Dietary Risk Assessment of Discovery Health Medical Aid's Vitality Members in South Africa

by
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Abstract

Background: The rising prevalence of non-communicable diseases (NCD) is cause for concern. Improving dietary quality is a key health promotion strategy aimed at reducing NCD morbidity and mortality. Assessments that quantify "risky" dietary behaviours are worthwhile, and may help to identify high risk individuals, that would benefit from targeted interventions.

Purpose: Discovery Vitality is a wellness incentive business associated with Discovery Health medical aid in South Africa. This study developed a Dietary Behaviour Score (DBS^{PHR}) that measured degrees of compliance of Discovery Vitality members with the "spirit of dietary guidance". It further categorized scores and identified members who may be at risk for developing NCDs due to poor dietary compliance.

Methods: The DBS^{PHR} included proportionally weighted components related to the consumption of fruit, vegetables, low fat dairy, whole-grain foods, lean meat, chicken and discretionary fat. The study population included adult South African members of Discovery Vitality, who had completed the programme's on-line health risk assessment (PHR) between the 1st February 2010 and 31st January 2011. Stratified random sampling was used (n=1600).

Half the sample included members who participated in Vitality's HealthyFood™ benefit (HFB) programme. The different Vitality Status groups were equally represented, and reflect degrees of engagement with the programme. Genders were equally represented. DBS^{PHR} data were categorized as: Poor (Score 0-18), Inadequate (18.5-22.5), Fair (23-26), Good (26.5-29), Excellent (29.5-36). DBS^{PHR} data was analyzed for variables: Vitality status, HFB participation, smoking, physical activity, alcohol consumption, body mass index (BMI), age and gender. The relationships between continuous response variables and nominal input variables were analysed using analysis of variance (ANOVA). When ordinal response variables were compared versus a nominal input variable, non-parametric ANOVA methods were used. Further, the Mann-Whitney test or the Kruskal-Wallis test was used. A p-value of $p < 0.05$ was considered to represent statistical significance, and 95% confidence intervals were used to describe the estimation of unknown parameters.

Results: Of the sample, 67.13% of members had DBS^{PHRs} that were considered "poor" or "inadequate". The mean DBS^{PHR} of the sample was 20.47 points. Women achieved better DBS^{PHRs} than men ($p<0.01$). Greater engagement with the Vitality programme was associated with better DBS^{PHRs} ($p<0.01$). There was no significant difference between the mean DBS^{PHR} of members participating in the HFB and Non-HFB members, however the

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HFB was not assessed as an intervention. Members with “risky” lifestyle behaviours such as; inactivity, smoking and consuming alcohol excessively, demonstrated lower DBS^{PHR} than members without these risks. Obese members achieved significantly lower DBS^{PHRs} than normal weight and overweight members ($p<0.01$).

Conclusions: It is concerning that Discovery Vitality members did not perform better than the general global standard of inadequate compliance with the “spirit of dietary guidance”. Engagement with the Vitality programme seems to positively impact on dietary compliance. Members at an increased risk for NCD morbidity and mortality due to; aging, obesity, smoking, inactivity or non-compliance with alcohol consumption guidelines, demonstrated lower DBS^{PHRs} compared to members without these risks. Targeted interventions aimed at addressing “risky” dietary and lifestyle behaviours may benefit these members.

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Abstrak

Agtergrond: Die styging in voorkoms van nie-oordraagbare siektes (NOS) is rede tot kommer. Verbetering van dieetkwaliteit is 'n sleutel gesondheidsbevordering strategie gemik daarop om NOS morbiditeit en mortaliteit te verminder. Assesserings wat "riskante" dieetgedrag kwantifiseer is waardevol en mag help om hoë risiko individue te identifiseer wat sal baatvind by geteikende intervensies.

Doel: Discovery Vitality is 'n welwees motiveringsbesigheid wat geassosieer is met Discovery Health mediese fonds in Suid-Afrika. Hierdie studie het 'n dieet-gedragstelling ("Dietary Behaviour Score - DBS^{PHR}") ontwikkel wat die graad van nakoming van Discovery Vitality lede gemeet het aan die "gees van leiding oor dieet". Dit het verder tellings gekategoriseer en lede geïdentifiseer wat 'n verhoogde risiko vir die ontwikkeling van NOS mag hê as gevolg van swak nakoming van dieet.

Metodes: Die DBS^{PHR} het proporsioneel geweegde komponente bevat, verwant aan die inname van vrugte en groente, laevet suiwelprodukte, volgraan voedsels, maer vleis, hoender en diskresionêre vet. Die studiepopulasie het volwasse Suid-Afrikaners ingesluit wat lede van die Discovery Vitality program was en wat die program se aanlyn gesondheidsrisiko assessering tussen 1 Februarie 2010 en 31 Januarie 2011 voltooi het. Gestratifiseerde, ewekansige steekproeftrekking was gebruik (n=1600).

Helfte van die steekproef het lede ingesluit wat aan Vitality se HealthyFood™ voordeel program deelgeneem het. Die verskillende Vitality Status groepe was gelyk verteenwoordig en reflekteer verskillende grade van interaksie met die program. Geslagte was gelyk verteenwoordig. DBS^{PHRs} data was gekategoriseer as: Swak (Telling 0-18), Onvoldoende (18.5-22.5), Matig (23-26), Goed (26.5-29), Uitstekend (29.5-36). DBS^{PHR} data was vir die volgende veranderlikes geanaliseer: Vitality status, deelname aan die HealthyFood™ voordeel, rook, fisiese aktiwiteit, alkohol inname, liggaamsmassa indeks (LMI), ouderdom en geslag. Die verhouding tussen aaneenlopende reaksie veranderlikes en nominale inset veranderlikes was geanaliseer deur die gebruik van analise van variansies (ANOVA). Wanneer ordinale reaksie veranderlikes vergelyk was teenoor 'n nominale inset variansie, was nie-parametriese ANOVA metodes gebruik. Verder was die Mann-Whitney toets of die Kruskal-Wallis toets gebruik. 'n P-waarde van $p < 0.05$ was gesien as verteenwoordigend van statistiese beduidendheid en 95% sekerheidsintervalle was gebruik om die skatting van onbekende parameters te beskryf.

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Resultate: Van die studie monster het 67.13% van die lede DBS^{PHRs} getoon wat gereken was as “swak” of “onvoldoende”. Die gemiddelde DBS^{PHR} van die steekfproef was 20.47 punte. Vroue het beter DBS^{PHR} as mans behaal ($p<0.01$). Meer interaksie met die Vitality program was geassosieer met beter DBS^{PHRs} ($p<0.01$). Daar was geen beduidende verskille tussen die gemiddelde DBS^{PHR} van lede wat aan die HealthyFood^{TM} voordeel program deelneem en die lede wat nie aan die program deelneem nie, alhoewel die HealthyFood^{TM} voordeel nie geëvalueer was as ‘n intervensie nie. Lede met “riskante” lewenstyl gedrag soos onaktiwiteit, rook en hewige alkoholinname het laer DBS^{PHR} getoon as lede sonder hierdie risiko’s. Vetsugtige lede het laer DBS^{PHR} behaal as normale gewig en oorgewig lede ($p<0.01$).

Gevolgtrekking: Dit is ‘n bron van kommer dat Discovery Vitality lede nie beter vertoon het as wat blyk ‘n algemene globale standaard van gebrekkige nakoming van die “gees van leiding oor dieet” te wees nie. Interaksie met die Vitality program blyk ‘n positiewe impak te hê op dieet nakoming. Lede wat ‘n verhoogde risiko gehad het vir NOS morbiditeit en mortaliteit as gevolg van veroudering, vetsugtigheid, rook, onaktiwiteit of verontagsaming van alkohol inname riglyne het ook laer DBS^{PHRs} getoon in vergelyking met lede sonder hierdie risiko’s. Geteikende intervensies gemik op die aanspreek van riskante dieet en lewenstyl gedrag mag tot voordeel van hierdie lede wees.

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Contributions made by principle researcher and fellow researchers

The principal researcher (Anne Till) developed the idea and the protocol. The principal researcher planned the study and developed and set up appropriate data extraction sheets. The data was extracted by one of Discovery Vitality's actuarial scientists (Jaco Conradie). The principle researcher then sorted extracted data and completed the random sampling process. She then analysed the data with the assistance of a statistician (Prof DG Nel), interpreted the data and drafted the thesis. Prof Vicki Lambert and Mrs Lisanne du Plessis provided input at all stages and revised the protocol and thesis.

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Definition of terms

The Nutrition Transition: refers to predictable shifts in diet and energy expenditure that coincide with modernization, urbanization and economic development.[a]

Discovery Vitality: for the purpose of this study "Discovery Vitality" refers only to the South African wellness incentive business associated with Discovery Health medical aid.

Discovery Vitality Status: refers to a Vitality member's "status" within the Vitality program at the time of completing their online health risk assessment questionnaire (Personal Health Review (PHR)) between the period; the 1st February 2010 to the 31st January 2011.

HealthyFood™ benefit (HFB): for the purpose of this research the *HealthyFood™ benefit (HFB) refers the Discovery Vitality South African initiative* of discounting "specific" foods to their members and the allocation of points for the purchasing of these foods. The HFB does not refer to the Vitality HealthyFood™ initiative in the United Kingdom or the United States of America.

Discovery Vitality HealthyFood™ benefit (HFB) members: refers to Discovery Vitality members who have activated the HealthyFood™ benefit in South Africa. These members are referred to as HealthyFood™ benefit (HFB) members in this study.

Discovery Vitality Non-HealthyFood™ benefit (N-HFB) members: refers to Discovery Vitality members in South Africa who have not activated the activated the HealthyFood™ benefit.

Personal Health Review (PHR): refers specifically to the on-line general lifestyle and brief dietary assessment tool (or health risk assessment questionnaire) made available by Discovery Vitality to its members who are South African residents.

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[a]. Definition of the Nutrition Transition. [Internet]. C2013[updated 2006; cited 2014 February]. Available from: http://www.cpc.unc.edu/projects/nutrans/whatis

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List of Acronyms

Acronym	Description
ADG	American Dietary Guidelines
AHA	American Heart Association
AHEI	Alternate Healthy Eating Index
ANOVA	Analysis of Variance
BMI	Body Mass Index
BMIs	Body Mass Indexes
CHD	Coronary Heart Disease
CVD	Cardiovascular Disease
DBS	Dietary Behaviour Score
DBS^{PHR}	Dietary Behaviour Score calculated from Discovery Vitality's Personal Health Review Questionnaire
DBS^{PHRs}	Dietary Behaviour Scores calculated from Discovery Vitality's Personal Health Review Questionnaire
DGI	Dietary Guidelines Index
DPAS	Diet and Physical Activity Strategy
DQI	Diet Quality Index
DQI-I	Diet Quality Index International
DQI-R	Diet Quality Index Revised
DVS	Diet Variety Score
FAO	Food and Agricultural Organization
FFQ	Food Frequency Questionnaire
GDP	Gross Domestic Product
GHS	General Household Survey
HEI	Health Eating Index
HFB	HealthyFood™ Benefit
HRA	Health Risk Assessment
HREC	Health Research Ethics Committee
LMI	Liggaamsmassa indeks (Afrikaans)
LS	Least-Squares
LSM	Living Standards Measure
MDQI	Mediterranean Diet Quality Index
MDS	Mediterranean Diet Scale
MRC	South African Medical Research Council

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List of Acronyms

Acronym	Description
NCD	Non-Communicable Disease
NCDs	Non-Communicable Diseases
NCI	National Cancer Institute
NHANES	National Health and Nutrition Examination Surveys
N-HFB	Non-HealthyFood™ Benefit
NOS	Nie-oordraagbare siektes (Afrikaans)
PHR	Personal Health Review
PP	Principle Member
REAP	Rapid Eating and Activity Assessment
RFS	Recommended Food Score
SAFBDG	South African Food Based Dietary Guidelines
SP	Spouse Member
UK	United Kingdom
US	United States
USA	United States of America
USDA	United States Department of Agriculture
WHO	World Health Organization

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CHAPTER 1

LITERATURE REVIEW

1.1. Introduction

Poor diet quality and physical inactivity are the most important lifestyle factors contributing to the global epidemic of overweight and obesity affecting, men, women and children worldwide.[1-3] Even in the absence of overweight, poor diet and physical inactivity are associated with major causes of morbidity and mortality globally.[1,3,4] The high prevalence of non-communicable diseases (NCD), including diabetes, cardiovascular disease (CVD), hypertension and cancer in both developed and developing countries is of concern, indicating, in general, poor compliance with advocated dietary and activity guidelines. According to the Joint World Health Organization (WHO) and Food and Agricultural Organization (FAO) Expert Consultation Report on Diet, Nutrition and the Prevention of Chronic Diseases, by 2020 chronic diseases will account for almost 75% of deaths worldwide.[3]

The consequences of this global pandemic are numerous and have far reaching implications, one being the economic burden for developed and developing countries in terms of medical care costs as well as lost productivity.[5,6] These financial consequences filter down to international and local businesses, and have far reaching implications even to individuals and their households.[6] The repercussions for medical insurance companies in countries where private health care is available are also likely to be significant.[5,6]

Assessments that can quantify “risky” dietary and/or lifestyle behaviours that promote an increase in NCD risk and therefore greater incidence of NCD morbidity and mortality are worthwhile. Such indicators will enable medical insurance companies and/or state health facilities to identify high risk individuals and in turn target interventions at these specific individuals or groups. Identification of high risk individuals/groups can further assist medical insurance companies and/or state health departments to develop/enhance educational materials and/or behaviour change strategies that will target the specific requirements of these individuals. Targeted interventions are expected to promote greater compliance with the “spirit of dietary guidance” and improve lifestyle behaviours that can reduce risk for NCD morbidity and mortality, which consequently should also have a significant impact on the financial burden of the global chronic disease pandemic.[5]

1.2 The Nutrition Transition

Changes to the global food supply as a result of industrialization, modernization, globalization, and international food markets have played a significant role in contributing to the global problem of overweight and obesity as well as the current pandemic of NCD. A

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large number of epidemiological studies show that high risk dietary practices associated with the "Nutrition Transition" are significant contributors to disease and obesity risk. These risky dietary behaviours refer to higher intakes of calorie dense foods, higher consumption of sugar, sugary foods and refined grains, higher consumption of fat - specifically saturated and trans fatty acids, and lower intakes of fresh fruit and vegetables.[3,4,7,8] All of these undesirable dietary practices are associated individually and collectively with a risk for becoming overweight and/or developing NCD.[1,2] Coupled with these risky dietary behaviours, the "Nutrition Transition" is associated with the consumption of larger portions of food by individuals and in turn the consumption of excess calories.[8-11] Risky dietary practices in conjunction with inactivity and sedentary living (also promulgated by modern day lifestyle) are major contributors to the burden of NCD worldwide, and in turn the rising incidence of NCD mortality.[3,4]

1.3 Advocated dietary guidelines

In the face of rising levels of obesity and NCD, it has become essential that individual governments and other significant organizations such as the WHO, provide dietary guidelines to populations and individuals that are supported by scientific evidence, and are expected to promote health and prevent disease.[3,4] The WHO has provided clear guidelines in their report on Diet and Physical Activity Strategy (DPAS) in 2003 and 2006.[3,4] In South Africa, the South African Food Based Dietary Guidelines (SAFBDG) published in 2001, provided dietary guidelines for the South African population in terms of nutritional principles that could promote health and prevent disease.[12] These guidelines are currently being updated. In the United Kingdom, the "The Eat Well Plate" is advocated.[13,14] In the United States of America, the American Dietary Guidelines (ADG) are updated every five years and the latest guideline of 2010 provides evidenced based recommendations for dietary intake for all Americans that aim to promote health and prevent and manage NCD.[1] Individual organizations such as the American Heart Association (AHA) and the Heart and Stroke Foundation of South Africa produce dietary guidelines for the management and prevention of CVD, which are noteworthy as CVD is the leading cause of death worldwide.[3,4,15,16]

Although these guidelines are usually tested for population specific understanding, cultural sensitivity, availability, appropriateness and sustainability, the guidelines for each organization and/or publication convey fundamentally similar, if not almost the same, health and nutrition messages. A collective summary of these guidelines is given in Table 1.1 and represent the most widely accepted dietary recommendations for individuals and

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populations in terms of health promotion and the prevention of NCD, including the prevention of overweight, obesity and CVD.

Recommended guidelines (Table1.1) provide individuals, health practitioners, and government organizations with a "gold" standard regarding dietary recommendations for attainment and maintenance of health and the prevention of disease. The advocated dietary guidelines can also be considered a "yard-stick" against which to evaluate dietary practices and/or habits of individuals and/or groups in order to establish compliance with the "spirit of dietary guidance".

For many years it has been perceived that absolute compliance with advocated guidelines is necessary to reduce the risk for developing NCD. Nonetheless a study conducted by Kant and colleagues,[17] has shown that compliance in keeping with the "spirit of dietary guidance", and not absolute compliance may have a significant impact on reducing mortality risk related to NCD.[17] Similar results have been shown by a number of other studies that have used a variety of different dietary scores which have been formulated from key recommendations of specific population based dietary guidelines. These studies show that degrees of compliance and increasing levels of diet quality and compliance with advocated dietary guidelines, are associated with improved health outcomes, and significant reductions in risk for morbidity and mortality attributable to NCDs.[18-31] Further, these studies support the idea that the effect of an overall dietary pattern is likely to be considerably greater than the effect of individual foods or nutrients.[32]

While compliance with advocated dietary guidelines remains strongly recommended, recommendations should not be seen in isolation, but in the context of overall diet quality. Further, assessment of degrees of compliance with the "spirit of dietary guidance" making use of appropriate scoring models may be advantageous, due to the predictive capabilities of a number of these scores in relation to NCD risk and mortality outcomes.[33]

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Table 1.1 : Collective summary of dietary and lifestyle guidelines for the prevention of non-communicable diseases including overweight and obesity.[1,12-16]

1. ***Balance Calorie intake*** and physical activity to achieve or maintain a healthy body weight by[15,16]:
    a. Controlling portion sizes of foods consumed
    b. Giving preference to fresh and wholesome foods and minimized convenience foods and fast foods.
    c. Following a structured meal plan that includes regular meals with limited snacking
    d. Increasing physical activity to at least 30 minutes on most days of the week, at least five. For successful weight management 60 minutes daily is preferable.
2. Include ***a variety of foods*** to improve overall nutrient intake, and select an eating pattern that meets nutrient needs over time at an appropriate calorie level.[1]
3. Consume a diet ***rich in*** a variety of ***vegetables and fruits (***5 or more servings daily)[12]
4. ***Choose whole grain and high fibre foods.*** Examples of wholegrain foods include: rolled oats, whole rye, whole-wheat, whole corn - such as "mealies", barley, buckwheat, millet, brown rice, quinoa, spelt, popcorn, and sorghum. At least 50% of grain intake should be from whole grains or at least 3 servings daily. [1]
5. Increase intake of ***fat free or low fat milk*** and milk products, such as milk, yoghurt, cheese and fortified soya beverages. [1,12]
6. ***Limit*** consumption of foods that contain ***refined grains***, especially refined grain foods with added solid fats, added sugar and sodium.[1]
7. Consume fish especially ***oily fish at least twice a week***. Examples include: salmon, pilchards, sardines, mackerel, rainbow trout and herring. Give preferences to seafood in place of red meat and poultry.[1,13]
8. ***Give preference to unsaturated fat***, and limit intake of saturated fat to <7%-10% of energy intake, trans fat to <1% of energy intake, and cholesterol to <300mg per day by:
    a. Choosing lean meats and vegetable alternatives, such as legumes and lentils
    b. Selecting fat free and low fat dairy products
    c. Minimizing intake of partially hydrogenated fats such as brick margarines and commercially prepared foods made with hydrogenated fat. Use fat sparingly in food preparation and preferably use low fat cooking methods such as baking, grilling, microwave or steaming.
    d. Giving preference to monounsaturated fats such as canola oil, olive oil, avocado pear, nuts and seeds, but use these foods sparingly[1,12,13,15]
9. ***Minimize intake*** of beverages and foods with ***added sugars*** and preferably avoid these foods between meals.[1,12]
10. Choose and prepare foods with little or no salt. ***Aim to reduce sodium intake*** to less than 2300mg daily, and less than 1500mg daily for individuals older than 51 years of age.[1]
11. If consuming ***alcohol*** do so ***in moderation***. Drink no more than 1 drink per day for women or 2 per day for men.[1]
12. Drink lots of clean safe ***water.***[12]
13. When you eat foods ***outside of the home***, try to avoid deep fried and fatty foods, pastries and sugary foods. Give preference to fish, skinless chicken and lean meat, fresh produce and high fibre and whole grain foods***. Keep portions small*** other than vegetables and salads.[15,16]

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1.4 Dietary assessment methods

Dietary studies are carried out in order to collect diet information at a national, institutional, household or individual level. The collection of dietary information allows for: the assessment of the adequacy of dietary intake; the exposure of differences in eating patterns of individuals or groups compared to advocated dietary guidelines or compared to other individuals or groups; the determination of a relationship between dietary components and disease states; dietary intake to be monitored as a variable in research projects; the identification of needs for interventions for a specific study populations.[34]

To facilitate the assessment of dietary and nutrient intake and in turn compliance with advocated dietary guidelines, a wide variety of dietary assessment methods are available. However estimating an individual's usual dietary and nutrient intake is difficult. This task is complicated by weaknesses of data gathering techniques, human behaviour, the day to day variation in nutrient intake of the individual/groups under investigation, as well as the limitations of nutrient composition tables and data bases.[35]

There are various methods for collecting food consumption data, and it is important to note that no single best method exists.[35] Various factors such as the purpose of the study (to obtain qualitative food intake data or quantitative data), the characteristics of the study population (for example: age, gender, education level, socioeconomic status), availability of resources (for example: skilled interviewers, measuring instruments and scales) all determine the choice of method.[34] The advantages and disadvantages of each dietary assessment method should be weighed against the priorities of the proposed study, when making the final choice regarding which dietary assessment tool to be used[34]. The methods for assessing food intake can be divided into two categories; recording data at the time of food consumption or recall of foods eaten in the past (immediate, recent or distant past).[34] All dietary assessment tools have their limitations and therefore the effectiveness of these tools warrants some further discussion.[36]

1.4.1 Weighed food records

Weighed food records require that all food and drinks be accurately weighed and measured and recorded on data collection sheets for the duration of the study. Participants need to be equipped with research quality scales which tend to be costly. Everything that is consumed at meal times and between meals needs to be weighed and recorded, placing a heavy burden on respondents. For this reason, respondents need to be literate, dedicated, and highly motivated to participate in a study that makes use of weighed food records. The researcher is required to thoroughly train respondents regarding weighing and measuring of foods and beverages eaten at home and outside of

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the home, as well as equipping them to deal with combination dishes such as stews, casseroles, pizza and so on. Food records need to be checked often for accuracy, sometimes even daily. As a result of the high calibre respondent that is required to make use of weighed food records in research, random sampling cannot be used to select these respondents, and therefore the representativeness of the sample is usually limited. Weighed food records are usually used for studies of short duration (7 -30 days). A number of studies indicate that reported energy and protein intakes on dietary records are underestimated in the range of 4-37% compared to energy expenditure as measured by double labelled water or protein intake as measured by urinary nitrogen.[37] Underreporting may be due to: the complexity of data collection, or that respondents may simplify their diets to make it easier to keep the records and incomplete recording.[34,37] Weighed food records may not reflect usual dietary practices of participants, and results cannot be extrapolated to larger population groups.

1.4.2 Duplicate food collections

This method of dietary analysis requires that respondents keep a weighed record and also weigh out and put aside a duplicate portion of each food or beverage consumed for later analysis by the researcher. This method of dietary assessment allows for direct analysis of dietary intake.[36] However the limitations of this type of dietary assessment are the same as those for weighed food records, in that respondents need to be highly motivated, literate and trained, and as a result random sampling may not be used and the representativeness of the sample is limited. This method of assessment is also expensive. In addition, due to the complexity of collecting data via this method, respondents may simplify their diets to make record keeping easier. Results may therefore not be representative of usual food intake, and therefore cannot be extrapolated to be representative of the usual dietary behaviours of respondents or of larger population groups. Studies making use of this method of assessment are usually of short duration, and are focused on assessment of current nutrient intakes as opposed to assessment of usual patterns of dietary behaviours.[34,36]

1.4.3 Estimated food records

The estimated food record refers to a record keeping sheet, where portions of food and beverages are described in household measures (cups, measuring spoons, and quantified servings such as one egg, one 8cm diameter and 1cm thick meat patty, 1 can (12 oz or 350ml) of soda and so on). This method aims to estimate the actual quantity of food eaten.[34,36] Study participants need to be trained to estimate food intake accurately, and

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written instructions are usually required. Estimated records may be kept for 7 to 28 days, but the duration is usually determined by the purpose of the study.[34]

The strength of the food record is that food consumption is recorded at the time it is consumed and therefore recall is not dependant on the respondent's memory. Multiple day food intake records may also be representative of usual intake. However multiple food records from non-consecutive days including weekends, and covering different seasons are necessary to arrive at useful estimates of usual intake.[35] This method of dietary assessment also has limitations, and requires a literate, motivated, cooperative subject, who is willing to commit time and effort to completing the food record. As a result these participants may not be representative of the general population. Furthermore the act of recording food intake, may in itself cause the subject to change his/her usual diet, by simplifying his/her diet in order to streamline the record keeping process.[35] Food records therefore also have limitations when aiming to investigate the usual dietary behaviours of individuals or groups.

1.4.4 24-hour recall

In the dietary recall method, a trained interviewer asks the respondent to recall in detail all the food and drink consumed during a period of time in the recent past. The interviewer needs to be experienced and must use visual aids (food models, real foods, spoons and cups of varying sizes) to assist the respondent in quantifying food intake. In most instances the time period is the last 24 hours. Occasionally the recall period may be the last 48 hours or the past 7 days. However a person's ability to recall accurately food that has been consumed in the past few days is often compromised by an inadequate memory of what was actually consumed. Food intake using this method of dietary assessment is usually under reported.

Studies with biological markers such as doubly labelled water and urinary nitrogen generally have found underreporting for energy intake of 3-24% and for protein a range between 12-23%, when using this method of dietary assessment.[37] Thus the loss in accuracy may exceed the gain in representativeness. The primary limitation of this method of assessment is that data on a single day's (24 hour period) diet, no matter how accurate, remains a very poor descriptor of an individual's usual nutrient intake because of day to day or intra-individual variability. However a sufficiently large number of 24-hour recalls recorded over a period of time may provide a reasonable estimate of the mean nutrient intake of a group.[34,35]

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1.4.5 Quantified food frequency questionnaire (FFQ)

This dietary assessment method makes use of a structured lengthy questionnaire that is administered by a trained interviewer. In most cases the purpose of the FFQ is to obtain a crude estimate of total intakes over a designated time period.[37] The researcher and interviewer require insight into the eating habits of the research population to ensure that customary foods are included in the FFQ. The respondent is required to recall how often and in what quantities the foods listed are eaten over a specific time period. The time period may be as short as the last month, or as long as a year. Visual aids may be used to assist in quantifying intake.

For certain diets where increased food variety is common, such as for the Western diet, this method of dietary assessment tends to overestimate intake, due to the large number of foods recorded. Respondents are also usually not able to compensate in their reporting for food substitutions made in a given time period.

The quantified FFQ, gives a better indication of usual food intake than the 24 hour recall method.[34] FFQ is considered one of the methods of choice for research on diet-disease relationships on both the macro-nutrient and micronutrient levels.[35] Nonetheless the FFQ has limitations, because the list of food related questions are usually limited to a hundred or fewer questions. Furthermore, specified portions allow limited choices and they must also be typical of what is usually eaten, which is not always possible, due to individual variability with respect to acceptable portion sizes. FFQs that fail to include foods commonly eaten by various groups may result in underestimates of nutrient intakes. Another limitation is the reliance on the respondent to describe his or her diet adequately or completely.[35]

1.4.6 Food frequency method (qualitative food intake data)

The FFQ – qualitative dietary assessment is a structured questionnaire, and can be completed by the interviewer or the respondent, who are required to fill in the number of times a specific food is eaten over a specified period of time. The quantity of food usually consumed at each eating occasion is not recorded. Data from this method cannot be used to calculate nutrient intake, but can be used to monitor the types of foods usually consumed, or to expose differences in frequency of consumption of foods consumed by other individuals or groups.[34]

One of the strengths of a FFQ-qualitative method is that this method of assessment may be more representative of the types of foods usually consumed than what is reported using the 24 hour recall method or than a few days of diet records.[37]

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Limitations of the FFQ-qualitative method are as for the food frequency quantified questionnaire, with respect to: the limited number of questions (a hundred) in the questionnaire, the need for the FFQ to be culturally specific and to include customary foods, the inability of the FFQ to accommodate diets with increased levels of food variety such as the Western diet which may in turn overestimate food intake. Nonetheless, the FFQ-qualitative method is relatively easy to administer and are usually inexpensive and are therefore often used in large scale studies.[35]

1.4.7 Diet history

The diet history is used to assess an individual's usual dietary intake over an extended period of time, such as over the past month or year.[35] A diet history usually consists of a combination of a 24 hour recall with a meal pattern (that is how many eating occasions per day and what foods are usually consumed at these times). Food quantities are usually specified in house hold measures. A check list of foods usually consumed is also used to cross check foods that the respondent may eat as part of his usual diet.[34]

This method is the preferred method for obtaining estimates of usual nutrient intake, and appears adequate to determine an individual's typical diet. However a weakness of this approach is that respondents are asked to make judgements about the usual foods consumed and the amounts of food eaten, these subjective tasks may be difficult for many individuals. Moreover, the meal pattern method of assessment may not be useful for individuals who "graze" throughout the day, and who do not have a regular meal or snacking pattern[37]. The diet history method of assessment has limitations, as the assessment interview is time consuming, trained interviewers are needed, the method is not well standardized, energy intake may be under-reported by between 2-23%, and coding for analysis is complicated and expensive.[35,37]

1.4.8 Food purchases as an assessment of dietary intake

A relatively new method of dietary assessment makes use of household food purchases as a means of assessing dietary intake. Food purchasing behaviour usually refers to all food and beverages purchased by a household from all sources, including grocery stores, convenience stores, restaurants, coffee shops and department stores.[38] Household food purchasing behaviour is considered important to measure because it contributes to the understanding of important influences on energy intake for individuals as well as diet quality.[38] Tracking food purchases has advantages over traditional and conventional dietary assessment tools as it is not subject to reporting bias as food purchases and by inference food consumption patterns can be obtained from till slips. The advantages of

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using food purchasing behaviours as a tool in identifying food consumption patterns have been reported by other researchers.[38-41]

Nonetheless there are limitations to making use of food purchases as being absolutely representative of food consumption patterns, as the food that is purchased may not be consumed by all members of the household. Therefore information obtained from food purchasing behaviour needs to be considered in general terms as representing the type of foods available within households and not necessarily representing actual foods consumed by each member of the household. In other words food purchases can indicate if the types of foods available within households are consistent with the types of foods advocated by population based dietary guidelines.[38-41] However it is not possible from food purchasing analysis to identify an individual's "risky" dietary behaviours.

1.4.9 Brief dietary assessment instruments

Many brief dietary assessment instruments have also been developed. These types of instruments can also be referred to as dietary "screeners". Brief dietary assessment is useful, when the assessment of total diet is not required, or where quantitative accuracy in dietary estimates is not needed. An example of where such assessment is suitable, is when specific dietary components may be used to sort large numbers of respondents into groups to allow for more focused attention on those with the greatest need for intervention and/or education.[37] Further, measuring dietary intake even if imprecise, can serve to activate interest from participants, which can facilitate the nutrition education process.

Brief assessment instruments may therefore be useful in research, in the clinical setting or in situations where health promotion and health education are the goal.[37] Brief instruments may be simplified or targeted FFQs that focus on specific eating behaviours other than frequency of intake of specific foods or daily checklists. The brief instrument questionnaire may be reduced to 15-30 questions related to selected foods or food types. The National Cancer Institute (NCI- USA) has developed a register of validated short dietary assessment instruments, which is available on their website.[42] This register includes approximately 103 instruments assessing more than 25 dietary factors. Instruments from 29 countries have been registered.

Much of the focus of brief instrument development has been on fruit and vegetable intake and on fats, however there have also been a number of brief multifactor instruments that have been developed as well.[37] An example of a multifactor instrument is - the dietary screener administered in the 2009-2010 National Health and Nutrition Examination Surveys (NHANES), which included 28 items addressing consumption of fruit and

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vegetables, whole grains, added sugars, dairy, fibre, calcium, red meat and processed meat. Some instruments combine aspects of food frequency and behavioural questions to assess multiple dietary patterns, for example: the Rapid Eating and Activity Assessment for Patients (REAP).

However brief instruments also have limitations, as they do not capture information about the entire diet. Most measures are quantitatively not meaningful, and estimates of dietary intake for population groups usually cannot be made. Further, many dietary screeners are population specific, and are often not useful when used for the assessment of different population groups with dissimilar demographics.[37]

1.4.10 Dietary indices

In nutritional epidemiology, focus in the past has been directed toward the assessment of single dietary components in the development of disease, but this reductionist approach has limitations, as it is the view of many researchers that the intake of foods and nutrients are related, as people consume combinations of foods, not single foods or nutrients. For this reason, whole dietary patterns have gained considerable attention in recent years.[43,44] In theory, defined dietary patterns consist of nutritional variables, generally foods and/or nutrients considered to be important to health that are quantified and summed to provide an overall measure of diet quality. In keeping with this concept, a number of predefined indexes of overall diet quality have been proposed and validated over recent years.[43] To validate dietary scores, they are usually related to nutrient adequacy and/or health outcomes.[43,45] Indices of diet quality are considered preferred “summary” measures of overall diet quality and can be used as a simple and quick assessment of diet quality to evaluate adherence to dietary guidelines and to monitor overall dietary changes.[45]

However, not all indices are simple, some complex dietary indexes such as the Healthy Eating Index (HEI), the Alternate Healthy Eating Index (AHEI), the Diet Quality Index (DQI), the Diet Quality Index Revised (DQI-R) and Diet Quality Index International (DQI-I) have been developed, which evaluate diets for meeting quantitative goals for several individual nutrients and food groups.[44,46-50]

A large number of other simplified scores have also been developed such as the Diet Variety Score (DVS), the Recommended Food Score (RFS), the Dietary Guidelines Index (DGI), the Mediterranean Diet Quality Index (MDQI) and the Mediterranean Diet Scale (MDS), to name a few such scores.

Comprehensive reviews of the different dietary scores and indices have been completed.[43-45] The merits and limitations of a number of dietary indices are discussed in

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these reviews, and recommendations are given regarding criteria that should be considered when developing scores to assess diet quality. Further, conclusions drawn from these papers report that the assessed indexes were unable to predict disease or mortality significantly better than individual dietary factors, but that dietary scores remain useful to measure the extent to which individuals adhere to dietary guidelines.[43] In addition it was recommended that the development of weighted dietary indices, with weights in proportion to the importance of food/nutrient to the burden of disease of interest is considered essential when developing dietary indices in the future.[45]

Since these publications, there have been a number of studies that have assessed the ability of certain dietary indices to predict disease outcomes and mortality risk. While most scores are capable of assessing overall diet quality, it appears that only a limited number of indices seem to be related to all-cause mortality.[43] For example: the HEI and the DQI have generally shown weak or no association with major chronic diseases mortality in US cohorts,[17] while the Mediterranean Diet Score and the RFS have both been associated with all-cause mortality in British cohorts[20] and the AHEI has been strongly associated with chronic disease risk, particularly coronary heart disease and diabetes in US cohorts.[28] The use of diet quality indices is becoming more widespread with applications in more countries, both developed and developing, for the prevention of specific diseases and for specific sub-populations. It remains important that the index is tailored to the specific purpose of the study and the population under investigation.[45]

1.4.11 Dietary assessment: Dietary Behaviour Score (DBS)

Accurate dietary assessment remains challenging, and traditional dietary assessment methods have many limitations, especially when gathering information for large cohorts. It has therefore been proposed by Kant and colleagues[17] that the recall of *usual dietary behaviours* may be less prone to recall errors than requiring respondents to recall specific types and amounts of food, and that individuals who adopt food selection and consumption behaviours compatible with the "spirit of dietary guidance" will have healthier diet patterns and in turn a lower risk of NCD mortality from all causes. Kant and colleagues[17] developed a *dietary behaviour score (DBS)* for their study, that reflected the "spirit of dietary guidance" for the Dietary Guidelines for Americans of 2005.

The DBS was calculated from data collected from a FFQ, which queried about 124 food items over 12 months. The FFQ also included questions about food groups and fat intake. The DBS score developed for this study was determined primarily from behavioural questions from the FFQ and reflected key recommendations for fruit and vegetable intake, whole grains, low fat or fat free dairy, and low fat meats, as well as added solid fat

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(discretionary calories). Details regarding the computation of DBS for this study are given in Addendum 1: Supplemental Material.

The final analytical cohort for this study included 199 874 men and 151 012 women aged 50-71 years, who were followed up over 10.5 years. The association between DBS and mortality from all causes including cancer and coronary heart disease were examined. An inverse association between DBS and mortality was significant in both genders. Nearly 12% of the covariate-adjusted population risk of mortality was attributed to non-conformity with the dietary recommendations.[17] The results in this study also suggested that adoption of recommended dietary guidance was associated with a 20-25% lower risk for mortality after 10 years of follow-up in older men and women.

This study therefore demonstrated that an increasing DBS (positive association with the "spirit of dietary guidance") was associated with a reduction in risk of NCD mortality from all causes.[17] The DBS (degree of compliance with the "spirit of dietary guidance") can in turn be considered to be a useful assessment tool to facilitate the identification of usual dietary behaviours that are consistent with advocated guidelines, and can further help to identify individuals at risk for developing NCD.[17]

Since the study conducted by Kant and colleagues[17] was published, other studies making use of different yet not dissimilar dietary indices to assess degrees of compliance with the "spirit of dietary guidance" of a variety of populations groups, have shown that increasing diet quality as assessed by these indices is associated with reductions in mortality risk related in some studies to all-causes and in other studies to disease specific causes such as coronary heart disease and cancer.[20,22,26,27,30,33,51] It appears that the use of dietary indices that are associated with all-cause mortality, such as the DBS determined by Kant and colleagues[17] may have practical implications for nutrition interventions and assessment, being easier to use and understand and less prone to dietary measurement error.[17]

1.5 Dietary behaviours and NCD mortality risk

Kant and co-workers made all decisions about the potential DBS components and their scoring prior to the examinations of any outcomes. The DBS was related in their study to all cause NCD mortality, and there is further merit in reviewing other studies and/or published peer review papers that report on the risk of individual dietary components that were used by Kant and colleagues to compute their DBS.[17] This exercise assists with verification of key dietary components that were selected for computation of the DBS, and will help to confirm the value of the DBS presented by Kant and co-workers.[17]

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It is also recognised that individuals who engage in risky lifestyle behaviours may have a compounded risk for NCD mortality with varying degrees of dietary compliance. A brief discussion of lifestyle factors are known to contribute to all-cause mortality risk related to NCD follows the discussion given below on dietary components, as these factors were discussed by Kant and colleagues,[17] and were confounding factors that were corrected for in their study. [17]

1.5.1 Fruit and vegetable intake and mortality related to NCD

WHO reports that it is estimated that approximately 1.7 million (2.8%) of deaths worldwide are attributable to low fruit and vegetable consumption. Further, low fruit and vegetable intake is among the top ten selected risk factors for global mortality[52]. A number of other scientific papers also report on the important contribution that that fruit and vegetables make to improving overall diet quality and reducing chronic disease mortality risk.[26,53-55]

The importance of an adequate fruit and vegetable intake as part of a "healthy" diet is well recognized. For this reason a large number of brief dietary assessment instruments as well as most dietary scores/indices include fruit and vegetable consumption as fundamental components of these dietary assessment tools.[37,45]

1.5.2 Wholegrain intake and mortality related to NCD

In the Harvard-based Nurses' Health Study, women who ate 2 to 3 servings of whole-grain products (mostly bread and breakfast cereals) each day were 30 percent less likely to have a heart attack or die from heart disease over a 10-year period than women who ate less than 1 serving per week.[56] Other studies also report an inverse association between wholegrain intake and risk of all-cause mortality and incidence of coronary artery disease and stroke.[57,58]

Wholegrain foods provide dietary fiber, vitamins, minerals and antioxidants that are likely to offer a protective effect against NCD mortality.[58] A number of brief multifactor instruments as well as some dietary scores/indices aimed at assessing overall diet quality have included the consumption of whole-grain foods as important components of dietary assessment. Low intakes of whole grains appear to affect scores adversely.[37,45]

1.5.3 Saturated and trans-fatty acids and mortality related to NCD

A meta-analysis by Hooper[59] showed a small but potentially important reduction in cardiovascular risk with the modification of dietary fat, but not the reduction of total fat

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intake. Results from this research suggest that reducing saturated fat by reducing and/or modifying fat intake reduced the risk for cardiovascular events by 14% in respondents. Conclusions from this paper recommended that lifestyle advice to all at risk for cardiovascular disease, and to lower risk, population groups should continue to include permanent reduction of dietary saturated fat and partial replacement by unsaturated fat.[59]

Another paper by Jakobsen[60] supports these recommendations. From their pooled analysis of eleven cohort studies they report that during a 4 to 10 year follow-up period, a 5% lower energy intake from saturated fat and with a concomitant higher energy intake from polyunsaturated fats; an inverse association between polyunsaturated fats and risk of coronary events was found.[60]

Another study reported that the Mediterranean diet, which is lower in saturated fat with a greater proportion of unsaturated fat than the traditional Western style diet, is significantly associated with reduced all-cause-specific mortality for both men and women.[61] Lowering saturated fat intake and giving preference to unsaturated fat appears to play a relevant role in the reduction of chronic disease mortality risk from all causes. Principle sources of saturated fat include: meat, full fat dairy products, butter, lard, coconut oil, palm kernel and palm oil.[62]

With regards to trans-fatty acids and the prevention and management of cardiovascular disease, the American Heart Association (AHA) recommends that no more than 1% of total energy intake be consumed per day as trans-fatty acids.[15,16] Trans-fatty acids are limited mostly because they raise LDL cholesterol. Most trans-fatty acids intake comes from partially hydrogenated vegetable oils.[4,15,62]

Intake of saturated fat is generally recognized as deleterious to health, and the fatty acid composition of the diet is considered to be an important health determinant. For this reason a number of brief dietary assessment instruments as well as many dietary scores/indices include assessment on either the different types and/or amounts of fat consumed as part of the usual diet, or may specifically assess intake of saturated fat, or the ratio of saturated to unsaturated fatty acids in the usual diet. There appears to be consensus between dietary scores/indices that intake of saturated fat should be assessed and that high intakes affect diet quality scores adversely.[37,43,45]

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1.5.4 Milk and low fat or fat free dairy consumption and mortality related to NCD

Higher intake of dairy calcium versus non-dairy calcium has been associated with a lower incidence of stroke among men and women.[62] The consumption of low fat and fat free dairy products are considered to be a good source of calcium in the diet and an important component of a healthy balanced diet, which is aimed at promoting health and preventing chronic disease.[1,63] Regular consumption of dairy products has been shown to reduce the risk for several chronic diseases, including osteoporosis, hypertension, obesity, and type 2 diabetes mellitus. However, some compounds in milk, primarily lactose, causes negative effects in susceptible individuals. In addition, full fat dairy products contain higher quantities of saturated fat and should preferably be distinguished from skim milk and low fat or fat free dairy products.[43] A number of studies report that independently, apart from overall diet quality, the consumption of low fat and fat free dairy products tends to be neutral in terms of NCD mortality risk.[64-66] A study by Elwood[67] showed that the consumption of milk and dairy products may have some survival advantage from chronic diseases such as diabetes, cancer and vascular disease.[67] It appears that low fat and fat free milk and dairy products contribute to overall diet quality and by replacing full fat milk and dairy products in the diet with these lower fat alternatives, offered some protection through a reduction in dairy fat intake.[62,64] A number of brief multifactor instruments as well as many dietary scores/indices assess intake of calcium and/or the consumption of dairy products as important components that affect diet quality.[37]

1.5.5 Sugar intake, refined starchy foods and risk for NCD

The intake of refined starchy foods and the increased consumption of sugar and sugary beverages have been identified as a "risky" dietary behaviour associated with an increased risk for developing obesity and NCD.[4,7] Undesirable nutritional characteristics associated with sugar, sugary foods and beverages and refined starchy foods include: reduced micronutrient availability and increased calorie density contributing to the consumption of a hyper-caloric diet.[4,7,8,62,68]

Nonetheless there do not appear to be published papers on studies that directly link chronic disease mortality risk from all causes with either sugar consumption, or the consumption of refined starchy foods or sugary foods and beverages. A number of studies do associate abnormal glycaemia, and hyperglycaemia with the development and/or poor management of NCDs such as diabetes, cardiovascular disease, colon cancer and pancreatic cancer, but no direct correlation with specific foods and/or sugars is made.[69-75]

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The consumption of sugar and refined starchy foods was not included as a component of the DBS score in the study conducted by Kant and colleagues.[17] This omission may have been because there was insufficient evidence at the time to link sugar consumption and/or the consumption of refined starchy foods to NCD mortality specifically. Nonetheless the DBS is understood to be capable of assessing "spirit of dietary guidance" in accordance with the 2005 Dietary Guidelines for Americans.[17] These guidelines do nonetheless state that Americans consume too much added sugar, and that individuals should choose foods that limit the intake of added sugars.[76] Further, it is reported that the consumption of sugar and sugary foods is associated with a reduced intake of desirable micronutrients and an increase in the calorie density of foods contributing to a hyper-caloric intake, and consequently obesity and NCDs.[76] It is of interest too, that many of the reviewed dietary scores/indices also do not usually assess intake of added sugars and or sugary foods and beverages. Very few assess the intake of sweets, sweetened beverages or the intake of monosaccharides and/or disaccharides of respondents, and those that do have not been related to all-cause mortality.[43] It appears that more research is needed in this area.

