CHAPTER 1:   **RESEARCH PROBLEM IN CONTEXT**

Chapter overview

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1.1   RATIONALE FOR STUDY: THEORETICAL CONTEXT

The high prevalence of chronic non-communicable diseases (CNCD) such as coronary heart disease, diabetes mellitus and certain cancers, makes these conditions worldwide - in industrialised and developing countries [1] - as well as in South Africa [2] - public health issues. In fact, in the World Health Organisation (WHO) study on the Global Burden of Disease, ischaemic heart disease is on top of the list of causes of death worldwide [3] and is expected to stay there according to the 2020 projection.[4] King et al [5] estimate that by the year 2025 more than 75% of people with diabetes mellitus will reside in developing countries. This represents a 170% increase from current prevalence rates, compared to a projected increase of 42% in developed countries.

Whilst South Africa as a whole is classified as a developing country,[6] a major component of its population is in the so-called nutrition transition,[7] meaning that traditional lifestyles are increasingly replaced with Western eating habits.[8] The nutrition programming theory implies that developing societies may be subject to the double burden of disease, whereby early nutritional deprivation (such as maternal and fetal malnutrition commonly seen in developing countries) predisposes an individual to the development of CNCD's later in life.[9]

Numerous risk factors, including diet, are linked to CNCD as a group.[10] This has resulted in the formulation of dietary guidelines by various organisations, such as the National Heart, Lung, and Blood Institute's National (NHLBI) Cholesterol Education Program (NCEP), and the regularly revised and updated Dietary Guidelines 2000 of the American Heart Association[11] and the United States Department of Agriculture.[12] In South Africa a set of food-based dietary guidelines has been developed in accordance with international guidelines.[13] These country-specific,

evidence based guidelines were officially approved and adopted by government in 2003 for use by South Africans seven years and older.[14] One of these guidelines stipulates: "Eat fats sparingly".

There is growing consensus that the dietary guidelines should include children in general terms, as well as specifically in respect of fat intake.[11, 12, 15, 16, 17] Not only did a meta-analysis of the NCEP Step 1 and 2 diets point to multiple beneficial effects on cardiovascular risk factors in adults,[18] but these dietary changes also resulted in lowering of low density lipoproteins (LDL) over three years while maintaining growth, iron stores, nutritional adequacy, and psychological well-being in children with elevated LDL-cholesterol concentrations.[19] Similarly, Obarzenek et al [20] reported from the Dietary Intervention Study in Children (DISC) trial on the feasibility, efficacy and safety of cholesterol lowering intervention up to 7.4 years after the randomised controlled trial was started.

Thus, within the primary health care paradigm, where increasing emphasis is placed on nutrition in health promotion and disease prevention, targeting children at a stage when food acceptance patterns are being developed and before lifelong eating habits have become ingrained,[16] appears sensible. This position is supported by evidence of tracking of nutrient intake,[16] obesity [21] and hypercholesterolaemia [22] into adulthood. All of these, plus smoking and hyperglycaemia, are closely related to fatty streaks and the development of atherosclerotic lesions in the second decade of life.[23] More than ten years ago a WHO Expert Committee published a report "Prevention in childhood and youth of adult cardiovascular diseases: time for action", in which the above is acknowledged and the potential for primary prevention programs is outlined.[24]

It follows that the assessment of dietary intakes of children is important for nutrition monitoring, research and intervention efforts.[25] This is mainly the focus of interest in nutritional epidemiology where the relationship between dietary exposure and disease outcome is being studied. Whilst nutrition epidemiologists and community dietitians investigate diets of groups of people, clinical dietitians see dietary assessment as an essential part of the evaluation of the nutritional status of their individual patients,[26] since this forms the starting point of the nutrition care process which consists of assessment, planning, implementation and evaluation.[10]

Measuring diets poses many challenges relating to accuracy and precision. Random and / or systematic errors may occur, the direction and extent of which may vary with the method used

and the population and nutrients studied.[27] These methodological limitations lead Beaton [28] and others to conclude: "All dietary assessment methods are imperfect".

