material that cannot be set in type, such as photographs and line drawings.
2. Tables and legends for illustrations should appear on separate sheets and should be clearly identified.
3. Line drawings should be arranged to conserve vertical space. Note that reduction to 80 mm for a single column or 170 mm for double columns should not render lettering illegible. Explanations should be included in the legend and not on the figure itself.
4. Figure numbers should be clearly marked on the back of prints and the top of illustrations should be indicated.
5. If any tables or illustrations submitted have been published elsewhere, written consent to republication should be obtained by the author from the copyright holder and the author(s).
6. A limited number of illustrations are free at the discretion of the editor. Colour illustrations are encouraged but are charged to the author.
7. A quote will be provided on request. Consider sponsorship.

### **References**

References should be inserted in the text as superior numbers and should be listed at the end of the article in numerical and not in alphabetical order. Authors are responsible for verification of references from the original sources.

References should be set out in the Vancouver style and approved abbreviations of journal titles used; consult the List of Journals in Index Medicus for these details.

Names and initials of all authors should be given unless there are more than six, in which case the first three names should be given followed by et al. First and last page numbers should be given.

### ***Journal references***

should appear thus:

1. Price NC . Importance of asking about glaucoma. BMJ 1983; 286: 349-350.

***Book references*** should be set out as follows:

1. Jeffcoate N. Principles of Gynaecology. 4th ed. London: Butterworth, 1975: 96-101.
2. Weinstein L, Swartz MN. Pathogenic properties of invading microorganisms. In: Sodeman WA jun, Sodeman WA, eds. Pathologic Physiology: Mechanisms of Disease. Philadelphia: WB Saunders, 1974: 457-472.

***Manuscripts accepted but not yet published*** can be included as references followed by (in press).

***Unpublished observations and personal communications***, may be cited in the text, but not in the reference list.

### **Manuscript revisions**

In the event of a manuscript needing revision following the peer review process, all revision changes to the original manuscript should be made using the "track changes" function in Microsoft Word, or in any other such similar format so as to facilitate the speedy completion of the review process. In the event of an "author-reviewer" difference of opinion, the author(s) should state their opinion in writing in the text, which should be bracketed. Revised manuscripts which do not conform to this revision format will be returned to the authors for editing.

***Revised manuscript should be resubmitted electronically within 3 weeks of receipt thereof.***

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Galley proofs will be forwarded to the author before publication and if not returned within 2 weeks will be regarded as approved. Please note that alterations to typeset articles are costly and will be charged to the authors.

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1. As part of the submission process, authors are required to check off their submission's compliance with all of the following items, and submissions may be returned to authors that do not adhere to these guidelines.
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3. The submission file is in Microsoft Word, or RTF file format
4. When available, the URLs to access references online are provided, including those for open access versions of the reference. The URLs are ready to click (e.g., <http://pkp.sfu.ca>).
5. The text is single-spaced; uses a 12-point font; employs italics, rather than underlining (except with URL addresses); and all illustrations, figures, and tables are placed within the text at the appropriate points, rather than at the end.
6. The text adheres to the stylistic and bibliographic requirements outlined in the [Author Guidelines](#), which is found in About the Journal.
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8. The manuscript has an abstract.