1.5.6 Overall diet quality and risk for NCD

Growing evidence suggests long term influences from habitual food and beverage intake predict subsequent risk for chronic disease, including coronary heart disease, diabetes and cancer.[77] Traditionally research on diet and chronic diseases have focused on isolated nutrients and results, and although helpful have been limited in their translational applications.[77]

Further, the idea that a single nutrient or food will lower disease risk is considered a reductionist and over simplistic view. According to Martinez-Gonzales,[32] "The effect of an overall dietary pattern is likely to be considerably greater than the effect of individual foods or nutrients". This view fits well with the current paradigm of assessing overall food patterns instead of isolated food or nutrients.[32]

In recent years, more sophisticated approaches have been used to assess diet patterns as the exposure, thereby offering potential benefits for developing food-based interventions associated with reduced risk of cardiovascular disease and other NCDs.[77] Research results support the predictive value of using methodological approaches to summarize dietary data and identify relationships between diet patterns and health.[77] As a result, measures of dietary patterns and diet quality are becoming increasingly used in

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investigations of diet and longevity in an effort to capture the complex exposures of dietary intake.

Diet quality is usually assessed according to how well individuals comply with dietary guidelines and as discussed above a range of dietary indices have been developed for this purpose.[20] Existing indices assess dietary quality in a variety of ways: some focus on foods and food groups, other focus on nutrients, and some measure combine intakes of foods and nutrients to assess diet quality. Food-based tools offer promise both in terms of their ability to predict disease and also in their application and translation to evaluation and clinical practice.

The usefulness of diet quality measures has been assessed against nutrient intakes, biomarkers and socio-demographic factors. Studies have also investigated their associations with health and in particular all-cause mortality.[20] A number of studies now show that diet quality, and increasing compliance with the “spirit of dietary guidance” is a better predictor of NCD risk and all-cause mortality than individual food or nutrient intakes, and increasing compliance with advocated dietary guidelines is associated with a reduction in NCD risk and in many cases a reduction in all-cause mortality risk.[18-31,33]

1.6 Lifestyle behaviours and risk for mortality from NCD

1.6.1 Smoking and mortality risk from NCD

The AHA reports that as many as 30% of all CHD deaths in the United States each year are attributable to cigarette smoking, with the risk being strongly dose related.[78] In a meta-analysis conducted by Mucha,[79] which assessed disease risk associated with smoking, by gender and intensity of smoking, it was reported that few systems in the body are unaffected by smoking, with intensity of smoking being a significant risk factor for disease. Results from this study supported the findings of many other research papers, demonstrating an increase in overall risk with an increase in smoking intensity. In addition gender differences were noted that may contribute to risk magnitude.[79] In another pooled analysis of three large cohort studies in Japan, it was reported that leading causes of smoking attributable deaths were cancer, ischemic heart disease and stroke, and chronic obstructive pulmonary diseases and pneumonia.[80] Smoking is considered a “risky” lifestyle behaviour associated with an increased risk of developing NCD.[1]

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1.6.2 Alcohol consumption and mortality risk from NCD

The consumption of alcohol can have beneficial or harmful effects, depending on the amount consumed, age, and other characteristics of the person consuming the alcohol. Alcohol consumption may have beneficial effects when consumed in moderation. Strong evidence from observational studies has shown that moderate alcohol consumption is associated with a lower risk of CVD. Moderate alcohol consumption also is associated with reduced risk of all-cause mortality among middle-aged and older adults and may help to keep cognitive function intact with age.[1,81-83] However, excessive (i.e. high-risk, or binge) drinking has no benefits, and the hazards of heavy alcohol intake are well established.[1,84] Excessive drinking increases the risk of cirrhosis of the liver, hypertension, stroke, type 2 diabetes, cancer of the upper gastrointestinal tract and colon, injury, and violence. It is also over time associated with increased body weight and can impair short and long-term cognitive function. Excessive alcohol consumption is responsible for an average of 79,000 deaths in the United States each year. More than half of these deaths are due to binge drinking.[1]

In South Africa, alcohol misuse is causally implicated in a range of chronic health problems such as cirrhosis of the liver. However, many of the primary effects of alcohol misuse occur from episodes of acute alcohol intoxication.[85] Evaluation of usual practices of alcohol consumption can assist with the overall evaluation of an individual's risk for mortality attributable to NCD. Refer to Table 1.2 for definitions regarding recommended restrictions for alcohol consumption for individuals.

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Table 1.2 : Key definitions for alcohol consumption[1]

Moderate alcohol consumption: Defined as up to 1 drink per day for women and up to 2 drinks per day for men.
Heavy or high-risk drinking: Is defined as the consumption of more than 3 drinks on any day or more than 7 drinks per week for women and more than 4 drinks on any day or more than 14 drinks per week for men.
Binge drinking: Defined as the consumption of 4 or more drinks for women and 5 or more drinks for men within a time frame of 2 hours.
Standard drink : definition One drink is defined as 12 fluid ounces (340ml) of regular beer (5% alcohol), 5 fluid ounces (150ml) of wine (12% alcohol), or 1.5 fluid ounces (40ml) of 80% proof (40% alcohol) distilled spirits. One drink contains 0.6 fluid ounces (17 grams) of alcohol.

1.6.3 Inactivity and mortality risk from NCD

Inactivity is associated with an increased risk for NCD[1]. Woodcock[86] reports that being physically active reduces the risk of all-cause mortality. The largest benefit was found from moving from no activity to low levels of activity, but even with higher levels of activity benefits accrue from additional activity.[86] The minimum recommendation of moderate intensity physical activity for adults is 30 minutes on 5 days per week,[1,87] or the equivalent of 150 minutes of accumulated moderate intensity exercise each week.[1,88,89] Evaluation of usual levels of physical activity can assist with the overall evaluation of an individual's risk for mortality from NCD.

1.6.4 Body Mass Index (BMI) and mortality risk from NCD

Obesity is related to many chronic health conditions.[1] This statement is supported by a systematic review and meta-analysis completed by Guh,[90] who stated that both overweight and obesity are associated with the incidence of multiple co-morbidities including: type II diabetes, cancer and CVD. Maintenance of a healthy weight is important to averting the large NCD disease burden facing the globe.[1,90] Other researchers reported that it is specifically obesity (defined as a BMI greater than 30 kilograms/m^2), that is associated with an elevated risk for most of the diseases studied.[62,91] Evaluation of BMI may in turn assist with the overall evaluation of an individual's risk for mortality from NCD.

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1.7 The economic impact of NCD

NCD places significant financial burdens on individuals, families, companies, medical insurers and government. According to the WHO, the current global burden of chronic NCDs has a significant impact on the gross domestic product (GDP) of developed and developing countries.[92] Further, the growing global incidence of NCD places an unrealistic economic burden on state health care facilities for individual countries, and drains financial resources that could be used elsewhere.[5,92,93] It has also been reported that there is increased health care expenditure associated with an increased number of risk factors for NCD as well as increased absenteeism from work.[94]

The financial implications of NCDs extend to individuals and individual households, due to loss of income and increased health care costs.[5] Interventions that promote behaviour change and the adoption of advocated lifestyle and dietary behaviours in order to reduce the incidence of chronic NCDs should be strongly encouraged and supported.[5]

1.8 Wellness programmes

For several decades, the dominant paradigm for the health care system has been based on a medical model. During the 1970's people were guided by the philosophy that health care practitioners and institutions would provide as far as possible curative and/or treatment services to make them well. However escalating costs associated with this traditional approach to health care, environmental changes that hasten the development of NCDs, as well as the view that wellness is now considered a function of prevention, has resulted in the development and expansion of the "wellness" programme industry.[5,92,93,95,96]

Wellness programmes aim to meet the challenge of the next decade, which involves the transformation of the health care system from a system based on treatment of acute conditions to one based on disease prevention and health promotion. A paradigm shift from treatment to prevention holds to the idea of being a more economical route to good health than the more costly procedures necessitated by sickness and disease.[95]

Since the 1990's people have started to view wellness as a product of prevention, and as a result, many individuals have begun to take responsibility for their own health, and this pursuit of health has been marked by an increased interest in nutrition, fitness and health promotion.[95] As a result of these shifts in the philosophies that underpin health care, wellness programmes are now commonly offered through worksites, through health insurers, or even independently by services providers.

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Wellness programmes can be defined as: “The combination of educational and environmental supports for actions and conditions of living beneficial for health”. The term environmental support or strategies can be interpreted as strategies aimed at reducing barriers or increased opportunities for healthy choices. For example: by providing more healthy options, by making healthy choices more accessible, and by establishing policies that require healthy choices, or by restricting the number of less healthy options.[97]

In addition, wellness programmes may offer a wide variety of: health assessments, educational tools, interventions, support systems (coaching or counselling) and monitoring tools, both in and outside of the workplace aimed at health promotion and disease prevention. Core components of many wellness programmes tend to focus on factors that impact on disease risk, such as; nutrition, physical activity, smoking, alcohol consumption, mental health, health checks and compliance with prescribed medical interventions.

It is also common for wellness programmes to offer incentives alongside wellness offerings to promote greater engagement.[96] However a review completed on worksite wellness programmes conducted by Osilla and colleagues,[96] reported that while positive outcomes are associated with a number of wellness offerings, that many programmes are not evaluated with strong research designs, and that published evaluations of worksite wellness programmes yield mixed results. Osilla stated that the dynamic and innovative “wellness” industry appears to have outpaced the underlying evidence, and given the great interest in wellness programmes, more research is needed.[96]

Despite questions that surround the effectiveness of available wellness programmes, the industry continues to expand in the commercial sector, striving to meet the needs of the consumer and a health care system undergoing transformation. Osilla and colleagues, reported that programmes that offered incentives as part of their wellness offering seemed to produce better outcomes than programmes that did not incentivise participants, but results were inconclusive.[96] Wellness programmes coupled with incentives may therefore be more effective than non-incentivised programmes, but more research is needed.

1.9 Incentivising behaviour change

Changing “risky” lifestyle and dietary behaviours is fundamentally important to reduce the risk and consequences of NCD. However changing behaviour successfully toward more healthful practices in the short and long term has proved in recent years to be more challenging than expected. As a result, researchers have begun to investigate the role of incentives in promoting behaviour change and the adoption of healthier lifestyle practices and health goals.[70]

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1.9.1 Types of incentives

According to Volpp[98] incentives to promote behaviour change and the adoption of healthier lifestyle and dietary practices, can provide people with immediate and tangible feedback that helps make it easier for them to choose behaviours that promote long term health benefits as opposed to making decisions based on short-term gratification.[98]

Incentives can be positive or negative and according to Jochelson,[99] positive incentives can be described as "affirmative enablers" which offer a direct reward to individuals for engaging in a desired behaviour or achieving a desired outcome.[99] Negative incentives or disincentives, such as those which withdraw a reward or penalise an individual if they fail to achieve the desired behaviour change or outcome, are not as widely used as positive incentives and generally are not as successful. In the long-term, programmes which have made use of positive incentives have had better results.[99,100]

Economic or financial incentives as a reward to participants can be seen as positive incentives, and can be in the form of a reward for achieving a goal or may motivate change by removing a barrier which is hindering an individual from engaging in a specific health-promoting behaviour. For example: discounting the price of fresh produce may reduce financial constraints that inhibit the consumption of fruit and vegetables, or discounting gym memberships may make engagement in physical activity in a safe and secure environment more accessible.[100]

1.9.2 Concerns regarding the use of incentives

There are however, some concerns regarding the use of incentives to change behaviour. Some individuals choose to live salubrious lifestyles to reduce their risks for future health problems and do so independently without the nudge of positive incentives. While others accept the long term risks of unhealthy behaviours and live with them.

One concern with the use of incentives is that they may infringe on an individual's decision-making autonomy.[101] Another concern is that incentives may promote mercenary values and undermine social values, by offering incentives for behaviours that people need to adopt anyway. This may in turn undermine long term health outcomes as a result of individuals losing their intrinsic motivation to improve their own health.[101]

In addition, the fact that individuals need to be monitored when engaged with incentive programmes increases the involvement of employers, health insurers and at times government in the private life of individuals. However, people who value privacy more than rewards have the option to avoid incentive programmes and avoid such monitoring.[101]

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There is also the possibility that rewarding the achievement of healthy outcomes unfairly favours those living in more amenable social settings or with more forgiving genomes.[101] Another concern is that, variations in the effectiveness of financial incentives across different population groups have not been explored.[102]

1.9.3 The effectiveness of incentives

The effectiveness of wellness incentive programmes also needs to be considered. Some studies suggest that that incentives are more useful for encouraging simple one-off behaviours, such as attendance for vaccinations, than more complex sustained behaviour changes such as: smoking cessation, weight loss, or possibly the permanent adoption of advocated dietary changes.[102]

It seems that size of the reward needs to be taken into consideration, and significant rewards may be more capable of bringing about desired behavioural changes than smaller rewards.[99,100] The size of the incentive on offer must be adequate to motivate behaviour change, although the promise or certainty of receiving a relatively modest reward against the possibility or chance of winning a large prize is generally more appealing and effective, and research illustrates that even relatively modest incentives may be effective.[100]

The timing of the reward is another important factor to take into account with studies showing that more immediate delivery of a reward is more effective.[99,100,103] For programmes aimed at changing lifestyle behaviours, such as smoking and eating, periodic rewards or those offered intermittently are more effective than those offered once-off.[99,103]

A systematic review of four randomised controlled trials which examined the effectiveness of financial incentives in modifying dietary behaviour reported (although the studies had small sample sizes, were of short duration and had other methodological limitations) that monetary incentives did have a positive effect on food purchasing patterns, food consumption and weight loss. What is not clear from this review was whether these changes to behaviour were sustained in the long term.[104]

A number of experts agree, that positive financial incentives will promote healthy eating behaviours,[105,106] while other researchers report mixed results regarding the use of incentives to promote “healthy” eating, and conclusions regarding the use of incentives to promote healthier eating habits and healthy behaviours seem to be equivocal.[107,108]

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Due to the inconclusive evidence from research regarding the use of financial incentives to promote desired changes to eating behaviour, one needs to question why these studies are producing mixed results. According to Adams,[102] the apparent failure of many financial incentive programmes to achieve sustained behavioural change may reflect sub-optimal design of the intervention, rather than a failure of incentives *per se.*

Despite all of these concerns, it is still suggested that incentives may play an important role in curtailing unhealthy behaviours by making it easier for people to choose short-term actions that are consistent with their own long term best interests.[101]

Evidence for providing incentives to change dietary and lifestyle behaviours remains limited and it appears that more research is needed to fully elucidate the effectiveness of such programmes for health promotion and disease prevention, especially in terms of promoting long-term behaviour and lifestyle changes to improve nutritional status. However it is possible that providing incentives may facilitate greater adherence to recommended dietary and lifestyle guidelines, and in turn may impact on risk for the development of NCD and NCD mortality. This will may have far reaching economic and social implications for individuals, companies and governments.

1.10 Concluding remark

There is a global pandemic of obesity and NCD facing many countries worldwide with dire consequences for individuals, families, businesses and even governments. Since dietary factors play a pivotal role in obesity and chronic disease prevention and management, it is valuable to assess dietary behaviours of individuals within populations in terms of compliance with the “spirit of dietary guidance”. This allows for the nutritional risk profile of individuals and groups to be identified, and in turn can facilitate the recognition of high risk groups that require more intensive nutritional intervention, education and/or incentives to promote desired behaviours. Successful strategies that promote the adoption of healthful lifestyle behaviours will most likely contribute to a reduced economic burden related to the management and prevention of NCD, and in turn a reduction in the morbidity and mortality rate attributed to NCD.

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CHAPTER 2

STUDY PURPOSE AND CONCEPTS

2.1. Rational for proposed research

Health care costs attributable to NCD are significant in many countries globally.[92] In South Africa, a major private medical insurance business is Discovery Health medical aid. This company has identified the value of promoting health in order to prevent and/or delay the onset of NCD and in keeping with this, have established a sizeable wellness incentive business called Discovery Vitality.

As discussed in Chapter 1, "risky" dietary behaviours are significant contributors to the rising levels of NCDs worldwide and therefore are partly responsible for the economic burden and financial costs incurred by medical insurance businesses for managing NCDs. Identification of individuals with an elevated dietary risk for developing NCD is valuable, as this may motivate for the development of targeted interventions and/or incentives that could facilitate a reduction in the dietary attributed risk of these groups of people. Further, identification of high risk individuals or groups, and the application of targeted interventions, will most likely to be more cost effective than blanket interventions that may affect some individuals and not address the needs of others.

In keeping with the concept that one of Discovery Vitality's primary objectives is to promote health, prevent disease and reduce medical costs associated with NCD management, it was considered a worthwhile exercise, to assess the dietary risk profile of members, in order to determine if current interventions and/or incentives are capable of promoting compliance with the "spirit of dietary guidance", or if changes to current methods are required.

2.2 Purpose of this study

The purpose of this study was to develop a Dietary Behaviour Score (DBS) from Discovery Vitality's online health risk assessment questionnaire: the Personal Health Review (PHR). The DBS^{PHR} was expected to measure the degrees of compliance of members with the "spirit of dietary guidance". A secondary purpose of this study was to categorize the DBS^{PHRs} of Discovery Vitality members and by inference to identify members at possible risk for developing NCDs. Another purpose of this study was to identify high risk groups that would benefit from targeted interventions aimed at improving dietary intake, and at reducing NCD risk attributable to "risky" dietary behaviours.

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2.3 Concepts specific to Discovery Vitality

2.3.1 Discovery Vitality

Discovery Vitality is a large wellness incentive business that is associated with Discovery Health, a major private medical insurance business with representation in South Africa (SA) and the United Kingdom (UK). Discovery Vitality is represented in SA, the UK, the United States of America (USA) and China. Discovery Vitality has recognised the need to incentivise its members to adopt healthier lifestyle behaviours in order to reduce their risk for NCD, which in turn is expected to reduce medical care costs associated with managing these conditions. A number of papers have been published on the Vitality incentive programme, which illustrates the ability of these incentives to impact on medical care costs.[109-111]

2.3.2 Profile of Discovery Vitality members in the South African context

Discovery Health is one of a number of medical aid schemes or health insurance schemes available in South Africa. These schemes are intended to protect individuals against the risk of incurring medical expenses when they fall ill, or to pay for preventive treatments. Discovery Health provides these benefits to its members, and in addition has offered the Discovery Vitality Incentive wellness programme to its members since 1998.

Membership to the Vitality programme is voluntary and is offered to members at a monthly fee.[110] Discovery Vitality members therefore represent South Africans who are covered by medical aid and who in addition can afford to pay membership fees to belong to the Vitality programme.

Discovery Vitality members therefore most likely represent economically advantaged South Africans and not the greater South African population. This statement is supported by data gathered from the General Household Survey (GHS) conducted in South Africa in 2011. This survey showed that a total of 16% of the South African population in 2011 were covered by medical aid. There was no significant differences in medical aid coverage observed for gender but significant differences were observed for age, population group and province of usual residence.[112]

The percentage distribution of medical aid coverage by age group indicated that people who were covered by medical aid in 2011 were generally aged 35 years and older. While less than 15% of people in each of the age groups 0–4 to 25–34 were covered by medical aid, over 20% of each of the age groups from 35–44 to 65 years and older were covered by medical aid.[112]

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Further, analysis of medical aid coverage by population group showed that the majority of individuals from the white population group (69,6%) were covered by medical aid in 2011, followed by the Indian/Asian population group (40,6%). Just one in five (20,2%) individuals from the coloured population group were covered, and less than 10% (8,8%) of the black African population group were covered by medical aid in 2011.[112] Figure 2.1 shows medical aid coverage by population group.

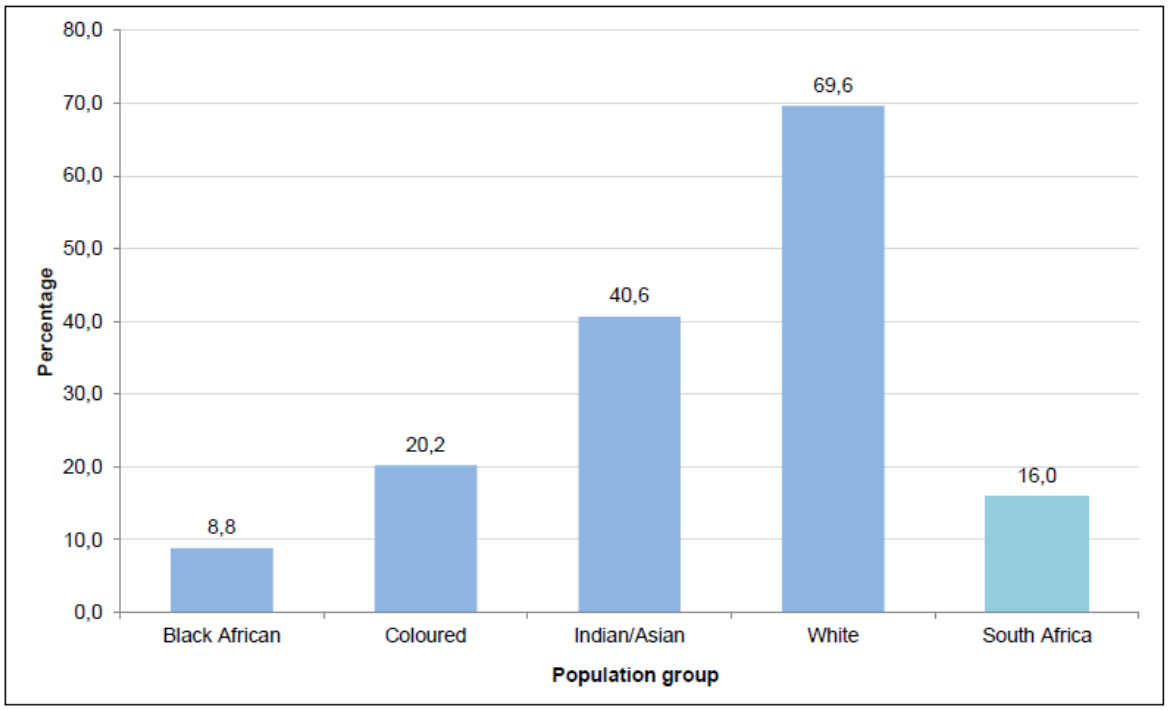

Figure 2.1 Percentage distribution of the population covered by medical aid or medical benefit scheme or other private health insurance, classified by population group: South Africa, 2011.[112]

In addition, differences in medical aid coverage by province of usual residence also show distinct patterns. The relatively affluent provinces of Western Cape and Gauteng had the highest percentage of the population covered by medical aid. In these two provinces, over 20% of the population was covered (25,0% in Western Cape and 23,7% in Gauteng). However, KwaZulu-Natal (12,2%), Eastern Cape (11,0%) and Limpopo (7,2%) had the lowest percentage of individuals covered by medical aid.[112]

Presently, the private health care system in South Africa when compared to the public system, accounts for the largest share of total health care financing (comprising both of medical schemes and private out-of-pocket payments). In 2005, private medical schemes in South Africa covered less than 16% of the population (a percentage that did not change

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in 2011 as reported in the GHS in South Africa) but accounted for about 45% of total health care financing.[113]

Currently, medical aid schemes cover high and middle income formal sector workers and sometimes their dependants.[113] On a per capita basis in 2008 about R10 000 was spent per medical scheme member on health care, while about R1 900 was spent per individual dependant on the public sector. In terms of human resources, about 79% of doctors work in the private sector, and for those who can afford it, first world health care is available within a third world setting.[113] Discovery Health is more than three times the size of its nearest competitor and alone accounts for approximately 35% of the open plan market and 25% of medical plan beneficiaries in South Africa.[110]

Deductions from the discussion above suggest that the majority of members of Discovery Vitality are likely to be white South Africans, followed by Indians/Asians and smaller percentages of people from other population groups. Members are also likely to be individuals who are economically advantaged and are between the ages of 35 and 65 years of age. Members are also likely to be individuals with an above average earning potential, they are also more likely to be well educated and belong to higher Living Standards Measure (LSM) groups (as per the South African Audience Research Foundation – Universal LSM groups),[114] as well as benefiting from first world health care and living standards. Discovery Vitality members are therefore probably not representative of the greater South African population, but share similarities (regarding health care and lifestyle practices) with other groups of individuals who live in first world countries.

The incidence of NCDs escalated initially in developed (first world) countries, but now also plagues developing countries like South Africa.[8,115] South Africans who live past the age of 45 years are more likely to suffer from a NCD than from an infectious disease, with 37% of deaths in South Africa in 2000 attributed to NCDs.[115]

2.3.3 Discovery Vitality member ranking and status

Members of Discovery Vitality are encouraged to participate in healthy behaviours and are further encouraged to monitor and know their health status. Members earn Vitality points when they participate in wellness activities such as physical activity, weight loss groups, regular medical and dental check-ups and on-line wellness assessments.

Members are ranked according to the points they have earned each year into different status groups. These status groups include: blue, bronze, silver, gold and diamond, with blue status reflecting members who have activated Vitality membership, but have little or no engagement with the programme and therefore have earned very few or no points. Gold

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status reflecting highly engaged members who have earned a significant number of points to raise their status to gold. Members who have been on gold status for three years receive diamond status.

Rewards that members can earn are most often financial in the form of refunds or discounts, and these rewards are linked to the members' Vitality status, with blue members receiving smaller rewards than gold status members. Discovery Vitality has conducted research in-house on the ranking of its members and has shown that highly engaged members have lower medical care costs than blue status members.[75] Table 2.1 provides greater detail on the points required by members to graduate to different status groups.

Table 2.1 : Vitality status and required points.[116]

	Blue status	Bronze status	Silver status	Gold status	Diamond status
Single member	Member starts at Blue Vitality status	15 000	35 000	45 000	Reach Gold Vitality status for three consecutive years
Family with two adults		30 000	70 000	90 000	
Family with three adults		40 000	90 000	120 000	
For each adult dependant add		10 000	20 000	30 000	

Vitality points have limits for certain categories of activities.

Additional information on the Discovery Vitality point system is available at: http://www.discovery.co.za/portal/loggedout-individual/points-overview

2.3.4 Discovery Vitality's HealthyFood™ benefit (HFB)

Discovery Vitality launched a wellness incentive initiative as part of the Vitality programme in March 2009 called the HealthyFood™ benefit (HFB). The HFB is made possible through a partnership between Discovery Vitality and national supermarket chain, Pick 'n Pay, and since 2013 from Woolworths. Vitality members are required to activate the HFB via the internet ~ Discovery website, or can call the Discovery Vitality Call Centre to do so. Once activated the benefit discounts healthy food purchases to members when

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made at appointed grocery store chains, by up to 25%. Members also are able to earn Vitality points for HealthyFood™ purchases.

Foods included on the benefit include: all fresh and frozen plain fruit and vegetables, dried unsweetened fruit, whole grain and high fibre foods, lean and skinless chicken and turkey, all plain fish (fresh, canned or frozen), eggs, fat free unsweetened dairy products, and foods that are good sources of mono-unsaturated fat, such as olive oil, canola oil, olive and canola oil soft tub margarines, and unsalted nuts and seeds. It is the intention of the HFB to financially incentivize members to make healthier food choices and at the same time make healthy foods more affordable to members.

As reported by others, positive incentives are associated with promoting desired behaviour change,[99,100,103] and discounting "healthy" - lower calorie and nutrient dense foods, has also been associated with increased sales of these foods.[117] In a similar manner the HFB, aims to incentivize changes to food purchasing behaviour and in turn promote healthier food choices among its members. It is expected that this should promote a reduction in chronic disease risk in the long term.

In 2010, Discovery Vitality introduced as an adjunct to their benefit the concept of "rate your basket". This component of the benefit, aims to rate the member's entire food purchases in the context of healthy versus less desirable foods. Less desirable foods include: sugar and sugary foods and foods high in fat, specifically saturated and trans-fatty acids. Included in this category therefore are: sugar, sweets, chocolates, sweetened carbonated beverages, potato crisps, cookies and biscuits, ice-cream, sausages, pies, pastries, cream, butter and brick margarines.

Additional benefits in the form of Vitality points and/or financial rewards (paid into medical aid savings account or investment account) are available to members if their overall basket contains more than or equal to 75% healthy food and therefore less than 25% less desirable food.

The criteria for food selection for the Discovery Vitality HealthyFood™ benefit are attached as Addendum 2. More details regarding the structuring of benefits related to the HealthyFood™ benefit are available at the HealthyFood™ benefit website.[118]

2.3.5 Personal Health Review (PHR)

The PHR is an on-line assessment tool that has been designed to assess key lifestyle and dietary practices that can contribute to/or help to prevent the development of NCD.

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Lifestyle assessments include evaluation of smoking status, physical activity patterns, alcohol consumption patterns, and environmental stress or perceived stress.

The PHR has been available on-line to Discovery Vitality members since December 2009. The dietary assessment section of the PHR is a "brief dietary assessment" tool that assesses the consumption of water, usual fruit and vegetable intake, the selection of lean or fatty meat and poultry, usual dietary intake of: fish, whole-grains, types of fat and low fat or fat free dairy products. The PHR assessment further assesses biochemical markers of NCD, such as cholesterol, blood pressure and blood glucose levels. Once completed online, members receive a computer generated report with feedback on their specific assessment related to the answers given. A copy of the PHR is given in Addendum 3. An example of the report generated for members once they have completed the PHR on line is included as Addendum 4.

2.4 Assessment of usual dietary behaviours of Discovery Vitality members

2.4.1 Tracking HealthyFood™ purchases and assessment of usual dietary behaviours

The Discovery Vitality HFB, may have far reaching implications, in terms of incentivising behaviour change, it further facilitates tracking member food purchases at Pick 'n Pay and Woolworths stores which is a means of tracking by implication food consumption patterns for a specific group of people. Analysis of food purchasing behaviour of members who have activated the HFB, can assess if foods purchased by member households comply with advocated dietary guidelines.

However, Discovery Vitality only has access to itemized food purchases of members at Pick 'n Pay and more recently Woolworths stores, and then also only for members who have activated the HFB. This is a significant limitation to consider with respect to using food purchasing behaviour linked to the HealthyFood™ benefit, as an assessment tool to assess member compliance with the "spirit of dietary guidance", as members do not purchase all the items they consume from Pick 'n Pay or Woolworths grocery stores. Members also shop at other grocery store chains such as Shoprite, Checkers or Spar, fruit and vegetable markets and others. These stores are not linked to the HealthyFood™ benefit. Members may also purchase food from restaurants, canteens, and fast food outlets as well as eat out at other people's homes and at their place of work. Thus grocery purchases from Pick 'n Pay or Woolworths stores would not be representative of true food purchasing behaviour as described by French.[38]

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Further available data would only be relevant for members who are engaged with the HFB and would not be applicable to unengaged members. Giving consideration to this, it would not be useful to analyse the food purchasing behaviour of Discovery members at Pick 'n Pay or Woolworths stores in the context of compliance with the "spirit of dietary guidance", as without analysing all food purchases from all stores, restaurants, canteens and so on for all members, the data would be incomplete and not reliable. In order to assess usual dietary behaviours and compliance with the "spirit of dietary guidance" another method of assessment was required.

2.4.2 Discovery Vitality's on-line Personal Health Review (PHR) and assessment of usual dietary behaviours

An alternative method of assessing Discovery member's usual dietary behaviours and compliance with the "spirit of dietary guidance" was to make use of data available from the Personal Health Review (PHR) online questionnaire. The data available from the PHR is very similar to the data extracted from the FFQ used by Kant and colleagues[17] to calculate their DBS which reflected the "spirit of dietary guidance" of the Dietary Guidelines for Americans of 2005. The Dietary Guidelines for Americans of 2005[1] provides dietary guidance for health promotion and NCD prevention that is fundamentally the same as that given by the South African Food Based Dietary Guidelines.[12] Thus, the proposal to apply the principles of the DBS scoring system to a South African population group that shared similarities with other populations living in a first world setting, seemed reasonable and plausible.

The application of the DBS scoring system to PHR data was considered feasible, because comparable data had been collected from self-reported data when members completed the on-line Discovery Vitality PHR questionnaire. It was therefore possible to calculate a modified dietary behaviour score from the PHR data (DBS^{PHR}).

It was proposed that the DBS^{PHR} be determined for all members of Discovery Vitality who had completed the online questionnaire (i.e. those who had activated the HealthyFood™ benefit (HFB) and members who had not activated the HFB (non-engaged (N-HFB)) within a specified time frame. The DBS^{PHR} was further to be computed for members that belonged to different tiers of Vitality status that is blue, bronze, silver, gold and diamond from both the engaged HFB group and the N-HFB group.

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2.5. The Dietary Behaviour Score for Discovery Vitality (DBS^{PHR}) and considered risk for developing NCD

The discussion that follows explains the development of a DBS for this study, making use of data available from Discovery Vitality's PHR.

2.5.1. Discussion of Dietary Behaviour Score (DBS) developed by Kant[17] and colleagues

The DBS determined by Kant and colleagues,[17] was a calculated score from participant responses to selected questions from a FFQ. The DBS included *equally weighted components per food category/group* derived from responses to questions on usual dietary behaviours[17]. The scientific publication by Kant and co-workers[17] is included as Addendum 5, and supplemental material as Addendum 1. The calculation of the DBS developed by Kant and colleagues[17] score is given in Table 2.2. A maximum score of 36 points was achievable.

2.5.2 Dietary Behaviour Score (DBS) related to the PHR (DBS^{PHR})

The DBS^{PHR} was based on the premise and rational of the DBS of Kant's[17] study. The method of scoring the DBS^{PHR} was the same as that used by Kant[17]. The DBS^{PHR} score therefore included proportionally weighted components per food category as given by Kant and colleagues.[17] The PHR collects information on usual dietary behaviours related to the consumption of: fruits, vegetables, low fat and fat free dairy products: high fibre and wholegrain foods, lean meat and poultry and types of added solid fat. Responses to the brief dietary screener which is included in the PHR were used to determine the DBS^{PHRs} for this study.

For the purpose of this study, fruit and vegetable consumption was allocated a score out of 12 points, low fat and fat free dairy consumption a score out of 6 points, the consumption of whole grain and high fibre foods a score out of 6 points, the consumption of lean meat and poultry a score out of 6 points and the consumption of added solid fats a score out of 6 points. Thus a total score of 36 points in keeping with the score determined by Kant and colleagues[17] was possible for the calculation of the DBS^{PHR}.

Moreover, the numerical scoring system used for this study was matched to the numerical system used for scoring the DBS by Kant.[17] The DBS^{PHR} was in turn used to assess members' degrees of compliance with the "spirit of dietary guidance", and also allowed for a discussion of contemplated nutritional risk for developing NCD. The DBS determined by

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Table: 2.2: Calculation of Kant and colleagues[17] Dietary Behaviour Score (DBS)

Servings of Vegetables	Number of servings of vegetables you usually eat (excluding salad and potatoes)					
Reported Consumption Pattern	>5-6/ week	3-4/ week	1-2 servings per week	<1 - 2 servings per week		
score	6	3	0	0		
Servings of Fruit	Number of servings of fruit you usually eat (excluding juices)					
Reported Consumption Pattern	>5-6/ week	3-4/ week	1-2 servings per week	<1 - 2 servings per week		
score	6	3	0	0		
Consumption of Wholegrains	Type of **bread** Used					
Type of Wholegrain	Dark Bread	Dark and white bread in equal amounts	white bread			
score	3	1.5	0			
Whole grains continued :	How often is the **cereal you eat high fibre**, such as All Bran or 100% Bran or other fibre cereals e.g. shredded wheat, granola, bran flakes					
Frequency of Consumption	3/4 of the time or almost always	1/2 the time for at least 1	1/4 of the time or never			
score	3	1.5	0			
Low Fat Dairy consumption	**Low fat or non fat milk as a drink**					
Frequency of Consumption	3-4 times per week or more often per week	1-2 / per week	<1-2 times per week or never drink			
Score	3	1.5	0			
Dairy Continued:	**Low fat or non fat milk in cereal**					
Frequency of Consumption	3/4 of the time or almost always	1/2 the time	1/4 of the time or never			
Score	3	1.5	0			
Selection of Lean Meats and Poultry	**Lean or regular meat** (ground beef, steak, roasts or chops)					
	Don't eat or choose lean	Lean and regular the same	regular			
Score	2	1	0			
Meat & Poultry continued	**Ground Beef (lean or regular)**					
	Don't eat or lean	Lean and regular the same	regular			
	2	1	0			
Meat & Poultry continued	**Chicken (with or without skin)**					
	Don't eat or choose without skin	with and without skin the same	chicken with skin			
Score	2	1	0			
Addition of Solid Fat to Foods after cooking or at table	**How often butter or margarine were added to**					
	Pancakes, waffles, French toast	potatoes	rice	pasta	cooked vegetables	gravy to meat
Never or almost never score	1	1	1	1	1	1
Other responses score	0	0	0	0	0	0

Kant[17] was specifically selected for this study as it had a weighted scoring system (which is considered desirable in terms of dietary risk assessment when making use of scores or indices),[43] was an uncomplicated score, and included components that could be readily matched with data available from the PHR. A comparison between the DBS developed by Kant and colleagues[17] and DBS^{PHR} for this study is given in Table 2.3. Further, a

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discussion of the different components of the DBS^{PHR} is also provided in Table 2.3. Details regarding the calculation of the DBS^{PHR} for this study are given in Table 2.4.

Table 2.3: Explanation of changes that were made to the Dietary Behaviour Score[17] to create the Dietary Behaviour Score^{PHR}

DBS component	Original DBS, Kant[17]	DBS^{PHR} – Modifications required
Fruit and Vegetable Intake	Asks separate questions for fruit intake an vegetable intake	Asks about fruit and vegetable intake in a combined question
	Excludes salad, potatoes and fruit juice	Includes salad, all vegetables and fruit juice
Modification required for fruit and vegetable scoring	Provides separate score for fruit and vegetable intake each.	It was necessary to combine scores and increase cut off for fruit and vegetable intake by one portion each, as juice, salad and all vegetables are included in the question about usual consumption behaviour. Refer to table 2.4 for further clarification regarding scoring
Whole grain consumption	Asks about frequency of consumption of whole-grain and high fibre foods	Asks specifically if high fibre or whole grain foods are consumed or not, and about the number of servings of high fibre or whole grain foods consumed daily.
Modification for wholegrain scoring	Scores are allocated based on frequency of consumption in general	Scores were allocated based on if whole grain and high fibre foods are consumed. If intake was in keeping with dietary guidelines, a higher score was given and if consumption is less than advocated by dietary guidelines a lower score was given. Refer to table 2.4. It was considered that the question on whole grain and high fibre foods in the PHR is still able to assess usual dietary behaviour on whole grain consumption, and so was able to assess compliance with the "spirit of dietary guidance".
Low fat and fat free milk and dairy	DBS assess the frequency of use of fat free milk and low fat milk as a drink and on cereal	The PHR only asks if the member uses fat free milk and dairy, low fat milk and dairy, or full cream milk and dairy, or no milk and dairy products. Frequency of consumption is not assessed.
Modification to dairy scoring	Scores are based on frequency of consumption. Refer to table 3.1	Scores were based on positive answers for the use of fat free and low fat milk. No scores were allocated for full cream milk or the avoidance of milk and dairy products. The PHR does not assess quantity, but members who confirm that they used fat free and low fat milk demonstrate compliance with the "spirit of dietary guidance", and scores could be allocate accordingly. Further it should be noted that the consumption of milk specifically is not associated with a reduction in NCD mortality risk but the reduction in dairy fat is, thus assessment of the type of milk and dairy used (fat free or low fat) has greater merit than the assessment of the quantity of milk consumed. Therefore although data on the quantity of milk consumed is not available in the PHR – this did not have an impact on the assessment of NCD mortality risk related to compliance with the "spirit

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DBS component	Original DBS, Kant[17]	DBS[PHR] – Modifications required
		of dietary guidance".
Red meat consumption	Asks if red meat is consumed and then, asks about frequency of consumption related to lean cuts or regular cuts of meat and ground beef Two questions are asked about red meat	Asks if red meat is consumed and then, asks about frequency in terms of weekly consumption related to lean cuts or fatty cuts of red meat. Only one question is asked about overall red meat consumption.
Modification for red meat	Scores are allocated for the two questions on red meat specifically to ground beef and then to cuts of meat.	Scores for the two questions in the DBS were combined for the DBS[PHR], as only one question on red meat was asked. This was considered to be without consequence in terms of consistency of the score, as the information on the general consumption of red meat and frequency of consumption was still available from the data collected for the PHR for both ground beef and other cuts of red meat. The PHR questions could further assess if the type of red meat usually consumed was fatty or lean as required for the DBS of Kant and co-workers.[17]
Poultry	Asks if chicken is consumed and asks about frequency of consumption related to chicken with and without skin.	Asks if chicken is consumed and asks if chicken is consumed with or without skin. Does not ask about frequency of consumption. However data in the PHR does provide an indication of usual food consumption behaviours which is relevant in terms of assessing compliance with the "spirit of dietary guidance".
Modification for poultry		Scores could not be allocated for frequency of consumption, but could be allocated for chicken with or without skin, which was sufficient, as the questions about chicken consumption specifically related to the type of fat consumed in the context of the "spirit of dietary guidance" and NCD prevention. The PHR questions provided this information in keeping with the nutritional components assessed by the DBS question as determined by Kant .[17]
Added solid fat	The DBS specifically asks about the addition of butter or margarine to specific foods such as toast, potatoes, rice, pasta vegetables, and gravy.	The PHR provided a list of fats and oils, such as butter, margarine, soft tub margarine, olive oil, sunflower and so on, and asked if the member added any of these to food that is consumed.
Modification for added solid fat	Scores are allocated for "seldom or never" responses. No score is given for other responses. Refer to Table 2.2	Scores were allocated for "never" responses for the addition of butter, hard margarine or soft margarine. No score was given for other responses. Refer to Table 2.4. While the assessment of added solid fat to food in the PHR follows a different format to the DBS of Kant[17], the PHR was still able to assess the consumption of added solid fat in keeping with the "spirit of dietary guidance"

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Table: 2.4: Calculation of Dietary Behaviour Score from the Personal Health Review (PHR) data – the Dietary Behaviour Score PHR.

Combine Servings of Vegetables and Fruit in PHR	**Number of servings of fruit and vegetables you usually eat per day (PHR includes salad and pure juice) Therefore add an extra serving (fruit and vegetable) for each per week), and double score as fruit and veg are one question**			
Specifications from Kant et al, 2009	>14-18/ week fruit and vegetables	10-12/ week	6-10 servings per week	<6-10 servings per week
Estimated daily requirement from DBS (Kant,2009)	>2 - 2.6 servings daily	1,4 -1,7 servings daily	0.85 - 1,4 servings daily	<0.85 - 1,4 servings daily
Rounded daily values to assess PHR data	3 or more servings daily	2 servings daily	1 or less serving daily	0 servings daily
proposed score for DBS PHR	12	6	0	0
Consumption of Wholegrains	**High fibre and whole grain products lumped together based on advocated dietary guidelines**			
PHR Questions	3 or more servings per day, complies with dietary guidelines most of the time	Less than 3 servings per day (could be 1 - 3 servings), but not specified	non or never	
proposed score for DBS PHR	6	3	0	
Low Fat Dairy consumption	Does use Skimmed or Fat Free Milk and Dairy	Does Use Low Fat Milk and Dairy	Uses Full Cream Milk and Dairy	No Dairy or Milk products
Frequency not available in PHR/ Proposed Score	6	6	0	0
Selection of Lean Meats and Poultry	**Lean or regular meat** (ground beef, steak, roasts or chops)			
PHR Questions	Don't eat meat or less than 2x/week lean	Lean meat >2 x per week	Meat with fat < than or > than 2 x/week	
proposed score for DBS PHR	4	2	0	
	Chicken (with or without skin)			
PHR Questions	Don't eat chicken or do eat but without skin	N/A	Does eat chicken with skin only	
proposed score for DBS PHR	2		0	
Addition of Solid Fat to Foods after cooking or at table	**How often butter or margarine were added to**			
PHR Questions	Hard Margarine	Soft Margarine	Butter or Fat	
Proposed DBS PHR for answer **Never**	2.5	1	2.5	
Proposed DBS PHR for all other answers	0	0	0	

2.5.3. Contemplated risk for NCD

The study conducted by Kant and colleagues[17] reported that adoption of recommended dietary behaviours in keep in with the "spirit of dietary guidance" was associated with a 20% to 25% lower risk of mortality after 10 years of follow up in older men and women[17]. It was also reported that even small changes in dietary behaviours in the desired direction showed risk reduction in mortality and this increased with greater compliance.[17]

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This research project was not conducted as a prospective study. Thus, in order to consider the risk profile of members for the development of NCD and NCD mortality, the DBS^{PHR} data for Discovery Vitality members allowed for a comparative discussion alongside results reported in Kant's[17] study. It was established from the study done by Kant and colleagues[17] that participants with low DBS scores had a higher relative risks for chronic disease mortality compared to the highest DBS scores. It was thus considered plausible to draw considered deductions about certain groups of Discovery Vitality members regarding their risk for developing NCDs and associated NCD mortality as determined by the DBS^{PHR} scores.