Dietary studies in children have even more difficulties because of children's cognitive abilities to record or remember their intake [29] as well as their restricted knowledge of food and food preparation.[30] All dietary measurements should thus be scrutinised for (comparative) validity, including reliability, before general implementation. The Dietary Assessment Calibration / Validation (DACV) Register [31] specifically aims to continually inform and update the international nutrition community of all validation / calibration studies and publications. It was the result of a strong appeal for such research at the First International Conference of Dietary Assessment in Minneapolis in 1993.[31] McPherson et al [25] recently compiled a comprehensive review on validity and reliability studies specifically among school-aged children.

Since full dietary assessments of usual intake of individuals are time-consuming for the participant / client and the researcher / dietitian and therefore costly, there has been a recent interest in short dietary assessments [32] and dietary screeners in the primary care setting.[33, 34] Such tools can be of a general nature, aimed at identifying nutritional risk, usually for undernutrition, [35, 36] or they can be targeted at specific dietary components, for example fat or folate intake. Analysis can be food-based [37, 38] or on the nutrient level of intake. The 'Healthy Eating Index' [39] and the 'Diet Quality Index Revised' [40] are examples of summary measures of overall diet quality, in addition to those reviewed by Kant.[41] Finally, tools can be designed for the population at large or for specific target groups (defined by age, culture, literacy, setting such as hospitals, health condition et cetera) with different time frames (for example recent intake versus usual habits). Validity of a tool depends on its aim,[42] and consequently a dietary screener for usual consumption of a high fat diet by South African children has to be locally developed and validated.

No such tool is currently available; to the contrary, no dietary screeners or short assessment tools, validated for South Africa, were included in the DACV data base up to 9 April 2001, nor was there any mention of validation studies of dietary assessment focusing on fat intake.

In conclusion: A validated dietary screener for fat intake of South African children will fill a research, public health and clinical practice need and may contribute to (cost) effectively managing and preventing the rising prevalence of CNCD's.

1.2   PRACTICAL CONTEXT

The current research project is the first within a research area "Nutritional assessment" established in the Division Human Nutrition, University of Pretoria. The outline of this research area is given in Figure 1.1.

NUTRITIONAL ASSESSMENT
Nutritional screening amongst South African children
(NuTeenScreen)

PhD Project (FAM Wenhold) Development and comparative validation of a dietary fat screener for (urban Afrikaans speaking) grade six learners	Repeat PhD methodology on: • Urban children of same age, but other cultural groups • Rural children of same and other cultural groups • Other age groups

Comparison of results from various target groups

Description of grade six children's dietary intakes

Expand aim of screener to include other dietary components

Integration of nutritional assessment into the mathematics curriculum of grade six learners

Expand screener to other nutritional (non-dietary) factors

Relationship between BMI-for-age of grade six learners and their body shape satisfaction

Expand to non-nutritional life-style / risk factors of relevance to the etiology of CNCD

Sensitisation / learning following dietary screening on subsequent 3-day food recording

Development of a food picture database for dietary screening of South-African children of various cultures and ages
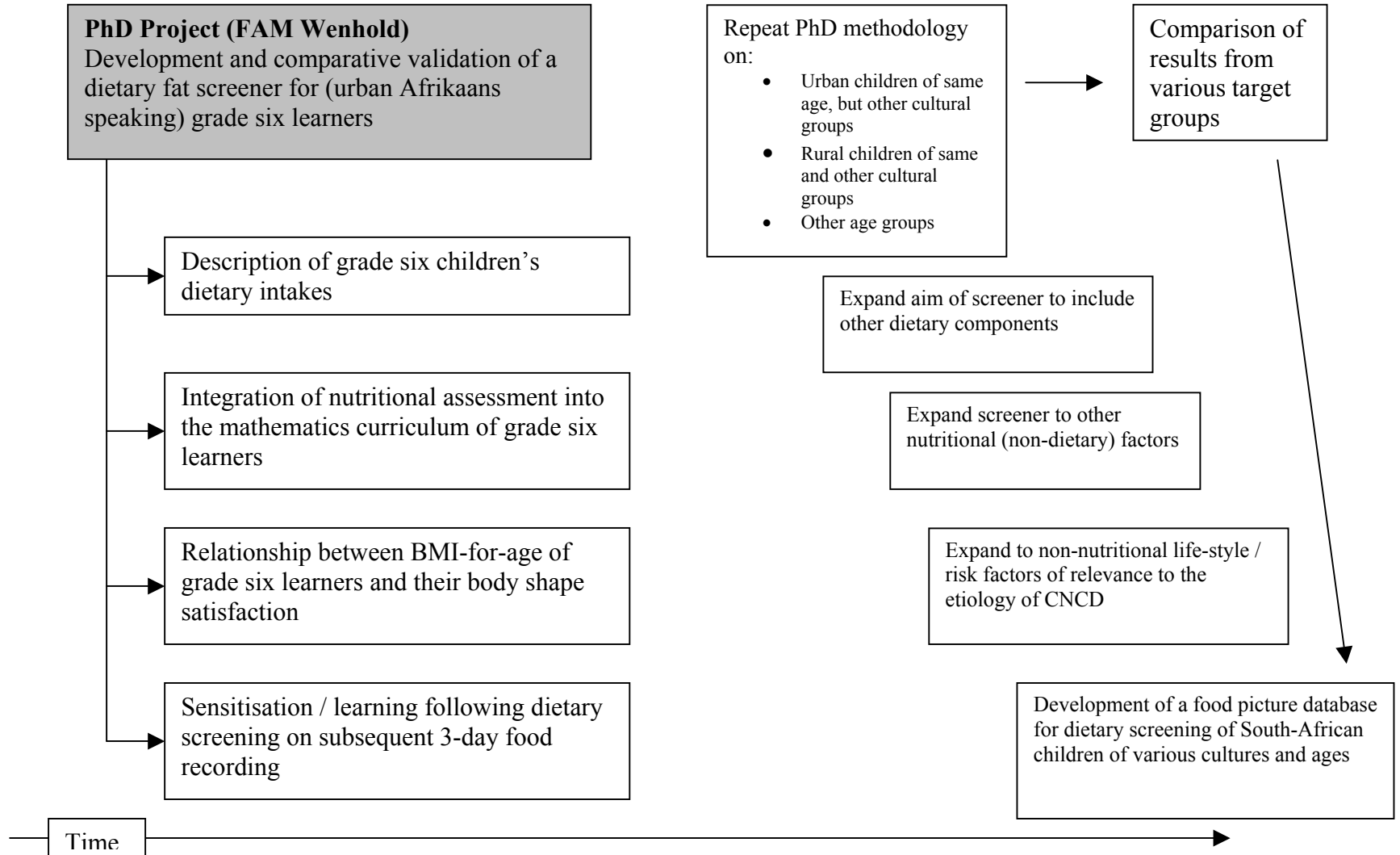
Time

FIGURE 1.1: CURRENT STUDY (shaded box) WITHIN BROADER CONTEXT

1.3   RESEARCH PROBLEM AND SUB-PROBLEMS

The research problem that formed the basis for this study was:

What is the comparative validity of a dietary fat screener (the test method) in grade six learners?

The following sub-problems were formulated:

- What is the reliability of the test method?
  - What is the internal consistency of the test method?
  - What is the test-retest reproducibility of the test method in terms of
    - portion size estimation of all food categories
    - frequency of intake of all food categories
    - category scores of all food categories
    - final scores
    - screener classification?

- What is the validity of the test method compared to a three-day food record?
  - What is the validity of the test method relative to mean daily dietary percent fat energy (PFE) as determined by a three-day food record?
  - What is the validity of the test method relative to mean daily dietary percent saturated fatty acid (PSFE) as determined by a three-day food record?
  - What is the validity of the test method relative to mean daily dietary cholesterol intake as determined by a three-day food record?