DBS quintiles in Kant's[17] study reflected degrees of compliance with the "spirit of dietary guidance". Risk reduction was reported to be relative to DBS, and thus it was deemed reasonable to assign labels to DBS^{PHRs} that reflected degrees of compliance with the "spirit of dietary guidance" for Discovery Vitality members in this study.

Dietary scores for this study were therefore categorised according to 5 groups with score ranges consistent with quintile ranges given by Kant[17]. Each dietary score range was assigned a label, namely: Poor (score 0-18), Inadequate (score 18.5-22.5), Fair (score 23-26), Good (score 26.5-29.0) and Excellent (score 29.5-36).

In theory a score of 0-18 points (Poor score) out of a possible 36 points would be suggestive of a 0% to 50% compliance level with the "spirit of dietary guidance". A score of 18.5-22.5 points (Inadequate score) out of a total possible score of 36 points would suggest a 51.4% to 62.5% compliance level with advocated dietary guidance. Similarly a score of 23-26 points (Fair score) would be suggestive of a 63.9% to 72.2% compliance level, and a score of 26.5-29 points (Good score) would be suggestive of a 73.6% to 80.6% compliance level. Lastly a score of 29.5-36 points (Excellent score) would suggest an 82% to 100% compliance level with the "spirit of dietary guidance".

While it was not possible to establish "real" risk for developing NCD or "real" NCD mortality risk from this informal grouping of DBS^{PHRS} for Discovery Vitality members, the categorization of DBS^{PHRs} did allow for some discussion around the degrees of compliance of Discovery Vitality members with the "spirit of dietary guidance". This in turn allows for consideration of mortality risk attributable to chronic disease as a result of reduced compliance with the "spirit of dietary guidance". It was therefore possible to draw considered deductions about certain groups of Discovery Vitality members regarding their risk for developing NCDs and associated NCD mortality as determined by the DBS^{PHRs}. This was not completed statistically, but rather addressed in the discussion of results.

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2.6 Strengths of the selected research tool

2.6.1 The use of a DBS to assess general dietary behaviour

Self-reported detailed nutritional information whether collected by trained dietitians and/or reported by untrained subjects has been shown to have a degree of inaccuracy due to under-reporting by subjects.[35] This may be attributed in part to subjects not understanding the specifics about complex nutritional information.[17,35]

However it was proposed by Kristal,[119] that the recall of general dietary behaviours may be less prone to reporting errors than frequencies and portion sizes of long lists of food.[119] This suggestion has been supported by Kant and co-workers,[17] who reported that the DBS was derived from estimates of reporting on certain dietary behaviours, and did not utilize the reported amount of individual foods or nutrients from a food frequency questionnaire, but nevertheless predicted intakes of dietary fibre, fat and protective nutrients in the expected direction.[17]

Further it was reported that unlike the frequently observed positive association of dietary patterns with energy intake, the relative independence of the DBS and energy intake suggests that the DBS are not merely a variation in the amounts of food consumed, but are due to a higher nutrient density of the diet or improved diet quality. From this perspective it can be concluded that the use of a DBS is an appropriate dietary screening tool that can be used for assessment of degrees of compliance with advocated dietary guidance, as well as providing a perspective of the overall diet quality of participants. Further the assessment of general dietary behaviours used to calculate the DBS may be less prone to reporting errors as seen with other dietary assessment tools.[17]

2.6.2 The suitability of Personal Health Review (PHR) data

The PHR (which incorporates a brief dietary screening tool) assesses usual dietary behaviours in the context of advocated dietary guidance, and is concerned with dietary principles that have the ability to impact on NCD. The PHR also includes questions that assess “risky” lifestyle behaviours that have been identified to contribute to NCD risk. The PHR questionnaire is uncomplicated, and has been developed for Discovery Vitality by its in-house Research and Development team, which includes a number of qualified dietitians, medical doctors, and biokineticists. Further the PHR questionnaire has been assessed by members of University of Cape Town (UCT)/Medical Research Council (MRC) Research Unit for Exercise Science and Sports Medicine from the department of Human Biology, Faculty of Health Sciences, University of Cape Town. Discovery Vitality works collaboratively with this unit.

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Nutrition related questions in the PHR were designed to assess dietary behaviours in the context of accepted national and international population based dietary guidelines. Questions in the PHR also record members reported "risky: lifestyle behaviours (Addendum 3). A report providing feedback is generated for each member after completing the PHR (Addendum 4). It is generally accepted by Discovery Vitality, its members and the Sports Science Institute, that the PHR sufficiently assesses general dietary behaviours and "risky" dietary behaviours in accordance with the assessment objectives of Discovery Vitality.

2.6.3 Dietary Behaviour Score determination from PHR data (DBS^{PHR})

For this study it was considered plausible to make use of the validated and reliable DBS developed by Kant[17] as the premise of this study, and as the basis for the determination of a DBS^{PHR}, with some minor modifications (Table 2.4) being necessary owing to the format of data collection in the PHR(Table 2.3). Therefore it seemed reasonable that the data from the PHR could be used to assess the usual dietary behaviours and general compliance with the "spirit of dietary guidance" of members of Discovery Vitality who had completed the PHR, and who had complete data. Data from calculated DBS^{PHR} scores in turn provided some insight into the varying degrees of dietary risk associated with an increased risk for developing NCD, extrapolated from the study completed by Kant and colleagues.[17]

Further details regarding the methodology and study process for this research are given in Chapter 3.

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CHAPTER 3

METHODOLOGY

3.1 Study aims

3.1.1 Research questions

3.1.1.1 Primary research question

What is the computed "Dietary Behaviour Score" (DBS^{PHR}) and considered dietary risk profile of Discovery Vitality members who have completed the on-line Personal Health Review (PHR) questionnaire between the 1st February 2010 and 31st January 2011?

3.1.1.2 Secondary research questions

- Does the DBS^{PHR} of members who have activated the HealthyFood™ benefit (HFB) differ from members who have not activated the benefit (N-HFB) at the time of completing the PHR?
- Does the DBS^{PHR} of members differ between Vitality status groups: namely blue, bronze, silver, gold and diamond?
- How does the DBS^{PHR} of the group of members who are current smokers compare to non-smokers and ex-smokers?
- How does the DBS^{PHR} of the group of members who consume alcohol in excess of recommendations compared to those who comply with recommendations?
- How does the DBS^{PHR} of the group of members who are inactive and/or who participate in less exercise than the recommended 150 minutes of exercise per week, compare to those members who comply with exercise recommendations?
- How does the DBS^{PHR} of the group of members who have a BMI greater than $30kg/m^2$ compare to those who are overweight, normal body weight or underweight?

3.1.1.3 Research aims

- To calculate a modified dietary behaviour score (DBS^{PHR}) for Discovery Vitality members who had completed the on-line Personal Health Review (PHR) between the 1st February 2010 and 31st January 2011.
- To categorize scores to assist with the identification of members who have an estimated nutritional risk for developing NCD.
- To compare the DBS^{PHR} of Discovery Vitality members who had activated the HFB with the DBS^{PHR} scores of Discovery Vitality members who had not activated the HFB.

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- To compare the DBS^{PHR} of members between status groups: namely blue, bronze, silver, gold and diamond.
- To compare the DBS^{PHR} of members who are current smokers to the DBS^{PHR} of non-smokers and former smokers.
- To compare the DBS^{PHR} of the group of members who consumed alcohol in excess of recommendations to those who complied with recommendations.
- To compare the DBS^{PHR} of the group of members who were inactive and/or who participated in less exercise than 150 minutes of exercise per week, to those members who complied with exercise recommendations.
- To compare the DBS^{PHR} of members who had a BMI greater than $30kg/m^2$ to those who were overweight, normal body weight or underweight.

3.2. Methods

3.2.1. Study Process

Figure 3.1 provides a diagrammatic representation of the study process

3.2.2 Study domain: The study domain was quantitative.

3.2.3 Study design: Cross-sectional, observational with analytical components.

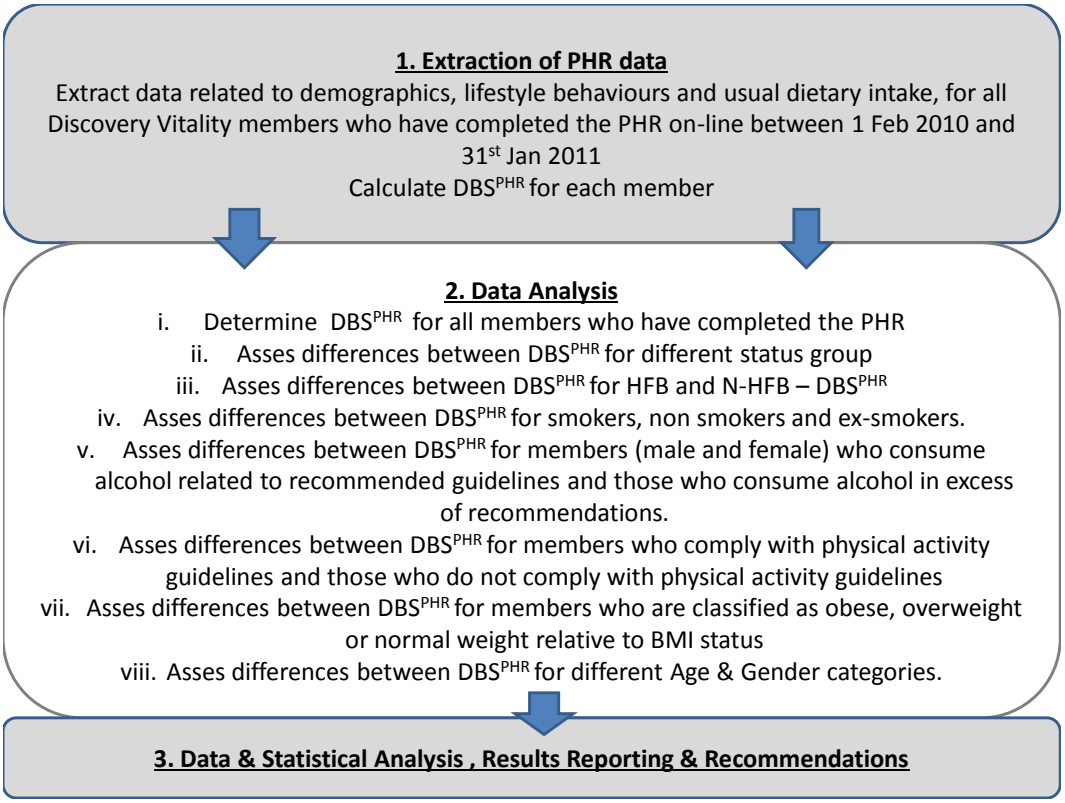

Figure 3.1: Diagrammatic representation of study process.

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3.2.4 Study population

The study population included adult South African residents who were also members of Discovery Medical Aid and the Discovery Vitality Programme, and who had been identified as completing the on-line PHR between the 1st February 2010 and 31st January 2011. Discovery Vitality has an in-house computerised system that collects data immediately and continuously as individuals register and activate their Discovery Vitality membership, activate benefits and complete available assessments.

Data prior to November/December 2009 was not considered to be suitable or compatible, as a different assessment called the "Health Risk Assessment" (HRA) was used at this time to assess dietary and lifestyle behaviours. The data from the HRA could not be matched to the components of the DBS of Kant[17], and therefore could not be used to calculate the DBS^{PHR} required for this study.

There were 231 442 Discovery Vitality members (principle and spouse members) who were indentified as having completed the PHR between the 1st February 2010 and the 31st January 2011.

3.2.5 Sampling method

Stratified random sampling with replacement was used for this study. Microsoft Excel Statistical component was used for this purpose.

3.2.5.1 Power analysis

Statistical power analysis determined that a sample of 170 members (half male and half female) per status group for HFB and N-HFB groups would be required to achieve an effect size of 0.25 with 90% power. A rounded up sample of 200 members per Vitality status group for both HFB and N-HFB therefore provided an adequate sample with considerable statistical power for this study. Therefore, a sample of 1600 members was required.

3.2.5.2 Inclusion and exclusion criteria

Inclusion criteria

- All Discovery Vitality members who had completed a PHR questionnaire online during the period 1st February 2010 to 31st January 2011 with complete data.

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- Adult members (both principle members and spouse members) of Discovery Vitality.
- Adults 20 years of age or older.

Exclusion criteria

- Discovery Vitality members who did not complete the on-line PHR between 1st February 2010 to 31st January 2011.
- Discovery Vitality Members with incomplete data
- Extreme Outliers, those with questionable data (discussed in detail in 3.2.6.2.)
- Discovery Vitality Members under the age of 20 years

3.2.5.3 Stratum

i. Discovery Vitality members who had completed the PHR between the 1st February 2010 and 31st January 2011 and who had complete data.
ii. Equal numbers of members who had activated the HFB and members who had not activated the HFB (N-HFB) at the time of completing the PHR.
iii. Discovery Vitality Status Groups: equal numbers from each of the following four groups: blue, bronze, silver, "gold and diamond combined" were represented.
iv. For gender, equal numbers of male and female member are represented.

3.2.6 Data handling

3.2.6.1 Study population data handling

- Microsoft Excel was used to extract data from the Discovery Vitality data base for the responses from all members who completed the on-line PHR between 1 February 2010 and 31st January 2011. This task was completed by one of Discovery Vitality's actuarial scientists. The extraction worksheet is attached as Addendum 6 and details on extracted data are included as Addendum 7. The data of 231 442 Discovery Vitality members was included in the extraction sheet.
- Discovery ID codes were allocated to each extracted line item, by the actuarial scientist.

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- Discovery Vitality's actuarial scientist provided the researcher with a list of ID attribute descriptions (Addendum 8).
- Once all data was extracted, the researcher reorganized the data in the Excel spreadsheet to include headings and descriptions of data in accordance with specifications set in the study protocol and according to recommendations provided by the appointed statistician.
- While working with the data, it was noted that some members had incomplete data, some were too young for the study, or had questionable data, and it was considered necessary to exclude these members from the study population. Accordingly, 31 705 members were excluded from the study population due to incomplete PHR data records. Further,195 members were excluded from the study population due to being younger that 20 years of age. In addition, 7 819 members were excluded from the study population due to incomplete height data, and 2 121 memebrs were excluded due to incomplete weight data. Incomplete data for smoking was found for 2 377 members. Questionable BMI data was found for 155 members with reported BMI <15,725kg/m^2, these members were excluded from the study population. Questionable information on exercise was found for 493 members. Questionable exercise information was considered when exercise exceeded 5040 minutes/week and/or was reported as between 1- 10 minutes/week, or incomplete data. Members who reported no exercise that is "zero" minutes of exercise per week were not excluded. With these exclusions, the study population was reduced to 186 577 members.
- Responses from the PHR were in turn allocated codes as detailed in the extraction worksheet (Addendum 6 and Addendum 7).
- Scores were allocated to these codes for the DBS ^{PHR}, and the researcher compiled a formula which then allowed for the computation of a DBS^{PHR} for each member of the study population with complete PHR data. The DBS^{PHR} was calculated using Microsoft Excel 2007.

3.2.6.2 Data handling: sampling process

- The sample was drawn from 107 950 members who had activated the HFB and who had completed the PHR (with complete data) during the period 1 February 2010 to 31st January 2011, and 78 627 members who had not activated the HFB at the time of completing the PHR (who had complete data), during the same period. The total study population was therefore 186 577 members who had completed the PHR and who had complete data for this time period.

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- The study sample included 200 members (100 male and 100 female) for each one of the four status group for both the HFB and N-HFB, therefore 1 600 members in total.
- Sample selection for the stratified sample was random with replacement. Replacement took place if more than one member [principle (PP) or spouse member (SP)] was selected for the study through the random sampling process. It was important to only include one member from each family therefore if a SP was randomly allocated to a group along with a PP then one member was excluded, as these are not independent. The second member selected from a family was in this case excluded and another member was in turn randomly selected from the study population according to the stipulated method of stratified random sampling to provide a replacement for the excluded member.
- Discovery Vitality's actuary, who was responsible for the extraction of data, built criteria into the data extraction workbook to facilitate identification of SP and PP members.
- During the sampling process only one replacement was necessary due to a SP and PP member being included in the sample. One member was excluded from the sampling process due to being considered an outlier - reporting consuming 120 standard alcoholic beverages per week. This member was replaced with the next randomly selected member in the group. Six members were excluded from the sample, who were also identified as outliers reporting regular exercise in excess of 1260 minutes (21 hours) of exercise per week. These members were replaced with the next consecutive randomly selected members from each of their respective groups.
- It is also important to note that the sampling framework was not proportionally representative of the Discovery Vitality membership between Vitality status groups, but this ensured that all groups were equally represented. This was considered prudent in order to facilitate the effective comparison of DBS^{PHR} between groups and to ensure that all groups were adequately represented for assessment of other variables such as BMI, smoking status, alcohol consumption and physical activity levels. Refer to Table 3.1 for a tabulated description of the sampling process for this study

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Table 3.1: Sample selection for this study (n=1600)

	Discovery Vitality Members who have completed PHR between 1 Feb 2010 and 31 January 2011, and who have complete data: 186577							
Stratum 1	HFB Members: 107950				NHFB Members: 78627			
Stratum 2	Blue	Bronze	Silver	GLD/DMD	Blue	Bronze	Silver	GLD/DMD
	46543	34081	7855	19471	47443	21271	3515	6398
Stratum 3								
Female	23457	17070	4099	8736	24208	11401	1925	3841
Male	23086	17011	3756	10735	23235	9870	1590	2557
Random Sample from Stratified Group	200 (100 Female and 100 Male)	200 (100 Female and 100 Male)	200 (100 Female and 100 Male)	200 (100 Female and 100 Male)	200 (100 Female and 100 Male)	200 (100 Female and 100 Male)	200 (100 Female and 100 Male)	200 (100 Female and 100 Male)
	(n)=800				(n)=800			
	(n)=1600							

- Once the sample was drawn, the sampled data was organized to include descriptions/rankings for:
  - BMI (Underweight, Normal Weight, Overweight and Obese),
  - Activity level (Inactive=no exercise, Low Activity <150 minutes/week and Active ≥150 minutes/week),
  - Compliance with recommendations for alcohol consumption (Never drinks, "Yes" = complies with recommendations of <7drinks/ week for women and < 14 drinks per week for men, or "No"=does not comply with recommendations and exceeds recommendations for alcohol consumption per week),
  - DBS^{PHR} (Poor (Score 0-18)[17], Inadequate (18.5-22.5)[17], Fair (23-26)[17], Good(26,5-29)[17], Excellent (29,5-36)[17]).
  - DBS^{PHR} data was sorted for the various variables such as: Vitality status group, activation of the HFB or N-HFB, smoking status, activity levels, alcohol consumption by gender, BMI, age and gender. Graphs and tables are used to illustrate findings from this study.
- The percentage of DBS^{PHR} was determined for each sampled member, with a DBS^{PHR} of 36 being considered to be a score of 100%. The percentage was therefore calculated as Member score/36 x 100 = DBS^{PHR}%
- Sampled members were also classified into age categories: 20-30 years; 31-40 years, 41-50 years, 51-60 years, 61-70 years and ≥71years.

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- The researcher then worked with the appointed statistician to analyse data, as described in section 3.2.8.

3.2.7 Clarification of PHR data

3.2.7.1 Collection of anthropometric data from the PHR

- All anthropometric data was self-reported, and collected on-line. Metric measurements were used in the PHR questionnaire. Weight was reported in kilograms and height in meters. The PHR questionnaire required that members report values to the nearest whole number, apart from height measurements which allowed for two decimal places.
- BMI values were calculated by Discovery Vitality during the process of data collection from self-reported anthropometric data, using the standard formula for BMI calculation.[62]

3.2.7.2 Collection of physical activity data from the PHR

Physical activity data was self-reported by members on-line. Data was available for the number of days per week that an individual exercises, as well as the duration of exercise per session. Thus it was possible to collect data for the following activity levels:

- Rarely/ Never engage in physical activity = 0 days per week
- Engage in physical activity less than 150 minutes per week
- Engage in physical activity greater than or equal to 150 minutes per week

3.2.7.3. Collection of data on tobacco smoking status from the PHR

- Data on smoking status was self-reported in the PHR by members on-line. Information was collected by the PHR on smoking status relative to: current smoker, former smoker or never smoked.

3.2.7.4 Collection of data on alcohol consumption behaviour from the PHR

- Data on alcohol consumption was self-reported in the PHR by members on-line. Information was collected by the PHR on alcohol consumption relative to the number of alcoholic beverages usually consumed per week.
- Data was collected for alcohol consumption as follows:
  - rarely/ never drink alcohol,
  - Women($\leq$ 7 standard drinks per week; > 7 standard drinks / week)
  - Men ($\leq$ 14 drinks per/ week; > 14 drinks/ week)

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3.2.7.5 Collection of data on usual dietary behaviour

The PHR included data on usual dietary behaviour. Specific information was extracted to calculate the DBS^{PHR} (Table 2.4). Data was self-reported by members for the PHR. Calculation of the DBS^{PHR} required extraction of data from PHR on usual dietary behaviour and calculation of the DBS^{PHR} to assess compliance with the "spirit of dietary guidance".

3.2.8 Statistical methods

A statistician appointed by the Faculty of Medicine and Health Sciences, Stellenbosch University, assisted with the analyses of data for this research project.

STATISTICA version 11 (StatSoft Inc. (2012) STATISTICA (data analysis software system), www.statsoft.com.) was used to analyse the data.

Summary statistics were used to describe the variables. Distributions of variables are presented with histograms and or frequency tables. Medians or means were used as the measures of central location for ordinal and continuous responses and standard deviations and quartiles as indicators of spread.

Relationships between two continuous variables were analysed with regression analysis and the strength of the relationship measured with Pearson correlation or Spearman correlation if the continuous variables were not normally distributed. If one continuous response variable needed to be related to several other continuous input variables, multiple regression analysis was used and the strength of the relationship measured with multiple correlation.

The relationships between continuous response variables and nominal input variables were analysed using appropriate analysis of variance (ANOVA).

When ordinal response variables were compared versus a nominal input variable, non-parametric ANOVA methods were used. Further for this completely randomized design, the Mann-Whitney test or the Kruskal-Wallis test was used.

The relations between nominal variables were investigated with contingency tables and appropriate chi-square tests like the likelihood ratio chi-square test or the McNemar test were completed.

A p-value of $p < 0.05$ was considered to represent statistical significance in hypothesis testing and 95% confidence intervals were used to describe the estimation of unknown parameters.

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3.3. Ethics and legal aspects

3.3.1 Ethics review committee

This study was approved by the Human Research Ethics Committee, Faculty of Medicine and Health Sciences, Stellenbosch University (Ref nr S12/04/101). (Addendum 9)

3.3.2 Permission to use data from Discovery Vitality

Discovery Vitality granted the researcher permission to make use of member data. A letter confirming their consent is attached in Addendum 10.

A memorandum of understanding was drawn up between Stellenbosch University and Discovery Vitality for the proposed research. This agreement ensures that the proposed research could be undertaken without risk of an imposed embargo on data or results (Addendum 13).

3.3.3 Confidentiality

There were no significant ethical considerations in this study, as member identity was not known by the researcher, the actuarial scientist completing the data extraction, nor the management or staff of Discovery Vitality. Data was exported by an actuarial scientist at Discovery Vitality into an excel spreadsheet. Thus the researcher gained access to data without knowledge of the individuals who had completed the PHR assessments on-line.

Discovery Vitality owns the collected data, and members are of the understanding that data can be used by Discovery Holdings and related businesses as deemed necessary for research purposes. (Addendum 11).

Discovery Vitality provided a written undertaking that the proposed study and results would not be used to prejudice members of Discovery Vitality in any way. (Addendum 12).The researcher had no contact with Discovery Vitality members at all, and the rights of these individuals were not compromised through this research in any way.

3.4 Assumptions and limitations

3.4.1 Assumptions

Assumptions made in this study were that:

I. Discovery Vitality members respond truthfully to the questions in the PHR.
II. That all members read and understood the questions in the PHR correctly.

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III. As the PHR questions are written in English, one would have to assume that all members can read and speak English.
IV. The brief dietary screener that was incorporated into the PHR was capable of assessing "usual dietary behaviours" in accordance with advocated dietary guidelines (SAFBDG and ADG-2005), and could be used to calculate a modified dietary behaviour score the DBS^{PHR}.

3.4.2 Limitations

The limitations of the study include:

I. Members are rewarded by receiving Vitality points for completing the PHR on-line, however not all members who are registered with Discovery Vitality completed the PHR. Therefore the sample population in this study is representative only of members who completed the PHR and who were potentially more engaged with the Vitality programme than members who did not complete the PHR.
II. Members who completed the PHR on-line may be healthier and more interested in their health than members who did not complete the PHR, thus the DB^{SPHR} of these members may be better than those of the greater Discovery Vitality population.
III. Existing PHR data had to be used to compute the DBS^{PHR}, and questions in the PHR differed to some extent from those used in the study conducted by Kant and co-workers.[17]
IV. The "brief dietary assessment tool" incorporated into the PHR has not been validated for research purposes.
V. All data in the PHR is self-reported and was not validated against another dietary assessment method such as: diet history, diet records or FFQ.
VI. Self-reported data has limitations in terms of the quality of data collected when compared to data collected by a trained interviewer. However when used for the assessment of foods usually consumed as part of the usual diet dietary, self-reported data has generally been considered to be adequate.[17,35,37]
VII. As this was a cross-sectional study, conclusions cannot be drawn from DBS^{PHR} about member's actual dietary risk for developing NCDs and NCD mortality risk. However, results allowed for the discussion of dietary behaviours of members and therefore implied risk for developing NCDs and NCD mortality.
VIII. Caution should be applied to the interpretation of results related to risk for NCDs and NCD mortality, as the current measured "usual dietary behaviour" may not be related to past or future dietary behaviours of participants

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IX. The sample population for this study included adults over the age of 20 years, while the study conducted by Kant[17], only included participants aged 50-71 years of age. Thus expected mortality and NCD risk attributed to non-conformity with advocated dietary guidelines may be lower for the study population under investigation, due to the age advantage of this group, as increasing age is associated with an increased risk for NCDs and NCD mortality.[62]

X. Only computer literate members participated.

XI. A pilot study was not conducted to assess the reliability of the DBS^{PHR}.

3.5 Disclosures

The researcher was a consultant to Discovery Vitality between June 2004 and December 2011. The researcher was involved in 2004 with the development of the Vitality Nutrition Assessment and assisted Discovery Vitality with the development of criteria for food selection for the HFB in 2009.

However the researcher has never worked on the PHR and has not been responsible for the content thereof or the questions related to the PHR.

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CHAPTER 4

RESULTS

4.1 Demographics

In accordance with the study design, half of the sampled members (n=1600) were female and 50% were male. All members had completed the PHR and had complete data, and half of the members belonged to the HFB and the other half were N-HFB members. Vitality status groups were equally represented with 400 members from each group, namely: blue, bronze, silver and gold/diamond groups.

Of the selected sample; 418 members (26,13%) were between 20-30 years of age, 624 members (39%) were between the ages of 31-40 years, 340 (21,25%) between the ages of 41-50 years, 150 members (9,5%) were between 51-60 years, 58 members (3,63%) were between 61-70 years and 8 members (0.5%) were 71 years or older. Figure 4.1 illustrates the sample population distribution by percentage for age and gender.

Table 4.1 below provides tabulated results of the sample population for: age, gender, vitality status, and engagement with the HFB.

Table 4.1: Age distribution of Vitality members by gender, Vitality status and engagement with HealthyFood™ benefit (n=1600)

	Male									Female									
		Blue		Bronze		Silver		Gold/ Diamond			Blue		Bronze		Silver		Gold/ Diamond		
	n(men) = 800	HFB	N-HFB	HFB	N-HFB	HFB	N-HFB	HFB	N-HFB	*n (women) =800*	HFB	N-HFB	HFB	N-HFB	HFB	N-HFB	HFB	N-HFB	*n(total)*
20-30 years	195	32	29	25	24	32	21	19	13	223	42	34	31	26	32	25	12	21	418
31-40 years	316	37	39	45	44	36	37	43	35	308	35	44	34	41	40	39	37	38	624
41-50 years	186	15	25	18	20	21	32	18	37	154	16	13	16	20	18	21	27	23	340
51-60 years	69	10	5	8	8	10	7	11	10	83	6	4	17	10	6	11	16	13	152
61-70 years	27	6	2	4	4	1	1	6	3	31	1	5	2	3	4	4	7	5	58
71+ years	7	0	0	0	0	0	2	3	2	1	0	0	0	0	0	0	1	0	8

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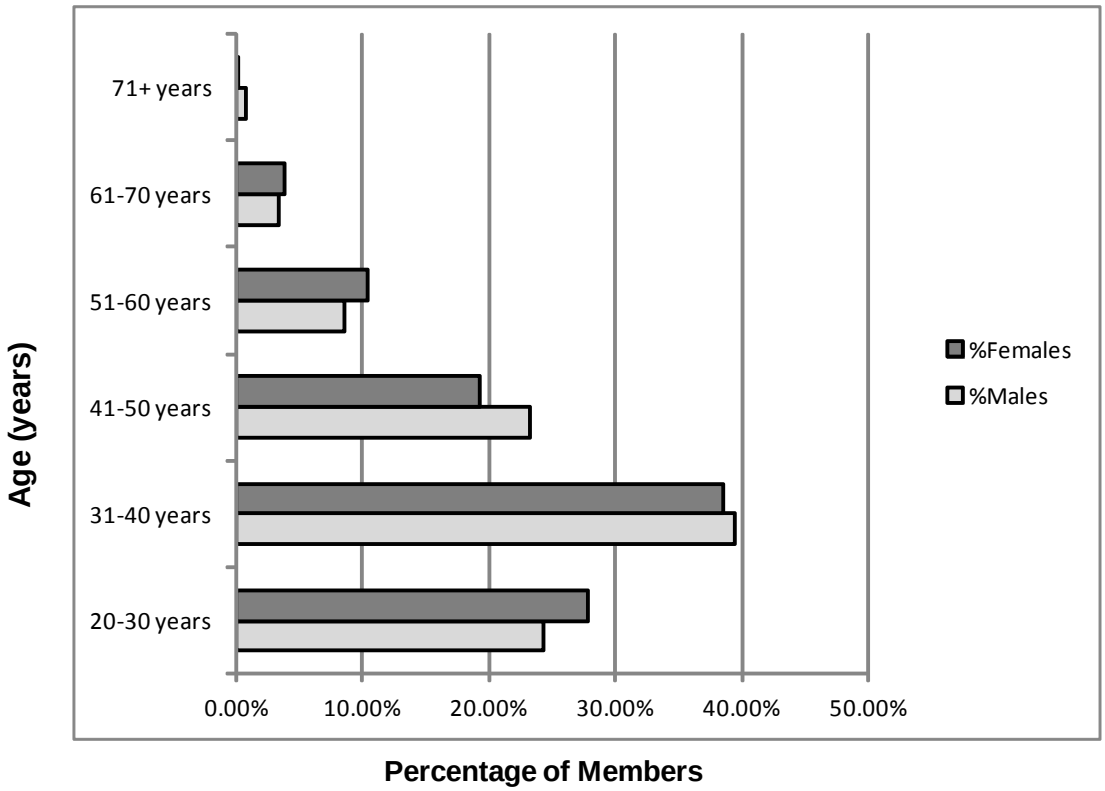

Figure 4.1: Representation of percentage (%) of Vitality members by age and gender (n=1600)

4.2 DBS^{PHR} of sample population

The DBS^{PHRs} were calculated for each member in accordance with specifications set out in Chapter 2 and Table 2.4. All members were awarded a dietary behaviour score out of a maximum of 36 points. Dietary scores were categorised according to five groups namely: Poor (score 0-18), Inadequate (score 18.5-22.5), Fair (score 23-26), Good (score 26.5-29.0) and Excellent (score 29.5-36).

Table 4.2 tabulates the DBS^{PHR} of sampled Discovery Vitality members according to DBS^{PHR} groups and provides the median score for each group. The majority of members (67.13%) received scores that are considered either poor or inadequate.

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Table 4.2: Dietary Behaviour Score^{PHR} of Discovery Vitality members by score group (n=1600)

DBS^{PHR} Group	Poor	Inadequate	Fair	Good	Excellent
DBS^{PHR} Range	0-18	18.5-22.5	23-26	26.5-29	29.5-36
Median	15	20	24	27	31
n (Total n=1600)	550	524	250	128	148
% of members	34.38%	32.75%	15.63%	8.00%	9.25%

Results of DBS^{PHRs} analysis indicated that most Discovery Vitality members who have completed the PHR have undesirable DBS^{PHRs}. There were only 20 members (1.25%) of the study sample of 1 600 who achieved a score of 36 points. The mean DBS^{PHR} of the study sample was 20.47 points and the median score for the sample population was 20 points, confirming that the majority of Discovery Vitality members who had completed the PHR appeared to be "inadequately" or "poorly" compliant with "spirit of dietary guidance". If it were feasible to ascribe a percentage to the degrees of compliance with the "spirit of dietary guidance", a mean DBS^{PHR} of 20.47 out of a possible 36 points, suggests that the average compliance level of members is approximately 57%. The median DBS^{PHR} was 20, implying that at least half of the members are no more than 55% complaint with the "spirit of dietary guidance".

4.3 Gender and DBS^{PHR}

In accordance with the study plan, half of the study population was male (n=800) and the other half female (n=800). An objective of this study was to establish if the DBS^{PHR} of men differed from the DBS^{PHRs} of women who had completed the PHR during the period under investigation from the 1st February 2010 to the 31st January 2011.

Results showed that 40.25% of men and 28.5% or women achieved "poor" scores and a further 32.75% of men and 32.75% of women achieved "inadequate" scores. Only 6.88% of men and 11.63% of women demonstrated "excellent" compliance with the "spirit of dietary guidance" having scores that fell within the range of 28.5-36 points (Figure 4.2).

The mean DBS^{PHR} for women was 21.37 points and for men 19.56 points. ANOVA was completed to investigate if the mean of DBS^{PHRs} differed between gender groups. Results showed that mean DBS^{PHRs} of men and women differed significantly ($p<0.01$) (Refer to Figure 4.3). Women demonstrated better DBS^{PHRs} and therefore compliance with the "spirit of dietary guidance" compared to men.

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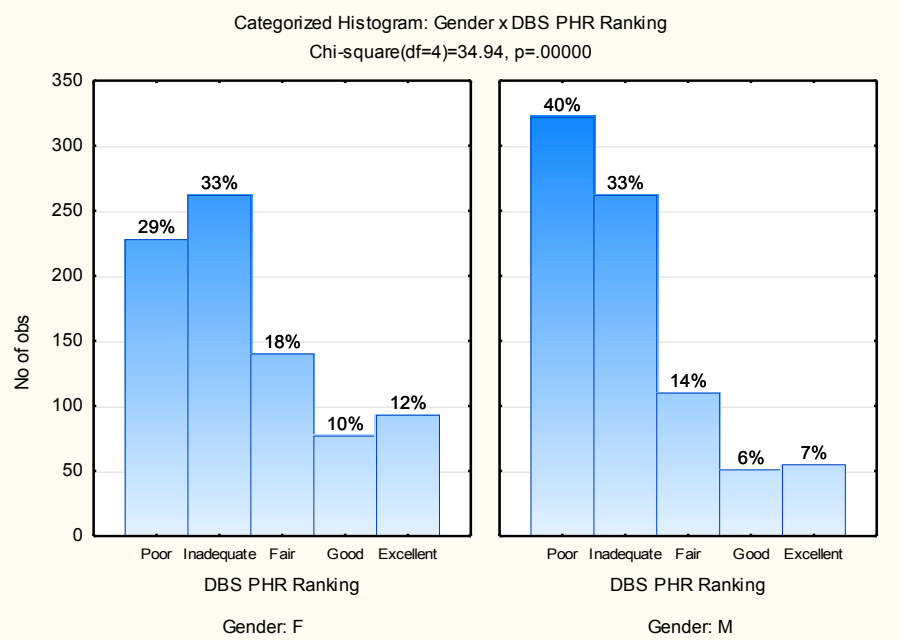

Legend: DBS^{PHR} Scores					
Ranking	Poor	Inadequate	Fair	Good	Excellent
Score	0-18	18.5-22.5	23-26	26.5-29	29.5-36

Figure 4.2: Gender and Dietary Behaviour Score ^{PHR} ranking (n=1600)

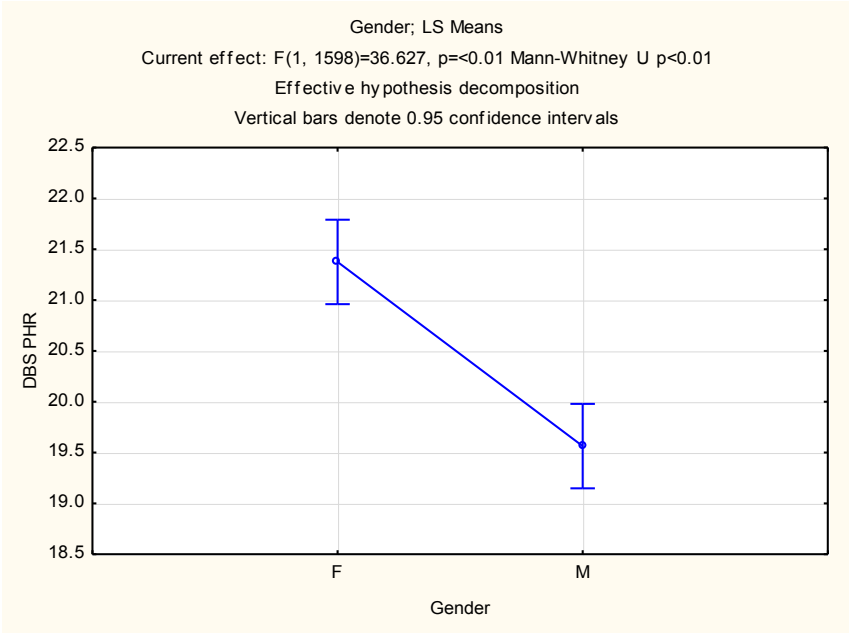

Figure 4.3: Least squares (LS) means: Dietary Behaviour Scores ^{PHR} for gender (n=1600)

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4.4 Age and DBS^{PHR}

Information collected from Discovery Vitality members via the PHR, included information on the age of each member. It was of interest to ascertain if members of different age groups showed differences in DBS^{PHRs}, as increasing age is associated with an increased risk for developing chronic NCD disease,[62,120,121] and reduced compliance with the "spirit of dietary guidance" could exacerbate this risk.

Figure 4.4 graphically represents the age distribution for each group. Table 4.3 shows observed frequencies according to age groups and gender for the different DBS^{PHR} score ranges.

Results showed that for members aged 20-30 years, a large percentage of men (43.59%) and fair percentage of women (32.74%) demonstrated "poor" scores, and only a small percentage of men (8.21%) and women (9.87%) achieved "excellent" scores. Results were similar for members in the 31-40 year and 41-50 year age groups.

Of particular interest in this study are aging members who have an increased risk for developing NCDs due to the aging process. For the age group of 51-60 years, a smaller percentage of members demonstrated "poor" compliance with the "spirit of dietary guidance" than other age groups, however, still only a small percentage of men (7.25%) and women (16.87%) from this age group achieved "excellent" DBS^{PHRs}. For older members (61-70 years), 44.44% of men and 9.86% of women achieved "poor" scores, and 0% of men and 22.58% of women achieved "excellent" scores. The group of members that were 71 years old or older from the selected sample was small (8 members in total), and of these members, 7 of them were men and one member was female. Three of the men older than 71 years of age demonstrated DBS^{PHRs} that fell within the score range of 29.5-36 points, in contrast the one women who was in this age category received a DBS^{PHR} that fell within the 0-18 point score range.

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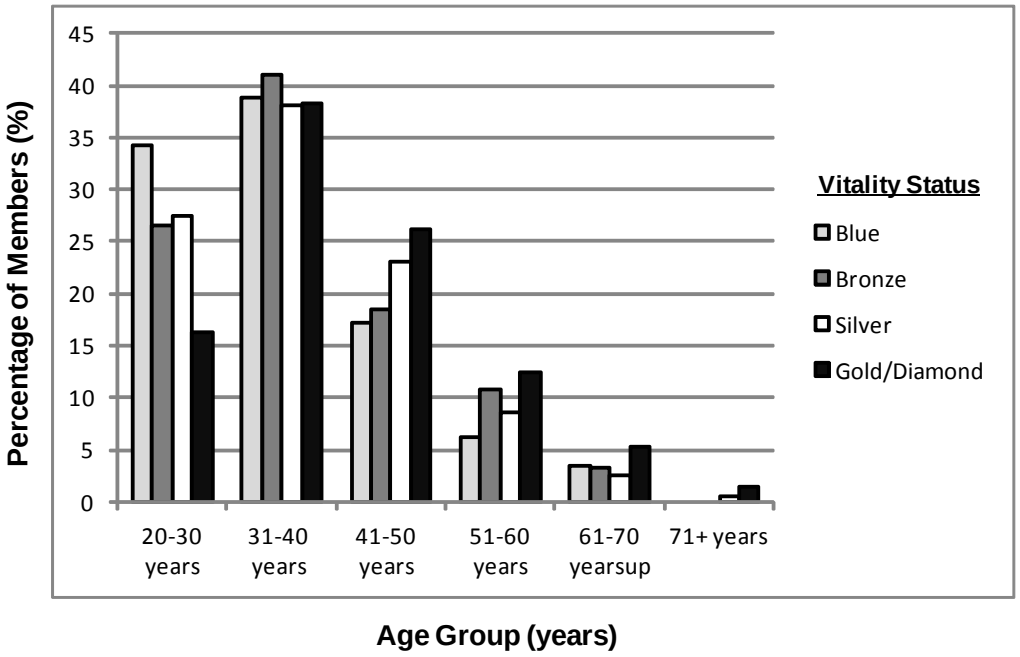

Figure 4.4: Age distribution of Discovery Vitality members by Vitality status (n=1600)

Table 4.3: Dietary Behaviour Score^{PHR} ranges for men and women differentiated by age group (n=1600)

	Men					Women				
DBS^{PHR} Group	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**
DBS^{PHR} Range	0-18	18.5-22.5	23-26	26.5-29	29.5-36	0-18	18.5-22.5	23-26	26.5-29	29.5-36
Age										
20-30 years (n=195 men; n= 223 women)	85	61	23	10	16	73	70	36	22	22
% of Members 20-30 years	43.59	31.28	11.79	5.13	8.21	32.74	31.39	16.14	9.87	9.87
31-40 years (n=316 men; n= 308 women)	138	95	42	20	21	89	101	51	26	41
% of Members 31-40 years	43.67	30.06	13.29	6.33	6.65	28.90	32.79	16.56	8.44	13.31
41-50 years (n=186 men; n= 154 women)	76	64	25	11	10	42	55	30	18	9
% of Members 41-50 years	40.86	34.41	13.44	5.91	5.38	27.27	35.71	19.48	11.69	5.84
51-60 years (n= 69men; n= 83 women)	11	27	16	10	5	20	26	15	8	14
% of Members 51-60 years	15.94	39.13	23.19	14.49	7.25	24.10	31.33	18.07	9.64	16.87
61-70 years (n= 27 men; n= 31 women)	12	13	2	0	0	3	10	8	3	7
% of Members 61-70 years	44.44	48.15	7.41	0.00	0.00	9.68	32.26	25.81	9.68	22.58
71+ years (n= 7 men; n= 1 women)	0	2	2	0	3	1	0	0	0	0
% of Members 71+ years	0.00	28.57	28.57	0.00	42.86	100.00	0.00	0.00	0.00	0.00

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4.4.1 Statistical analysis for age and male gender: DBS^{PHR}

The mean DBS^{PHR} values for men are given in Table 4.4.

Table 4.4: Vitality members' age groups (men) and mean Dietary Behaviour Scores^{PHR} (n=800)

	Gender=M Descriptive Statistics						
Effect	Level of Factor	N	DBS PHR Mean	DBS PHR Std.Dev.	DBS PHR Std.Err	DBS PHR -95.00%	DBS PHR +95.00%
Total		800	19.5643	5.97265	0.21116	19.1498	19.9788
Age Groups	20-30	195	19.2666	6.33784	0.45386	18.3715	20.1618
Age Groups	31-40	316	19.2167	6.01740	0.33850	18.5507	19.8827
Age Groups	41-50	186	19.4704	5.59830	0.41048	18.6605	20.2802
Age Groups	51-60	69	22.0434	5.43392	0.65416	20.7381	23.3488
Age Groups	61-70	27	18.1851	3.38306	0.65107	16.8468	19.5234
Age Groups	71+	7	26.9285	6.93078	2.61958	20.5186	33.3384

Statistical analysis showed that the difference in weighted mean DBS^{PHRs} of men from different age groups was statistically significant ($p<0.01$). (Figure 4.5).