- What is validity of the test method compared to the screener as completed by the parents?
  - What is the validity of the test method compared to parental completion of the screener in terms of
    - portion size estimation of all food categories
    - frequency of intake of all food categories
    - category scores of all food categories
    - final scores
    - screener classification?

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- What is the validity of the test method when compared to the three-day food record and the screener completed by parents simultaneously?

An overview of the current project is graphically presented in Figure 1.2, which at the same time is intended to clarify the above-mentioned research sub-problems and outline the conceptual framework of the project. The shaded areas represent the sub-problems, whilst the unshaded boxes refer to the developmental evaluation sub-studies and the quality control measures that were performed in this study.
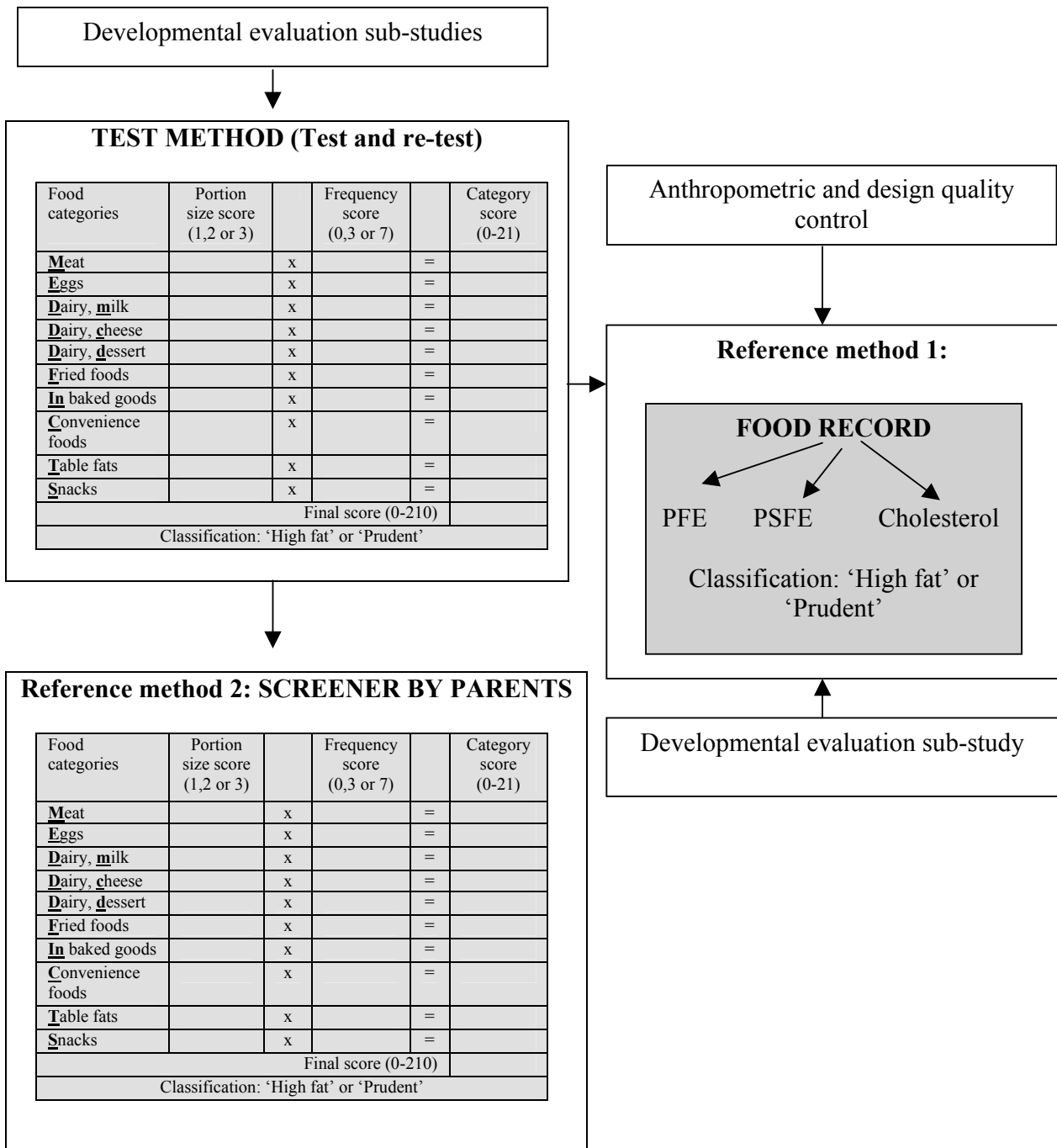
Food categories	Portion size score (1,2 or 3)		Frequency score (0,3 or 7)		Category score (0-21)
Meat		x		=	
Eggs		x		=	
Dairy, **m**ilk		x		=	
Dairy, **c**heese		x		=	
Dairy, **d**essert		x		=	
Fried foods		x		=	
In baked goods		x		=	
Convenience foods		x		=	
Table fats		x		=	
Snacks		x		=	
				Final score (0-210)	
			Classification: 'High fat' or 'Prudent'		

Developmental evaluation sub-studies

TEST METHOD (Test and re-test)

Anthropometric and design quality control

Reference method 1:

FOOD RECORD

PFE   PSFE   Cholesterol

Classification: 'High fat' or 'Prudent'

Reference method 2: SCREENER BY PARENTS

Food categories	Portion size score (1,2 or 3)		Frequency score (0,3 or 7)		Category score (0-21)
Meat		x		=	
Eggs		x		=	
Dairy, **m**ilk		x		=	
Dairy, cheese		x		=	
Dairy, dessert		x		=	
Fried foods		x		=	
In baked goods		x		=	
Convenience foods		x		=	
Table fats		x		=	
Snacks		x		=	
			Final score (0-210)		
			Classification: 'High fat' or 'Prudent'		

Developmental evaluation sub-study

FIGURE 1.2 CONCEPTUAL FRAMEWORK

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1.4   TERMINOLOGY

In Table 1.1 the core concepts and abbreviations as used in this study are (operationally) defined. Where no strict differentiation between terms was applied, stipulating the synonyms used indicated this.

TABLE 1.1: TERMINOLOGY, (OPERATIONAL) DEFINITIONS AND ABBREVIATIONS FOR THIS STUDY
(Arranged alphabetically; Concepts in italics are cross-referenced)

Terminology / abbbreviation	Description and / or operational definition
ADA	American Dietetic Association
AMDR	Acceptable macronutrient distribution ranges
Agreement	For categorical data: A *match* between corresponding variables in two methods / administrations, for example portion size in the test method and in the reference method, or *classification* in the first and the second administration of the screener; expressed in terms of percentage identical responses and chance-corrected kappa statistic For continuous data: Inferred from statistical results, for example (linear) associations (comparisons of rank orders), comparisons of means and assessing the extent of differences, including indications of random and systematic errors, and the Bland-Altman method
Anthropometry	Study of the size and dimensions of the human body In this study: Weight and height of the children, combined into the following indices: • Weight for age • Height for age • Body mass index for age Interpreted by expressing in terms of mean percentiles and Z-scores with the CDC 2000 growth charts as reference
Assessment	The numerical value given to some physical property (for example weight) or behaviour (for example dietary intake) Synonyms: Measurement, estimation, prediction, evaluation, determination
Bias	For categorical data: The absence of symmetry in a cross tabulation of corresponding variables as indicated by the McNemar test for symmetry For continuous data: The difference between values obtained in the test method and the reference method [43] or between two administrations of the test method Synonym: Systematic error (see text in review of literature) In this study: Dependent on the phase in the validation process, for example in the test-retest reproducibility study this could refer to portion size scores in first versus second administration (categorical data), or in the child-parent comparative validation this could refer to final scores of children minus the final scores of parents (continuous data)