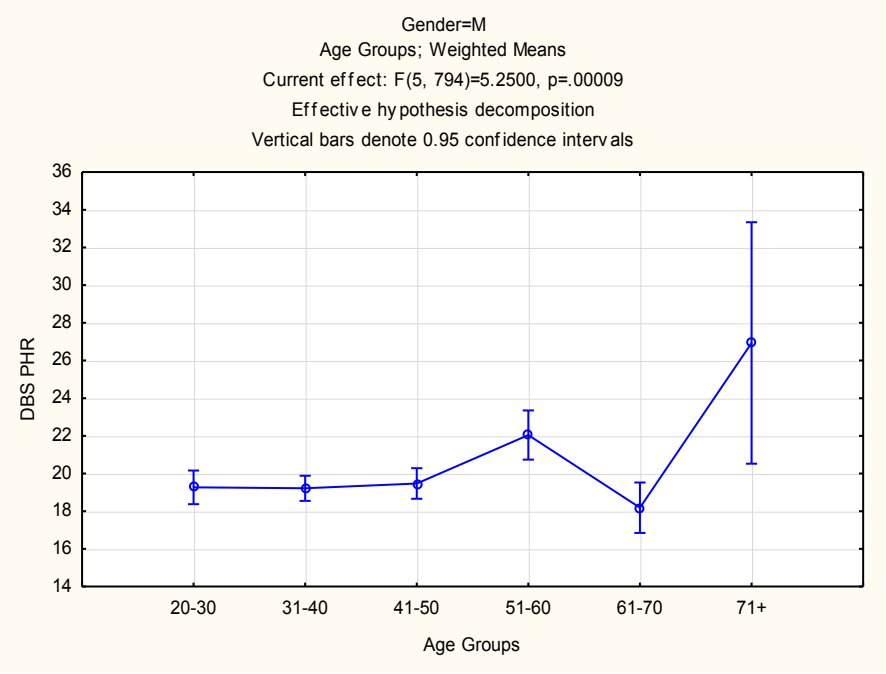

Figure 4.5: Dietary Behaviour Score^{PHR} means for men of different age groups (n=800)

As six levels of nominal data were involved with the analysis of DBS^{PHRs} of men of different age groups, the Bonferroni test of significance was completed. It appeared that the DBS^{PHR} mean scores for men age 51-60 years and men aged 71 years or older differed significantly from younger men age 20-30 years, 31-40 years and 41-50 years, and this

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difference was statistically significant. Men who were 71 years or older also showed DBS^{PHRs} that were significantly better than those of men aged 61-70 years of age. However, the differences in mean DBS^{PHRs} between other groups did not differ significantly (Table 4.5).

Table 4.5: Bonferroni test for significance for Dietary Behaviour Score^{PHR} mean values for age groups (men) (n=800)

Cell No.	Gender=M Bonferroni test; variable DBS PHR Probabilities for Post Hoc Tests Error: Between MS = 34.748, df = 794.00						
	Age Groups	{1} 19.267	{2} 19.217	{3} 19.470	{4} 22.043	{5} 18.185	{6} 26.929
1	20-30		1.000000	1.000000	0.012122	1.000000	0.011454
2	31-40	1.000000		1.000000	0.004905	1.000000	0.009740
3	41-50	1.000000	1.000000		0.03039	1.000000	0.015903
4	51-60	0.012122	0.004905	0.03039		0.060614	0.555160
5	61-70	1.000000	1.000000	1.000000	0.060614		0.007448
6	71+	0.011454	0.009740	0.015903	0.555160	0.007448	

Comparison of weighted means for DBS^{PHRs} for men of different age groups showed that the there was a small effect size (5.25), but that this was statistically significant ($p<0.001$) (Table 4.6). These results indicate that there is a significant difference between the mean DBS^{PHRs} of men of different age groups, attributable mostly to the better DBS^{PHRs} of older men (51 – 60 years of age), who demonstrated better compliance with the "spirit of dietary guidance" when compared to men from other age groups.

Table 4.6: Weighted mean Dietary Behaviour Scores^{PHR} for men by age group (n=800)

Cell No.	Gender=M Age Groups; Weighted Means Current effect: F(5, 794)=5.2500, p=.00009 Effective hypothesis decomposition					
	Age Groups	DBS PHR Mean	DBS PHR Std.Err.	DBS PHR -95.00%	DBS PHR +95.00%	N
1	20-30	19.26667	0.453862	18.37153	20.16180	195
2	31-40	19.21677	0.338500	18.55075	19.88279	316
3	41-50	19.47043	0.410488	18.66059	20.28027	186
4	51-60	22.04348	0.654167	20.73817	23.34880	69
5	61-70	18.18519	0.651072	16.84689	19.52348	27
6	71+	26.92857	2.619589	20.51867	33.33847	7

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4.4.2 Statistical analysis for age and female gender: DBS^{PHR}

The mean DBS^{PHR} values for women are given in Table 4.7.

Table 4.7: Vitality members' age groups (women) and mean Dietary Behaviour Scores^{PHR} (n=800)

	Gender=F Descriptive Statistics						
Effect	Level of Factor	N	DBS PHR Mean	DBS PHR Std.Dev.	DBS PHR Std.Err	DBS PHR -95.00%	DBS PHR +95.00%
Total		800	21.3762	6.00268	0.21222	20.9596	21.7928
Age Groups	20-30	223	20.8183	6.30365	0.42212	19.9865	21.6502
Age Groups	31-40	308	21.4529	6.00232	0.34201	20.7799	22.1259
Age Groups	41-50	154	20.9577	5.43288	0.43779	20.0928	21.8226
Age Groups	51-60	83	22.2469	5.79127	0.63567	20.9824	23.5115
Age Groups	61-70	31	24.5806	6.11432	1.09816	22.3378	26.8234
Age Groups	71+	1	15.0000				

ANOVA was also completed for DBS^{PHRs} of women of different age groups, and results showed that the difference in weighted mean DBS^{PHRs} of women from different age groups was statistically significant ($p<0.05$) (Figure 4.6).

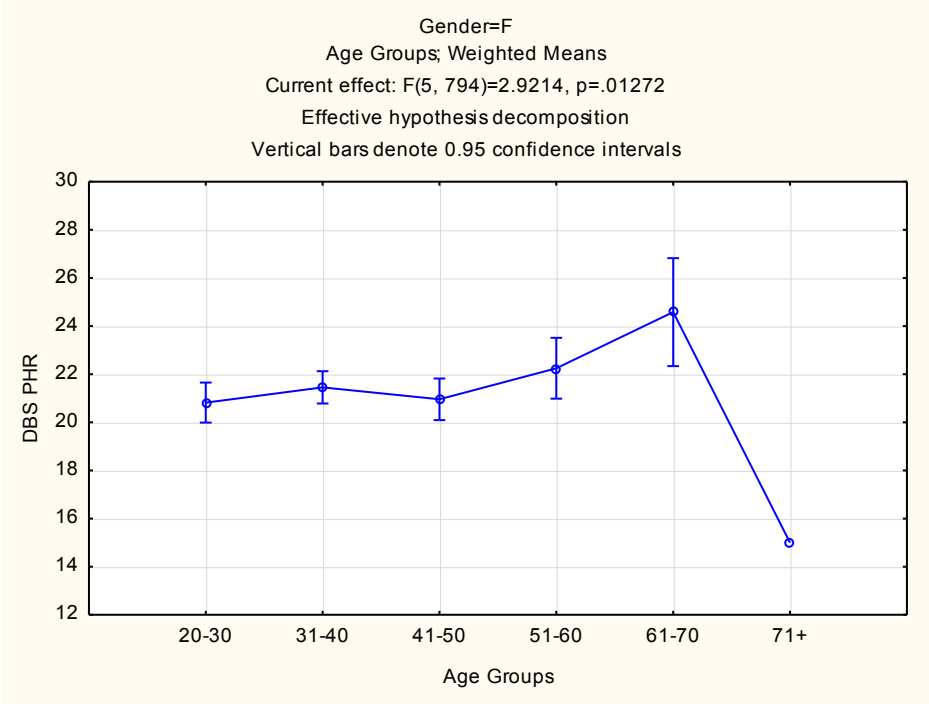

Figure 4.6: Dietary Behaviour Score^{PHR} means for women of different age groups (n=800)

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As six levels of nominal data were involved with the analysis of DBS^{PHRs} for women of different age groups, the Bonferroni test of significance was completed. It appeared that the DBS^{PHR} mean scores for women age 61-70 years differed significantly from younger women aged 20-30 years and 41-50 years, and that this difference was statistically significant. The differences in mean DBS^{PHRs} for other groups of women did not differ significantly (Table 4.8).

Table 4.8: Bonferroni test for significance for Dietary Behaviour $Score^{PHR}$ mean values for age groups (women) (n=800)

Cell No.	Gender=F Bonferroni test; variable DBS PHR Probabilities for Post Hoc Tests Error: Between MS = 35.604, df = 794.00 Age Groups	{1} 20.818	{2} 21.453	{3} 20.958	{4} 22.247	{5} 24.581	{6} 15.000
1	20-30		1.000000	1.000000	0.944473	0.015725	1.000000
2	31-40	1.000000		1.000000	1.000000	0.082990	1.000000
3	41-50	1.000000	1.000000		1.000000	0.031660	1.000000
4	51-60	0.944473	1.000000	1.000000		0.953005	1.000000
5	61-70	0.015725	0.082990	0.031660	0.953005		1.000000
6	71+	1.000000	1.000000	1.000000	1.000000	1.000000	

Comparison of weighted means for DBS^{PHRs} for women of different age groups showed that there was a small effect size (2.92), but this was statistically significant ($p<0.05$) (Table 4.9).

Table 4.9: Weighted mean Dietary Behaviour $Scores^{PHR}$ for women by age groups (n=800)

Cell No.	Gender=F Age Groups; Weighted Means Current effect: F(5, 794)=2.9214, p=.01272 Effective hypothesis decomposition Age Groups	DBS PHR Mean	DBS PHR Std.Err.	DBS PHR -95.00%	DBS PHR +95.00%	N
1	20-30	20.81835	0.422124	19.98650	21.65027	223
2	31-40	21.45292	0.342014	20.77993	22.12591	308
3	41-50	20.95775	0.437794	20.09285	21.82265	154
4	51-60	22.24695	0.635675	20.98243	23.51155	83
5	61-70	24.58065	1.098165	22.33785	26.82345	31
6	71+	15.00000				1

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4.5 Vitality status and DBS^{PHR}

In accordance with the study plan, 400 Discovery Vitality members (200 men and 200 women) were selected from each status group (Blue, Bronze, Silver and Gold/Diamond). Tabulated results for the numbers of members by status group for selected DBS^{PHRs} ranges are given in Table 4.10 for both men and women.

Analysis showed that larger percentages of members in the Blue status group achieved "poor" scores namely 59% of men and 47% of women, while a smaller percentage of men (28%) and women (18.5%) who were members of the Gold/Diamond status group achieved "poor" scores. Only a very small percentage of Blue status members (1% of men and 3% of women) achieved "excellent" DBS^{PHRs}, while for Gold/Diamond members 18.5% of men and 17% of women achieved scores within the range of 29.5-36 points suggesting "excellent" compliance with the "spirit of dietary guidance".

Table: 4.10 Members by status group for designated Dietary Behaviour Scores^{PHR} ranges for gender (n=1600)

	Men					Women				
DBS^{PHR} Group	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**
DBS^{PHR} Range	0-18	18.5-22.5	23-26	26.5-29	29.5-36	0-18	18.5-22.5	23-26	26.5-29	29.5-36
Vitality Status										
Blue (n)	118	63	16	1	2	94	74	25	4	3
% of Blue Members (n= 200 men; n=200 women)	59	31.5	8	0.5	1	47	37	12.5	2	1.5
Bronze (n)	86	71	27	7	9	66	73	33	10	18
% of Bronze Members(n= 200 men; n=200 women)	43	35.5	13.5	3.5	4.5	33	36.5	16.5	5	9
Silver (n)	62	70	28	18	22	31	68	40	24	37
% Silver Members (n= 200 men; n=200 women)	31	35	14	9	11	15.5	34	20	12	18.5
Gold/Diamond (n)	56	58	39	25	22	37	47	42	39	35
%Gold/Diamond Members (n= 200 men; n=200 women)	28	29	19.5	12.5	11	18.5	23.5	21	19.5	17.5

Table 4.11 shows results for the numbers of members who achieved scores within the different score ranges by Vitality status group. Analysis of DBS^{PHRs} by Vitality status group showed that of the members who achieved "poor" scores (n-550), the majority of these (38.55%) were Blue status members. For members who achieved "inadequate"

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scores (n=524), similar results were found across status groups with approximately 20% to 27% of members from each group achieving scores within the range of 18.5-22.5 points. The majority of members who achieved "fair" scores (n=250), were Gold/Diamond status members (32.4%). For members who achieved "good" scores (n=128), only 3.91% were Blue status members, while the majority were Silver status members (32.81%) and 50% were Gold/Diamond status members. The majority of members who achieved "excellent" scores (n=148), were either Silver status (39.86%) or Gold status (38.51%)members.

Table 4.11: Member scores by Dietary Behaviour Score ^{PHR} group and Vitality status group (n=1600)

Vitality Status		Blue	Bronze	Silver	Gold/Diamond
DBS^{PHR}	*n*				
Poor Scores (0-18)	550	212	152	93	93
% Poor DBS ^{PHR} by status group		38.55	27.64	16.91	16.91
Inadequate Scores (18.5-22.5)	524	137	144	138	105
% Inadequate DBS ^{PHR} by status group		26.15	27.48	26.34	20.04
Fair Scores (23-26)	250	41	60	68	81
%Fair DBS ^{PHR} by status group		16.40	24.00	27.20	32.40
Good Scores (26.5-29)	128	5	17	42	64
%Good DBS ^{PHR} by status group		3.91	13.28	32.81	50.00
Excellent Scores (29.5-36)	148	5	27	59	57
% Excellent DBS ^{PHR} by status group		3.38	18.24	39.86	38.51

Further, a comparison of DBS^{PHRs} mean values for each status group is provided in Table 4.12. It is noted that the mean DBS^{PHR} of Blue status members was 17.35 points, for Bronze members 19.76 points, for Silver members 22.07 points and for Gold/Diamond members 22.72 points.

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Table 4.12: A comparison of mean Dietary Behaviour Scores^{PHR} by Vitality status (n=1600)

Effect	Descriptive Statistics						
	Level of Factor	N	DBS PHR Mean	DBS PHR Std.Dev.	DBS PHR Std.Err	DBS PHR -95.00%	DBS PHR +95.00%
Total		1600	20.4703	6.05402	0.15135	20.1734	20.7671
VITALITY STATUS	Gold/Diamon	400	22.7150	5.96859	0.29843	22.1283	23.3016
VITALITY STATUS	Silve	400	22.0650	6.24746	0.31237	21.4509	22.6791
VITALITY STATUS	Bronze	400	19.7550	5.43692	0.27184	19.2205	20.2894
VITALITY STATUS	Blue	400	17.3462	4.97671	0.24883	16.8570	17.8354

Statistical analysis showed that the difference in mean DBS^{PHRs} of members of different status groups was statistically significant ($p<0.01$). Further the Kruskal-Wallis test also showed significance ($p<0.01$), confirming that the differences in mean scores of DBS^{PHRs} for members of different status groups was statistically significantly. Members with a higher ranking in Vitality status demonstrated higher DBS^{PHRs} compared to members with a lower ranking in Vitality status (Figure 4.7).

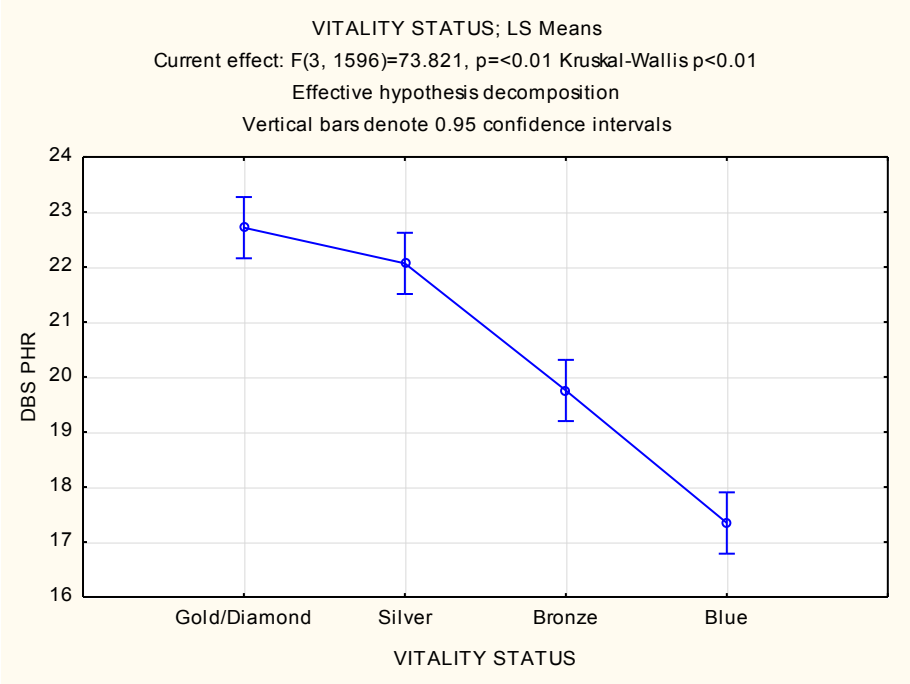

Figure 4.7: Dietary Behaviour Score^{PHR} and Vitality status; LS means (n=1600)

Four levels of nominal data were involved with this analysis; therefore, the Bonferroni test of significance was completed. The mean scores of Gold/Diamond members did not differ significantly from Silver members. However Gold/Diamond mean scores and Silver mean DBS^{PHRs} did differ significantly from Bronze and Blue mean DBS^{PHRs} (Table 4.13).

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Table 4.13: Bonferroni test for significance Dietary Behaviour Score^{PHR} mean values for Vitality status (n=1600)

Cell No.	Bonferroni test; variable DBS PHR Probabilities for Post Hoc Tests Error: Between MS = 32.246, df = 1596.0 VITALITY STATU	{1} 22.715	{2} 22.065	{3} 19.755	{4} 17.346
1	Gold/Diamon		0.63413	0.00000	0.00000
2	Silve	0.63413		0.00000	0.00000
3	Bronze	0.00000	0.00000		0.00000
4	Blue	0.00000	0.00000	0.00000	

Comparison of LS means for DBS^{PHRs} for Vitality Status showed that the there was a statistically significant effect size ($p<0.001$) (Table 4.14). These results showed that there was a significant difference between the mean DBS^{PHRs} of members belonging to different Vitality status groups. Notable differences were between members of the Gold/Diamond and silver group when compared to members from the Blue and Bronze group.

Table 4.14: Dietary Behaviour Score^{PHR} and Vitality status; LS Means (n=1600)

Cell No.	VITALITY STATUS; LS Means Current effect: F(3, 1596)=73.821, p=0.0000 Effective hypothesis decomposition VITALITY STATU	DBS PHR Mean	DBS PHR Std.Err.	DBS PHR -95.00%	DBS PHR +95.00%	N
1	Gold/Diamon	22.7150	0.28392	22.1580	23.2719	400
2	Silve	22.0650	0.28392	21.5080	22.6219	400
3	Bronze	19.7550	0.28392	19.1980	20.3119	400
4	Blue	17.3462	0.28392	16.7893	17.9031	400

4.6 HealthyFood™ benefit members (HFB) and Non- HealthyFood™ benefit members (N-HFB)

In accordance with the study plan, half of the sampled population included members who had activated the HFB, and who had completed the PHR either at the time of activating the benefit or during the period under investigation, namely from the 1st February 2010 to the 31st January 2011. The other 50% of the sampled population included members who had not activate the HFB during this period but who had completed the PHR assessment.

One of the objectives of this study was to establish if the DBS^{PHR} of members engaged with the HFB (n=800) differed from the DBS^{PHRs} of unengaged (N-HFB) (n=800) members. Figure 4.8 illustrates the percentage of HFB and N-HFB members according to score ranges.

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The mean DBS^{PHR} for HFB members was 20.73 points and for N-HFB members 20.47 points. Statistical analysis showed that the mean DBS^{PHRs} of HFB and N-HFB members did not differ significantly ($p>0.05$). Further, the Mann-Whitney test also showed that differences in mean scores of HFB and N-HFB members was not significant ($p >0.05$).

These results indicated that the usual dietary behaviours and degree of compliance of HFB members and N-HFB members with the "spirit of dietary guidance" is very similar and that no significant difference between the two groups was found. Figure 4.9 shows the comparison of mean DBS^{PHRs} for HFB and N-HFB members.

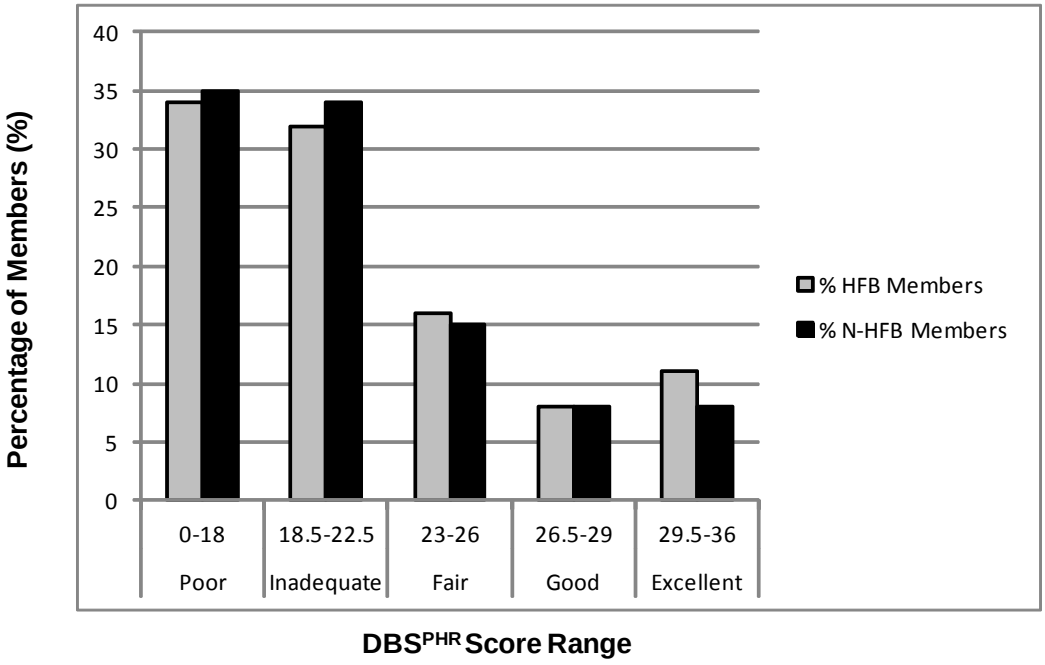

Figure 4.8: Percentage HealthyFood™ benefit (n=800) and Non- HealthyFood™ benefit (n=800) Discovery Vitality members by score group (n[total]=1600)

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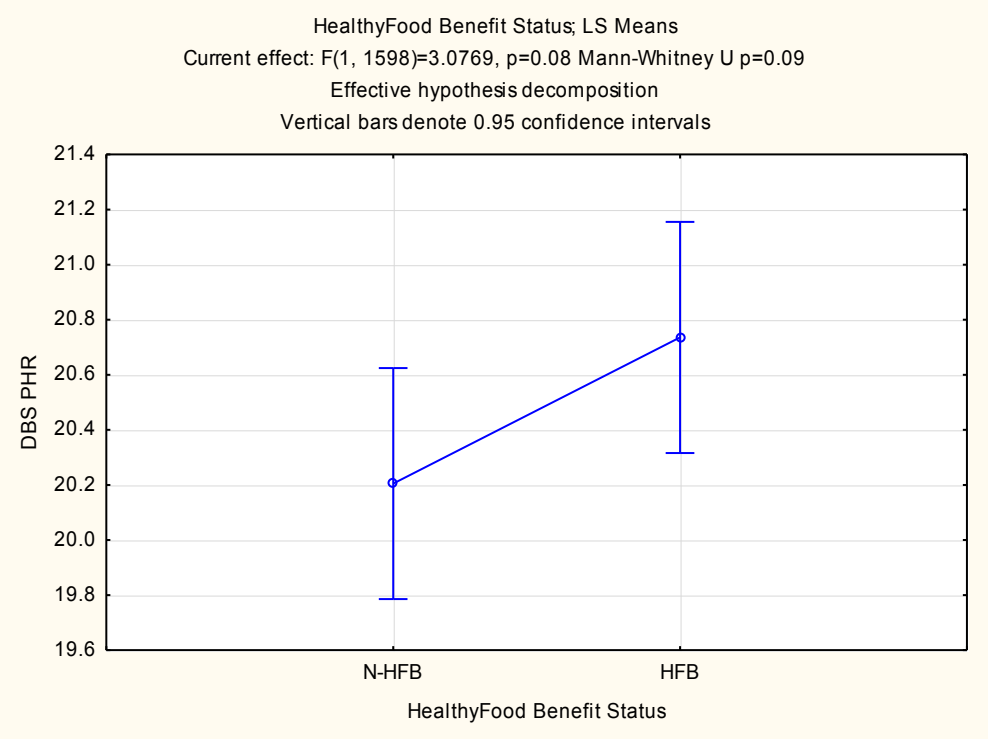

Figure 4.9: Dietary Behaviour Score^{PHR} and HealthyFood^{TM} benefit status; LS means (n=1600)

4.7 Smoking status and DBS^{PHR}

Information collected from Discovery Vitality members via the PHR, included information on tobacco smoking status, namely non-smoker (NS), former smoker (FS) and smoker (S). Figure 4.10 illustrates smoking status of members by Vitality status.

From the sample population; 1 119 members were NS, 328 members were FS and only 153 members were reported S. The majority of Gold/Diamond members (n=314) 78.5% were reported to be NS, and 16.75% (n=67) were reported FS and only 4.75% (n=19) were reported S. While the majority of Silver members 71.25% (n=285) were also report NS, 21% (n=84) reported being FS and 7.75% (n=31) were reported S. The percentage of NS dropped for Bronze status members and Blue members to 69.75% (n=279) and 60.25% (n=241) respectively. FS were reported to be 21.75% (n=87) for Bronze status members and 22.5% (n=90) for Blue status members. The majority of reported smokers were blue status members with 17.25% (n=69) of this group being reported S, followed by Bronze status members where 8.5% (n=34) of members were reported S.

One of the objectives of this study was to establish if the DBS^{PHRs} of Discovery Vitality members differed significantly for S, FS and NS. Table 4.15 shows observed frequencies

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according to smoking status for men and women for the different DBS^{PHR} score ranges. The analysis of results showed that majority of men (56.38%) and women (42.37%) who were S demonstrated unsatisfactory compliance with the "spirit of dietary guidance" and received "poor" scores. In contrast, a lower percentage of men (37.57%) and women (31.93%) who were NS achieved "poor" scores, and similarly for FS, 39.66% of men and 28.86% of women achieved scores within the range of 0-18 points.

Only 3.19% of men and 10.17% of women who were S, had DBS^{PHRs} that fell within the range of 29.5-36 points, while 8.16% of men and 11.82% of women who were NS achieved "excellent" scores, and 5.03% of men and 11.41% of women who were FS received "excellent" scores. It was noted that the mean DBS ^{PHR} score of S was 18.27 points, for FS it was 20.12 points and for NS, 20.87 points.

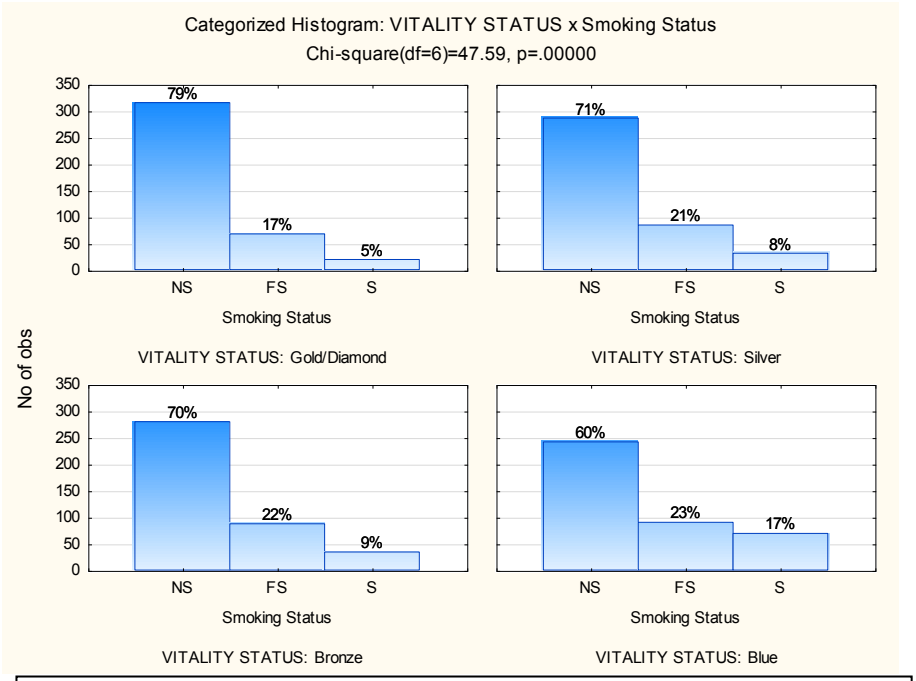

Figure 4.10: Vitality status and smoking status (n=400 per status group; n[total]=1600)

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Table 4.15 Smoking status for men and women observed frequencies for Dietary Behaviour Score^{PHR} ranges (n=1600)

	Men					Women				
DBS^{PHR} Group	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**
DBS^{PHR} Range	0-18	18.5-22.5	23-26	26.5-29	29.5-36	0-18	18.5-22.5	23-26	26.5-29	29.5-36
Smoking Status										
Smoker (n (men)=94; n(women)= 59)	53	25	8	5	3	25	17	9	2	6
% of Smokers by gender	56.38	26.60	8.51	5.32	3.19	42.37	28.81	15.25	3.39	10.17
Non-Smoker (n (men)=527; n(women)= 592)	198	173	76	37	43	160	189	109	64	70
% of Non- smokers by gender	37.57	32.83	14.42	7.02	8.16	27.03	31.93	18.41	10.81	11.82
Former Smoker (n (men)=179; n(women)= 149)	71	64	26	9	9	43	56	22	11	17
% of Former- smokers by gender	39.66	35.75	14.53	5.03	5.03	28.86	37.58	14.77	7.38	11.41

Statistical analysis showed that the difference in mean DBS^{PHRs} of S, NS and FS members was statistically significant ($p<0.01$) (Figure 4.11). The Kruskal-Wallis test also showed significance ($p<0.01$), confirming that the differences in DBS^{PHRs} mean values for members of different smoking status groups was statistically significantly. NS and FS demonstrated better DBS^{PHRs} compared to S.

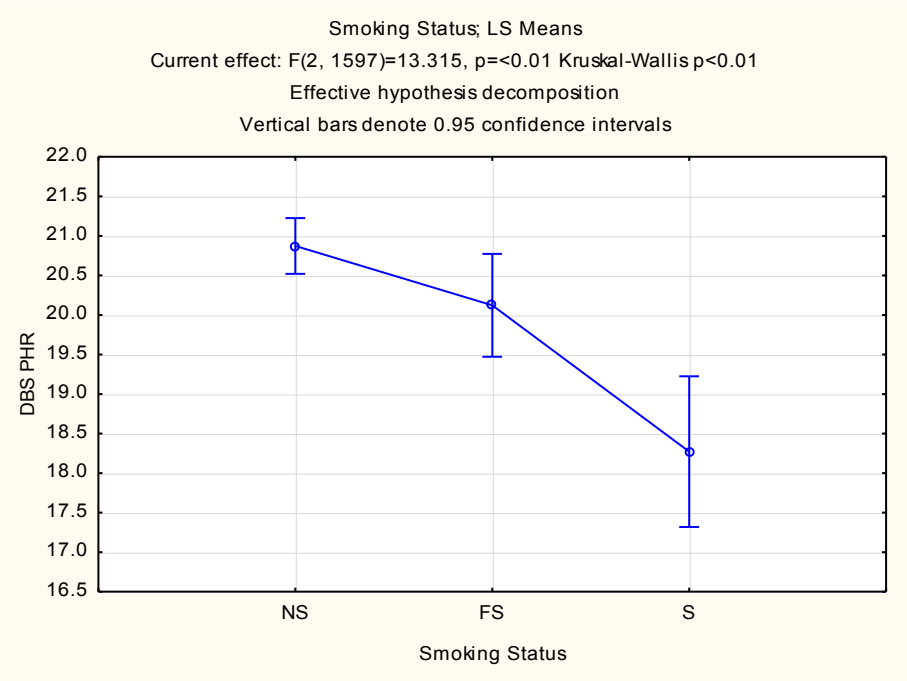

Figure 4.11: Dietary Behaviour Score^{PHR}: smoking status; LS means (n=1600)

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As three levels of nominal data were involved with this analysis, the Bonferroni test of significance was completed. It appeared that the DBS^{PHR} mean scores of FS and NS did not differ significantly, however the mean DBS^{PHRs} for FS and NS did differ from mean DBS^{PHRs} of S, and this difference was found to be is statistically significant (Table 4.16).

Table 4.16: Bonferroni test for significance DBS^{PHR} mean values for smoking status (n=1600)

Cell No.	Bonferroni test; variable DBS PHR Probabilities for Post Hoc Tests Error: Between MS = 36.095, df = 1597.0			
	Smoking Status	{1} 20.873	{2} 20.122	{3} 18.271
1	NS		0.13988(	0.00000:
2	FS	0.13988(		0.00504'
3	S	0.00000:	0.00504'	

Comparison of LS means for DBS^{PHRs} for S, NS and FS showed that the there was a statistically significant effect size ($p<0.001$). These results showed that there was a significant difference between the mean DBS^{PHRs} of members belonging to the NS and the S group as well as between the FS and the S group. Refer to Table 4.17.

Table 4.17: Dietary Behaviour Scores^{PHR} and smoking status; LS means (n=1600)

Cell No.	Smoking Status; LS Means Current effect: F(2, 1597)=13.315, p=.00000 Effective hypothesis decomposition					
	Smoking Status	DBS PHR Mean	DBS PHR Std.Err.	DBS PHR -95.00%	DBS PHR +95.00%	N
1	NS	20.8731(	0.17960'	20.5208:	21.2253:	1119
2	FS	20.1219'	0.33173:	19.4712'	20.7726:	328
3	S	18.2712.	0.48571:	17.3185.	19.2239.	153

4.8 Alcohol consumption and DBS^{PHR}

Information collected from Discovery Vitality members via the PHR, included information on alcohol consumption. Information was collected regarding the number of standard alcoholic drinks a member consumed on average per week. Recommendations state that women should consume no more than 1 standard drink daily, translating into not more than 7 standard drinks per week, and that men should consume no more than 2 standard alcoholic drinks daily and therefore not more than 14 standard drinks per week.

Data collected from the PHR allowed for the comparison of usual alcohol consumption patterns of members to recommended guidelines. Members were flagged as complying

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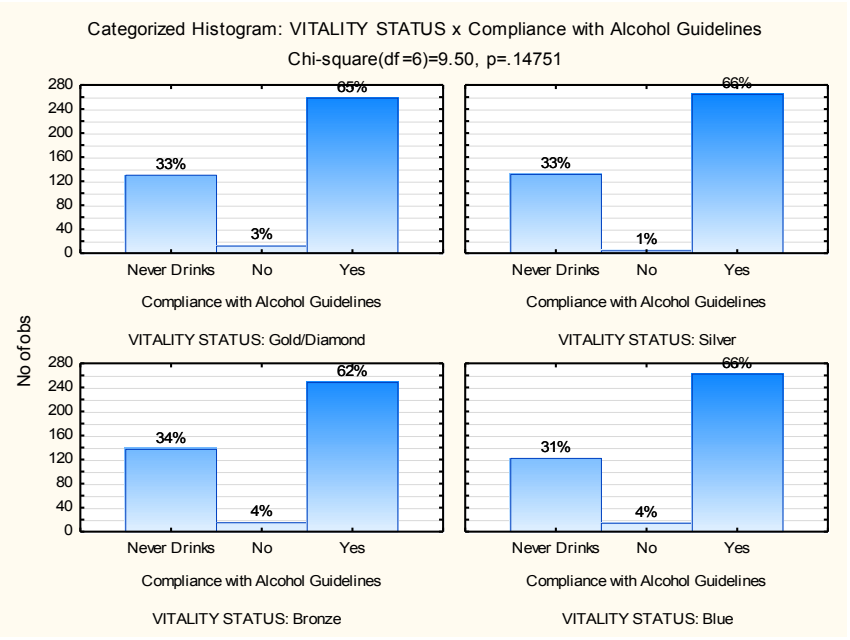
with recommendations "Yes", not complying with recommendations "No". If members did not usually consume alcohol, they were flagged as "Never Drinks". Figure 4.12 shows percentage of members by Vitality status related to usual alcohol consumption behaviour. From the sample population; 520 (32.5%) members reported never consuming alcohol, 1032 (64.5%) members reported compliance with the alcohol guidelines ("Yes'), and only 48 (3%) members reported non-compliance with alcohol guidelines ("No").

Across status groups the percentage of members who did not consume alcohol appeared to be similar, and approximately 30-34% of members from each status group reported that they did not consume alcohol. Similarly, across status groups approximately 62-66% of members reported compliance with alcohol recommendations. Further, across status groups with the exception of Silver status 3-4% of members reported non-compliance with alcohol consumption guidelines. For Silver status only 1.25% of members reported non-compliance with alcohol guidelines, however there were only 5 members within this group (Figure 4.12).



Sample Size:
Never Drink (n=520)
Non-Compliant "No" (n=48)
Compliant "Yes" (n=1032)

Figure 4.12: Vitality status and compliance with alcohol guidelines (n=400 per status group; n[total]=1600).

Another objective of this study was to establish if the DBS^{PHRs} of Discovery Vitality members differed significantly for members regarding usual alcohol consumption behaviours. Table 4.18 shows observed frequencies according to alcohol consumption patterns for men and women for the different DBS^{PHR} score ranges. The analysis of results showed that a large percentage of men (43.75%) and women (46.88%) who were non-compliant with alcohol guidelines achieved "poor" dietary scores. By comparison, slightly

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lower percentages of men (41.11%) and women (28.60%) who were compliant with alcohol guidelines also received "poor" scores, and comparable percentages of men (37.62%) and women (26.45%), who did not consume alcohol, achieved DBS^{PHRs} that fell within the range of 0-18 points.

In contrast, very few members (no men and only 3.13% of women) who were non-compliant with alcohol guidelines achieved "excellent" dietary scores. While 5.92% of men and 10.26% of women who were compliant with alcohol guidelines had DBS^{PHRs} that fell within the range of 29.5-36 points. For members who did not consume alcohol, 10% of men and 14.52% of women had "excellent" DBS^{PHRs}.

Additional results regarding DBS^{PHRs} of members related to compliance with alcohol consumption guidelines are given in Table 4.18. It was noted that the mean DBS^{PHRs} of members who "never drink" was 21,23, for members who complied with alcohol guidelines, the mean DBS^{PHR} was 20.19, and for members who did not comply with alcohol guidelines the mean DBS^{PHR} was 18.30. It is also noted, that the sample population of members who did not comply with alcohol guidelines is small and included 48 members.

Table 4.18: Alcohol consumption behaviours for men and women and observed frequencies for Dietary Behaviour Score^{PHR} ranges (n=1600)

	Men					Women				
DBS^{PHR} Group	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**
DBS^{PHR} Range	0-18	18.5-22.5	23-26	26.5-29	29.5-36	0-18	18.5-22.5	23-26	26.5-29	29.5-36
Compliance with Alcohol Guidelines										
Yes (n=574 men; n=458 women)	236	196	78	30	34	131	158	75	47	47
% of Members who comply with alcohol guidelines	41.11	34.15	13.59	5.23	5.92	28.60	34.50	16.38	10.26	10.26
No (n=16 men ; n- 32 women)	7	7	1	1	0	15	11	4	1	1
% of Members who don't with alcohol guidelines	43.75	43.75	6.25	6.25	0.00	46.88	34.38	12.50	3.13	3.13
Never Drink Alcohol (n=210 men; n=310 women)	79	59	31	20	21	82	93	61	29	45
% of Members who do no drink alcohol	37.62	28.10	14.76	9.52	10.00	26.45	30.00	19.68	9.35	14.52

Statistical analysis was completed to investigate if the DBS^{PHRs} mean values differed between members regarding usual alcohol consumption behaviour. Results showed that the difference in mean DBS^{PHRs} of members who complied with alcohol guidelines, members who did not comply with alcohol guidelines, and members who never drank alcohol was statistically significant ($p<0.01$) (Figure 4.13). The Kruskal-Wallis test also

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showed significance ($p < 0.01$), confirming that the differences in mean scores of DBS^{PHRs} of members relative to usual patterns of alcohol consumption was statistically significantly.

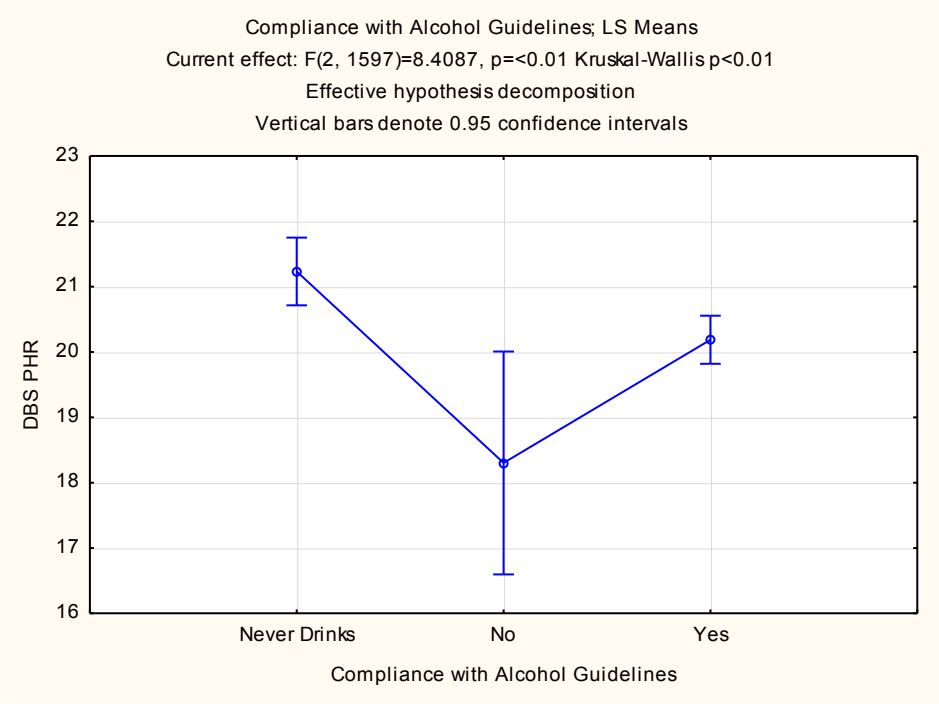

Figure 4.13: Dietary Behaviour Score^{PHR} and compliance with alcohol guidelines; LS means (n=1600)

As three levels of nominal data were involved with this analysis, the Bonferroni test of significance was completed. It was shown, that the mean DBS^{PHRs} of members who never consumed alcohol did differ significantly from the mean DBS^{PHR} of members who did not comply with alcohol guidelines, as well as from members who did comply with alcohol guidelines (Table 4.19).

Table 4.19: Bonferroni test for significance DBS^{PHR} mean values for alcohol consumption behaviours (n=1600).

	Bonferroni test; variable DBS PHR Probabilities for Post Hoc Tests Error: Between MS = 36.315, df = 1597.0			
Cell No.	Compliance with Alcohol Guideline:	{1} 21.233	{2} 18.302	{3} 20.187
1	Never Drinks		0.00387	0.00383
2	No	0.00387		0.10289
3	Yes	0.00383	0.10289	

Comparison of LS means for DBS^{PHRs} for members with different compliance levels regarding alcohol consumption guidelines, showed that there was a statistically significant

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effect size ($p<0.001$), and that there was a significant difference between the DBS^{PHRs} mean values of members belonging to different groups regarding alcohol consumption.

Table 4.20 provides tabulated results of LS means for DBS^{PHRs} for groups of members who differed from each other based on alcohol consumption behaviours.

Table 4.20: Dietary Behaviour Score^{PHR} and compliance with alcohol consumption guidelines; LS means(n=1600).

	Compliance with Alcohol Guidelines; LS Means Current effect: F(2, 1597)=8.4087, p=.00023 Effective hypothesis decomposition					
Cell No.	Compliance with Alcohol Guideline:	DBS PHR Mean	DBS PHR Std.Err.	DBS PHR -95.00%	DBS PHR +95.00%	N
1	Never Drink:	21.2326	0.26426	20.7143	21.7510	520
2	No	18.3020	0.86980	16.5960	20.0081	48
3	Yes	20.1870	0.18758	19.8190	20.5549	1032

Members, who were non-compliant with alcohol guidelines, demonstrated lower DBS^{PHRs} compared to members who "never drink" or those who complied with recommended restrictions regarding alcohol consumption.

4.9 Physical activity level and DBS^{PHR}

Information collected from Discovery Vitality members via the PHR, included information on behaviours of regular physical activity. Information was collected regarding the time spent in minutes per exercise session and the frequency of exercise each week. It was thus possible to compute the number of minutes spent exercising each week.

Guidelines for health promotion and disease prevention recommend that individuals engage in at least 150 minutes of regular exercise each week.[1] Members were identified as "active" – complying with or exceeding exercise recommendations, "low activity" – indicating regular exercise but not meeting recommendations and "inactive" – not engaging in regular physical activity each week.

From the sample population; 82 (5.1%) members were "inactive", 586 (36.6%) reported "low activity" levels, and 932 (58.3%) members were "active". Only 3% (n=12) of Gold/Diamond members were classified as "inactive", while 11.5% (n=46) of Blue status members were "inactive". In comparison, 67% (n=268) of Gold/Diamond members were "active", while only 41.5% (n=166) of Blue status members met or exceeded recommendations (Figure 4.14).

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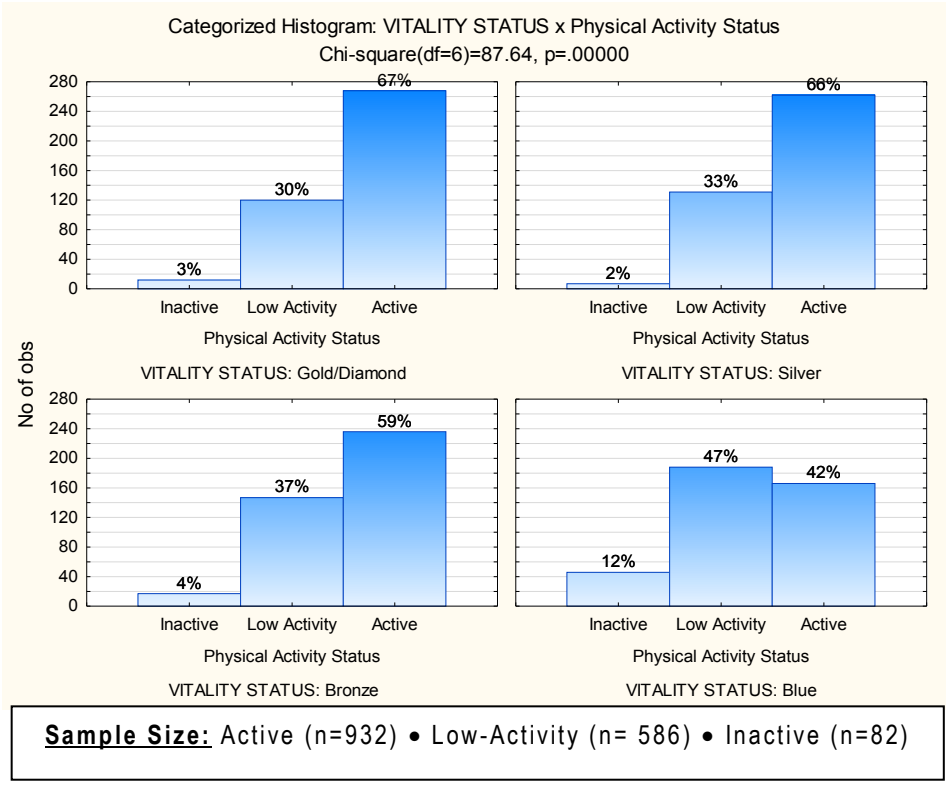

Figure 4.14: Vitality status and physical activity status (n=400 per status group; n[total]=1600)

Another objective of this study was to establish if the DBS^{PHRs} of Discovery Vitality members differed significantly for members who complied with activity guidelines and those who did not comply. Table 4.21 shows observed frequencies according to physical activity status for men and women for the different DBS^{PHR} score ranges. Results showed that most "inactive" men (57.63%) and women (43.9%) had DBS^{PHRs} that fell within the range of 0-18 points. In comparison, a lower percentage of "active" men (32.3%) and women (21.69%) achieved "poor" dietary scores, while a fair percentage of "low activity" men (50%) and women (34.88%) also demonstrated "poor" scores.

Of particular interest is that there were no "inactive" men or women that had DBS^{PHRs} that fell within the top score group of 29.5-36 points. However for the "low activity" group, a small percentage of men (3.31%) and women (8.72%) received "excellent" DBS^{PHRs}. A larger percentage of men (9.09%) and women (15.18%) from the "active" group achieved scores within the "excellent" score range demonstrating better compliance with the "spirit of dietary guidance".

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Additional results regarding physical activity status for DBS^{PHRs} ranges are provided in Table 4.21. Results from this study also showed that the mean DBS^{PHR} score for "active" members was 21.51, for "low activity" members the mean DBS^{PHR} was 19.47, and for "inactive" members it was 15.79. It was noted that the sample population of "inactive" members was small and include 82 members.

Table 4.21: Physical activity status for men and women observed frequencies for Dietary Behaviour Score^{PHR} ranges(n=1600)

	Men					Women				
DBS^{PHR} Group	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**
DBS^{PHR} Range	0-18	18.5-22.5	23-26	26.5-29	29.5-36	0-18	18.5-22.5	23-26	26.5-29	29.5-36
Physical Activity										
Inactive (n= 59 men; n= 41 women)	34	5	2	0	0	18	17	4	2	0
% of Inactive members	57.63	8.47	3.39	0.00	0.00	43.90	41.46	9.76	4.88	0.00
Low Activity (n=242 men; 344 women)	121	73	29	11	8	120	110	58	26	30
% of Low activity members	50.00	30.17	11.98	4.55	3.31	34.88	31.98	16.86	7.56	8.72
Active (n-517 men; 415 women)	167	184	79	40	47	90	135	78	49	63
% of Active members	32.30	35.59	15.28	7.74	9.09	21.69	32.53	18.80	11.81	15.18

Statistical analysis showed that the difference between mean DBS^{PHRs} of "active", "low activity" and "inactive" members was statistically significant ($p<0.01$) (Figure 4.15). The Kruskal-Wallis test also showed statistical significance ($p<0.01$).

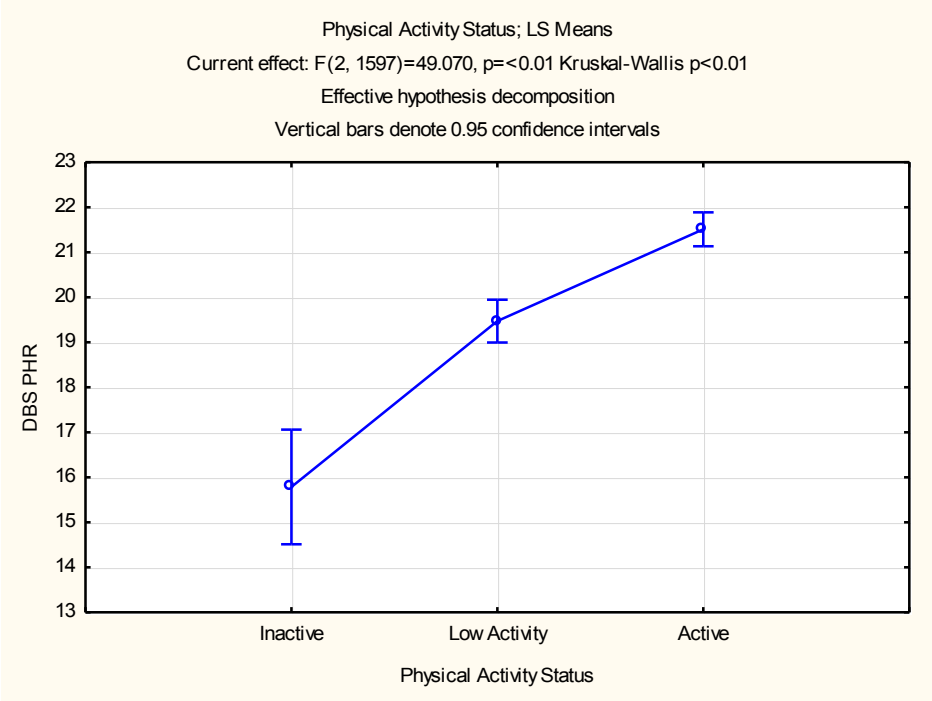

Figure 4.15: Physical activity status and Dietary Behaviour Score ^{PHR}; LS means (n=1600)

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As three levels of nominal data were involved with this analysis, the Bonferroni test of significance was completed. Results showed that the DBS^{PHR} mean scores of "active", "low activity" and "inactive" did differ significantly (Table 4.22).

Table 4.22: Bonferroni test for significance Dietary Behaviour Score^{PHR} mean values for physical activity status(n=1600)

Cell No.	Physical Activity Status	{1} 15.787	{2} 19.471	{3} 21.511
	Bonferroni test; variable DBS PHR Probabilities for Post Hoc Tests Error: Between MS = 34.573, df = 1597.0			
1	Inactive		0.00000	0.00000
2	Low Activity	0.00000		0.00000
3	Active	0.00000	0.00000	

Comparison of LS means for DBS^{PHRs} for members who were "active", "low activity" and "inactive", showed that there was a statistically significant effect size ($p<0.001$) (Table 4.23). Based on these results, it can be concluded that there was a significant difference between the mean DBS^{PHRs} of "active", "low activity" and "inactive" members. Active members demonstrated better DBS^{PHRs} compared to "low activity" members, and both of these groups demonstrated better DBS^{PHRs} when compared to "inactive" members.

Table: 4.23: Dietary Behaviour Score^{PHR} and physical activity status; LS means(n=1600)

Cell No.	Physical Activity Status	DBS PHR Mean	DBS PHR Std.Err.	DBS PHR -95.00%	DBS PHR +95.00%	N
	Physical Activity Status; LS Means Current effect: F(2, 1597)=49.070, p=0.0000 Effective hypothesis decomposition					
1	Inactive	15.7865	0.64932	14.5129	17.0602	82
2	Low Activity	19.4709	0.24289	18.9945	19.9474	586
3	Active	21.5107	0.19260	21.1329	21.8885	932

4.10 Weight status related to BMI (Kg/m^2) and DBS^{PHR}

Information collected from Discovery Vitality members via the PHR, also included information on height and current weight, and allowed for the calculation of BMI (Kg/m^2) for each member. Table 4.24 provides a summary of observed frequencies for different BMI classifications and Vitality status. From the sample population; 28 members (1.75%) had BMI <18.5kg/m^2 and were classified as underweight, 727 members (45.44%) had a BMI between 18.5 – 24.9 kg/m^2 and were classified as normal weight, 573 members (35.81%) had a BMI between 25-29.9 kg/m^2 and were classified as overweight, and 272

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members (17%) had a BMI >30 kg/m^2 and were classified as obese. Figure 4.16 illustrates percentages of members by BMI classification for different Vitality status groups.

Table 4.24: Observed frequencies Body Mass Index (BMI) classification and Vitality status (n=1600)

Vitality Status	Total	Blue	Bronze	Silver	Gold/Diamond
BMI					
Underweight <18,5kg/m^2 (n)	28	14	5	3	6
% of Underweight members by status group	1.75%	50.00	17.86	10.71	21.43
Normal Weight 18,5 - 24,9kg/m^2 (n)	727	157	187	190	193
% of Normal weight members by status group	45.44%	21.60	25.72	26.13	26.55
Overweight 25 - 29,9 kg/m^2 (n)	573	140	143	137	153
% of Overweight members by status group	35.81%	24.43	24.96	23.91	26.70
Obese >30 kg/m2 (n)	272	89	65	70	48
%of Obese members by status group	17%	32.72	23.90	25.74	17.65

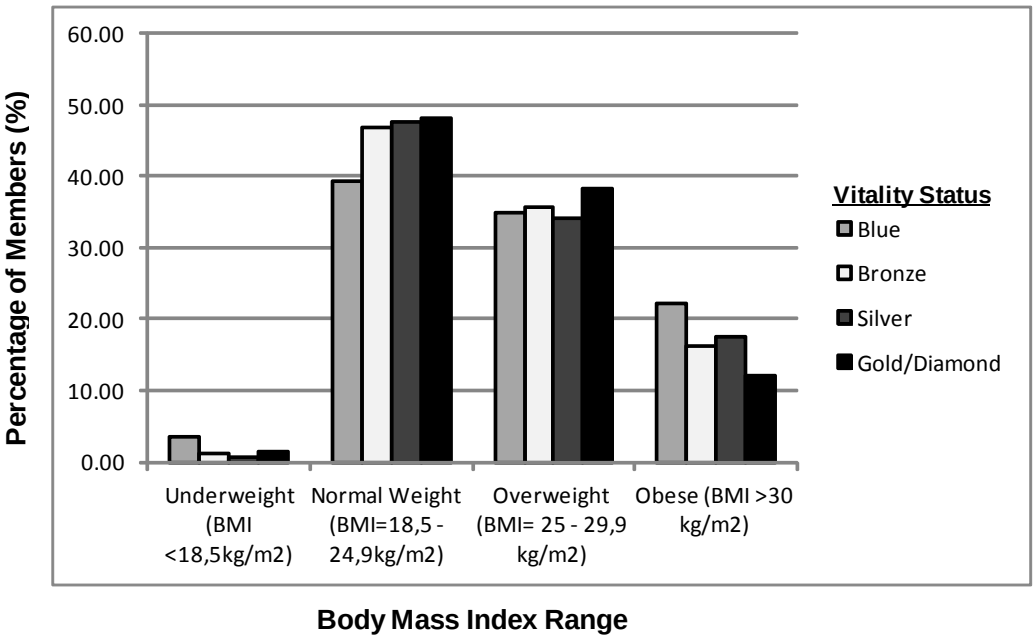

Figure 4.16: Percentage of members according to Body Mass Index (BMI) status and Vitality status (n=1600)

A further objective of this study was to establish if the DBS^{PHRs} of Discovery Vitality members differed significantly according to body weight status. Table 4.25 shows observed frequencies according to BMI status for men and women for the different DBS^{PHR}

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score ranges. Results showed that more than 50% of men in the obese category, and a fair percentage of obese women (29.6%) achieved "poor" dietary scores. In comparison, only a small percentage of obese men (4.76%) and women (9.6%) achieved high scores within the range of 29.5-36 points

Only a very small group of Discovery Vitality members were classified as underweight, 28 members in total. Of this small group, 66.67% of men and 45.45% of women received "poor" scores, while 16.67% of men and 4.55% of women from this group achieved "excellent" scores (Table 4.25). It was noted that the mean DBS ^{PHR} score for underweight members was 17.95 points, for normal weight members it was 20.99 points, for overweight members it was 20.46 points and for obese members 19.36 points.

Table 4.25: Dietary Behaviour Score ^{PHR} ranges for men and women differentiated by Body Mass Index (BMI) classification of Discovery Vitality members (n=1600)

	Men					Women				
DBS^{PHR} Group	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**	**Poor**	**Inadequate**	**Fair**	**Good**	**Excellent**
DBS^{PHR} Range	0-18	18.5-22.5	23-26	26.5-29	29.5-36	0-18	18.5-22.5	23-26	26.5-29	29.5-36
BMI										
Underweight <18,5kg/m^2 (n= 6 men; n=22 women)	4	0	1	0	1	10	7	3	1	1
% of Members who are underweight	66.67	0.00	16.67	0.00	16.67	45.45	31.82	13.64	4.55	4.55
Normal Weight 18,5 - 24,9kg/m^2 (n= 279 men; n= 448 women)	103	95	43	20	18	113	149	84	50	52
% of members who are normal weight	36.92	34.05	15.41	7.17	6.45	25.22	33.26	18.75	11.16	11.61
Overweight 25 - 29,9 kg/m^2 (n= 368 men; n= 205 women)	136	130	47	26	29	68	59	34	16	28
% of Members who are overweight	36.96	35.33	12.77	7.07	7.88	33.17	28.78	16.59	7.80	13.66
Obese >30 kg/m^2 (n= 147 men; n= 125 women)	79	37	19	5	7	37	47	19	10	12
%of Members who are obese	53.74	25.17	12.93	3.40	4.76	29.60	37.60	15.20	8.00	9.60

Statistical analysis was completed to investigate if the mean DBS^{PHRs} of each BMI grouping differed between members regarding weight status. Results showed that the difference in mean DBS^{PHRs} between underweight, normal weight, overweight or obese members was statistically significant ($p<0.01$) (Figure 4.17). The Kruskal-Wallis test also showed significance ($p<0.01$), confirming that the differences of mean scores of DBS^{PHRs} of "underweight, normal weight, overweight or obese members was statistically significantly.

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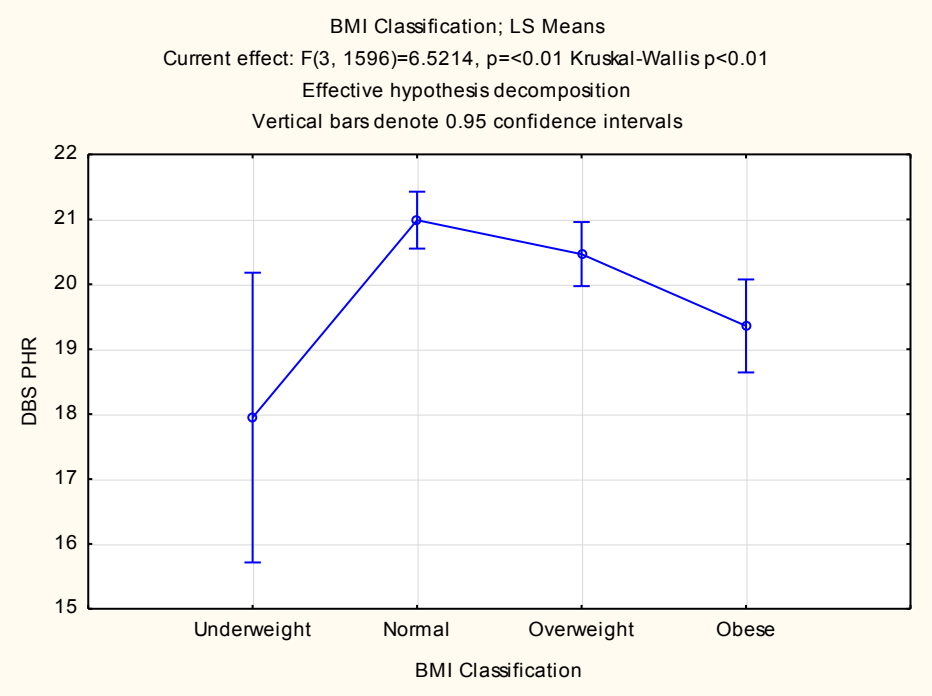

Figure 4.17: Dietary Behaviour Score^{PHR} and Body Mass Index (BMI) classification; LS means (n=1600)

As, four levels of nominal data were involved with this analysis, the Bonferroni test of significance was completed. Results showed that the difference between the mean DBS^{PHR} scores for normal weight and obese members was statistically significant, however the difference in mean DBS^{PHRs} for other groups did not differ significantly (Table 4.26).

Table 4.26: Bonferroni test for significance Dietary Behaviour Score^{PHR} mean values for Body Mass Index (BMI) status (n=1600)

	Bonferroni test; variable DBS PHR Probabilities for Post Hoc Tests Error: Between MS = 36.275, df = 1596.0				
Cell No.	BMI Classification	{1} 17.946	{2} 20.988	{3} 20.464	{4} 19.358
1	Underweigh		0.05287	0.18557	1.00000
2	Norma	0.05287		0.71709	0.00087
3	Overweigh	0.18557	0.71709		0.07652
4	Obese	1.00000	0.00087	0.07652	

Comparison of LS means for DBS^{PHRs} for members who were underweight, normal weight, overweight or obese showed that there was a small effect size (6.52) but that this was statistically significant ($p<0.01$) (Table 4.27). These results show that members who are classified as obese or who are classified as underweight have lower mean DBS^{PHRs} when compared to normal and overweight members.

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Table 4.27: Dietary Behaviour Score[PHR]: Body Mass Index (BMI) classification; LS means (n=1600)

Cell No.	BMI Classification	DBS PHR Mean	DBS PHR Std.Err.	DBS PHR -95.00%	DBS PHR +95.00%	N
	BMI Classification; LS Means Current effect: F(3, 1596)=6.5214, p=.00022 Effective hypothesis decomposition					
1	Underweigh	17.9464	1.13822	15.7138	20.1790	28
2	Norma	20.9883	0.22337	20.5501	21.4264	727
3	Overweigh	20.4642	0.25161	19.9707	20.9577	573
4	Obese	19.3584	0.36519	18.6421	20.0747	272

4.11 Summary of results

A summary of results is given in Table 4.28

Table 4.28: Summary of statistical results for Dietary Behaviour Scores[PHR] of Discovery Vitality members related to investigated variables

Variable	(n)	DBS[PHR] Mean	SD	p value of independent variable and DBS[PHR]
Gender				p<0.01[a,b,c]
Men	800	19.56	5.97	
Women	800	21.38	6.00	
Age				
Men				p=0.00009[a,b]
20-30 years	195	19.27	6.33	
31-40 years	316	19.22	6.02	
41-50 years	186	19.47	5.60	
51-60 years	69	22.04	5.43	
61-70 years	27	18.19	3.38	
71+ years	7	26.93	6.93	
Women				p=0.01272[a,b]
20-30 years	223	20.82	6.30	
31-40 years	308	21.45	6.00	
41-50 years	154	20.96	5.43	
51-60 years	83	22.25	5.79	
61-70 years	31	24.6	6.11	
71+ years	1	15	-	
Vitality Status				p<0.01[a,b,c]
Blue	400	17.35	4.98	
Bronze	400	19.76	5.44	
Silver	400	22.07	6.25	
Gold/Diamond	400	22.72	5.97	

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Variable	(n)	DBS^{PHR} Mean	SD	p value of independent variable and DBS^{PHR}
HealthyFood™ Benefit				p=0.08[b]
HFB	800	20.21	5.86	p=0.09[c]
N-HFB	800	20.74	6.24	
Smoking Status				p<0.01[a,b,c]
S	153	18.27	6.37	
FS	328	20.12	5.89	
NS	1119	20.87	5.99	
Alcohol Consumption - Compliance with Guidelines				p<0.01[a,b,c]
Yes	1032	20.19	5.87	
No	48	18.3	4.90	
Never Drink	520	21.23	6.40	
Physical Activity				p<0.01[a,b,c]
Inactive	82	15.79	5.22	
Low Activity	586	19.47	5.84	
Active	932	21.51	5.96	
BMI				p<0.01[a,b,c]
Underweight <18,5kg/m^2	28	17.95	6.78	
Normal Weight 18,5 - 24,9kg/m^2	727	20.99	5.93	
Overweight 25 - 29,9 kg/m^2	573	20.46	6.04	
Obese >30 kg/m2	272	19.36	6.11	

[a] significance, where p<0.05

[b] ANOVA F-test

[c] Kruskal-Wallis test

The results from this study showed that the majority of Discovery Vitality members, showed inadequate compliance with the "spirit of dietary guidance". Women showed better compliance than men, and older members (>50 years) demonstrate better compliance with dietary guidance than younger members. Blue status members demonstrated poorer compliance with dietary guidance than members who were more engaged with the Vitality programme. There was no difference between the DBS^{PHRs} of HFB and N-HFB members; however this may be attributed to the study design. Lifestyle risk factors for developing NCDs appeared to cluster with reduced compliance with the "spirit of dietary guidance" with: S demonstrating lower compliance than NS and FS, inactive members showing reduced compliance compared to low-activity and active members; obese members demonstrating poorer compliance than normal weight and overweight members; and members who did not comply with recommendations regarding alcohol intake showing

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reduced compliance compared to members who either never drink, or who are compliant with recommendations.

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CHAPTER 5

DISCUSSION

5.1 The "spirit of dietary guidance" and the DBS^{PHR}

A primary aim of this study was to calculate a dietary behaviour score (DBS^{PHR}) from data collected by Discovery Vitality's existing online "health risk assessment" questionnaire. The use of dietary scores or indices to assess dietary patterns and compliance with advocated dietary guidelines are considered preferred "summary measures" of overall diet quality[45]. Further, a few scores/indices have been shown to be related to all-cause and NCD mortality risk,[20,22,26,27,30,33,51] such as the DBS that was used in the study conducted by Kant and colleagues.[17]

Dietary scores/indices provide a better "snapshot" of overall dietary compliance than traditional dietary assessment methods. Because of this and that some scores/indices have the ability to predict NCD risk as well and NCD mortality risk, their use in research and in dietary surveillance is rapidly becoming more widespread.[37,44,45]

In this study, it was possible to compute a DBS^{PHR} from Discovery Vitality's PHR data. The premise of the DBS^{PHR} for this study was the DBS developed by Kant and co-workers[17]. DBS^{PHR} therefore provided a composite measure of compliance with the "spirit of dietary guidance" in keeping with guidelines advocated by the ADG-2005,[76] which was the basis for the DBS in Kant's[17] study.

The DBS^{PHR} provided a collective score that quantified responses of Discovery Vitality members regarding usual food consumption behaviours related to of fruit and vegetables, whole grain foods, lean meat and chicken, low fat and fat free dairy products as well as discretionary fat. These dietary components capture the "spirit of dietary guidance" as recommended by the ADG-2005[76] and ADG 2010.[1] They also form the fundamentals of the SAFBDG,[12] as well as the recommendations of the AHA Dietary and Lifestyle Guidelines of 2006.[15]

Of interest, is that a number of these dietary components (adequate fruit and vegetable intake, preference for whole grains and unsaturated fat - specifically olive oil), are also features of a Mediterranean type diet, which has also been found to promote positive health outcomes and a reduction in CHD mortality risk.[32,122]

Results from the study by Kant and co-workers[17] suggest that reported adoption of recommended dietary guidance in keeping with ADG-2005, was associated with a 20-25%

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lower risk of mortality after a 10 year follow up in older men and women. Further, relative to respondents reporting the least amount of desirable dietary behaviours, the risk reduction was noted in all categories of DBS.[17]

This study did not relate DBS^{PHR} of Discovery Vitality members to NCD mortality risk however this is something that could be done in future studies. The DBS^{PHR} did nonetheless provide a perspective on the degrees of compliance of members with the "spirit of dietary guidance", and by inference (in keeping with the findings from Kant and colleagues[17]) it can be deduced, that reduced compliance with the "spirit of dietary guidance" could translate into an increased risk for NCD and associated mortality for members. It is recommended that further investigations be completed to confirm this suggestion. In addition, the results from the Kant and colleagues[17] study suggested that benefits of even small changes in dietary behaviours (improving DBS) in the expected direction, as well as higher reduction in mortality risk was associated with greater compliance with "the spirit of dietary guidance". Similarly, one could expect that improving DBS^{PHRs} among Discovery Vitality members would be associated with better health outcomes as well as a lower risk for NCD and associated mortality, although further research is needed to confirm this.

5.2 The DBS^{PHRs} of Discovery Vitality members

A further aim of this study was to categorize computed DBS^{PHRs} for the study sample, to assist with the identification of members who may be at risk for developing NCDs due to reduced compliance with the "spirit of dietary guidance". The score groups in this study were modelled on the quintile ranges given in the Kant and colleagues study.[17]

The results of this study showed that approximately two thirds of Discovery Vitality members demonstrated suboptimal levels of compliance with the "spirit of dietary guidance", as evidenced by the fact that just over a third of members had DBS^{PHRs} that fell into the score range of "poor" compliance, and another third of members received scores suggestive of "inadequate" compliance with the "spirit" of dietary guidance.

The median DBS^{PHR} was 20 points, and only 1% of the sampled members received a perfect score of 36 points. It was not part of this study design to investigate which dietary components contributed to the suboptimal DBS^{PHRs} of members. Nonetheless, the results of this research indicate that greater emphasis should be placed on improving the overall diet quality of Discovery Vitality members, in order to potentially reduce members risk for

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developing NCDs, as well as future NCD mortality risk attributed to poor dietary behaviours.

It was also not possible as part of this study to compare the dietary behaviour scores of Discovery Vitality members to individuals or groups that are not Discovery Vitality members (i.e. members of the general public with similar demographics to Discovery Vitality members as discussed in Chapter 2 in section 2.3.2), to ascertain if the DBS^{PHR} of Discovery Vitality members is the same as, better than, or worse than that of members of the public who have been matched demographically. This may be a worthwhile study to consider for future research.

In addition, there is also the possibility that the results from this study are representative of the eating habits of South Africans from similar socio-economic groups and educational backgrounds, but these conclusions cannot be drawn from the current study. Overall the DBS^{PHRs} of Discovery Vitality members were surprisingly inadequate, but these results are consistent with larger studies in South Africa and in other countries around the world that report low levels of compliance with advocated dietary guidelines for a variety of population groups.[1,20,26,28,43,123,124]

For this study, the reported inadequate and poor compliance of Discovery Vitality members with advocated dietary guidelines indicates that; well-thought-out, evidence-based interventions that promote improved compliance among members with the “spirit of dietary guidance” are warranted. Emphasis should be placed on targeting both younger and older members. The adoption of healthier dietary practices by younger members will help to delay the onset of chronic disease associated with poor dietary behaviour. In addition, purposeful interventions aimed at older members will be beneficial, as evidence suggests that individuals who are 50-71+ years[17] of age benefit significantly from improved dietary compliance with the “spirit of dietary guidance”, and consequently have a reduced NCD mortality risk.[17]

5.3 Gender and DBS^{PHR}

The main purpose of differentiating between groups of Discovery Vitality members regarding DBS^{PHRs} was to ascertain if certain groups would benefit from intensive nutrition intervention programmes in order to improve the usual dietary behaviours of these members. Improvements in usual dietary behaviours and greater compliance with the “spirit of dietary guidance” should further translate into a lower risk for developing NCDs and a lower risk for NCD mortality.

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Results from this study showed that women had a statistically significant higher mean DBS^{PHR} compared to men. These results indicate that in general female members of Discovery Vitality tended to have better DBS^{PHRs} than men and can therefore be considered to be slightly more compliant with the "spirit of dietary guidance". However both mean scores fell into the range of "inadequate" compliance with the "spirit of dietary guidance".

The possibility that women may demonstrate better general compliance with advocated dietary guidelines are consistent with the findings from other studies, which have also shown that there are differences in the usual dietary behaviours of men and women. In a small study on college students (adults aged 19-24 years of age), it was found that men ate out more frequently at fast food outlets, had higher BMIs than women, and fewer men agreed with the statement: "the nutrient content of food is important to me" than women.[125]

In a population based study among Swiss residents, it was also found that while overall adherence to nutritional guidelines was low, women had a higher adherence to the guidelines than men except for fish and dairy products.[126] In a Danish study it was found that greater food variety and frequent intentions to eat healthy were more common among women than men, and were associated with high diet quality.[127]

Another study investigated the significant differences in fruit and vegetable intake between men and women from different geographical regions across America, and found that women reported more favourable attitudes and greater perceived behaviour control regarding fruit and vegetable intake than men, and these beliefs mediate observed gender difference in fruit and vegetable intake.[128] As the mean DBS^{PHR} for men is lower than that of women, this may imply a slightly higher dietary risk for developing NCDs and for NCD mortality among men than women, however these deductions cannot be conclusively drawn from this study and further investigations are necessary.

5.4 Age and DBS^{PHR}

The proportion of elderly is increasing worldwide, and this trend is paralleled by an increase in NCDs.[129] Aging is associated with disability and chronic disease in South Africa,[123] and increases in life expectancy makes it important to remain healthy for as long as possible.[130] Successful aging has been defined by Sabia and colleagues as; good cognitive, physical, respiratory and cardiovascular functioning, in addition to the absence of disability, mental health problems and chronic disease (coronary artery disease, stroke, cancer and diabetes).[130] When compared with individuals who engage in no healthy

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behaviours, individuals who engage in all four healthful behaviours (never smoking, moderate alcohol consumption, physical activity (≥2.5h/week moderate physical activity or ≥1h/week vigorous physical activity), and follow a healthy diet – specifically eating fruit and vegetables daily) are reported to have 3.3 times greater odds for successful aging.[130]

It is of interest, that the results from this study show that just over two thirds of male members in the study sample were between 20 and 40 years of age, and a little over one third of male members from the sample were over 40 years of age. Similar results are found for female members.

Male members with the best DBS^{PHRs} were men aged 51-60 years. These results may indicate that male members who are aging have a better knowledge regarding the importance of applying healthier dietary behaviours to their lifestyles than younger male members, but further investigation is necessary to establish why older men showed slightly better dietary compliance. Nonetheless, it should still be kept in mind that a mean DBS^{PHR} of men in this age group was 22.04 points, which does not represent "excellent" compliance with the "spirit of dietary guidance", but rather "inadequate" compliance with the "spirit of dietary guidance".

Aging male members of Discovery Vitality, due to their increased risk for developing NCDs as a result of the aging process, represent a sub-set of members that would benefit from targeted interventions and incentives aimed at improving member compliance with recommended dietary guidelines, which in turn may promote health and contribute to successful aging. Further, as younger men (≤50 years of age) demonstrate a significantly lower mean DBS^{PHR} than men who are over 50 years of age, interventions aimed at promoting compliance with the "spirit of dietary guidance" should also be targeted at this younger group of male members. This is considered to be important, because younger men will inevitably also face the aging process and without improved compliance with the "spirit of dietary guidance" may be accelerated toward developing NCDs and have an increased NCD mortality risk, perhaps even greater than the current group of older male members.

The mean DBS^{PHR} for women was significantly better than the mean DBS^{PHR} for men. As for male members, DBS^{PHRs} for women was also higher with age except for women aged 71+ years. However only one member fell within the 71+ age group and so the results for this member cannot be considered to be representative of women in this age group. The highest mean DBS^{PHR} for women was again found within the age group of 51-60 years of age.

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These results seem to indicate that female members who are aging have a better knowledge regarding the importance of applying healthier dietary behaviours to their lifestyles than younger women, but further investigations are necessary to establish why older women show slightly better dietary compliance.

As for male members, women aged 51-60 years received an "inadequate" mean DBS^{PHRs}. Aging female members due to increased risk for developing NCDs related to the aging process, represent another sub-set of members that would benefit from targeted interventions and incentives aimed at improving member compliance with the "spirit of dietary guidance".

As for men, younger women ($\leq$50 years of age) showed a lower mean DBS^{PHR} than women who are over 50 years of age, and interventions aimed at promoting dietary compliance within in this group may also be beneficial.

5.5 Vitality status and DBS^{PHR}

An objective of this study was to compare the DBS^{PHRs} of members who belonged to different Vitality status groups. Members who have a higher ranking in Vitality status (Gold/Diamond status) represent members who are more engaged with the Vitality programme, while members who belong to the Blue status group represent members with little to no engagement with the Vitality programme. Results from this study showed that the DBS^{PHRs} of members were higher with an improved ranking in Vitality status. Gold/Diamond and Silver status members displayed better DBS^{PHRs} compared to Bronze and Blue status members. These results at a glance appear to be very encouraging and could suggest that financial incentives provided by Discovery Vitality, which increase in magnitude as Vitality status improves, seem to be impacting positively on the DBS^{PHRs} of members.

However it should be considered that Discovery Vitality has not set out specifically to change the eating behaviours of Vitality members, and has also not set targets or goals for members regarding eating behaviours in order to earn rewards (at the time of this study 1st February 2010 – 31st January 2011). The PHR simply serves to inform members about their overall health behaviours of which "healthy" eating is a component.

Further, graduation from one status group to another is not dependant on dietary behaviours. In order for a member to receive points and rewards, he/she needs to complete assessments both on-line and/or at service providers, and/or to engage with

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other Vitality offerings. These offerings may include: the HealthyFood™ benefit; participation in regular exercise (gym memberships); signing a non-smokers declaration; and/or for meeting goals for metabolic indicators (fasting glucose, serum cholesterol levels, blood pressure, BMI, waist circumference, HIV status). This implies that a member does not need to meet certain dietary goals in order to earn rewards or to graduate from one status group to another, and does not receive rewards for being compliant with advocated dietary guidelines.

However members may be influenced through on-line assessments and through attendance at appointments with service providers to adopt healthier eating behaviours. Members who are Gold/Diamond status members will have completed more assessments and received more feedback on healthy eating behaviour than Blue status members, and one could deduce then that the better DBS^{PHR} of Gold/Diamond members is partly as a result of increased exposure to recommended dietary guidelines through these indirect methods.

Nonetheless, the DBS^{PHRs} of Gold/Diamond members, although above average for the sample population, was still “inadequate”, and was no more than two thirds of an ideal DBS^{PHR} score. While there certainly are benefits for relative compliance with the “spirit of dietary guidance” as shown by Kant,[17] one must still ask why the DBS^{PHR} of Diamond/Gold members was not much better than identified.

One reason may be that Discovery Vitality did not at the time of this study offer any form of structured nutrition education to members, and nutrition education was not linked to their reward system. It has been reported that financial incentives used to promote healthier eating habits, seem to yield better and sustainable results when coupled with targeted nutrition education programmes.[131] It must also be considered that changing people’s eating behaviours was not a primary objective of Discovery Vitality (at the time of PHR data collection for this study), even though their mantra has been “to enhance and protect the lives of their members”. However, the Vitality programme is dynamic and fluid and is constantly evolving, and intervention programmes aimed specifically at the promotion of compliance with advocated dietary guidelines may well be developed in the future.

With regard to the incentive arm of the Vitality programme, some experts caution, that while it is considered most likely that financial incentives do have the ability to promote healthy eating behaviours, it should also be taken into account that the conceptual appeal of incentives for many providers may be so persuasive that little empirical evidence is taken into consideration to support certain incentive programmes, which may in turn survive empirical evidence to the contrary.[132]

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It has been pointed out by researchers,[132] that the large gap between the rapid and extensive uptake of health incentive plans, and the knowledge base available to inform the design of these plans, presents considerable opportunity for missteps. This implies that while the provision of incentives is an attractive tool to promote changes to health behaviour, that poorly designed incentive programmes may be ineffective in promoting desired changes to behaviour.

Current research does not provide total clarity on all the necessary components that will ensure a successful incentive programme, but multiple factors play a role. For example: the way in which incentives are offered, how rewards are structured and provided, the size of the reward, the timing of rewards, as well as a number of other components which may determine the success and/or failure of a wellness incentive programme.[99,100,103,104]

Discovery Vitality has however been successful in structuring their incentive programme effectively and in promoting change to health behaviour, as demonstrated by members who have changed patterns of physical activity, stopped smoking, who attend regular health assessments and who show trends toward making healthier food purchases.[110,111,133,134] Based on the success of the Vitality programme regarding other health behaviours, if rewards in the future could be matched to goals related to eating behaviours and dietary compliance, then perhaps Discovery Vitality members would demonstrate improved compliance with the “spirit of dietary guidance” beyond the results of this study. This is something that Discovery Vitality may want to investigate and consider for the future.

Another point to consider in this regard is that a significant and ever increasing number of providers are offering rewards for participation in wellness programmes. The wellness incentive business is certainly becoming competitive. It is estimated that approximately 62% of employers in the USA, up to 87% of large employers, and 16-41% of employers in other countries outside the US, offer rewards linked to wellness programmes.[132,135] While there is good evidence that certain components of these interventions are highly effective in changing behaviour, experts warn that there are still many programmes that are not well designed and most have been implemented without testing, so the effect on health is highly uncertain.[132] This is yet another reason to ensure that methods used to affect the dietary behaviours of Discovery Vitality members be based on solid evidence, should be well designed and thoroughly tested.

Further, the effectiveness of wellness incentive programmes is often questioned as it has been reported by employers who offer these programmes that there are very low (for example, 5-10 percent) rates of participation particularly in programmes targeted at

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complex problems such as smoking and obesity.[135] Loewenstein reports that many programmes, although well-meaning, are unlikely to have much impact because they require information, expertise, and self-control that few people possess. As a result, benefits are likely to accrue disproportionately to individuals who already are taking adequate care of their health.[135]

In keeping with this discussion, the annual report of Discovery Health Medical Scheme of 2011,[136] stated that Vitality had a total membership at 31st December 2011 of 1.5 million members, however during the year of investigation for this study (1st February 2010 to the 31st January 2011), only 231 442 Discovery Vitality members (principle and spouse members) were indentified as having completed the PHR. This implies that aproximately 15% of Vitality members completed the PHR, and of these only 186 577(12% of members) had complete data, and were eligible for selection into this study.

Of the members who had completed the PHR, 25 869 were Gold/Diamond members implying 14% of members who had completed the PHR were Gold/Diamond members and this group represented only about 2% of the estimated 1.5 million Vitality members. In contrast 93 986 members who had completed the PHR (complete data) were classified as Blue status members representing 50% of the study population under investigation and 6% of the estimated 1.5 million Vitality members.

So, while Discovery Vitality members who are ranked as Gold/Diamond members can boast a mean DBS^{PHR} that is significantly better than Blue status members, it really is the minority of Vitality members who fall within the Gold/Diamond group. These members may just be individuals who choose to live healthy lifestyles to reduce their risks for future health problems and they also may have done so independently without receiving a positive “nudge” from the Vitality programme. It could be speculated that these members choose to engage with Vitality in order to receive rewards for their already healthy behaviour, and as they are more knowledgeable about healthy eating, therefore received an overall better DBS^{PHR}. This suggestion is speculative, but this study unfortunately cannot prove otherwise and further well designed studies are recommended that can assess the impact of Vitality engagement on eating behaviours. Future studies should focus on dietary assessments of members at the point of activation of the Vitality benefit and then at identified points in time after activation.

Further, the dietary scores of individuals who are Blue status members should be monitored as members graduate through different status groups. In this manner, improvements in scores if noted, will be more meaningful and in turn support the integrity of the Vitality programme.

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5.6 Discovery Vitality HealthyFood™ benefit and DBS^{PHR}

The concept of discounting “healthy” food to individuals to promote desired changes to eating behaviour and compliance with advocated dietary guidelines is a novel idea. Although research in this area is very limited, there are a few studies that have shown that discounting “healthy” foods, in particular fruit and vegetables, does hold promise for changing food purchasing behaviour, which may result in the consumption of a healthier diet overall in the short and long term.[104,106,133,134,137-139]

An objective of this study was to compare the DBS^{PHR} of engaged HFB member to the DBS^{PHR} of N-HFB members. However, this study did not allow for the investigation of the Discovery Vitality HealthyFood™ benefit as an intervention to promote improvements in the DBS^{PHR} scores of members. While 50% of the sample population included HFB members, these members had completed the PHR either at the point of activation of the HFB or at some point in time during the course of the year under investigation (1st February 2010 to 31st January 2011). As a result PHR data for HFB members either reflect member’s usual dietary behaviour at the point of activation of the benefit (before HFB intervention) or less than a year after activation of the benefit.

Further this study did not allow for the reassessment of DBS^{PHR} scores of HFB members after activation of the HFB, and thus no conclusions can be drawn about the effectiveness of the HFB as an intervention that may have an impact on DBS^{PHR} outcomes. Nonetheless it is also possible that members who had activated the HFB may have done so not only to receive discounts on “healthy” food, but because they are more engaged Vitality members who are more aware of offered initiatives, as well as being more aware of the importance of a healthy diet in health promotion.

When comparing DBS^{PHR} of HFB members and N-HFB members, results showed that approximately one in ten HFB-men, and only one in 20 N-HFB-men had DBS^{PHRs} that fell within the range of “excellent” compliance with the "spirit of dietary guidance". In addition, approximately one in ten HFB-women and N-HFB-women received DBS^{PHRs} that were categorized as “excellent” scores suggestive of excellent compliance with the “spirit of dietary guidance”. Further, results for other DBS^{PHR} score ranges did not show any differences between HFB and N-HFB members and were inconsistent. Further, the mean DBS^{PHRs} of HFB members and N-HFB members were very similar.

Nonetheless, the question of whether the HFB has the ability to impact on food purchasing behaviour and more specifically on usual dietary behaviours of members in order to

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promote health and assist with the prevention of NCDs among members should be investigated. In a separate study to this, research was conducted by Discovery Vitality on the HFB, to investigate if reducing prices of healthy food leads to changes in self-reported measures of food consumption and weight status. Results showed that participation in the HFB was associated with more consumption of fruit, vegetables and wholegrain foods, and less consumption of sugary and salty foods, as well as lower consumption of fried foods, processed meats and fast-food among engaged members, but did not have an effect on reducing obesity.[134]

However this particular study had limitations and did not report on the overall diet quality of members or the DBS^{PHR} of members. The results were also based on a minority of individuals who were eligible for the HFB. In addition, this study's biggest limitation was selection bias into the HFB, as while all Vitality members are eligible to participate in the HFB, 74% of families did not activate the benefit, and of those who did activate the benefit 56% did not complete the online health risk assessment that was used to collect dietary information from members.[134]

While increased fruit and vegetable consumption as well as the consumption of whole-grains should be associated with overall improvements in diet quality and usual dietary behaviours, these conclusions cannot be drawn from this study. Further, other dietary aspects such as: types of fat usually consumed and the consumption of lean protein foods and dairy products should also be taken into consideration in the context of assessing improvements in the usual dietary behaviours of members, which this study failed to do. Nonetheless, while the results from the study completed by Discovery Vitality are not conclusive, it appears that subsidizing healthy food purchases among Discovery Vitality members, that is the HFB may still be a promising intervention for promoting desirable changes to the usual dietary behaviours of members.[134]

5.7 Smoking status and DBS^{PHR}

The prevalence of smoking cigarettes has decreased in South Africa over the last 20 years. This decrease is as a result of comprehensive tobacco control legislation, particularly large cigarette tax increases. However, "roll-your-own" cigarette smoking, as well as illegal cigarette trading has increased.[140]

It has been estimated that approximately 25% of adults are smokers in South Africa[115]. It is widely agreed that people who smoke tobacco have a higher risk for developing NCDs than non-smokers or former smokers. The effectiveness of quitting tobacco use surpasses

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any other intervention to minimize the risk for chronic cardiac and respiratory conditions[141]. It is also extensively agreed that getting individuals and groups to adopt an overall healthier diet is also an essential component of effective strategies aimed at large scale NCD prevention.[142]

A number of studies have shown that the health behaviours, including eating habits of non-smokers and former smokers, is better than those of regular smokers.[143] In one study, smokers were found to have higher consumption of animal fat, total fat, cholesterol and a lower intake of Vitamin E than non-smokers.[144] In other studies smokers have been found to have higher calorie intakes, lower diet quality and to consume fewer traditional foods compared to non-smokers.[145,146]

Dietary diversity is a useful indicator of diet quality, and smokers have been found to have a lower overall diversity score than non-smokers or former smokers.[147] It has been reported that single healthy lifestyle behaviours such as non-smoking, being physically active and having a high quality diet, have a positive effect on reducing NCD mortality risk and increasing survival rate, but a combination of these healthy lifestyle behaviours is even more strongly related to survival than individual factors.[148]

Results from this study showed that there were far more smokers within the Blue status group, than smokers in the Gold/ Diamond group. Overall there were more male smokers than female smokers from the sample population. Further, one in ten members of the sample population were self-reported smokers, which is less than the proportion of estimated smokers for the general South African population. These results may be indicative of the positive effect that the Discovery Vitality incentive programme, has on smoking cessation.