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Terminology / abbbreviation	Description and / or operational definition
Categorised weekly consumption	Conversion of reported times per day or week consumption *(frequency of intake)* in the test method and reference method 2 (screener by parents) into the following categories: • Less than once per week • Once or more (up to three times) per week • More than three times per week
Category score	In the test method and the screener completed by the parents: The mathematical product of the *portion size score* and the *frequency of intake score* of each food category
Chronic non-communicable diseases (CNCD)	Chronic (in contrast to acute) non-contagious diseases, also called 'diseases of lifestyle', for example cardiovascular disease, including hypertension, type 2 diabetes mellitus, certain cancers (for example colon, breast, prostate)
Classification	Dichotomisation of *final scores* in test method and screener by parents (reference method 2), and of *PFE, PSFE* and cholesterol intake (reference method 1) to *'high fat' or 'prudent'*
Comparative validation	The relation between a less detailed method of dietary assessment to a more detailed method, assumed or shown to more closely reflect the truth Synonyms: Calibration, relative validation, standardisation, congruent validation In this study: Reported intakes from the test method relative to the chosen reference methods (three-day food record and screener by parents), where the reference method(s) were assumed to reflect true usual fat intakes (that is the truth)
Construct	The unobservable (or latent) trait being measured by the questionnaire. The construct or trait is measured along a continuous scale. Synonyms: Trait, domain, latent variable, theta, characteristic, attribute In this study: Usual fat intake
Developmental evaluation sub-study	First stage evaluation of a test method where the adequacy of a tool as such is assessed prior to field testing and comparative validation in the target population[44] In this study: The sub-studies described in the chapter 'Development and developmental evaluation' that is: • Sub-study 1: Content and face validity (Test method) • Sub-study 2: Reference portion size (Test method) • Sub-study 3: Portion size estimation aids (Test method) • Sub-study 4: Frequency of intake (Test method) • Sub-study 5: Food record (Reference method 1)
Dietary fat screener	Short method for *assessing* fat intake (see *screener*)
DRI	Dietary Reference Intakes
Final score	Mathematical sum of the ten *category score*s in the test method and in reference method 2 (screener by parents), in both cases potentially ranging from 0 to 210

Terminology / abbbreviation	Description and / or operational definition
Food category	Line item in the food frequency type test method and reference method 2 (screener by parents), referring to **M**eat, **E**ggs, **D**airy (milk), **D**airy (cheese), **D**airy (dessert), **F**ried foods, fats **I**n baked goods, **C**onvenience foods, **T**able fats
Food consumption	Food and drink ingested by participants Synonyms: Food intake; dietary intake
Food frequency questionnaire (FFQ)	A list-based interview procedure during which the participant recalls how often specified foods or food groups are eaten per day, per week or per month. It may include quantitative assessment of usual portion size (and is then more accurately called a 'food frequency and amount questionnaire') In this study: A ten item (food category) list with per day or per week frequency of intake format, and relative portion size reporting
Food record	A written record / diary of current food and drink intake by the participant concurrently or immediately following the eating occasion for the specified *recording period*
Frequency of intake	Number of times a food category is usually consumed per day or per week
Frequency score	Point score given to *categorised weekly consumption* in the test method and reference method 2 (screener by parents) • Less than once: 0 points • Once or more (up to three times per week): 3 points • More than three times: 7 points
Grade six child	Learner (scholar, pupil, student) in the sixth grade (Intermediate Phase of the South African Department of Education C2005 for schools); typically 12 years old
High fat / prudent diet	Test method and screener by parents: If the *final score* obtained exceeded 68, it was classified as 'high fat'; conversely it was classified as 'prudent' Reference method 1 (Three-day record): If the following conditions were met based on the mean daily intake in the three-day *food record*, the diets were classified as 'high fat'; conversely the diets were classified as 'prudent': • Percentage total fat energy (PFE) > 30 • Percentage saturated fat energy (PSFE) > 10 • Cholesterol intake => 300mg
Inter-individual	Between persons / participants
Internal consistency	Homogeneity, uni-dimensionality of a *scale* In this study: Internal consistency together with reproducibility were taken as indicators of reliability of the test method. Internal consistency was measured by item total correlations, Cronbach's coefficient alpha and the split half method (equivalent forms approach)

Terminology / abbbreviation	Description and / or operational definition
Intra-individual	Within the person / participant
IOM	Institute of Medicine
Item	Question in a *scale* In this study: The ten food categories (**M**eat, **E**ggs, **D**airy [milk, cheese and dessert], **F**ried foods, fats **I**n baked goods, **C**onvenience foods, **T**able fats, **S**nacks) contained in the dietary fat screener, being the line items in a FFQ
Match	When categorical data (for example reported portion size, frequency of intake or fat intake classification) were the same in two or more assessments (for example test and re-test or child and parent) Expressed as percentage identical responses or 'perfect agreement' in tables, or as overlap areas in figures
MEDFICTS	Dietary assessment tool developed by National Cholesterol Education Program (NCEP) Acronym for food categories contained in test method, that is • **M**eat • **E**ggs • **D**airy (milk) • **D**airy (cheese) • **D**airy (dessert) • **F**ried foods • fats **I**n baked goods • **C**onvenience foods • **T**able fats
NCEP	National Cholesterol Education Program
Negative predictive value (NPV)	The probability of the person not having the condition when the test is negative[45]. The formula for negative predictive value is TN / (TN + FN) where TN and FN are the number of true negative and false negative results respectively In this study: Proportion of individuals who truly consumed a prudent diet according to the three-day food record, out of all who tested negative with the test method
Odds ratio (OR)	The ratio of the odds of exposure among the cases to the odds in favour of exposure among the controls [45]
Overall predictive value (OPV)	The proportion of predictions that are true positives and negatives In this study: Proportion of individuals that truly consumed a high fat and prudent diet
PFE (Percentage fat energy)	Mean daily total dietary fat intake (in grams) from the three-day records was converted to an energy (kJ) equivalent by multiplication by 37.8. PFE was then calculated by expressing mean total fat energy as a percentage of mean daily energy intakes.
Physical Activity Level (PAL)	Ratio of dietary energy intake to basic metabolic rate (BMR); Part of the 'Goldberg' cut-off for performing quality control in self-reported energy intake [46]

Terminology / abbbreviation	Description and / or operational definition
Portion / Serving size	In the test method and reference method 2 of this study: • A small portion was defined as half as much or less than the *reference portion* • A medium portion was defined as about the same amount than the *reference portion* • A large portion was equivalent to one-and-a-half times or more the size of the *reference portion*
Portion size estimation aid (PSEA)	Two-dimensional (2D) and three-dimensional (3D) props to help participants gauge intake quantities consisting of geometrical shapes, photos and household measures (measuring cups and spoons) In this study: Full list of PSEA used are described in text
Portion size score	Point score given to reported *portion size*: • Small = 1 point • Medium = 2 points • Large = 3 point
Portion, serving	The amount of food that a person reports as being the quantity usually consumed. There is no standard portion size and no single right or wrong portion size In this study: No official standardisation is available for South Africa and in the Afrikaans language no differentiating terminology is generally accepted. Thus portion and serving were used interchangeably (and always explained), except where to specific studies was referred
Positive predictive value (PPV)	The positive predictive value of a test is the probability of the person having the condition when the test is positive.[45] The formula for positive predictive value is TP / (TP + FP) where TP and FP are the number of true positive and false positive results respectively. In this study: The likelihood that individuals categorised by the test method as having a high fat diet had a diet that was high in fats according to the 3-day record
Primary / elementary school	Typically school in the South African Department of Education school system accommodating grades 1 to 7
Percentage fat energy (PFE)	Mean daily, total fat intake (in grams) from the three-day records was converted to an energy (kJ) equivalent by multiplication by 37.8. PFE was then calculated by expressing total fat energy as a percentage of mean daily energy intakes
Percentage saturated fat energy (PSFE)	Mean daily, saturated fatty acid intake (in grams) from the three-day records was converted to an energy (kJ) equivalent by multiplication by 37.8. PSFE was then calculated by expressing saturated fatty acid energy as a percentage of mean daily energy intakes
RDA	Recommended Dietary Allowance
Recording period	One of three specific sets of consecutive days during which children kept *food record,* that is either one of the following: • Thursday, Friday and Saturday • Tuesday, Wednesday and Thursday • Sunday, Monday and Tuesday