These results are supported by a systematic review completed by Osilla and colleagues,[96] who report that wellness programmes show a positive effect on smoking cessation, with engagement showing higher quit rates, and one study showing that participants were 4 times more likely to reduce smoking than non-participants.[96] However, these deductions cannot be conclusively drawn from this study.

A further aim of this study was to compare the DBS^{PHR} of S to that of NS and FS. Results showed that the mean DBS^{PHR} of non-smokers and former smokers did not differ significantly, but both scores differed significantly from the mean DBS^{PHR} of smokers. These findings are consistent with other studies, showing that smokers show poorer compliance with the “spirit of dietary guidance” than former smokers and non-smokers.[143]

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5.8 Alcohol consumption behaviours and DBS^{PHR}

Alcohol misuse has been identified as one of the main risk factors for NCDs.[149] However, moderate alcohol consumption has been identified as an independent contributor to decreased all-cause mortality risk, and moderate levels of alcohol intake (1-2 drinks per day for women and 2-4 drinks per day for men) are inversely associated with total mortality in both men and women.[26,83]

Nonetheless, high levels of alcohol consumption are associated with increased mortality,[83] and have also been associated with a decline in total diet quality.[150] Among men, diet quality has been found to decline significantly with increasing consumption of alcoholic beverages, due to a significant decline in the intakes of fruit, total grains, whole-grains and milk, and due to increased energy intake from alcoholic beverages, solid fats and added sugars.[150] Among women, diet quality also appears to decline with increasing consumption of alcoholic beverages, in particular due to a decrease in the consumption of fruit, and an increase in the percentage of energy consumed from alcoholic beverages, solid fat and sugar.[150]

It is well known that heavier alcoholic beverage consumption and less healthful dietary intake have been associated with chronic diseases, including cardiovascular disease, cancers of the colo-rectum and upper aero-digestive tract, and alcohol-related liver disease.[150] For this reason it was of interest in this study, to identify if Discovery Vitality members, who were non-compliant with advocated guidelines for alcohol restriction, also had lower than desirable DBS^{PHRs}.

In accordance with population dietary guidelines, which aim to promote health and prevent disease, alcohol consumption should be restricted to one standard drink per day for women and up to two standard drinks per day for men.[1,12] In this study, only a small percentage of Discovery Vitality members failed to comply with alcohol consumption guidelines. This percentage of members appeared to be lower than the estimated population percentage of risky drinkers in South Africa of 6%.[151] This may be as a result of under-reporting of usual alcohol consumption behaviours by Discovery Vitality members, or may be a result of the Vitality incentive programme, or as a result of demographical differences (discussed in Chapter 2 section 2.3.2) between Discovery Vitality members and the general South African population.

The difference in results may also be due to different assessment methods used, and/or differences in definitions between studies for “risky drinkers” or non-compliant alcohol consumption behaviour. Further research is required to elucidate why the percentage of

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members who do not comply with dietary guidelines regarding alcohol consumption differ from the general South African population.

There was a statistically significant difference between the DBS^{PHRs} of the three reported groups. While "never drinkers" had a better mean DBS^{PHR} than members who complied with alcohol consumption guidelines, no deductions can be drawn regarding the possible risk for developing NCDs for these members, as moderate alcohol consumption has been identified as an independent contributor to decreased all-cause mortality risk.[26] However, members who were at the greatest risk for developing NCDs and for NCD mortality were members who were non-compliant with alcohol guidelines and who had "poor" DBS^{PHRs}. This groups represents only 3% of the study population, however intervention to alter alcohol consumption behaviour as well as the dietary compliance of these members may be warranted.

5.9 Physical activity status and DBS^{PHR}

Maintaining an active lifestyle has been associated with a 47% reduction in risk for all-cause mortality among adults in the United States.[152] Improved nutrition, appropriate eating behaviours and increased physical activity have tremendous potential to decrease morbidity and premature mortality. Further, all-cause mortality risk decreases progressively as the number of healthy behaviours (not smoking, healthy diet and adequate physical activity) increases.[1,152]

Physical activity guidelines for adults recommend that 150 minutes of moderate-intensity aerobic activity be maintained each week.[1] In this study, only one in twenty members of the sample population reported no physical activity, and this proportion of "inactive" members was much lower than the reported level of inactivity (37,5%) among the general South African population.[115] This may be due to over reporting of activity levels among Discovery Vitality members, or due to the effectiveness of the Vitality wellness incentive programme to promote increased levels of physical activity among members.

A systematic review by Osilla and colleagues[96] reported that participants of incentivised wellness programmes showed improvements in health behaviours including levels of physical activity. Further, research conducted on the Vitality programme has also shown that engagement with the programme increases participation in physical activity among members.[111] It is therefore possible that Discovery Vitality members are actually more active than the general population.

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One of the objectives of this study was to assess the DBS^{PHR} of members in relation to physical activity status. The results of this study are concerning, as the mean DBS^{PHR} of "inactive" members was 15.8 points, which was well below the mean DBS^{PHR} of the total sample population of 20.5 points. The differences in mean DBS^{PHRs} between the "active" and "low activity" groups was also statistically significant. It appeared that physically "active" members seemed to demonstrate healthier dietary behaviours than members who reported "low-activity" levels, and these two groups showed healthier dietary behaviours than "inactive" members.

It is possible that being physically active may raise members health awareness and in so doing promote the adoption of healthier dietary behaviours. A study completed by Gilman and colleagues[153] found similar results, in that sedentary individuals were found to consume smaller amounts of foods and nutrients considered to be healthful, such as fruits and vegetables, fibre, calcium, folate and vitamins A, C and E, than more active participants. For nutrients considered to be detrimental such as saturated fat, trans fat and dietary cholesterol, the association with physical activity was inversely related,[153] however additional research is needed to confirm these findings. The results from this study do however, serve to reinforce the need to promote an "active" lifestyle to all members in order to promote health and prevent disease. The results from this study also show that Discovery Vitality members who are "inactive" may be at a considerably increased risk for the development of NCDs and NCD mortality, as all-cause mortality risk increases progressively as the number of healthy behaviours (not smoking, healthy diet, and adequate physical activity) decreases.[152]

5.10 Weight status (BMI) and DBS^{PHR}

Elevated BMI is associated with increased mortality risk.[154] Relative to normal weight (BMI 18.5-24.9 kg/m^2), increasing levels of obesity, specifically grade 2 and grade 3 obesity (BMI>35kg/m^2), have been associated with significantly higher all-cause mortality.[155] Further, all-cause and cancer mortality has been shown to have a U-shaped relationship with BMI: decreasing first, levelling off, and then rising with increasing BMI, with the lowest mortality risk approximately between 23 and 28kg/m^2 for men and 21 to 28 kg/m^2 for women.[156] Other researchers also report a significant relationship between BMI and mortality from all-causes, cardiovascular disease and cancer. Increased risk was significant at levels above 30kg/m^2, however overweight individuals (BMI 25-29.9kg/m^2) also had an approximately 60% higher risk of cardiovascular disease mortality.[157]

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In this study, it was found that just over one third of members from the study sample were classified as overweight and almost one in five members were classified as obese. For different genders, it was found that 46% of men in the study sample were classified as overweight and 18.4% of men were obese, while 25.6% of women were classified as overweight and 15,7% as obese. These percentages are in stark contrast to those provided by the South African Medical Research Council's (MRC) Report: Chronic Diseases of Lifestyle in South Africa since 1995 - 2005, which show that an estimated 21.7% of men in South Africa were classified as overweight and 7.5% were obese, while 26.6% of women were considered overweight and 30.0% were obese.[115] Differences in levels of obesity and overweight of Discovery Vitality members in comparison to nationally reported percentages may be as a result of differences in demographical variables (discussed in Chapter 2 section 2.3.2) between the study sample and the general population of South Africa, suggesting that the study sample is not representative of the South African population, as well as the fact that reported percentages from the MRC report may be out-dated.

Nonetheless the high levels of obesity among male members of Discovery Vitality is a cause for concern, and requires further investigation as well as the development of targeted interventions to reduce the levels of obesity in this group, in order to facilitate a reduction in the risk of all-cause mortality attributed to elevated BMI (>30kg/m^2).

One of the aims of this study was to compare the DBS^{PHRs} of members in relation to weight status. Results showed mean DBS^{PHR} of underweight members was found to be 17.85 points and this is considerably lower than the DBS^{PHR} mean of the study sample. It is important to keep in mind that the lowest all-cause mortality risk occurs when BMI falls approximately between 23 and 28kg/m^2 for men and 21 to 28 kg/m^2 for women. Further it should be noted that a nutritionally unbalanced diet can negatively affect a person's health regardless of weight status.[1] While the number of members that fell within the underweight group only represented 1.75% of the sample population, the mean DBS^{PHRs} of these members is cause for concern and should be further investigated, and targeted interventions developed if deemed necessary.

Results also showed that there was a statistically significant difference between the mean DBS^{PHRs} of normal weight members and obese members. This outcome is supported by the findings from another study that showed that individuals with the highest diet quality were less likely to be overweight or obese.[158] Further, it has been demonstrated that all BMI groups can and do benefit from the adoption of healthy habits, and the greatest benefits are seen within the obese group.[159] It is well known that obesity is a risk factor for the

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development of NCDs and for premature mortality, and the unhealthy dietary behaviours may accelerate this risk. Obese and overweight Vitality members therefore represent sub-groups of members that would benefit from targeted interventions aimed at improving dietary compliance, as well as interventions aimed at weight loss and the attainment and maintenance of a lower body weight.

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CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

The DBS^{PHR} developed for this study appeared to adequately measure the degrees of compliance of South African Discovery Vitality members with the "spirit of dietary guidance", in keeping with the ADG-2005, which are comparable to the SAFBDG. Results showed that the DBS^{PHRs} of the majority of the sampled population were suboptimal. Inadequate dietary compliance with the "spirit of dietary guidance" is a consistently reported finding among different studies conducted in diverse population groups globally, and is not unique to the members of Discovery Vitality in South Africa. However, it is cause for concern, that members who are engaged with a highly regarded wellness incentive initiative aimed at health promotion and disease prevention did not perform better than what appears to be the global standard of inadequate compliance with the "spirit of dietary guidance."

This study also revealed that members who were at an increased risk for developing NCDs and for NCD mortality due to aging, obesity, or "risky" lifestyle behaviours such as smoking, inactivity or non-compliance with recommendations regarding alcohol consumption, also demonstrated lower DBS^{PHRs} compared to members without these risks. These groups of members represent individuals who would benefit from targeted nutrition education programmes, on-going monitoring, and perhaps different or greater rewards to promote desired changes to behaviour.

Women demonstrated better DBS^{PHRs} than men, and South African male members of Discovery Vitality therefore represent another sup-group that would benefit from targeted interventions and/or incentives. Older men and women demonstrated better DBS^{PHRs} than younger men and women. What is unknown from this study is; if younger members will become more compliant with "the spirit of dietary guidance" as they age, or if they will maintain low levels of dietary compliance through the aging process. This would undoubtedly be a cause for concern for Discovery Vitality.

There was no detected difference in DBS^{PHRs} between members who were engaged with the HFB and non-engaged members. This is most likely because the design of this study did not allow for the assessment of the HFB as an intervention aimed at promoting dietary compliance, but assessed the dietary behaviours of members at a single point in time, either at the time of activation of the HFB, or sometime during the year after activating the benefit.

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Lastly, the results from this study showed that members who were more highly engaged with the Discovery Vitality programme, namely Gold/Diamond status members demonstrated better DBS^{PHRs} than members who had little or no engagement with the Discovery Vitality programme namely Blue status members. Higher ranking in Vitality status was associated with higher DBS^{PHRs} through all status groups. This study was unable to determine if engagement with the Vitality programme contributed to higher DBS^{PHRs} of members, or if members who belong to the higher status groups were individuals, who chose to be healthier, chose to be rewarded for healthful behaviour, and who therefore had better DBS^{PHRs}. The Vitality programme and compliance with the "spirit of dietary guidance" therefore represent a "chicken and egg" scenario of "cause and effect". Nonetheless, highly engaged members did demonstrate better compliance with the "spirit of dietary guidance" and therefore greater engagement of members with the Vitality programme could be encouraged.

6.2 Recommendations

6.2.1 Dietary surveillance of Discovery Vitality members

Discovery Vitality is an innovative company and major global wellness incentive business. This study made use of PHR data collected from Discovery Vitality's South African members only, however, the company also has the potential to complete research on different population groups globally as they roll out their wellness incentive business to other countries such as the USA, the UK, China and Australia. Vitality's PHR currently collects pertinent lifestyle, dietary and health information on an ongoing basis.

Discovery Vitality has the infrastructure and resources to collect important nutrition data, and to conduct dietary surveillance on a number of large population groups. While the DBS^{PHR} in this study performed as expected, it is still a recommendation of this study that some of questions in the PHR be revised to improve the quality of the dietary data collected in the future. The dichotomous nature of some of the data provided by the current PHR, as well as the exclusion of certain foods from the DBS^{PHR} that are now known to be beneficial to health such as fish, nuts and legumes, and the exclusion of other foods now expected to have adverse effects on health such as sugar and sugary foods, should be taken into consideration when revising the DBS^{PHR} and the PHR questionnaire in the future.[1,7,8,32,68,76,122]

The DBS^{PHR} did appear to measure compliance with the "spirit of dietary guidance" consistent with the DBS of Kant and colleagues.[17] However, newer scores and indices of

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diet quality have been developed[37,44,45,47] since the Kant[17] study and should be considered going forward.

Discovery Vitality's PHR questionnaire includes a "brief dietary assessment instrument" or "dietary screener". Dietary screeners are most useful in situations where health promotion and health education are the goal[37], as is the case for Discovery Vitality. However, dietary assessment via a reliable modified PHR-dietary screener, would possibly allow for a better assessment of dietary variables considered to be important to health, which in turn could be summed to provide an overall measure of diet quality via the computation of a revised-DBS^{PHR}. Preferably the "dietary screener" that forms part of the PHR should be validated to ensure that it is capable of assessing "usual dietary behaviour" reliably, in accordance with the goals of the organization and in keeping with the objectives of future research.

This study did not look at the individual dietary components of the DBS^{PHR} that contributed to the lower scores of certain groups of Discovery Vitality members. However this should be a consideration for future research, and may help to identify specific dietary behaviours of members that would benefit from targeted interventions, and that could in turn improve the DBS^{PHRs} of Discovery Vitality members in the future.

Apart from the PHR, it is also worthwhile considering, that useful and effective dietary surveillance need not be re-invented, complicated or expensive for large population groups, as a number of existing validated FFQs, brief dietary screeners as well as dietary indices have already been developed and may be suitable for monitoring dietary intake of Discovery Vitality members in different countries. While variability in traditional diets and populations does complicate the selection of brief dietary assessment tools, most instruments can be modified to include culturally specific foods. Modified assessment tools should be appropriately evaluated for suitability before being applied to long term dietary surveillance studies. Another consideration for Discovery Vitality would be to make use of dietary assessment tools that are specific to certain populations, such as the Australian Diet Quality index for use among Australian members, or the Revised USDA Healthy Eating Index for Americans.

On-going dietary surveillance will help Discovery Vitality to better understand the health behaviours of their members and identify groups of members that will benefit from targeted nutrition intervention programmes and/or incentives. Discovery Vitality is also in the unique position in some countries, of being able to track the wellness profile (including; certain biochemical markers such as fasting glucose and cholesterol levels, health indicators such as blood pressure, weight and waist circumference, as well as NCD onset, incidence and mortality) of members over time which in turn could be correlated

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with dietary surveillance data and lifestyle behaviour data. Should Discovery Vitality choose to conduct on-going research of this kind, research results have the prospect of contributing to the body of evidence that currently links “risky” lifestyle behaviours including poor diet quality to NCD risk and NCD mortality. In addition, research of this nature may be able to help the research community find some of the much needed answers and solutions that are required to stem the tide of the present global NCD pandemic.

6.2.2 Dietary behaviour and Vitality status

The Vitality programme offers financial rewards for participating in a variety of health assessments, for engagement with certain education initiatives, for demonstrating healthful behaviour such as regular exercise or not smoking, for meeting certain health goals and/or for maintaining Vitality status. While financial incentives are reported to have the ability to promote healthy eating behaviour, this study was unable to prove that the provision of incentives and engagement with Vitality programme contributed to improved compliance with “the spirit of dietary guidance”.

It is therefore recommended, that research be conducted to establish if the provision of financial incentives and engagement with Vitality programme has the ability to improve the dietary compliance of members in keeping with “the spirit of dietary guidance” and in so doing promote a reduction in the risk of members for developing NCDs and in NCD mortality. To this end, suitable dietary surveillance systems (as recommended in section 6.2.1) need to be adopted by Discovery Vitality as part of their programme. It will then be possible to effectively assess and monitor the usual dietary behaviours of Discovery Vitality members from the time individuals join the Vitality programme and as they graduate through the different status groups. With appropriate planning and an approved study design, it will be possible to assess the ability of financial incentives to affect usual dietary behaviours and to better clarify the ability of the Vitality programme to promote improved dietary compliance in keeping with “the spirit of dietary guidance”.

Further, results from this study did show that more highly engaged Discovery Vitality members demonstrated better DBS^{PHRs} as well as other desirable behaviours such as not smoking and increased levels of physical activity. However, it was only a small percentage of Discovery Vitality members who seemed to have achieved and/or maintained Silver, Gold or Diamond status. Therefore, it is also a recommendation of this study that methods that promote greater levels of engagement with the Vitality programme

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should be investigated, as increased participation could have the potential to affect dietary and health behaviours of many more members positively, who for some reason remain unengaged.

6.2.3 Dietary behaviour and the HealthyFood™ benefit

Appropriate and suitable methods of dietary surveillance (as recommended in section 6.2.1) will allow for better assessment of the effectiveness of Discovery Vitality's HFB. Dietary assessment prior to activating the HFB and regular and repeated assessments after activation of the HFB will allow dietary behaviours to be monitored over time as members learn more about "HealthyFood™" options, and about advocated dietary guidelines through engagement with the benefit. Tracking of food purchases will also be more meaningful if food purchasing behaviour can be correlated with the usual dietary behaviours of members, which have been assessed by appropriate dietary surveillance systems.

Further, well designed studies should be completed to assess the capability of the HFB to promote improved compliance with "the spirit of dietary guidance" compared to members who have not activated the HFB. Once more, appropriate dietary surveillance of engaged HFB members and non-engaged members will facilitate this comparison. Research of this nature will help to support the scientific credibility of Discovery Vitality's HFB and its expected ability to promote improved compliance with the "spirit of dietary guidance", and in so doing reduce the incidence of NCDs and NCD mortality risk.

6.2.4 Dietary behaviour, age and gender

Continued and on-going dietary surveillance of male and female Discovery Vitality members of different ages is recommended, as women demonstrated better compliance with "the spirit of dietary guidance" than men, and older men and women showed better compliance with dietary recommendations than younger members in this study. Continual surveillance of dietary behaviours will make it possible for Discovery Vitality to identify high risk age and gender groups over time that could benefit from targeted educational initiatives as well as structured incentives to promote desired changes to dietary behaviours. The identification of high risk groups as well as the provision of targeted programmes and incentives may facilitate a reduction in NCD risk and NCD mortality risk among members. Such programmes and initiatives provide yet another opportunity for

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research, and given the large membership of Discovery Vitality, results from this type of research could be meaningful and facilitate a greater understanding of the required solutions that are needed to impact on the NCD morbidity and mortality risk relating to different age and gender groups.

6.2.5 Dietary behaviour and "risky" lifestyle behaviours

Results from this study should motivate Discovery Vitality to develop targeted interventions to address the dietary behaviours of members who demonstrate "risky" lifestyle behaviours such as smoking, inactivity, and non-compliance with recommended restrictions regarding alcohol consumption. Current initiatives and incentives aimed at altering "risky" lifestyle behaviours should be continued and promoted in order to facilitate a reduction in member risk for developing NCDs and for NCD mortality. Further, it is possible that targeting "risky" lifestyle behaviours may in itself promote improved dietary compliance, as non-smokers, active members and members who complied with guidelines for alcohol consumption all demonstrated better DBS^{PHRs} than non-compliant members.

It is noteworthy that members who engage in "risky" lifestyle behaviours and who are identified as poorly compliant with dietary recommendations have a compounded risk for developing NCDs and for NCD mortality. For this reason, ongoing dietary surveillance of members is recommended, as this will facilitate the monitoring of groups of members who have a higher risk for developing NCDs as a consequence of "risky" lifestyle and dietary behaviours. The identification of groups of members at a higher risk for developing NCDs, in turn allows for the development of more targeted interventions and/or rewards for these members in order to promote changes to behaviour in the desired direction.

6.2.6 Dietary behaviour and weight status

Discovery Vitality members who are obese demonstrated lower DBS^{PHRs} than overweight and normal weight members. Members who are obese, have a known risk for developing NCDs and for NCD mortality, which is likely to be compounded by poor dietary compliance. With this in mind, it is strongly suggested that Discovery Vitality develop targeted intervention and incentive programmes that will promote sustained weight loss and the adoption of recommended dietary guidelines among obese members. Ongoing dietary

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surveillance of obese members will further assist in monitoring the effectiveness of targeted intervention and incentive programmes aimed at promoting improvements in dietary compliance among obese members. Independent of weight loss, improved compliance with the "spirit of dietary guidance" will be beneficial to the health of obese members and may contribute to a reduction in NCD risk and NCD mortality risk. This is a message that should be communicated to members of the Discovery Vitality programme who are classified as overweight or obese. Initiatives aimed at tackling obesity and dietary compliance provide a further opportunity for research, and with the large membership that Discovery Vitality has globally, results from this type of research could be meaningful and facilitate a greater understanding of the required solutions that are needed to combat obesity as well as the global NCD pandemic.

6.3 Closing remarks

A key finding from this study is that the Discovery Vitality members showed suboptimal levels of compliance with "the spirit of dietary guidance". These results should be a major concern for Discovery Vitality, because a primary aim of the company is to enhance and protect the lives of its members through effective health promotion strategies, intervention programmes and the provision of incentives. "Risky" dietary behaviours and non-conformity to advocated dietary guidelines plays a fundamental role in the development of NCDs and in NCD mortality risk. In order to realize goals of health promotion and disease prevention, suboptimal levels of dietary compliance among members needs to be addressed. To this end evidence based, appropriate and suitable dietary surveillance systems need to be implemented, which will allow for ongoing, dependable dietary assessment of members. The ability of interventions, educational initiatives and structured incentives provided by Discovery Vitality to promote dietary compliance in keeping with "the spirit of dietary guidance" among members can further be assessed if suitable and up-to-date dietary assessment tools are adopted by the programme. For the programme to claim effectiveness in health promotion strategies in the global arena, Discovery Vitality members should demonstrate superior levels of dietary compliance when compared to population groups that are not engaged with the Discovery Vitality programme. Discovery Vitality is a dynamic company that is always changing and evolving, and the results of this study show that it may be time to address the dietary behaviours of members and to develop strategies, interventions, initiatives and incentive offerings that are capable of doing this effectively.

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LIST OF REFERENCES

1. McGuire S. U.S. Department of Agriculture and U.S. Department of Health and Human Services, Dietary Guidelines for Americans, 2010. 7th ed. Washington, DC: U.S. Government Printing Office, January 2011. Advances in Nutrition. 2011;2(3):293-294.

2. World Health Organization (WHO). Globalization, Diets and Non-Communicable Diseases. Switzerland: WHO Library Cataloguing-in-Publication Data; 2002.

3. World Health Organization(WHO). Diet, Nutrition and the Prevention of Chronic Diseases: Report of the joint WHO/FAO expert consultation. Switzerland. WHO Library Cataloguing-in-Puiblication Data; 2003.

4. World Health Organization (WHO). The WHO Global Strategy on Diet, Physical Activity and Health (DPAS): Implementation Plan for Latin America and the Caribbean. Switzerland. WHO Library Cataloguing-in-Puiblication Data; 2006.

5. National Centre for Chronic Disease Prevention and Health Promotion Promotion (CDC). The Power of Prevention: Chronic Disease ... the Public Health Challenge of the 21st Century.[updated c2009; cited c2013 June] Available from: http://www.cdc.gov/chronicdisease/pdf/2009-Power-of-Prevention.pdf.

6. Nugent R. Chronic Diseases in Developing Countries: Health and Economic Burdens. Annals of the New York Academy of Sciences. 2008;1136:70-79.

7. Bengmark S. Acute and "chronic" phase reaction-a mother of disease. Clinical Nutrition (Edinburgh, Scotland). 2004;23(6):1256-1266.

8. Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with non-communicable diseases. Am J Clin Nutr. 2006;84(2):289-298.

9. Wansink B, van Ittersum K. Portion Size Me: Downsizing Our Consumption Norms. JADA. 2007;107(7):1103-1106.

Stellenbosch University http://scholar.sun.ac.za

10. Young LR, Nestle M. The Contribution of Expanding Portion Sizes to the US Obesity Epidemic. Am J Public Health. 2002;92(2):246-249.

11. Nielsen SJ, Popkin BM. Patterns and Trends in Food Portion Sizes, 1977-1998. JAMA. 2003;289(4):450-453.

12. Gibney M, Vorster, HH. South African Food Based Dietary Guidelines. SAJCN. 2001;14(3):S2-S76.

13. Food Standards Agency. The UK Government's Eight Guidelines for a Healthy Diet: The Balance of Good Health.[Homepage on the Internet]. cJune 2013 [updated c2010 February; cited 2013 June 10]. Available from: http://www.food.gov.uk/multimedia/pdfs/bghbooklet.pdf.

14. The British Dietetic Association (BDA). Food Fact Sheet : Healthy Eating. [Homepage on the Internet] cJune 2013 [updated c2011 October; cited 2013 June 10]. Available from: http://www.bda.uk.com/foodfacts/HealthyEating.pdf.

15. Lichtenstein AH, Appel LJ, Brands M, Carnethon M, Daniels S, Franch HA, et al. Diet and lifestyle recommendations revision 2006: a scientific statement from the American Heart Association Nutrition Committee. Circulation. 2006;114(1):82-96.

16. Gidding SS, Lichtenstein AH, Faith MS, Karpyn A, Mennella JA, Popkin B, et al. Implementing American Heart Association pediatric and adult nutrition guidelines: a scientific statement from the American Heart Association Nutrition Committee of the Council on Nutrition, Physical Activity and Metabolism, Council on Cardiovascular Disease in the Young, Council on Arteriosclerosis, Thrombosis and Vascular Biology, Council on Cardiovascular Nursing, Council on Epidemiology and Prevention, and Council for High Blood Pressure Research. Circulation. 2009;119(8):1161-1175.

17. Kant AK, Leitzmann MF, Park Y, Hollenbeck A, Schatzkin A. Patterns of Recommended Dietary Behaviors Predict Subsequent Risk of Mortality in a Large Cohort of Men and Women in the United States. J Nutr. 2009;139(7):1374-1380.

Stellenbosch University http://scholar.sun.ac.za

18. Ye X, Scott T, Gao X, Maras JE, Bakun PJ, Tucker KL. Mediterranean Diet, Healthy Eating Index 2005, and Cognitive Function in Middle-Aged and Older Puerto Rican Adults. J Acad Nutr Diet. 2013;113(2):276-281.e271-273.

19. Dilis V, Katsoulis M, Lagiou P, Trichopoulos D, Naska A, Trichopoulou A. Mediterranean diet and CHD: the Greek European Prospective Investigation into Cancer and Nutrition cohort. Br J Nutr. 2012;108(4):699-709.

20. McNaughton SA, Bates CJ, Mishra GD. Diet Quality Is Associated with All-Cause Mortality in Adults Aged 65 Years and Older. J Nutr 2012;142(2):320-325.

21. Gouveri ET, Tzavara C, Drakopanagiotakis F, Tsaoussoglou M, Marakomichelakis GE, Tountas Y, et al. Mediterranean diet and metabolic syndrome in an urban population: the Athens Study. Nutrition in Clinical Practice : Official publication of the American Society for Parenteral and Enteral Nutrition. 2011;26(5):598-606.

22. Olsen A, Egeberg R, Halkjaer J, Christensen J, Overvad K, Tjonneland A. Healthy aspects of the Nordic diet are related to lower total mortality. J Nutr. 2011;141(4):639-644.

23. Gardener H, Wright CB, Gu Y, Demmer RT, Boden-Albala B, Elkind MS, et al. Mediterranean-style diet and risk of ischemic stroke, myocardial infarction, and vascular death: the Northern Manhattan Study. Am J Clin Nutr. 2011;94(6):1458-1464.

24. Buckland G, Agudo A, Travier N, Huerta JM, Cirera L, Tormo MJ, et al. Adherence to the Mediterranean diet reduces mortality in the Spanish cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC-Spain). Br J Nutr. 2011;106(10):1581-1591.

25. Sjogren P, Becker W, Warensjo E, Olsson E, Byberg L, Gustafsson IB, et al. Mediterranean and carbohydrate-restricted diets and mortality among elderly men: a cohort study in Sweden. Am J Clin Nutr. 2010;92(4):967-974.

Stellenbosch University http://scholar.sun.ac.za

26. Akbaraly TN, Ferrie JE, Berr C, Brunner EJ, Head J, Marmot MG, et al. Alternative Healthy Eating Index and mortality over 18 y of follow-up: results from the Whitehall II cohort. Am J Clin Nutr. 2011;94(1):247-253.

27. Dehghan M, Mente A, Teo KK, Gao P, Sleight P, Dagenais G, et al. Relationship between healthy diet and risk of cardiovascular disease among patients on drug therapies for secondary prevention: a prospective cohort study of 31 546 high-risk individuals from 40 countries. Circulation. 2012;126(23):2705-2712.

28. Chiuve SE, Fung TT, Rimm EB, Hu FB, McCullough ML, Wang M, et al. Alternative dietary indices both strongly predict risk of chronic disease. J Nutr. 2012;142(6):1009-1018.

29. Akbaraly TN, Singh-Manoux A, Tabak AG, Jokela M, Virtanen M, Ferrie JE, et al. Overall diet history and reversibility of the metabolic syndrome over 5 years: the Whitehall II prospective cohort study. Diabetes Care. 2010;33(11):2339-2341.

30. Kaluza J, Hakansson N, Brzozowska A, Wolk A. Diet quality and mortality: a population-based prospective study of men. Euro J Clin Nutr. 2009;63(4):451-457.

31. Zarrin R, Ibiebele TI, Marks GC. Development and validity assessment of a diet quality index for Australians. Asia Pacific J Clin Nutr. 2013;22(2):177-187.

32. Martinez-Gonzalez MA, Gea A. Mediterranean diet: the whole is more than the sum of its parts. Br J Nutr. 2012;108(4):577-578.

33. Drake I, Gullberg B, Sonestedt E, Wallstrom P, Persson M, Hiebowicz J, et al. Scoring models of a diet quality index and the predictive capability of mortality in a population-based cohort of Swedish men and women. Public Health Nutrition. 2013;16(3):468-478.

34. Katzenellenbogen JM Joubert G, Abdool Karim SS, editors. Epidemiology : A Manual For South Africa. Cape Town: Oxford University Press; 2004.

Stellenbosch University http://scholar.sun.ac.za

35. Lee RD, Neiman DC. Measurement of Diet. Nutritional Assessment. London: Mc Graw Hill; 2003:49-73.

36. Nelson M, Bingham SA. Assessment of food consumption and nutrient intake. In: Margetts BM, Nelsn M, editors. Design Concepts in Nutritional Epidemiology. 2nd ed. Great Britain. Oxford University Press; [2006. Chapter 6;p123-169].

37. Thompson FE, Subar AF. Dietary Assessment Methodology. In: Coulston AM, Boushey CJ, Ferruzzi MG, editors. Nutrition in the Prevention and Treatment of Disease. 3rd ed. San Diego, CA, USA: Academic Press - Elsevier; [2013. Chapter 1; p5-20].

38. French SA, Shimotsu ST, Wall M, Gerlach AF. Capturing the spectrum of household food and beverage purchasing behavior: a review. JADA. 2008;108(12):2051-2058.

39. Tin ST, Mhurchu CN, Bullen C. Supermarket sales data: feasibility and applicability in population food and nutrition monitoring. Nutr Rev. 2007;65(1):20-30.

40. Ransley JK, Donnelly JK, Botham H, Khara TN, Greenwood DC, Cade JE. Use of supermarket receipts to estimate energy and fat content of food purchased by lean and overweight families. Appetite. 2003;41(2):141-148.

41. Weinstein JL, Phillips V, MacLeod E, Arsenault M, Ferris AM. A universal product code scanner is a feasible method of measuring household food inventory and food use patterns in low-income families. JADA. 2006;106(3):443-445.

42. National Cancer Institute for Applied Research - Cancer Control and Population Sciences : Register of Short Dietary Assessment Instruments. [Internet]. c2013 [updated 2013 October 18; cited 2013 October 20]. Available from: http://appliedresearch.cancer.gov/diet/shortreg/.

43. Waijers PM, Feskens EJ, Ocke MC. A critical review of predefined diet quality scores. Br. J. Nutr. 2007;97(2):219-231.

Stellenbosch University http://scholar.sun.ac.za

44. Arvaniti F, Panagiotakos DB. Healthy indexes in public health practice and research: a review. Critical Reviews in Food Science and Nutrition. 2008;48(4):317-327.

45. Fransen HP, Ocke MC. Indices of diet quality. Curr Opin Clin Nutr Metab Care. 2008;11(5):559-565.

46. Roman-Vinas B, Ribas Barba L, Ngo J, Martinez-Gonzalez MA, Wijnhoven TM, Serra-Majem L. Validity of dietary patterns to assess nutrient intake adequacy. The Br. J. Nutr. 2009;101 Suppl 2:S12-20.

47. Wirt A, Collins CE. Diet quality-what is it and does it matter? Public Health Nutrition. 2009;12(12):2473-2492.

48. Kourlaba G, Panagiotakos DB. Dietary quality indices and human health: a review. Maturitas. 2009;62(1):1-8.

49. McNaughton SA, Ball K, Crawford D, Mishra GD. An index of diet and eating patterns is a valid measure of diet quality in an Australian population. J Nutr. 2008;138(1):86-93.

50. Fogli-Cawley JJ, Dwyer JT, Saltzman E, McCullough ML, Troy LM, Meigs JB, et al. The 2005 Dietary Guidelines for Americans and risk of the metabolic syndrome. Am J Clin Nutr. 2007;86(4):1193-1201.

51. Tognon G, Nilsson LM, Lissner L, Johansson I, Hallmans G, Lindahl B, et al. The Mediterranean diet score and mortality are inversely associated in adults living in the subarctic region. J Nutr. 2012;142(8):1547-1553.

52. World Health Organization (WHO). Fruit and Vegetable Consumption and Mortality Statistics. [Internet]. c2013 [updated c2002 May; cited c2013 June]. Available from: http://www.who.int/dietphysicalactivity/fruit/en/index2.html#.

Stellenbosch University http://scholar.sun.ac.za

53. Schneider M, Norman R, Steyn N, Bradshaw D. Estimating the burden of disease attributable to low fruit and vegetable intake in South Africa in 2000. SAMJ. 2007;97(8 Pt 2):717-723.

54. Anderson AL, Harris TB, Tylavsky FA, Perry SE, Houston DK, Hue TF, et al. Dietary patterns and survival of older adults. JADA. 2011;111(1):84-91.

55. Agudo A, Cabrera L, Amiano P, Ardanaz E, Barricarte A, Berenguer T, et al. Fruit and vegetable intakes, dietary antioxidant nutrients, and total mortality in Spanish adults: findings from the Spanish cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC-Spain). Am J Clin Nutr. 2007;85(6):1634-1642.

56. Liu S, Stampfer MJ, Hu FB, Giovannucci E, Rimm E, Manson JE, et al. Whole-grain consumption and risk of coronary heart disease: results from the Nurses' Health Study. Am J Clin Nutr. 1999;70(3):412-419.

57. Steffen LM, Jacobs DR, Jr., Stevens J, Shahar E, Carithers T, Folsom AR. Associations of whole-grain, refined-grain, and fruit and vegetable consumption with risks of all-cause mortality and incident coronary artery disease and ischemic stroke: the Atherosclerosis Risk in Communities (ARIC) Study. Am J Clin Nutr. 2003;78(3):383-390.

58. Jacobs DR Jr, Andersen LF, Blomhoff R. Whole-grain consumption is associated with a reduced risk of noncardiovascular, noncancer death attributed to inflammatory diseases in the Iowa Women's Health Study. Am J Clin Nutr. 2007;85(6):1606-1614.

59. Hooper L, Summerbell CD, Thompson R, Sills D, Roberts FG, Moore HJ, et al. Reduced or modified dietary fat for preventing cardiovascular disease. The Cochrane Database of Systematic Reviews. 2012;5:Cd002137.

60. Jakobsen MU, O'Reilly EJ, Heitmann BL, Pereira MA, Balter K, Fraser GE, et al. Major types of dietary fat and risk of coronary heart disease: a pooled analysis of 11 cohort studies. Am J Clin Nutr. 2009;89(5):1425-1432.

Stellenbosch University http://scholar.sun.ac.za

61. Mitrou PN, Kipnis V, Thiebaut AC, Reedy J, Subar AF, Wirfalt E, et al. Mediterranean dietary pattern and prediction of all-cause mortality in a US population: results from the NIH-AARP Diet and Health Study. Archives of Internal Medicine. 2007;167(22):2461-2468.

62. Mahan LK, Escott-Stump S, editors. Krause's Food & Nutrition Therapy, 12th ed. Missouri: Saunders Elsevier; 2008.

63. Scholtz SC, Vorster HH (jun), Matshego L, Vorster HH. Foods from animals can be eaten every day - not a conundrum. SAJCN. 2001;14(3):S39-S47.

64. Goldbohm RA, Chorus AM, Galindo Garre F, Schouten LJ, van den Brandt PA. Dairy consumption and 10-y total and cardiovascular mortality: a prospective cohort study in the Netherlands. Am J Clin Nutr. 2011;93(3):615-627.

65. Soedamah-Muthu SS, Ding EL, Al-Delaimy WK, Hu FB, Engberink MF, Willett WC, et al. Milk and dairy consumption and incidence of cardiovascular diseases and all-cause mortality: dose-response meta-analysis of prospective cohort studies. Am J Clin Nutr. 2011;93(1):158-171.

66. Bonthuis M, Hughes MC, Ibiebele TI, Green AC, van der Pols JC. Dairy consumption and patterns of mortality of Australian adults. Euro J Clin Nutr. 2010;64(6):569-577.

67. Elwood PC, Givens DI, Beswick AD, Fehily AM, Pickering JE, Gallacher J. The survival advantage of milk and dairy consumption: an overview of evidence from cohort studies of vascular diseases, diabetes and cancer. J Am Coll Nutr. 2008;27(6):723s-734s.

68. Popkin BM, Gordon-Larsen P. The nutrition transition: worldwide obesity dynamics and their determinants. International Journal of Obesity and related Metabolic Disorders : Int J Obes Relat Metab Disord. 2004;28 Suppl 3:S2-9.

69. Chahwala V, Arora R. Cardiovascular manifestations of insulin resistance. Am J Ther. 2009;16(5):e14-28.

Stellenbosch University http://scholar.sun.ac.za

70. Lopes NH, Paulitsch FS, Pereira AC, Gois AF, Gagliardi A, Garzillo CL, et al. Impact of metabolic syndrome on the outcome of patients with stable coronary artery disease: 2-year follow-up of the MASS II study. Coronary Artery Disease. 2008;19(6):383-388.

71. Hart AR, Kennedy H, Harvey I. Pancreatic cancer: a review of the evidence on causation. Clin Gastroenterol Hepatol : The Official Clinical Practice Journal American Gastroenterological Association. 2008;6(3):275-282.

72. Bartnik M, Norhammar A, Ryden L. Hyperglycaemia and cardiovascular disease. J Int Med. 2007;262(2):145-156.

73. Michaud DS. Epidemiology of pancreatic cancer. Minerva Chirurgica. 2004;59(2):99-111.

74. Heine RJ, Balkau B, Ceriello A, Del Prato S, Horton ES, Taskinen MR. What does postprandial hyperglycaemia mean? Diabetic Medicine : A Journal of the British Diabetic Association. 2004;21(3):208-213.

75. Giovannucci E. Modifiable risk factors for colon cancer. Gastroenterology Clinics of North America. 2002;31(4):925-943.

76. United States Department of Health and Human Services: United States Department of Agriculture (USDA). Dietary Guidelines for Americans, 2005. 6th ed. Washington DC: U.S. Government Printing Office; 2005. [Internet]. c2013 [updated c2005 January; cited c2013 June]. Available from: http://www.health.gov/dietaryguidelines/dga2005/document/

77. Horn LV, Tian L, Neuhouser ML, Howard BV, Eaton CB, Snetselaar L, et al. Dietary patterns are associated with disease risk among participants in the Women's Health Initiative Observational Study. J Nutr. 2012;142(2):284-291.

Stellenbosch University http://scholar.sun.ac.za

78. Ockene IS, Miller NH. Cigarette smoking, cardiovascular disease, and stroke: a statement for healthcare professionals from the American Heart Association. American Heart Association Task Force on Risk Reduction. Circulation. 1997;96(9):3243-3247.

79. Mucha L, Stephenson J, Morandi N, Dirani R. Meta-analysis of disease risk associated with smoking, by gender and intensity of smoking. Gender Medicine. 2006;3(4):279-291.

80. Katanoda K, Marugame T, Saika K, Satoh H, Tajima K, Suzuki T, et al. Population attributable fraction of mortality associated with tobacco smoking in Japan: a pooled analysis of three large-scale cohort studies. J Epidemiol / Japan Epidemiological Association. 2008;18(6):251-264.

81. Ronksley PE, Brien SE, Turner BJ, Mukamal KJ, Ghali WA. Association of alcohol consumption with selected cardiovascular disease outcomes: a systematic review and meta-analysis. BMJ (Clinical research ed.). 2011;342:d671.

82. Costanzo S, Di Castelnuovo A, Donati MB, Iacoviello L, de Gaetano G. Alcohol consumption and mortality in patients with cardiovascular disease: a meta-analysis. J Am Coll Cardiol. 2010;55(13):1339-1347.

83. Di Castelnuovo A, Costanzo S, Bagnardi V, Donati MB, Iacoviello L, de Gaetano G. Alcohol dosing and total mortality in men and women: an updated meta-analysis of 34 prospective studies. Arch Intern Med. 2006;166(22):2437-2445.

84. Roerecke M, Rehm J. Irregular heavy drinking occasions and risk of ischemic heart disease: a systematic review and meta-analysis. Am J Epidemiol. 2010;171(6):633-644.

85. South African Health Information Website. Hosted by the South African Medical Research Council (MRC). Alcohol and Drug Abuse Module. [Internet]. 2013. [updated 2008 October 30; cited 2013 June 13]. Available from: http://www.sahealthinfo.org/admodule/alcohol.htm.

Stellenbosch University http://scholar.sun.ac.za

86. Woodcock J, Franco OH, Orsini N, Roberts I. Non-vigorous physical activity and all-cause mortality: systematic review and meta-analysis of cohort studies. Int J Epidemiol. 2011;40(1):121-138.

87. Murphy MH, McNeilly AM, Murtagh EM. Session 1: Public health nutrition: Physical activity prescription for public health. The Proceedings of the Nutrition Society. 2010;69(1):178-184.

88. Elsawy B, Higgins KE. Physical activity guidelines for older adults. Am Fam Physician. 2010;81(1):55-59.

89. Siddiqui NI, Nessa A, Hossain MA. Regular physical exercise: way to healthy life. MMJ. 2010;19(1):154-158.

90. Guh DP, Zhang W, Bansback N, Amarsi Z, Birmingham CL, Anis AH. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. BMC Public Health. 2009;9:88.

91. Lenz M, Richter T, Muhlhauser I. The morbidity and mortality associated with overweight and obesity in adulthood: a systematic review. Deutsches Arzteblatt International. 2009;106(40):641-648.

92. World Health Organization (WHO). Guide to identifying the economic consequences of disease and injury. Department of Health Systems Financing Health Systems and Services. Geneva: WHO Library Cataloguing-in-Publication Data; 2009.

93. Mayosi BM, Flisher AJ, Lalloo UG, Sitas F, Tollman SM, Bradshaw D. The burden of non-communicable diseases in South Africa. Lancet. 2009;374(9693):934-947.

94. Kolbe-Alexander TL, Buckmaster C, Nossel C, Dreyer L, Bull F, Noakes TD, et al. Chronic disease risk factors, healthy days and medical claims in South African employees presenting for health risk screening. BMC Public Health. 2008;8:228.

Stellenbosch University http://scholar.sun.ac.za

95. Boyle MA, Holben DH, editors. Community Nutrition in Action, An Entrepreneurial Approach. 5th ed. Belmont, CA, USA: Wadsworth, Cegage Learning; 2010.

96. Osilla KC, Van Busum K, Schnyer C, Larkin JW, Eibner C, Mattke S. Systematic review of the impact of worksite wellness programs. Am J Manag Care. 2012;18(2):e68-81.

97. Engbers L, World Health Organization(WHO). Monitoring and Evaluation of Worksite Health Promotion Programs - Current state of knowledge and implications for practice. Background paper prepapred for the WHO/WEF Joint Event on Preventing Non-Communicable Disease in the Workplace (Dalian/China, September 2007) Geneva, Switzerland 2008. [Internet] 2013. [updated c2008; cited c2013 June]. Available from: http://www.who.int/dietphysicalactivity/Engbers-monitoringevaluation.pdf.