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Terminology / abbbreviation	Description and / or operational definition
Reference method	Comparison (more detailed or accurate) method assumed to be superior to the test method Synonyms in literature: (gold) standard; 'outcome for that which is to be predicted or detected by the screener' [47] <u>In this study</u>: Reference method 1: The three-day food record Reference method 2: Screener completed by parents
Reference period	The time span in relation to which intakes in a FFQ are reported <u>In this study</u>: From the beginning of the academic year (January) to the time of assessment (that is September), representing nine months and assumed to reflect usual intake of fat
Reference portion	The amount given to participants relative to which the own intake had to be reported (see *portion size*)
Relative risk (RR)	The ratio of the risk occurrence of a condition among exposed people to that among the unexposed [45] Synonym: Risk ratio
Reliability	Synonyms: Absence of random error, precision, consistency, reproducibility, repeatability, dependability; see text (literature study) for more detail <u>In this study</u>: Conceptualised in terms of *internal consistency* and test-retest *reproducibility*
Reproducibility	The extent to which a method produces the same results when applied repeatedly in the same situation Synonym: Repeatability <u>In this study</u>: Test-retest reproducibility of the test method was measured and, together with (statistically quantified) *internal consistency*, were taken as indicators of *reliability*
Scale	Synonyms: Measure, questionnaire, instrument or test; but also apparatus or equipment <u>In this study</u>: • The dietary fat screener was taken to be a scale, which measured a single *construct* or domain, namely fat intake • The term 'scale' was also used to refer to the instrument / physical equipment used for weighing foods (Soehnle scales) and to measure the children's body mass (Tanita scale)
Screener	Synonyms: Short assessment, 'low intensity method',[48] simple indices as alternatives to more complex methods, [49] 'short-cut method' [50] <u>In this study</u>: *Dietary fat screener* (the test method)
Sensitivity	The sensitivity of a test is the probability of a positive test in people with the condition[45]. The formula for sensitivity is TP / (TP + FN) where TP and FN are the number of true positive and false negative results respectively. Sometimes called the "true positive fraction" and calculated as Prob [screener positive | outcome positive] [47] <u>In this study</u>: Proportion of individuals with high fat intake in the three-day food record who were correctly classified by the test method as having a high fat intake

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Terminology / abbbreviation	Description and / or operational definition
Specificity	The specificity of a test is the probability of a negative test in people without the condition.[45] The formula for specificity is TN / (TN + FP) where TN and FP are the number of true negative and false positive results respectively. Sometimes defined within the context of conditional probability, where the "false positive fraction" = 1- specificity = Prob [screener positive | outcome negative] [47] In this study: Proportion of individuals following a prudent diet according to the three-day food record correctly classified by the test method as not being at risk of high fat intake
Test method	The new or simpler method or method of unknown performance Synonyms: Pepe et al [47] used the generic term 'marker' for a factor, score or biomarker used for screening In this study: The dietary fat screener
Tool	The means by which dietary assessment and screening were performed Synonyms: Instrument, questionnaire, test, measure In this study: Examples of tools are the dietary fat screener or the three-day food record
Uni-dimensionality	The set of questions are measuring a single continuous latent variable (*construct*) In this study: All food categories (items) in the test method measure fat intake
WHO	World Healh Organisation