98. Volpp KG. Paying people to lose weight and stop smoking. Leonard David Institute (LDI) Issue Brief. 2009;14(3):1-4.

99. Jochelson KJ. Paying the patient - Improving health using financial incentives. King's Fund. London;2007.

100. Kane RL, Johnson PE, Town RJ, Butler M. Economic incentives for preventive care. Evidence Report / Technology Assessment No. 101. (Prepared by the University of Minnesota Evidence-Based Practice Centre under contract no. 290-02-009). AHRQ Publication no. 04-E024-2. Rockville, MD. Agency for Healthcare Research and Quality; 2004.

101. Marteau TM, Ashcroft RE, Oliver A. Using financial incentives to achieve healthy behaviour. BMJ (Clinical research ed.). 2009;338:b1415.

102. Halpern SD, Madison KM, Volpp KG. Patients as mercenaries?: The ethics of using financial incentives in the war on unhealthy behaviors. Circulation. Cardiovascular Quality and Outcomes. 2009;2(5):514-516.

Stellenbosch University http://scholar.sun.ac.za

103. Adams J, Giles EL, Robalino S, McColl E, Sniehotta FF. A systematic review of the use of financial incentives and penalties to encourage uptake of healthy behaviors: protocol. Systematic Reviews. 2012;1:51.

104. Wall J, Mhurchu CN, Blakely T, Rodgers A, Wilton J. Effectiveness of monetary incentives in modifying dietary behavior:a review of randomized, controlled trials. Nutr Rev. 2006;64(12):518-531.

105. Waterlander WE, Steenhuis IH, de Vet E, Schuit AJ, Seidell JC. Expert views on most suitable monetary incentives on food to stimulate healthy eating. Eur J Public Health. 2010;20(3):325-331.

106. Ni Mhurchu C, Eyles H, Dixon R, Matoe L, Teevale T, Meagher-Lundberg P. Economic incentives to promote healthier food purchases: exploring acceptability and key factors for success. Health Promot Int. 2012;27(3):331-341.

107. Blumenthal KJ, Saulsgiver KA, Norton L, Troxel AB, Anarella JP, Gesten FC, et al. Medicaid incentive programs to encourage healthy behavior show mixed results to date and should be studied and improved. Health Affairs (Project Hope). 2013;32(3):497-507.

108. Long JA, Helweg-Larsen M, Volpp KG. Patient opinions regarding 'pay for performance for patients'. J Gen Intern Med. 2008;23(10):1647-1652.

109. Patel DN, Lambert EV, da Silva R, Greyling M, Nossel C, Noach A, et al. The association between medical costs and participation in the vitality health promotion program among 948,974 members of a South African health insurance company. American Journal of Health Promotion : AJHP. 2010;24(3):199-204.

110. Lambert EV, da Silva R, Fatti L, Patel D, Kolbe-Alexander T, Derman W, et al. Fitness-related activities and medical claims related to hospital admissions - South Africa, 2006. Preventing Chronic Disease. 2009;6(4):A120.

Stellenbosch University http://scholar.sun.ac.za

111. Patel D, Lambert EV, da Silva R, Greyling M, Kolbe-Alexander T, Noach A, et al. Participation in fitness-related activities of an incentive-based health promotion program and hospital costs: a retrospective longitudinal study. Am J Health Promot. : AJHP. 2011;25(5):341-348.

112. Lehohla P. Use of health facilities and levels of selected health conditions in South Africa: Findings from the General Houeshold Survey, 2011. Pretoria, South Africa: Statistics South Africa;2013.

113. Ataguba J. Health care financing in South Africa: moving towards universal coverage. CME. 2010;28(2):74-78.

114. South African Audience Research Foundation (SAARF). The SAARF Universal Living Standards Measure (SU-LSM™): Twelve years of continuous development. [Internet]. 2013 [updated c2012; cited c2013 September]. Available from: http://saarf.co.za/LSM/lsm-article.asp.

115. Steyn K, Fourie J, Norman T, editors. Chronic Diseases of Lifestyle in South Africa 1995-2005. Technical Report. Cape Town. South African Medical Research Council. 2006.

116. Discovery Vitality South Africa. Points Table for Vitality Status Groups. [Internet]. 2013. [updated c2010; cited c2011 June]. Available from: http://www.discovery.co.za/portal/loggedout-individual/points-overview.

117. Ni Mhurchu C, Blakely T, Jiang Y, Eyles HC, Rodgers A. Effects of price discounts and tailored nutrition education on supermarket purchases: a randomized controlled trial. Am J Clin Nutr. 2010;91(3):736-747.

118. Discvery Vitality South Africa. HealthyFood™ Benefit Information for Vitality Members. [Internet] 2013. [updated c2013; cited c2011 June]. Available from: http://www.discovery.co.za/discovery_za/web/logged_out/you_and_your_family/card/how_to_save/healthyfood_benefit_content/healthyfood_savings.xml.

Stellenbosch University http://scholar.sun.ac.za

119. Kristal AR, Peters U, Potter JD. Is it time to abandon the food frequency questionnaire? Cancer Epidemiology, Biomarkers & Prevention : A Publication of the American Association for Cancer Research, Co-sponsored by the American Society of Preventive Oncology. 2005;14(12):2826-2828.

120. Escott-Stump S. Nutrition and Diagnosis-Related Care. 7th ed. Philadelphia: Lippincott Williams & Wilkins, a Wolters Kluwer business; 2012.

121. Mahan LK, Escott-Stump S, Raymond JL, editors. Krause's Food and the Nutrition Care Process. 13th ed. St Louis, Missouri, USA: Elsevier Saunders; 2012.

122. Estruch R, Ros E, Salas-Salvado J, Covas MI, Corella D, Aros F, et al. Primary prevention of cardiovascular disease with a Mediterranean diet. NEJM. 2013;368(14):1279-1290.

123. Steyn NP, Bradshaw D, Norman R, Joubert JD, Schneider M, Steyn K. Dietary changes and the health transition in South Africa: Implications for health policy. Cape Town: South African Medical Research Council [Internet] 2013. [updated c2006; cited c2013 June]. Available from: http://www.sahealthinfo.org/lifestyle/dietaccess.pdf

124. Kvaavik E, Batty GD, Ursin G, Huxley R, Gale CR. Influence of individual and combined health behaviors on total and cause-specific mortality in men and women: the United Kingdom health and lifestyle survey. Arch Intern Med. 2010;170(8):711-718.

125. Morse KL, Driskell JA. Observed sex differences in fast-food consumption and nutrition self-assessments and beliefs of college students. Nutrition Research (New York, N.Y.). 2009;29(3):173-179.

126. Meier M, Berchtold A, Akre C, Michaud PA, Suris JC. Who eats healthily? A population-based study among young Swiss residents. Public Health Nutr. 2010;13(12):2068-2075.

Stellenbosch University http://scholar.sun.ac.za

127. Biltoft-Jensen A, Groth MV, Matthiessen J, Wachmann H, Christensen T, Fagt S. Diet quality: associations with health messages included in the Danish Dietary Guidelines 2005, personal attitudes and social factors. Public Health Nutr. 2009;12(8):1165-1173.

128. Emanuel AS, McCully SN, Gallagher KM, Updegraff JA. Theory of Planned Behavior explains gender difference in fruit and vegetable consumption. Appetite. 2012;59(3):693-697.

129. Tourlouki E, Matalas AL, Panagiotakos DB. Dietary habits and cardiovascular disease risk in middle-aged and elderly populations: a review of evidence. Clin Interv Aging. 2009;4:319-330.

130. Sabia S, Singh-Manoux A, Hagger-Johnson G, Cambois E, Brunner EJ, Kivimaki M. Influence of individual and combined healthy behaviours on successful aging. CMAJ. 2012;184(18):1985-1992.

131. Michels KB, Bloom BR, Riccardi P, Rosner BA, Willett WC. A study of the importance of education and cost incentives on individual food choices at the Harvard School of Public Health cafeteria. J Am Coll Nutr. 2008;27(1):6-11.

132. Loewenstein G, Asch DA, Friedman JY, Melichar LA, Volpp KG. Can behavioural economics make us healthier? BMJ (Clinical research ed.). 2012;344:e3482.

133. Sturm R, An R, Segal D, Patel D. A cash-back rebate program for healthy food purchases in South Africa: Results from scanner data. Am J Prev Med :AJPN. 2013;44(6):567-572.

134. An R, Patel D, Segal D, Sturm R. Eating better for less: a national discount program for healthy food purchases in South Africa. Am J Health Behav. 2013;37(1):56-61.

135. Loewenstein G, Asch DA, Volpp KG. Behavioral economics holds potential to deliver better results for patients, insurers, and employers. Health Affairs (Project Hope). 2013;32(7):1244-1250.

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136. Discovery Health (South Africa) Medical Scheme. Annual Report. 2011; [Internet] 2013. [updated c2011; cited c2013 October] Available from: https://www.discovery.co.za/discovery_za/web/pdfs/health/annual_financial_statements_2011.pdf.

137. Waterlander WE, Steenhuis IH, de Boer MR, Schuit AJ, Seidell JC. The effects of a 25% discount on fruits and vegetables: results of a randomized trial in a three-dimensional web-based supermarket. Int J Behav Nutr Phys Act. 2012;9:11.

138. Eyles H, Ni Mhurchu C, Nghiem N, Blakely T. Food pricing strategies, population diets, and non-communicable disease: a systematic review of simulation studies. PLoS medicine. 2012;9(12):e1001353.

139. Inglis V, Ball K, Crawford D. Does modifying the household food budget predict changes in the healthfulness of purchasing choices among low- and high-income women? Appetite. 2009;52(2):273-279.

140. Ayo-Yusuf OA, Olutola BG. 'Roll-your-own' cigarette smoking in South Africa between 2007 and 2010. BMC Public Health. 2013;13(1):597.

141. Godtfredsen NS, Prescott E. Benefits of smoking cessation with focus on cardiovascular and respiratory comorbidities. Clinical Respir J. 2011;5(4):187-194.

142. Ezzati M, Riboli E. Can noncommunicable diseases be prevented? Lessons from studies of populations and individuals. Science (New York, N.Y.). 2012;337(6101):1482-1487.

143. Sangthong R, Wichaidit W, McNeil E, Chongsuvivatwong V, Chariyalertsak S, Kessomboon P, et al. Health behaviors among short- and long- term ex-smokers: results from the Thai National Health Examination Survey IV, 2009. Prev Med. 2012;55(1):56-60.

Stellenbosch University http://scholar.sun.ac.za

144. Adamkova V, Hubacek JA, Hubalkova M, Lanska V. The quality of the nutrition in smokers. Neuro Endocrinology Letters. 2012;33 Suppl 2:3-5.

145. Rittmueller SE, Corriveau A, Sharma S. Differences in dietary quality and adequacy by smoking status among a Canadian Aboriginal population. Public Health. 2012;126(6):490-497.

146. Rittmueller SE, Roache C, Sharma S. Dietary adequacy and dietary quality of Inuit in the Canadian Arctic who smoke and the potential implications for chronic disease. Public Health Nutrition. 2012;15(7):1268-1275.

147. Vandevijvere S, De Vriese S, Huybrechts I, Moreau M, Van Oyen H. Overall and within-food group diversity are associated with dietary quality in Belgium. Public Health Nutr. 2010;13(12):1965-1973.

148. Haveman-Nies A, de Groot L, Burema J, Cruz JA, Osler M, van Staveren WA. Dietary quality and lifestyle factors in relation to 10-year mortality in older Europeans: the SENECA study. Am J Epidemiol. 2002;156(10):962-968.

149. Jones AC, Geneau R. Assessing research activity on priority interventions for non-communicable disease prevention in low- and middle-income countries: A Bibliometric Analysis. Global Health Action. 2012;5:1-13.

150. Breslow RA, Guenther PM, Juan W, Graubard BI. Alcoholic beverage consumption, nutrient intakes, and diet quality in the US adult population, 1999-2006. JADA. 2010;110(4):551-562.

151. Peltzer K, Ramlagan S. Alcohol Use Trends in South Africa. J Soc Sci. 2009;18(1):1-12.

152. Ford ES, Bergmann MM, Boeing H, Li C, Capewell S. Healthy lifestyle behaviors and all-cause mortality among adults in the United States. Preventive Medicine. 2012;55(1):23-27.

Stellenbosch University http://scholar.sun.ac.za

153. Gillman MW, Pinto BM, Tennstedt S, Glanz K, Marcus B, Friedman RH. Relationships of physical activity with dietary behaviors among adults. Preventive Medicine. 2001;32(3):295-301.

154. Staiano AE, Reeder BA, Elliott S, Joffres MR, Pahwa P, Kirkland SA, et al. Physical activity level, waist circumference, and mortality. Appl Physiol Nutr Metab. 2012;37(5):1008-1013.

155. Flegal KM, Kit BK, Orpana H, Graubard BI. Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. JAMA. 2013;309(1):71-82.

156. Song X, Pitkaniemi J, Gao W, Heine RJ, Pyorala K, Soderberg S, et al. Relationship between body mass index and mortality among Europeans. Euro J Clin Nutr. 2012;66(2):156-165.

157. Katzmarzyk PT, Reeder BA, Elliott S, Joffres MR, Pahwa P, Raine KD, et al. Body mass index and risk of cardiovascular disease, cancer and all-cause mortality. Can J Public Health. 2012;103(2):147-151.

158. Nicklas TA, O'Neil CE, Fulgoni VL, 3rd. Diet quality is inversely related to cardiovascular risk factors in adults. J Nutr. 2012;142(12):2112-2118.

159. Matheson EM, King DE, Everett CJ. Healthy lifestyle habits and mortality in overweight and obese individuals. J Am Board Fam Med : JABFM. 2012;25(1):9-15.

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List of Addenda

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Addendum1: Supplemental Material for the Computation of a Dietary Behaviour Score (DBS)

Online Supporting Material

Supplemental Appendix: Computation of dietary behavior score components

The six individual dietary moderation components contributing to the dietary behavior score were computed as follows:

Servings of vegetables were as mentioned by the subjects in response to two separate questions that asked the respondent to "record the number of servings of vegetables and fruits you usually ate". The number of vegetable servings specifically excluded salad or potatoes in the instruction. Mention of ≥5-6 servings/week=6 points; 3-4 servings/week=3 points; and 1-2 servings/week or less=0.

Servings of fruits were as mentioned by the subjects in response to two separate questions that asked the respondent to "record the number of servings of vegetables and fruits you usually ate". The number of fruit servings specifically excluded juices in the instruction. Mention of ≥5-6 servings/week=6 points; 3-4 servings/week=3 points; and 1-2 servings/week or less=0.

Consumption of whole grains was determined from 2 questions each on bread and cereal usage. The 2 bread questions enquired about type of bread usually used for sandwiches or "not in sandwiches" with each question contributing maximum of 3 points (if dark bread=1.5 points; white and dark bread same amount=0.75; white bread=0). The 2 cereal questions were from the food frequency questionnaire (FFQ), and enquired "how often is the cereal you eat" high fiber (such as fiber one, All Bran, or 100% Bran) or other fiber cereals (such as cheerios, shredded wheat, raisin bran, bran flakes, and granola). These were scored as about ¾ of the time or almost always=3 points; ½ the time for at least 1=1.5 points; both never or both ¼ =0.

The low-fat dairy consumption was determined from 2 questions on use of low-fat or non-fat milk as a drink, and in cereal, in the FFQ. If low-fat or non-fat milk as a drink was reported 3-4 times or more often /week=3 points; 1-2 times/week=1.5 points; <1-2 times or never drink=0 points. Reporting of low-fat or non-fat milk in cereal ¾ of the time or always=3 points; ½ of the time=1.5 point; both never or both ¼ time=0.

Selection of lean meats and poultry was determined from three questions that queried about kind of meat usually consumed and included, ground beef (lean or regular); beef steaks, roasts, or chops (lean or regular); and chicken (with or without skin). Each question contributed 2 points: don't eat or choose lean or without skin=2; 1 point if lean and regular (with skin) about the same; only regular or with skin=0.

Addition of solid fat to foods after cooking or at the table was determined from response to questions about how often butter or margarine were added to: pancakes, waffles, french toast; potatoes; rice; pasta; cooked vegetables; and gravy to meat. Response of never or almost never to each question=1 point; other responses=0.

The FFQ defined "usually" as more than half the time.

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Supplemental Table 1: Multivariate-adjusted[1] relative risk of all-cause mortality by quintiles of dietary behavior score (DBS) in men, stratified by categories of age at baseline, race/ethnicity, years of formal education, body mass index, smoking status, physical activity, and alcohol use

	Quintiles of Dietary behavior score					$P^{2}_{(trend)}$
	Q1	Q2	Q3	Q4	Q5	
Range	0-18	18.25-22.75	23-26	26.25-29.0	29.25-36.0	
Aged 50-55 y at baseline; n=38657; deaths 1554						
Deaths, n	580	334	293	196	151	
Multivariate Relative risk[2]	1.0	0.79	0.92	0.80	0.78	0.008
95% CI		0.69-0.91	0.80-1.07	0.67-0.94	0.65-0.95	
Aged 56-60 y at baseline; n=50459, deaths 3265						
Deaths, n	1094	764	636	422	349	
Multivariate Relative Risk	1.0	0.88	0.90	0.73	0.75	<0.0001
95% CI		0.80-0.97	0.82-1.0	0.65-0.83	0.66-0.85	
Aged 61-65 y at baseline; n=57895, deaths 6113						
Deaths, n	1918	1399	1153	903	740	
Multivariate Relative Risk	1.0	0.88	0.86	0.83	0.79	<0.0001
95% CI		0.82-0.94	0.79-0.92	0.76-0.90	0.72-0.86	
Aged 66-71 y at baseline; n=52863, deaths 8503						
Deaths, n	2292	1972	1696	1401	1142	
Multivariate Relative Risk	1.0	0.95	0.90	0.88	0.82	<0.0001
95% CI		0.89-1.01	0.84-0.96	0.82-0.94	0.76-0.88	
P^{3} value DBSXethnicity=0.2						
Non-Hispanic White; n=186483, deaths 18248						
Deaths, n	5390	4209	3595	2791	2263	
Multivariate Relative Risk	1.0	0.90	0.89	0.83	0.79	<0.0001
95% CI		0.87-0.94	0.85-0.93	0.79-0.87	0.75-0.83	
Non-Hispanic Black; n=4966, deaths 535						
Deaths, n	271	123	68	42	31	
Multivariate Relative Risk	1.0	0.86	0.64	0.69	0.67	0.0007
95% CI		0.69-1.07	0.49-0.85	0.49-0.96	0.46-0.99	
Hispanic; n=3542, deaths 248						
Deaths, n	95	49	35	28	41	
Multivariate Relative Risk	1.0	0.81	0.82	0.85	1.20	0.6
95% CI		0.57-1.16	0.55-1.22	0.55-1.32	0.81-1.78	
Asian, Pacific Islander or American Indian/Alaskan Native; n=3272, deaths 230						
Deaths, n	72	49	42	38	29	
Multivariate Relative Risk	1.0	0.89	0.83	0.96	0.90	0.7
95% CI		0.61-1.30	0.56-1.24	0.63-1.47	0.56-1.42	
P value DBSXeducation=0.2						
Y of formal education = <12; n=38991, deaths 4882						
Deaths, n	1986	1151	834	524	387	

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Multivariate Relative Risk	1.0	0.93	0.90	0.81	0.86	<0.0001
95% CI		0.86-1.0	0.83-0.98	0.74-0.90	0.77-0.96	
Y of formal education =12; n=18276, deaths 2031						
Deaths, n	700	454	394	275	208	
Multivariate Relative Risk	1.0	0.82	0.87	0.80	0.81	0.002
95% CI		0.72-0.92	0.77-0.99	0.69-0.92	0.69-0.95	
Y of formal education= >12 or some college; n=43487, deaths 4488						
Deaths, n	1392	1051	897	654	494	
Multivariate Relative Risk	1.0	0.91	0.94	0.87	0.80	<0.0001
95% CI		0.83-0.98	0.86-1.02	0.79-0.96	0.72-0.89	
Y of formal education=college and postgraduate; n=94901, deaths 7474						
Deaths, n	1596	1696	1558	1397	1227	
Multivariate Relative Risk	1.0	0.91	0.85	0.82	0.76	<0.0001
95% CI		0.85-0.97	0.79-0.91	0.76-0.88	0.70-0.82	
P value DBSXBody mass index=0.001						
Body mass index <18.5 (kg/m^2); n=652, deaths 123						
Deaths, n	62	30	14	9	8	
Multivariate Relative Risk	1.0	0.84	0.54	0.44	0.41	0.005
95% CI		0.49-1.43	0.28-1.03	0.20-0.97	0.18-0.95	
Body mass index 18.5-24.9 (kg/m^2); n=61460, deaths 6327						
Deaths, n	1990	1333	1185	943	876	
Multivariate Relative Risk	1.0	0.89	0.90	0.83	0.79	<0.0001
95% CI		0.83-0.96	0.84-0.97	0.77-0.90	0.73-0.87	
Body mass index 25-29.9 (kg/m^2); n=100766; deaths 9047						
Deaths, n	2615	2140	1798	1403	1091	
Multivariate Relative Risk	1.0	0.91	0.90	0.85	0.80	<0.0001
95% CI		0.86-0.97	0.84-0.96	0.80-0.91	0.75-0.87	
Body mass index $\geq$30 (kg/m^2); n=37996, deaths 3938						
Deaths, n	1217	966	781	567	407	
Multivariate Relative Risk	1.0	0.91	0.88	0.83	0.85	0.0002
95% CI		0.83-0.99	0.80-0.96	0.75-0.92	0.75-0.95	
P value DBSXSmoking status=0.01						
Never smoked; n=62894, deaths 3759						
Deaths, n	778	759	843	712	667	
Multivariate Relative Risk	1.0	0.86	0.93	0.84	0.81	0.0005
95% CI		0.78-0.95	0.84-1.03	0.75-0.93	0.73-0.91	
Former smoker; n=108166, deaths 10473						
Deaths, n	2778	2486	2102	1734	1373	
Multivariate Relative Risk	1.0	0.93	0.86	0.85	0.78	<0.0001
95% CI		0.88-0.98	0.81-0.91	0.80-0.91	0.73-0.84	
Current smoker; n=21535, deaths 4396						
Deaths, n	2086	1050	692	342	226	
Multivariate Relative Risk	1.0	0.89	0.98	0.75	0.87	<0.0001
95% CI		0.82-0.96	0.90-1.07	0.66-0.84	0.75-1.00	

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P value DBSXPhysical activity=0.001						
Never engage in physical activity lasting ≥20 minutes in past 12 months; n=5144, deaths 972						
Deaths,n	473	213	137	87	62	
Multivariate Relative Risk	1.0	0.84	0.90	0.88	1.00	0.7
95% CI		0.71-0.99	0.74-1.10	0.69-1.11	0.76-1.31	
Rarely engage in physical activity lasting ≥20 minutes in past 12 months; n=20960, deaths 2924						
Deaths, n	1233	739	466	292	194	
Multivariate Relative Risk	1.0	0.95	0.89	0.84	0.83	0.0007
95% CI		0.86-1.04	0.80-0.99	0.74-0.96	0.71-0.97	
1-3 times/month engage in physical activity lasting ≥20 minutes in past 12 months; n=27033, deaths 2711						
Deaths, n	963	674	519	327	228	
Multivariate Relative Risk	1.0	0.95	0.94	0.86	0.88	0.01
95% CI		0.86-1.05	0.84-1.05	0.75-0.98	0.76-1.02	
1-2 times/week engage in physical activity lasting ≥20 minutes in past 12 months; n=46201, deaths 4357						
Deaths, n	1247	1055	920	672	463	
Multivariate Relative Risk	1.0	0.92	0.94	0.87	0.79	<0.0001
95% CI		0.85-1.00	0.86-1.03	0.79-0.96	0.71-0.88	
3-4 times/week engage in physical activity lasting ≥20 minutes in past 12 months; n=56980, deaths 4862						
Deaths, n	1188	1065	990	871	748	
Multivariate Relative Risk	1.0	0.83	0.79	0.76	0.72	<0.0001
95% CI		0.76-0.90	0.73-0.86	0.69-0.83	0.65-0.79	
≥5 times/week engage in physical activity lasting ≥20 minutes in past 12 months; n=42461, deaths 3467						
Deaths, n	718	688	722	663	676	
Multivariate Relative Risk	1.0	0.91	0.92	0.87	0.83	0.001
95% CI		0.82-1.01	0.82-1.02	0.78-0.97	0.75-0.93	
P value DBSXAlcohol use=0.08						
0 g Alcohol/day; n=8730, deaths 995						
Deaths, n	284	203	186	144	178	
Multivariate Relative Risk	1.0	0.98	0.97	0.86	0.91	0.2
95% CI		0.82-1.18	0.80-1.18	0.69-1.06	0.74-1.11	
>0 - <5 g of alcohol/day; n=94318, deaths 9078						
Deaths, n	2673	2087	1827	1385	1106	
Multivariate Relative Risk	1.0	0.93	0.91	0.85	0.80	<0.0001
95% CI		0.87-0.98	0.86-0.97	0.80-0.91	0.75-0.87	
5- <15 g of alcohol/day; n= 37161, deaths 3004						
Deaths, n	807	652	606	506	433	
Multivariate Relative Risk	1.0	0.83	0.86	0.81	0.79	0.0003
95% CI		0.75-0.92	0.77-0.96	0.72-0.91	0.70-0.90	

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≥15 g of alcohol/day; n=59665, deaths 6358						
Deaths, n	2120	1527	1159	887	665	
Multivariate Relative Risk	1.0	0.88	0.84	0.80	0.76	<0.0001
95% CI		0.83-0.95	0.78-0.90	0.74-0.87	0.69-0.83	

[1]Values are relative risk estimates and 95% confidence intervals from Cox proportional hazards regression models. Multivariate model included: race (NH white, NH black, Hispanic, Asian/pacific/islander/American Indian/Alaskan native, unknown), education (<8, 8-11, 12, some college, college/post graduate, unknown), 30-level smoking status (nonsmoker; former smoker, stopped ≥10 years ago, 1-10 cigarettes/d; former smoker, stopped ≥10 years ago, 11-20 cigarettes/d; former smoker, stopped ≥10 years ago, 21-30 cigarettes/d, former smoker, stopped ≥10 years ago, 31-40 cigarettes/d; former smoker, stopped ≥10 years ago, 41-60 cigarettes/d; former smoker, stopped ≥10 years ago, >60 cigarettes/d; former smoker, stopped 5-9 years ago,1-10 cigarettes/d; former smoker, stopped 5-9 years ago, 11-20 cigarettes/d; former smoker, stopped 5-9 years ago, 21-30 cigarettes/d; former smoker, stopped 5-9 years ago, 31-40 cigarettes/d; former smoker, stopped 5-9 years ago, 41-60 cigarettes/d; former smoker, stopped 5-9 years ago, >60 cigarettes/d; former smoker, stopped 1-4 years ago, 1-10 cigarettes/d; former smoker, stopped 1-4 years ago,11-20 cigarettes/d; former smoker, stopped 1-4 years ago, 21-30 cigarettes/d; former smoker, stopped 1-4 years ago, 31-40 cigarettes/d; former smoker, stopped 1-4 years ago, 41-60 cigarettes/d; former smoker, stopped 1-4 years ago, >60 cigarettes/d; former smoker, stopped within last year, 1-10 cigarettes/d; former smoker, stopped within last year, 11-20 cigarettes/d; former smoker, stopped within last year, 21-30 cigarettes/d, former smoker, stopped within last year, 31-40 cigarettes/d; former smoker, stopped within last year, 41-60+ cigarettes/d; current smoker 1-10 cigarettes/d; current smoker 11-20 cigarettes/d; current smoker 31-40 cigarettes/d; current smoker 51-60 cigarettes/d; Current smoker >60 cigarettes/d; unknown smoking status), BMI (<18.5, 18.5-24.9, 25-29.9, >=30), physical activity lasting ≥20 minutes and resulting in sweating or increased breathing and heart rate over the past 12 months (never, rarely, 1-3 times/month, 1-2 times/week, 3-4 times/week, ≥5times/week), alcohol intake in g/day (0, 0.01-4.9, 5.0-14.9, ≥15), energy intake (quintiles). BMI stratified models included BMI as a continuous variable and models for former and current smokers included the duration and dose information. Stratified analyses are not presented for the unknown category.

[2]$P_{(trend)}$ DBS quintiles as a trend variable, 1-5.

[3]P value for significance of the interaction of DBS with each covariate.

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Supplemental Table 2: Multivariate-adjusted[1] relative risk of all-cause mortality by quintiles of dietary behavior score (DBS) in women, stratified by categories of age at baseline, race/ethnicity, years of formal education, body mass index, smoking status, physical activity, and alcohol use

	Quintiles of dietary behavior score					P[2] (trend)
	Q1	Q2	Q3	Q4	Q5	
Range	0-18	18.25-22.75	23-26	26.25-29.0	29.25-36.0	
Aged 50-55 y at baseline; n=30441, deaths 861						
Deaths, n	238	200	159	135	129	
Multivariate relative risk[2]	1.0	1.04	0.89	0.83	0.83	0.03
95% CI		0.86-1.26	0.72-1.10	0.67-1.04	0.66-1.05	
Aged 56-60 y at baseline; n=38324, deaths 1773						
Deaths, n	454	369	332	298	320	
Multivariate Relative Risk	1.0	0.86	0.82	0.75	0.79	0.0006
95% CI		0.75-0.99	0.71-0.95	0.64-0.87	0.67-0.92	
Aged 61-65 y at baseline; n=43737, deaths 3312						
Deaths, n	794	670	678	595	575	
Multivariate Relative Risk	1.0	0.85	0.83	0.74	0.70	<0.0001
95% CI		0.78-0.94	0.75-0.93	0.66-0.83	0.63-0.79	
Aged 66-71 y at baseline; n=38510, deaths 4457						
Deaths, n	842	862	950	896	907	
Multivariate Relative Risk	1.0	0.94	0.93	0.88	0.77	<0.0001
95% CI		0.85-1.03	0.85-1.03	0.80-0.98	0.69-0.85	
P[3] value DBSXEthnicity=0.07						
Non-Hispanic White; n=37647, deaths 9534						
Deaths, n	2063	1907	1948	1803	1813	
Multivariate Relative Risk	1.0	0.89	0.86	0.80	0.74	<0.0001
95% CI		0.83-0.94	0.81-0.92	0.75-0.85	0.69-0.79	
Non-Hispanic Black; n=6938, deaths 469						
Deaths, n	170	111	88	58	42	
Multivariate Relative Risk	1.0	0.96	0.95	0.80	0.62	0.009
95% CI		0.75-1.23	0.73-1.24	0.58-1.09	0.44-0.89	
Hispanic; n=2671, deaths 136						
Deaths, n	37	27	23	22	27	
Multivariate Relative Risk	1.0	0.82	0.77	0.77	0.99	0.8
95% CI		0.49-1.37	0.45-1.31	0.45-1.33	0.58-1.69	
Asian, Pacific Islander or American Indian/Alaskan Native; n=2158, deaths 118						
Deaths, n	17	23	33	18	27	
Multivariate Relative Risk	1.0	1.47	1.83	1.14	1.88	0.8
95% CI		0.76-2.81	0.98-3.42	0.56-2.32	0.97-3.62	
P value DBSXEducation=0.09						
Years of formal education= <12; n=44423, deaths 3542						
Deaths, n	1096	755	668	570	453	

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Multivariate Relative Risk	1.0	0.86	0.84	0.87	0.75	<0.0001
95% CI		0.79-0.95	0.76-0.92	0.78-0.96	0.66-0.84	
Years of formal education=12; n=16070, deaths 1167						
Deaths, n	261	272	246	211	177	
Multivariate Relative Risk	1.0	1.03	0.90	0.82	0.67	<0.0001
95% CI		0.86-1.22	0.75-1.08	0.68-0.99	0.55-0.82	
Years of formal education= >12 or some college; n=38059, deaths 2675						
Deaths, n	545	543	541	533	513	
Multivariate Relative Risk	1.0	0.87	0.82	0.78	0.70	<0.0001
95% CI		0.77-0.98	0.72-0.93	0.68-0.88	0.62-0.80	
Years of formal education= college and postgraduate; n=48613, deaths 2700						
Deaths, n	345	470	605	553	727	
Multivariate Relative Risk	1.0	0.94	0.99	0.78	0.82	<0.0001
95% CI		0.8-1.09	0.85-1.14	0.66-0.90	0.71-0.96	
P value DBSXBody mass index=0.002						
Body mass index <18.5 (kg/m^2); n=2043, deaths 284						
Deaths, n	105	60	40	43	36	
Multivariate Relative Risk	1.0	0.73	0.63	0.71	0.62	0.02
95% CI		0.52-1.03	0.43-0.93	0.48-1.06	0.44-0.96	
Body mass index 18.5-24.9 (kg/m^2); n=69330, deaths 4680						
Deaths, n	1054	916	971	832	907	
Multivariate Relative Risk	1.0	0.89	0.91	0.77	0.71	<0.0001
95% CI		0.82-0.98	0.83-1.0	0.70-0.85	0.64-0.78	
Body mass index 25-29.9 (kg/m^2); n=49537, deaths 3164						
Deaths, n	665	613	651	623	612	
Multivariate Relative Risk	1.0	0.88	0.88	0.83	0.80	0.0002
95% CI		0.79-0.99	0.79-0.99	0.74-0.93	0.71-0.90	
Body mass index ≥30 (kg/m^2); n=30102, deaths 2275						
Deaths, n	504	512	457	426	376	
Multivariate Relative Risk	1.0	0.98	0.84	0.89	0.82	0.002
95% CI		0.84-1.11	0.74-0.96	0.78-1.02	0.71-0.95	
P value DBSXSmoking Status=0.02						
Never smoked; n=67362, deaths 2996						
Deaths, n	445	530	647	676	698	
Multivariate Relative Risk	1.0	0.90	0.88	0.84	0.74	<0.0001
95% CI		0.79-1.02	0.78-1.0	0.74-0.95	0.65-0.84	
Former smoker; n=57347, deaths 3920						
Deaths, n	674	750	852	791	853	
Multivariate Relative Risk	1.0	0.91	0.90	0.82	0.78	<0.0001
95% CI		0.82-1.01	0.81-1.00	0.74-0.92	0.70-0.87	
Current smoker; n=21588, Deaths 3114						
Deaths, n	1125	739	542	402	306	
Multivariate Relative Risk	1.0	0.90	0.85	0.80	0.75	<0.0001
95% CI		0.82-0.99	0.77-0.95	0.71-0.89	0.66-0.85	

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P value DBSXPhysical activity=0.3						
Never engage in physical activity lasting ≥20 minutes in past year, n=7048; deaths 905						
Deaths, n	337	229	151	110	78	
Multivariate Relative Risk	1.0	1.05	0.92	0.91	0.82	0.08
95% CI		0.88-1.25	0.75-1.12	0.73-1.13	0.64-1.06	
Rarely engage in physical activity lasting ≥20 minutes in past year (n=23509; Deaths 2135)						
Deaths, n	686	515	392	300	242	
Multivariate Relative Risk	1.0	0.87	0.77	0.73	0.69	<0.0001
95% CI		0.78-0.98	0.68-0.87	0.63-0.84	0.59-0.80	
1-3 times/month engage in physical activity lasting ≥20 minutes in past year; n=22199, deaths 1463						
Deaths, n	368	351	299	232	213	
Multivariate Relative Risk	1.0	0.91	0.83	0.70	0.73	<0.0001
95% CI		0.78-1.05	0.71-0.97	0.59-0.83	0.61-0.87	
1-2 times/week engage in physical activity lasting ≥20 minutes in past year; n=32842, deaths 2091						
Deaths, n	405	405	457	431	393	
Multivariate Relative Risk	1.0	0.89	0.91	0.87	0.80	0.006
95% CI		0.77-1.02	0.79-1.04	0.76-1.00	0.69-0.92	
3-4 times/week engage in physical activity lasting ≥20 minutes in past year; n=39107, deaths 2256						
Deaths, n	312	373	498	509	564	
Multivariate Relative Risk	1.0	0.90	0.95	0.86	0.78	0.0004
95% CI		0.77-1.05	0.82-1.10	0.72-1.00	0.67-0.90	
≥5 times/week engage in physical activity lasting ≥20 minutes in past year; n=25179, deaths 1455						
Deaths, n	198	206	298	324	429	
Multivariate Relative Risk	1.0	0.74	0.79	0.75	0.68	0.0004
95% CI		0.61-0.91	0.66-0.95	0.62-0.90	0.57-0.81	
P value DBSXalcohol use=0.002						
0 g of alcohol/day; n=11950, deaths 967						
Deaths, n	193	177	181	184	232	
Multivariate Relative Risk	1.0	1.08	1.02	1.01	0.98	0.6
95% CI		0.88-1.33	0.86-1.26	0.82-1.25	0.79-1.20	
>0 - <5 g of alcohol/day; n=99885, deaths 6617						
Deaths, n	1442	1355	1360	1229	1231	
Multivariate Relative Risk	1.0	0.91	0.88	0.81	0.77	<0.0001
95% CI		0.84-0.98	0.81-0.95	0.75-0.88	0.71-0.83	
5- <15 g of alcohol/day; n=20862, deaths 1253						
Deaths, n	238	237	279	268	231	
Multivariate Relative Risk	1.0	0.82	0.83	0.77	0.57	<0.0001
95% CI		0.69-0.99	0.69-0.99	0.64-0.93	0.47-0.70	
≥15 g of alcohol/day; n=18305, deaths 1566						
Deaths, n	455	332	299	243	237	
Multivariate Relative Risk	1.0	0.82	0.79	0.68	0.71	<0.0001
95% CI		0.71-0.94	0.68-0.92	0.58-0.80	0.6-0.84	
P value DBSXhormone use=0.4						

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Never used exogenous hormones, n=67159; deaths=5560						
Deaths, n	1404	1195	1060	965	936	
Multivariate Relative Risk	1.0	0.9	0.85	0.82	0.76	<0.0001
95% CI		0.84-0.98	0.78-0.92	0.76-0.90	0.70-0.84	
Current user of exogenous hormones, n=70,293; deaths=3856						
Deaths, n	714	717	850	769	806	
Multivariate Relative Risk	1.0	0.89	0.89	0.78	0.74	<0.0001
95% CI		0.80-0.99	0.80-0.99	0.70-0.87	0.66-0.82	
Former user of exogenous hormones, n=13,296; deaths=964						
Deaths, n	208	186	202	185	183	
Multivariate Relative Risk	1.0	0.89	0.89	0.79	0.68	0.0003
95% CI		0.73-1.09	0.89-1.09	0.64-0.97	0.55-0.84	

[1] Values are relative risk estimates and 95% confidence intervals from Cox proportional hazards regression models. Multivariate model includes: race (NH white, NH black, Hispanic, Asian/pacific/islander/American Indian/Alaskan native, unknown), education (<8, 8-11, 12, some college, college/post graduate, unknown), 30-level smoking status (nonsmoker; former smoker, stopped ≥10 years ago, 1-10 cigarettes/d; former smoker, stopped ≥10 years ago, 11-20 cigarettes/d; former smoker, stopped ≥10 years ago, 21-30 cigarettes/d, former smoker, stopped ≥10 years ago, 31-40 cigarettes/d; former smoker, stopped ≥10 years ago, 41-60 cigarettes/d; former smoker, stopped ≥10 years ago, >60 cigarettes/d; former smoker, stopped 5-9 years ago,1-10 cigarettes/d; former smoker, stopped 5-9 years ago, 11-20 cigarettes/d; former smoker, stopped 5-9 years ago, 21-30 cigarettes/d; former smoker, stopped 5-9 years ago, 31-40 cigarettes/d; former smoker, stopped 5-9 years ago, 41-60 cigarettes/d; former smoker, stopped 5-9 years ago, >60 cigarettes/d; former smoker, stopped 1-4 years ago, 1-10 cigarettes/d; former smoker, stopped 1-4 years ago,11-20 cigarettes/d; former smoker, stopped 1-4 years ago, 21-30 cigarettes/d; former smoker, stopped 1-4 years ago, 31-40 cigarettes/d; former smoker, stopped 1-4 years ago, 41-60 cigarettes/d; former smoker, stopped 1-4 years ago, >60 cigarettes/d; former smoker, stopped within last year, 1-10 cigarettes/d; former smoker, stopped within last year, 11-20 cigarettes/d; former smoker, stopped within last year, 21-30 cigarettes/d, former smoker, stopped within last year, 31-40 cigarettes/d; former smoker, stopped within last year, 41-60+ cigarettes/d; current smoker 1-10 cigarettes/d; current smoker 11-20 cigarettes/d; current smoker 31-40 cigarettes/d; current smoker 51-60 cigarettes/d; Current smoker >60 cigarettes/d; unknown smoking status), BMI (<18.5, 18.5-24.9, 25-29.9, >=30), physical activity lasting ≥20 minutes and resulting in sweating or increased breathing and heart rate over the past 12 months (never, rarely, 1-3 times/month, 1-2 times/week, 3-4 times/week, ≥5times/week), alcohol intake g/day (0, 0.01-4.9, 5.0-14.9, ≥15), energy intake (sex-specific quintiles), hormone use (never used, current user, former user, unknown user). BMI stratified models included BMI as a continuous variable and models for former and current smokers included the duration and dose information. Stratified analyses are not presented for the unknown category.

[2] $P_{(trend)}$ DBS quintiles as a trend variable, 1-5.

[3] P value for significance of the interaction of DBS with each covariate.

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Addendum 2: Discovery Vitality criteria for the selection of food for the HealthyFood™ benefit

Discovery Vitality HealthyFood™ benefit

Selection criteria

August 2010

This document outlines the evidence-based criteria for product selection for the Vitality HealthyFood™ benefit. The content of this document is subject to change in accordance with scientific research, clinical practice dietary guidelines, and local and international trends in the food industry.

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Discovery Vitality HealthyFood™ benefit selection criteria

Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
1. Fruit	Fresh fruit	- Whole fresh fruit - Plain, raw, pre-cut fresh fruit	- Any fresh fruit with sugar, flavouring or other ingredients added	- Fruit is a good source of fibre as well as micronutrients needed for optimal health and disease prevention.[1] - The South African Food-Based Dietary Guidelines (SAFBDG) recommend that individuals "Eat plenty of vegetables and fruits everyday".[1] - Provides members with enough options to meet the 5-a-day recommended intake for fruit and vegetables.[1] - High intakes of simple refined sugars are recognised by the World Health Organization as a significant dietary risk factor associated with an increased risk for chronic disease.[4] - Currently the SAFBDG and international organisations warn against the use of sugar, and population guidelines recommend that individuals minimise their intake of foods with added sugar.[1-3,,5] In light of these recommendations we have decided not to include any foods that are high in simple sugars on the HealthyFood™ benefit.
	Frozen fruit	- Plain frozen fruit	- Any frozen fruit with sugar, flavouring or other ingredients added	- As above
	Canned fruit	- Fruit canned in natural juice	- Fruit canned in syrup	- As above
	Dried fruit	- Plain dried fruit - Dried fruit rolls	- Glazed, sugared, candied, chocolate-coated or candy-coated, or fried (e.g. fried banana chips)	- As above - The SAFBDG state that individuals should “Eat fats sparingly” and in particular the intake of saturated and trans fatty acids.[1] - According to the SAFBDG individuals over the age of two years’ fat intake should comprise less than 30% of the total energy intake and saturated fatty acids should be limited to <10% of total energy and polyunsaturated fatty acids to <10% of total energy in favour of monounsaturated fatty acids which should contribute >10% to total energy intake.[1] - Possible implications of a diet

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
				high in fat include increased risk of obesity and its associated complications; dyslipidaemia and atherosclerosis with a subsequent increased risk of cardiovascular diseases; insulin resistance as well as certain cancers (prostate, breast and colon).[1]
	Fruit juice	- No fruit juices are included	- All fruit juices are excluded	- Although fruit juice is considered to be a healthy beverage choice, whole fruit is a better choice[5] and because we are advocating the best choice within each food group, only whole fruit is included at this stage. - High intakes of fruit juice may be associated with an increased risk of weight gain and obesity.[4] - Drinks often contribute to caloric intake[4] and to maintain calorie balance, we recommend the intake of water and whole nutritious foods instead. All drinks are excluded.
2. Vegetables	Fresh vegetables	- Whole, fresh vegetables - Plain, raw pre-cut vegetables and herbs	- Fresh with spices, seasoning, flavouring, fat/ oil or sauces added	- The SAFBDG recommend that individuals "Eat plenty of vegetables and fruits everyday".[1] - Vegetables are a good source of fibre as well as micronutrients needed for optimal health and disease prevention.[1] - Provides members with enough options to meet the 5-a-day recommended intake for fruit and vegetables.[1] - Seasoned and flavoured vegetables often have salt (sodium) added. The SAFBDG state that individuals should "Use salt sparingly".[1] - According to international and local dietary guidelines, one should aim to reduce one's sodium(salt) intake.[1-,5] Research has shown that too much sodium can cause elevated blood pressure, which is a risk factor for the development of cardiovascular disease (a leading cause of deaths worldwide).[4]

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
	Canned vegetables	- No canned vegetables are included	- All canned vegetables are excluded, including tomato purees and pastes	- We chose to include fresh and frozen vegetables in the "fruit and vegetable group" as these are the best choice in this group. Although canned vegetables still keep many nutritious properties they are frequently high in sodium (salt). The SAFBDG state that individuals should "Use salt sparingly".[1] - According to international and local dietary guidelines, individuals should aim to reduce their sodium (salt) intake.[1-5] Research has shown that too much sodium can cause elevated blood pressure which is a risk factor for the development of cardiovascular disease (a leading cause of deaths worldwide)[4].
	Frozen vegetables	- Plain, unflavoured	- Frozen with spices, seasoning, flavouring, fat/ oil or sauces added	- Seasoned and flavoured vegetables often have salt (sodium) added. The SAFBDG state that individuals should "Use salt sparingly".[1] - Some frozen vegetables may also have added fat/ oil and according to the SAFBDG individuals should "Eat fats sparingly".[1] - According to the SAFBDG individuals over the age of two years' fat intake should comprise less than 30% of the total energy intake and saturated fatty acids should be limited to <10% of total energy and polyunsaturated fatty acids to <10% of total energy in favour of monounsaturated fatty acids which should contribute >10% to total energy intake.[1] - Possible implications of a diet high in fat include increased risk of obesity and its associated complications; dyslipidaemia and atherosclerosis with a subsequent increased risk of cardiovascular diseases; insulin resistance as well as certain cancers (prostate, breast and colon).[1]
	Dried vegetables	- No dried vegetables, e.g. sundried tomatoes, are included	- All dried vegetables are excluded	- May be salted or seasoned or packaged in oil and the SAFBDG state that individuals should "Use salt sparingly" and "Eat fats sparingly".[1]

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
	Vegetable juice	- No vegetable juices are included	- All vegetable juices are excluded	- Although vegetable juice is considered to be a healthy beverage choice, whole vegetables are a better choice[5] and because we are advocating the best choice within each food group, only whole vegetables are included at this stage. - Drinks often contribute to caloric intake[4] and to maintain calorie balance, we recommend the intake of water and whole nutritious foods instead. All drinks are excluded.
3. Carbohydrate-rich foods	Rice	- Plain, uncooked rice, - White, Brown, Wild, Basmati, Jasmine, Long Grain, Short Grain, Arborio, Risotto, Sushi rice - Wheat rice, Mealie rice	- Any rice with added salt, spices, seasoning, flavouring, herbs, fat/ oil added - Fragrant rice - Cooked or pre-prepared rice	- SAFBDG: "Make starchy foods the basis of most meals".[1] - The current SAFBDG emphasise that these starchy foods should as far as possible be unrefined or minimally processed.[1] - SAFBDG: "Use salt sparingly"[1]. - According to international and local dietary guidelines, individuals should aim to reduce their sodium(salt) intake.[1-5] Research has shown that too much sodium can cause elevated blood pressure which is a risk factor for the development of cardiovascular disease (a leading cause of deaths worldwide)[4].
	Pasta and noodles	- All types of plain, uncooked pasta (including wholewheat and maize pasta) - All types of plain, uncooked noodles (including egg noodles, rice noodles)	- Any pasta or noodle with added spices, seasoning, flavouring or fat/ oil or sauces - Cooked or pre-prepared pasta or noodles	- SAFBDG: "Make starchy foods the basis of most meals".[1] - The current SAFBDG emphasise that these starchy foods should as far as possible be unrefined or minimally processed.[1] - SAFBDG: "Use salt sparingly".[1] - Most flavoured or pre-prepared foods contain sodium and according to international and local dietary guidelines, individuals should aim to reduce their sodium(salt) intake.[1-,5] Research has shown that too much sodium can cause elevated blood pressure which is a risk factor for the development of cardiovascular disease (a leading cause of deaths worldwide)[4].

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
	Breads	- Rye, Wholewheat bread , rolls or pita bread. Wholegrain bread, rolls or pita bread. Seed breads, Wholewheat or rye bagels	- White, brown and other bread not specified under included	- SAFBDG: "Make starchy foods the basis of most meals".[1] - The American Heart Association recommends choosing wholegrain, high fibre foods and also recommends that at least half of an individual's grain intake should come from wholegrains.[5]
	Breakfast cereals	- High in fibre: ≥ 6g per 100g [6] - Low in saturated fat: ≤ 1.5g per 100g [6,7] - Not high in added sugars: ≤ 12.5g per 100g [11] -	- *Not high in fibre:* < *6g per 100g* [6] - *Not low in saturated fat:* > *1.5g epr 100g* [6,7] - *High in added sugars:* > *12.5g per 100g* [11]	- Diets low in fibre, high in saturated fat and high in sugar are associated with an increased risk of developing chronic diseases.[4] - Diets high in fibre have been found to have numerous health benefits , including improved laxation and reduced risk of coronary heart disease. [3] - Research has shown that a high saturated fat intake is associated with the development of cardiovascular disease. Saturated fat has negative effects on blood lipid levels, increasing total cholesterol and LDL-cholesterol levels. This can put one at risk of developing atherosclerosis and coronary heart disease.[4] International and local dietary guidelines suggest limiting saturated fat in the diet.[1,2,3,4,5] - High intakes of simple refined sugars are recognised by the World Health Organization as a significant dietary risk factor associated with an increased risk for chronic disease. [4] - Currently the SAFBDG and international organisations warn against the use of sugar, and population guidelines recommend that individuals minimise their intake of foods with added sugar. [1-3,,5] In light of these recommendations we have decided not to include any foods that are high in simple sugars on the HealthyFood™ benefit. -
	Porridges	- Plain, uncooked - Including Maize/ Mealie meal, Oats,Oat Bran, Mabela, Maltabella, Taystee Wheat -	- Instant porridges - Porridges with flavouring, sugar, salt, fat added -	- SAFBDG: "Make starchy foods the basis of most meals".[1] - The current SAFBDG emphasise that these starchy foods should as far as possible be unrefined or minimally processed.[1] - Many of the instant porridges available contain added

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
				ingredients such as sugar, hydrogenated vegetables oils, salt and flavouring. - According to international and local dietary guidelines, individuals should aim to reduce their sugar, salt (sodium) and fat intake.[1-5]
	Crackers	- High in fibre: ≥ 6g per 100g [6] (EU guidelines) - Low in saturated fat: ≤ 1.5g per 100g [6,7] - Low in sugars: ≤ 5g per 100g [6]	- Crackers not meeting the inclusion criteria i.e. those that are not high in fibre, low in saturated fat and low in sugar	- Crackers are carbohydrate-rich foods and together with breads, pasta, cereals and potatoes are part of the starchy food group.[4] Carbohydrate-containing foods are a valuable source of energy, vitamins, minerals and fibre, especially when eaten in the unrefined form.[1] - Diets low in fibre, high in saturated fat and high in sugar are associated with an increased risk of developing chronic diseases.[4] - Local and international dietary guidelines recommend that individuals limit their eating of foods high in fat (particularly saturated fat), high in salt and high in sugar and increase their intake of fibre-rich foods.[1-5] Based on these guidelines it can therefore be advised that crackers should preferably have a low fat (specifically low saturated fat), low salt and low sugar content and should also be high in fibre.
	Wholegrains	- Plain, raw, wholegrains - Pearled barley, buckwheat, bulgar wheat, millet, quinoa, spelt, sorghum, popcorn kernels, rolled oats	- Pre-prepared or cooked wholegrains - Wholegrains with sugar, spices, seasoning, flavouring, herbs, fat added. e.g. microwave popcorn	- The American Heart Association recommends choosing wholegrain, high fibre foods and further recommends that at least half of an individual's grain intake should come from wholegrains.[5]
	Other starchy foods	- Couscous, samp and beans, polenta, samp, digestive bran, semolina	- Cooked, pre-cooked, flavoured, - Cous cous, samp and beans, polenta, samp, digestive bran and semolina with sugar, spices, seasoning, flavouring, herbs, fat added.	- SAFBDG: "Make starchy foods the basis of most meals".[1] - Local and international dietary guidelines recommend that individuals limit their eating of foods high in fat (particularly saturated fat) and high in salt. [15]
4. Protein-rich foods	Eggs	- All uncooked	- Pre-prepared, cooked	- Eggs are low in saturated fat and they contain protein, folic acid, other B vitamins and monounsaturated fatty acids that could reduce the risk of coronary heart disease, therefore their effect on heart disease risk cannot be predicted by considering only

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
				the cholesterol intake and eggs can therefore be included in moderation as part of a healthy balanced diet.[8] - The consumption of 3-4 eggs a week should not result in the overconsumption of dietary cholesterol.[1]
	Chicken	- All plain, unseasoned, fresh and frozen, skinless chicken - Plain chicken mince	- Chicken with skin - Crumbed, battered - Chicken with salt, spices, seasoning, flavouring, herbs, fat/ oil, sauces added - Smoked or processed chicken e.g. viennas, polony	- Chicken in sauces, batter, or prepared meals as well as smoked, salted and processed chicken products are often high in salt, total fat and/ or saturated fat. Diets high in these nutrients are associated with an increased risk of chronic disease.[4] - Smoked foods also contain nitrosamines, which are known carcinogens and may contribute to the risk of developing cancer.[11]
	Fish	- All plain, whole or filleted, fresh and frozen fish that is unprocessed and compliant with the South African Sustainable Seafood Initiative (SASSI) www.wwfsassi.co.za[10]	- Crumbed, battered - Seasoned, flavoured, smoked, salted, pickled, curried fish - Processed fish - Fish that are not SASSI compliant www.wwfsassi.co.za[10]	- Fish in sauces, batter, or prepared meals as well as smoked, salted and processed fish products are often high in salt, total fat and/ or saturated fat. Diets high in these nutrients are associated with an increased risk of chronic disease.[4] - Smoked foods also contain nitrosamines, which are known carcinogens and may contribute to the risk of developing cancer.[11] - Nitrate or nitrite, which are used to cure some foods, are also carcinogenic.[11] - To ensure the HealthyFood™ benefit is implemented in line with current recommendations for environmental conservation, the decision was made to comply with the South African Sustainable Seafood Initiative (SASSI). One of the main objectives of SASSI is to "shift consumer demand away from over-exploited seafood species to more sustainable options".[10]
	Tinned fish	- All tuna and salmon in sachets or cans in brine or oil or dressing - Tinned pilchards in oil, brine, spring water, tomato sauce or chilli tomato sauce - Mackerel; sardines; herring; middlecut	- Those with other ingredients such as mayonnaise - Curried, pickled, smoked, mayonnaise,	- Fish is an excellent protein source.[1] - The SAFBDG recommend two to three servings of fish a week, preferably dark fatty marine fish such as mackerel or pilchards.[1] - Although tinned products generally have sodium (salt) added, in the case of fish, tinned fish is economical and convenient and therefore has

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
				been included to encourage South Africans to increase their intake of fish. - Population guidelines state that canned fish can be included[2] and are economical and healthy options.[1]
	Ostrich	- Plain ostrich, fresh or frozen - Plain ostrich mince	- Ostrich with salt, spices, seasoning, flavouring, herbs, fat/ oil, sauces added. - Ostrich in pre-prepared meals, smoked, salted and processed ostrich	- Ostrich in sauces, batter, or prepared meals as well as smoked, salted and processed ostrich products are often high in salt, total fat and/ or saturated fat. Diets high in these nutrients are associated with an increased risk of chronic disease.[4] - Smoked foods also contain nitrosamines, which are known carcinogens and may contribute to the risk of developing cancer.[11]
	Turkey	- All plain, unseasoned, fresh and frozen, skinless turkey	- Turkey with skin - Crumbed, battered - Turkey with salt, spices, seasoning, flavouring, herbs, fat/ oil, sauces added - Turkey in pre-prepared meals, smoked, salted and processed turkey	- Turkey in sauces, batter, or prepared meals as well as smoked, salted and processed turkey products are often high in salt, total fat and/ or saturated fat. Diets high in these nutrients are associated with an increased risk of chronic disease.[4] - Smoked foods also contain nitrosamines, which are known carcinogens and may contribute to the risk of developing cancer.[11]
	Red meat (beef, pork, lamb, game, venison)	- No red meat is included	- All red meat is excluded (fresh, frozen, smoked, salted, biltong, processed, cold meats, canned)	- The SAFBDG recommend that individuals eat no more than 560 g of red meat a week.[1] On average South Africans eat more than this recommended amount[1] and therefore, although lean red meats can form part of a healthy, balanced diet in an attempt to implement the SAFBDG and convey the correct health messages, and assist South Africans in achieving this goal, we have not included red meat. We do however provide alternative protein options such as skinless chicken, fish and ostrich.
	Shellfish (prawns, shrimp, lobster, crayfish, crab, oysters, mussels, clams), calamari, squid, octopus	- No shellfish or calamari, squid or octopus are included	- All shellfish, calamari, squid or octopus are excluded	- These foods are all significant sources of cholesterol and eating foods high in cholesterol can cause higher blood cholesterol levels and increase the risk of coronary heart disease. For this reason, dietary guidelines suggest limiting the intake of foods high

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
				in cholesterol.[5] The World Health Organization recommends a dietary cholesterol intake of less than 300 mg a day for the general population.[4]
	Organ meat/ offal (kidneys, livers, tripe)	- No organ meats or offal are included	- All organ meats/ offal are excluded	- These foods are all significant sources of cholesterol and eating foods high in cholesterol can cause higher blood cholesterol levels and increase the risk of coronary heart disease. For this reason, dietary guidelines suggest limiting the intake of foods high in cholesterol.[5] The World Health Organization recommends a dietary cholesterol intake of less than 300 mg a day for the general population.
	Tofu	- Plain, raw, unflavoured	- Flavoured, seasoned - Cooked or pre-prepared	- Tofu is a good source of calcium[3,4] and protein.[1]
5. Dairy and dairy alternatives	Milk	- Fat-free (Skim) fresh, long-life, UHT, powdered	- Low-fat; Full-cream; flavoured	- Dairy products are major sources of calcium and protein and have an important part to play in the diet.[4] For the adult population, both low fat and fat-free products are considered to be acceptable.[3,5] Low fat dairy products contain more saturated fat than fat-free products and because we are advocating the best choice within each food group, only fat-free dairy products are included at this stage. - Full cream dairy products contain more saturated fat than fat-free products and are therefore excluded.[5]
	Yoghurt	- Fat-free plain and flavoured	- Low fat; Full cream - Drinking yoghurts	- As above - No drinks are included.
	Cheese	- All fat-free plain and flavoured cottage cheeses are included -	- All low-fat and full fat cottage cheese is excluded - All other cheeses are excluded	- Research has shown that a high saturated fat intake is associated with the development of cardiovascular disease. Saturated fat has negative effects on blood lipid levels, increasing total cholesterol and LDL-cholesterol levels. This can put one at risk of developing atherosclerosis and coronary heart disease.[4] International and local dietary guidelines suggest limiting saturated fat in the diet.[1-5] The majority of the cheeses available contain significant amounts of

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
				saturated fat and are therefore excluded.
	Maas, buttermilk	- No maas or buttermilk are included	- All maas and buttermilk are excluded	- No fat-free or skim maas or buttermilk available.
	Soya milk and soya yoghurt	- Plain soya milk (unflavoured, unsweetened), including fresh, long life and powdered - Plain and flavoured and/ or sweetened soya yoghurt	- Flavoured and/ or sweetened soya milk	- Soya milk and yoghurt are a good source of protein.[1]
6. Lentils and legumes	Canned and bottled	- In brine, tomato sauce, chilli tomato sauce	- Curried, pickled, bean salad, chakalaka	- SAFBDG: "Eat dried beans, peas, lentils and soy regularly".[1] - Good source of protein and fibre as well as containing a variety of vitamins and minerals.[1,3,5] - Even though tinned/ canned, bottled legumes may contain added sodium(salt) the decision was made to include them based on the fact that they are an economical and practical means of encouraging more South Africans to include legumes in their diet.
	Dried	- All including sugar beans, butter beans, kidney beans, haricot beans, red speckled beans, chick peas, lentils, split peas, lupins, black eyed beans, soya beans	- Texturised or processed soya products (burgers, sausages etc)	- The South African Food-Based Dietary Guidelines recommend that individuals should eat dry beans, peas, lentils and soy regularly.[1] Although vegetarian products, such as burgers and sausages, are manufactured from soya beans the products also contain other ingredients which need to be considered with regards to their effect on health and in relation to what is currently recommended in population guidelines. Many of these types of vegetarian/ soya products available on the market exceed the recommended cut-offs for saturated fat and sodium (salt). International and local dietary guidelines stipulate that the intake of saturated fat and sodium should be limited.[15] Research has shown that both saturated fat and sodium intake are associated with the development of cardiovascular disease.[4] There are also no

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
				specific population guidelines relating to the eating of texturised or processed vegetarian products at this time.
	Hummus	- No hummus is included	- All hummus is excluded	- Although hummus is made from chickpeas, it has other ingredients added to it, including salt, and is considered a pre-prepared food item and therefore cannot be included. Research has shown that too much sodium can cause elevated blood pressure which is a risk factor for the development of cardiovascular disease (a leading cause of deaths worldwide) [4]
7. Oils, spreads, nuts and seeds	Oils	- Olive oil; canola oil; avocado oil	- Coconut oil, palm oil, palm kernel oil, sunflower oil, grape seed oil, sesame oil, flavoured olive oils, flavoured avocado oil	- The SAFBDG advise that mono-unsaturated fatty acids (MUFA) are the preferred choice of fats. [1] - There is convincing evidence to suggest a reduced intake of omega- 6 fatty acids, due to their pro-inflammatory nature, and subsequent association with heart disease, insulin resistance and insulin sensitivity. The main aim is for correcting the omega 6:3 ratio. Therefore, a reduced intake of poly-unsaturated fatty acids (PUFA) is advocated, with the aim of reducing the intake of omega 6 fatty acids.[9] Given SA's economical burden, however, other unsaturated fats are also approved. We have opted for phase 1 to only include MUFA-based spreads on the HealthyFood™ benefit.
	Spreads	- Olive oil spread; canola oil spread	- Butter, ghee, spreads made from sunflower oil	- As above - Spreads that have a high polyunsaturated, particularly omega-6 fatty acid, content are excluded because there is convincing evidence to suggest a reduced intake of omega- 6 fatty acids, due to their pro-inflammatory nature, and subsequent association with heart disease, insulin resistance and insulin sensitivity. The main aim is for

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
				correcting the omega 6:3 ratio. Therefore, a reduced intake of poly-unsaturated fatty acids (PUFA) is advocated, with the aim of reducing the intake of omega 6 fatty acids.[9]
	Sprays	- Olive oil spray	- Sunflower oil spray - Flavoured olive oil sprays	- As above
	Nuts	- Plain, raw, unsalted including almonds, hazel nuts, cashews, macadamia, peanuts, walnuts, pecan nuts, pine kernels, pistachios, chestnuts, brazil nuts	- Roasted (unless dry-roasted without oil) - Salted - Flavoured, seasoned - Chocolate- or candy-coated	- The SAFBDG advise that mono-unsaturated fatty acids (MUFA) are the preferred choice of fats. [1] - Not those that are salted or seasoned or roasted in oil as the SAFBDG state that individuals should "use salt sparingly" and "eat fats sparingly".[1]
	Seeds	- Linseeds, poppy seeds, pumpkin seeds, sesame seeds, sunflower seeds,	- Salted, flavoured, seasoned	- Not those that are salted or seasoned or roasted in oil as the SAFBDG state that individuals should "use salt sparingly" and "eat fats sparingly".[1]
	Peanut butter	- Unsweetened, no sugar added	- Peanut butter with sugar added	- Peanut butter contributes valuable mono-unsaturated fats to the diet, and the consumption of mono-unsaturated fat is encouraged by the SAFBDG.[1] - To comply with recommendations to lower overall sugar intake,[1,2,3,4,5] only sugar free peanut butter has been included onto the benefit.
	Mayonnaise and salad cream	- No mayonnaises or salad creams are included	- All mayonnaises and salad creams are excluded	- Usually made from polyunsaturated fat-based oils and the SAFBDG advise that mono-unsaturated fatty acids (MUFA) are the preferred choice of fats.[1] - There is convincing evidence to suggest a reduced intake of omega- 6 fatty acids, due to their pro-inflammatory nature, and subsequent association with heart disease, insulin resistance and insulin sensitivity. The main aim is for correcting the omega 6:3 ratio. Therefore, a reduced intake of poly-unsaturated fatty acids (PUFA) is advocated, with the aim of reducing the intake of omega 6 fatty acids.[9]

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
	Olives	- No olives are included	- All olives are excluded	- Although olives are a good source of monounsaturated fatty acids, the olives in bottles, packets and cans are high in salt. This can cause high blood pressure and increase the risk of cardiovascular disease. [4]
8. Other items				
8.1. Condiments and seasonings	Tomato sauce (ketchup), soya sauce, worchester sauce, bottled lemon juice, chilli sauce,	- No condiments, seasonings or spices are included	- All condiments, seasonings and spices are excluded.	- Currently there are no population guidelines for the use of condiments, other than to encourage populations to use salt sparingly. Many condiments have a high salt (sodium) content.[4]
8.2. Beverages	Carbonated drinks, juice concentrates, fruit / vegetable juices, cordials, squashes, Iced teas, sports drinks, energy drinks, powdered drinks, hot chocolate, tea, coffee, herbal teas, bottled water, drinking yoghurts, alcohol	- No beverages are included. (except for fat-free milk – see justification under section 5 "Dairy and dairy alternatives")	- All beverages are excluded (except for fat-free milk – see justification under section 5 "Dairy and dairy alternatives")	- There are no population guidelines for drinks, except for water, in South Africa. For this reason we've excluded all beverages at this time.[1] - While bottled water products provide convenience, tap water in South Africa is considered to be clean and safe. For this reason, although we encourage people to drink amounts of water, we have not included bottled water on the HealthyFood™ benefit at this time.
8.3. Artificial sweeteners		- No condiments, seasonings or spices are included.	- All condiments, seasonings and spices are excluded.	- Currently the use of artificial sweeteners in foods is regulated by the South African Department of Health and the amounts that manufacturers may use in food products is limited by food safety guidelines stipulated by current food legislation in South Africa. In our own country and internationally artificial sweeteners are subject to scientific scrutiny before they can be generally regarded as safe (GRAS) and in-turn used in the food manufacturing process. The Food and Drug Administration (FDA) has approved five non-nutritive sweeteners and regulates them as food additives: saccharin, aspartame, acesulfame potassium (or acesulfame K), sucralose, and most recently neotame. In South Africa the same sweeteners and cyclamate have been approved for use except neotame, which may be approved in the future.

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
				It is currently the position statement of the American Dietetic Association that consumers can safely enjoy a range of nutritive and non-nutritive sweeteners in a diet that is guided by current federal nutrition recommendations, such as the Dietary Guidelines for Americans and the Dietary References Intakes, as well as individual health goals. This statement is consistent with the position of the Association for Dietetics in Southern Africa.
8.4. Instant sauces, instant soups, cook-in sauces, dressings and flavourings		- No instant sauces, soups, cook-in sauces, dressings and flavourings are included.	- All instant sauces, soups, cook-in sauces, dressings and flavourings are excluded	- Many of these types of products may contribute to a higher fat, sodium (salt) and kilojoule intake which could lead the development of lifestyle related chronic diseases.[4] For this reason, none of these products are included at this time.
8.5. Pre-mixes, pre-prepared foods and ready-meals, convenience meals		- No pre-mixes, pre-prepared or ready-meals are included	- All pre-mixes, pre-prepared and ready-meals are excluded	- All pre-mixes, pre-prepared foods and ready-meals are currently excluded on the basis that at present there are no specific population guidelines available for these types of products. - We are aware that the South African Department of Health is currently developing criteria for a suitable nutrient profiling system. When available it is most probable that we will adopt these guidelines for assessing pre-prepared and convenience foods.
8.6. Disease-specific products; supplements; slimming products, meal replacements	Disease-specific products, nutritional supplements, slimming products, meal replacements and functional foods	- No disease-specific products, nutritional supplements, slimming products, meal replacements, functional foods are included	- All disease-specific products, nutritional supplements, slimming products, meal replacements, functional foods are excluded	- Although some disease-specific products and supplements may have some nutritional characteristics that may be of benefit to certain individuals, we do not select products independently of evidence-based scientific research and specified guidelines for whole population groups. - Currently all slimming products are excluded on the basis that there are no specific population guidelines for these products. We do not select products independently of evidence-based scientific research and specified guidelines for whole population groups.
8.7. Foods containing food additives	Any foods that contain food additives, such as colourants and	- At present foods are not excluded on the basis of the fact that they contain food additives, such as	- At present foods are not excluded on the basis of the fact that they contain food	- At present none of the dietary guidelines address concerns about food additives such as colorants and preservatives. In

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
	preservatives.	colourants and preservatives	additives, such as colourants and preservatives	time it is possible that international and local organizations may well address the subject of food additives in food as part of population dietary recommendations, however at this time there are no global population recommendations. We have therefore not considered food additives when making our selection of healthy foods. Nonetheless, we can say with confidence that our list of foods includes mostly fresh produce, and plain simple unprocessed foods, and as such, the number of food additives and preservative in these foods will be minimal.
8.8. Honey		- Honey is not included	- Honey is excluded	- Honey is made up of simple sugars namely glucose, fructose and some sucrose. High intakes of free sugars, including honey, are recognised by the World Health Organization as a significant dietary risk factor associated with an increased risk for chronic disease.[4] - Currently the SAFBDG and international organisations warn against the use of sugar, and population guidelines recommend that individuals minimise their intake of foods with added sugar.[1,2,3,5] In light of these recommendations we have decided not to include any foods that are high in sugar on the HealthyFood™ benefit. - While honey may have other characteristics which may be of benefit, the simple sugar content of honey cannot be ignored in terms of overall population guidelines.
8.9. Specialised milk formulas for small children (aged 12-36 months)		- No specialised milk formulas for small children (aged 12-36 months) are included	- All specialised milk formulas for small children (aged 12-36 months) are excluded	Currently all baby formulas are excluded, as the intention of the HealthyFood™ benefit is to increase the eating of healthy foods as based on the South African Food-Based Dietary Guidelines. While these products may have nutritional characteristics that may be of benefit to certain individuals we have not selected products for the Discovery Vitality HealthyFood™ benefit independent of evidence-based scientific research that relates to whole population groups. Current nutritional

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
				recommendations state that milk should no longer be the primary source of calories for children over the age of 12 months. A child's nutritional needs should be met through a well-balanced diet consisting of a variety of nutritious foods from each food group including normal pasteurised cow's milk and dairy products.
8.10 Low-glycaemic index (GI) products		- No products are currently included based only on the fact that they have a low glycaemic index.	- No products are currently included based only on the fact that they have a low glycaemic index	The GI is defined as the ranking of different dietary carbohydrates on their ability to raise blood glucose levels compared with a reference food (usually white bread or glucose). A food is considered to be low GI if the GI is less than 55, moderate GI if it is between 55 and 70 and high GI if it is greater than 70. Factors that influence the rate of digestion and absorption of a food, and hence the blood glucose response, determine the GI of the food. At present results of studies investigating the effect of the GI on various health outcomes have been inconsistent and therefore, no specific population guidelines regarding the use of low GI products are currently available. More research is needed, especially in terms of the long-term effects of consuming low GI diets, before blanket recommendations can be made for the greater population. Another important consideration is that fat delays the emptying of food from the stomach. Carbohydrate-rich foods, such as chocolate, are rendered low GI as a result of their high fat content. In contrast, pumpkin has a high GI, but this does not mean that chocolate is a better food choice than pumpkin. Diets high in fat, particularly saturated fat, can elevate cholesterol levels in the blood, which is a risk factor for developing atherosclerosis and heart disease. The amount of kilojoules the food contains as well as the fat, sugar, salt and fibre content should also be considered before making a decision to include a specific low GI food in the diet. The concept of the GI can be misleading as low GI foods are generally viewed as 'healthy' which may not always be the case. In terms of blood glucose control it is both

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
				the type and amount of carbohydrate that are important. Consumption of low GI foods, without consideration of the quantity or portion size can have a negative impact on regulation of blood glucose levels. It should be noted that certain low GI products have been included on the Discovery Vitality HealthyFood™ benefit. These foods satisfy the definition of a HealthyFood™ which is defined as a food that is nutrient-rich, low in saturated fat, added sugars, sodium(salt), and cholesterol, and devoid of trans fats. Based on this definition we are not able to include all low GI foods onto the Discovery Vitality HealthyFood™ Benefit.
9. Less desirable items				
Sweets, chocolate, ice-cream	Sweets, chocolates, ice-cream, jelly, chewing gum,	None included	None included	- SAFBDG: "Eat and drink food and drinks that contain sugar sparingly and not between meals."[4] - High intakes of free sugars are recognised by the World Health Organization as a significant dietary risk factor associated with an increased risk for chronic disease. [4] - Currently the SAFBDG and international organisations warn against the use of sugar, and population guidelines recommend that individuals minimise their intake of foods with added sugar. [1,2,3,5] In light of these recommendations we have decided not to include any foods that are high in sugar on the HealthyFood™ benefit . - According to the SAFBDG individuals should "Eat fats sparingly".
Sugary foods	Sugar, castor sugar, icing sugar, jam, honey, syrup, chocolate spreads, condensed milk, custard, lemon curd, sugar-coated cereals, sugar-coated popcorn	None included	None included	As above
Biscuits	Sweet biscuits, rusks	None included	None included	As above

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Food item category	Sub-category	Included / inclusion criteria	Excluded / exclusion criteria	Justification
High fat baked and fried items	Desserts and puddings, cakes, pastries, pies, croutons, pizza, quiches, muffins, scones, croissants, chelsea buns, pancakes, samoosas, doughnuts, spring rolls, pre-mixes, batters, cream, butter, coconut, coffee creamers, pork crackling, crisps	None included	None included	- According to the SAFBDG individuals should "eat fats sparingly" and "use salt sparingly".[1]

References : Discovery Vitality HealthFood™ benefit criteria.

1. South African Food-Based Dietary Guidelines
2. Food Standards Agency: Balance of Good Health. [Online] Available: http://www.food.gov.uk/multimedia/pdfs/bghbooklet.pdf
3. US Department of Health and Human Services. US Department of Agriculture. Dietary Guidelines for Americans, 2005. [Online] Available: www.healthierus.gov/dietaryguidelines
4. Joint WHO and FAO Expert Report on Diet, Nutrition and the Prevention of Chronic Disease. Executive Summary. March 2003.
5. Lichtenstein AH, Appel LJ, Brands M *et al*. Diet and Lifestyle Recommendations Revision 2006: a Scientific Statement from the American Heart Association Nutrition Committee. *Circulation* 2006; 114: 82-96. http://circ.ahajournals.org/cgi/content/full/114/1/82.
6. Regulation (EC) No 1924/ 2006 of the European Parliament and of the Council of 20 December 2006 on Nutrition and Health Claims Made on Foods.
7. The South African Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act 54 of 1972) – Regulations Relating to the Labelling and Advertising of Foodstuffs [Online] Available: http://www.doh.gov.za/docs/index.html
8. Discovery Mini Review on Cholesterol – including the following references

- Djoussé L and Gaziano MJ. Egg Consumption and Cardiovascular Disease and Mortality The Physicians' Health Study. *American Journal of Clinical Nutrition* 2008; 87(4): 964–969. including the following reference
- Willet WC. Eat, Drink, and Be Healthy - The Harvard Medical School Guide to Healthy Eating. *Chapter 4: Surprising News About Fats.* Simon & Schuster, New York. 2003.

9. Discovery Mini Review on Omega-3 Fatty Acids – including reference:

- Simopoulos, A., Leaf, A., Salem, N. Workshop on the Essentiality of and Recommended Dietary Intakes for Omega-6 and Omega-3 Fatty Acids. *Journal of the American College of Nutrition.* 1999. Vol. 18, No. 5, pp 487-489.

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10. South African Sustainable Seafood Initiative (SASSI) website: http://www.wwfsassi.co.za
11. Discovery Mini Review on Fish – reference: Grant, B. 2008. Medical Nutrition Therapy for Cancer, In: *Krause's Food & Nutrition Therapy*. Ed by Mahan, LK and Escott-Stump S. 12th edition. Philadelphia, Pennsylvania: W.B. Saunders, pp. 959-990.
12. Food Standards Agency. Front of Pack nutritional labelling technical guidance document. Available Online: http://www.food.gov.uk/multimedia/pdfs/frontofpackguidance2.pdf (accessed 23rd May 2010).

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Addendum 3: Personal Health Review Questionnaire (PHR)

Contact us
Tel: 0860 99 88 77, PO Box 784262, Sandton, 2146, www.discovery.co.za

Vitality Personal Health Review

Thank you for completing the Personal Health Review. The Personal Health Review will give you feedback about your lifestyle habits and health risks. Please answer all the questions in the Personal Health Review to allow us to give you an accurate assessment of your health risks and general wellness.

How to complete this form

1. Fill in the answers to all the questions to get the feedback and earn Vitality points. Please note that you will not earn any points if the form is not completed in full.
2. Fax the completed form to **011 539 7347.**

About yourself (main member)

First name

Surname

Discovery Health membership number

Discovery Vitality number

Identity number

About your spouse (complete this section only if your spouse is completing the Personal Health Review)

First name

Surname

ID number

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The Personal Health Review questions

1. Your medical history

Have you ever been diagnosed with any of the following medical conditions by a doctor or have you been prescribed medicine for any of them?

Allergies	Yes ☐	No ☐	High blood pressure	Yes ☐	No ☐
Arthritis	Yes ☐	No ☐	If **yes**, are you currently taking medicine to control your blood pressure?	Yes ☐	No ☐
Asthma	Yes ☐	No ☐	High cholesterol	Yes ☐	No ☐
Back pain	Yes ☐	No ☐	If **yes**, are you currently taking medicine to manage your cholesterol?	Yes ☐	No ☐
Cancer	Yes ☐	No ☐	Menopause	Yes ☐	No ☐
Chronic lung disease	Yes ☐	No ☐	Migraine headaches	Yes ☐	No ☐
Chronic pain	Yes ☐	No ☐	If **yes**, are you currently on treatment for migraine headaches?	Yes ☐	No ☐
Depression	Yes ☐	No ☐	Osteoporosis	Yes ☐	No ☐
Diabetes	Yes ☐	No ☐	If **yes**, are you currently on treatment for Osteoporosis?	Yes ☐	No ☐
If **yes**, what type of diabetes do you have?	Type 1 ☐	Type 2 ☐	Sleep disorder	Yes ☐	No ☐
Are you currently taking medicine to manage your diabetes?	Yes ☐	No ☐	If **yes**, are you currently on treatment for a sleep disorder?	Yes ☐	No ☐
Heartburn or acid reflux	Yes ☐	No ☐	Stroke	Yes ☐	No ☐
If **yes**, are you currently on treatment for heart burn?	Yes ☐	No ☐	If **yes**, are you currently on treatment for a stroke?	Yes ☐	No ☐
Heart disease	Yes ☐	No ☐	Thyroid disease	Yes ☐	No ☐
If **yes**, are you currently on treatment for heart disease?	Yes ☐	No ☐	If **yes**, are you currently on treatment for thyroid disease?	Yes ☐	No ☐

Do you have any other medical conditions? Yes ☐ No ☐

If **yes**, please provide more details about the condition(s).

Are you currently pregnant? Yes ☐ No ☐

2. Your family's medical history

Has anyone in your family (biological mother or father, brother or sister) been diagnosed with any of the following medical conditions?

Please choose all the conditions that apply.

Heart disease	Yes ☐	No ☐
Stroke	Yes ☐	No ☐
High blood pressure	Yes ☐	No ☐
High cholesterol	Yes ☐	No ☐
Diabetes	Yes ☐	No ☐
Cancer	Yes ☐	No ☐
Asthma	Yes ☐	No ☐
Chronic lung disease	Yes ☐	No ☐
Osteoporosis	Yes ☐	No ☐

3. Your key measurements

How tall are you? ☐ . ☐☐ **metres**

How much do you weigh? ☐☐☐ **kilograms**

What is your waist circumference? ☐☐☐ **centimetres** **Don't know** ☐

Please choose the option that best describes how you feel about your current weight

☐ You are happy with your weight

☐ You are not happy with your weight but have no intention of losing weight any time soon

☐ You would like to change your weight

Do you know your recent blood pressure readings? Systolic/Diastolic ☐☐☐ / ☐☐☐ ☐ Don't know

Do you know if it is ☐ High ☐ Normal ☐ Low ☐ Don't know

Do you know your total cholesterol level? ☐☐☐ mmol/l ☐ Don't know

Do you know if your total cholesterol level is ☐ High ☐ Normal ☐ Low ☐ Don't know

Do you know your high-density lipoprotein (HDL) level? ☐☐☐ mmol/l ☐ Don't know

Do you know your low-density lipoprotein (LDL) level? ☐☐☐ mmol/l ☐ Don't know

Do you know your triglyceride level? ☐☐☐ mmol/l ☐ Don't know

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3. Your key measurements *(continued)*

What is your random glucose level? ☐☐☐ mmol/l ☐ Don't know

Do you know if it is ☐ High ☐ Normal ☐ Low ☐ Don't know

Do you know your HbA1c level? ☐☐☐ % ☐ Don't know

Do you know if your HbA1c level is ☐ High ☐ Normal ☐ Low ☐ Don't know

4. Your smoking status

Do you use tobacco products like cigarettes, cigars or pipes?

☐ **No**, never used tobacco products

☐ **No**, but used to smoke tobacco products

☐ **Yes**, smoke or use tobacco products

If you are a smoker, how many cigarettes, tobacco products, cigars or pipes do you smoke on average a day? **Number** ☐☐☐

How long have you been a smoker or tobacco user? **Years** ☐☐ **Months** ☐☐

Please choose the option that best describes your smoking habits

☐ Have no intention of stopping smoking

☐ Would like to stop smoking but not now

☐ Want to give up smoking and need help to stop smoking

If you used to smoke, how many cigarettes, tobacco products, cigars or pipes did you smoke on average a day? **Number** ☐☐☐

If you used to smoke, how many years has it been since you stopped? **Years** ☐☐ **Months** ☐☐

5. Your alcohol intake

How much alcohol do you drink in a week?

Number of drinks ☐☐☐

One drink is equivalent to:

One beer can (340 ml)
One small glass of wine (120 ml)
One metric tot of spirits (25 ml)
One small glass of sherry (50 ml)
One small glass of liqueur (30 ml)

6. Your eating habits

Please choose the meals you eat regularly during the day

Breakfast	Yes ☐	No ☐
Morning snack	Yes ☐	No ☐
Lunch	Yes ☐	No ☐
Afternoon snack	Yes ☐	No ☐
Dinner	Yes ☐	No ☐
Evening snack	Yes ☐	No ☐

How many servings of vegetables and fruit do you eat on average in a day? Number ☐☐

Which of the below best describes your eating habits?

You eat poultry such as chicken or turkey Yes ☐ No ☐

When you eat poultry you generally have it:

☐ Without the skin
☐ With skin

You eat red meat

☐ Never
☐ Less than twice a week
☐ More than or equal to twice a week

When you eat red meat you generally have

☐ Lean meat
☐ With fat

You eat oily fish like salmon, tuna, pilchards or herring

☐ Never
☐ Less than twice a week
☐ More than or equal to twice a week

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6. Your eating habits *(continued)*

How many times a week do you eat other fish like hake, kingklip or Kabeljou?

- ☐ Never
- ☐ Less than twice a week
- ☐ More than or equal to twice a week

You like to add the following to your food:

- ☐ Soft margarine
- ☐ Hard brick margarine
- ☐ Butter or fat
- ☐ Avocado pear
- ☐ Nuts and/or seeds
- ☐ Salad dressings or mayonnaise
- ☐ Olive oil and/or canola oil
- ☐ Sunflower oil and/or grape seed oil
- ☐ None

When you have dairy products such as milk, yoghurt and cheese, you generally choose:

- ☐ Low fat or 2% fat
- ☐ Full cream
- ☐ Skimmed or fat free
- ☐ You don't have dairy products

How many glasses of water do you drink a day?

Number ☐☐

You eat wholegrain products (such as wholegrain bread, cereal, oats, barley, millet, whole corn (mealies), wholegrain crackers, brown rice or wholewheat pasta)

- ☐ Less than three servings a day
- ☐ Three or more servings a day

How salty do you like your food?

- ☐ Very salty
- ☐ Lightly salted
- ☐ Not salted

How often do you eat any of the following – cakes, cookies, pastries, doughnuts, muffins, chocolate, regular ice cream, sweets or fruit gums?

- ☐ Often
- ☐ Sometimes
- ☐ Never

Fried foods like chips, fried chicken, donuts or fritters

- ☐ Occasionally or never
- ☐ Weekly
- ☐ Daily

Processed meats like polony, viennas and other deli meats

- ☐ Occasionally or never
- ☐ Weekly
- ☐ Daily

You eat fast foods:

- ☐ Occasionally or never
- ☐ Weekly
- ☐ Daily

Which statement best describes how you feel about your diet?

- ☐ You are happy with your diet.
- ☐ I know my diet needs improvement but I don't really want to change it now
- ☐ You want to change your diet, and would appreciate some help

7. Your physical activity levels

The following questions assess how much exercise you do in a week.

On average how many days a week do you exercise? ☐☐ days

On the days you exercise, on average:

- How many minutes do you exercise for? ☐☐☐ minutes
- How intense are your exercise sessions? ☐ Low ☐ Moderate ☐ High

Note: The talk test is an easy indicator of the intensity at which you are exercising.

- **Low intensity –** if you can sing several phrases of a song without breathing hard.
- **Moderate intensity –** if you can have a conversation and breathe comfortably.
- **High intensity –** if you have to take a breath between every word you say.

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7. Your physical activity levels *(continued)*

How often do you do strength exercises like push-ups, pull-ups, sit-ups, lifting free weights or using weight machines?

- ☐ Rarely or never
- ☐ Once or twice a week
- ☐ Three to five times a week
- ☐ Six to seven times a week

How often do you do flexibility exercise like stretching, yoga or Tai Chi?

- ☐ Rarely or never
- ☐ Once or twice a week
- ☐ Three to five times a week
- ☐ Six to seven times a week

On an average day, how many hours a day do you spend doing the following activities?

Sitting in meetings	☐☐	hours a day	minutes	☐☐
Sitting in front of your computer	☐☐	hours a day	minutes	☐☐
Watching television	☐☐	hours a day	minutes	☐☐

Which statement best describes your exercise habits?

- ☐ You are happy with the amount of exercise you are doing
- ☐ You know your fitness level has to improve, but you don't really want to exercise more right now
- ☐ You want to increase your exercise and level of fitness, and would appreciate some help

8. Your stress levels

During the last 30 days, about how often did you:

feel tired out for no good reason?

- ☐ All the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ Not often
- ☐ Never

feel nervous?

- ☐ All the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ Not often
- ☐ Never

feel so nervous that nothing could calm you down?

- ☐ All the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ Not often
- ☐ Never

feel hopeless?

- ☐ All the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ Not often
- ☐ Never

feel restless or fidgety?

- ☐ All the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ Not often
- ☐ Never

feel so restless you could not sit still?

- ☐ All the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ Not often
- ☐ Never

feel depressed?

- ☐ All the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ Not often
- ☐ Never

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8. Your stress levels *(continued)*

feel that everything was an effort?

- ☐ All the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ Not often
- ☐ Never

feel so sad that nothing could cheer you up?

- ☐ All the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ Not often
- ☐ Never

feel worthless?

- ☐ All the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ Not often
- ☐ Never

Which statement best describes your perception of your stress?

- ☐ You feel that you are coping fine with your current level of stress.
- ☐ You feel stressed, but don't feel the need to do anything about your stress levels.
- ☐ You want to manage your stress better and would appreciate some help.

9. Your productivity

Please answer the following questions about how your wellbeing affects your daily activities.

In the last 28 days, how many days did you:

Miss a work day because of problems with your physical or mental health? Please include only the days you missed for health reasons.

Days ☐☐

Miss an entire work day for any other reason, including vacation?

Days ☐☐

Experience problems with your physical or mental health that affected your ability to do your work?

Days ☐☐

How would you describe your overall health over the last year?

☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor

10. Declaration

I confirm that the answers to the question are true and correct.

Signature ☐

Addendum 4: Personal Health Review (PHR): Sample Report for Member

Vitality Personal Health Review

Dear Anne Mary

Thank you for completing the Vitality Personal Health Review! To become as healthy as you can be, you need to know how healthy you are.
Here is a brief summary of your health indicators and lifestyle habits.

Your Vitality Age is calculated using your Body Mass Index (height and weight), smoking status, physical activity levels, daily fruit and vegetable intake and cholesterol levels.
This value is an estimate of your risk for developing lifestyle-related conditions for your age. Your Vitality Age is **42.**

Well done! You are younger than your last birthday suggests.

Health indicators and lifestyle habits

	Your results	What your goal is
Weight	69 Kilograms	52.84 - 71.4
Height	1.69 Meters	
Body Mass Index (BMI)	24.2	Between 18.5 and less than 25
Waist circumference	74 centimeters	Less than 88 cm
Blood pressure (non-diabetic)	105/74 mmHg	Less than 140/90 mmHg
Total cholesterol	4.3 mmol/l	Less than 5 mmol/l
Random glucose	4.2 mmol/l	Less than 6.1 mmol/l
Tobacco Use status	Used tobacco before	Not a tobacco user
Physical activity	240 minutes of physical activity each week	At least 150 minutes each week (5 sessions of 30 minutes each week)
Sedentary behaviour	5 hours of inactive behaviour	Less than 10 hours each day
Nutrition	Vegetables and fruit intake: 8 portions per day	At least 5 portions of vegetables and fruits daily
Alcohol	0 drinks a day	One or less than one drink a day

General Comments

Family history	Although you have a family history of diabetes, high blood pressure and high cholesterol which puts you at greater risk of developing this condition yourself, there are ways in which you can help to prevent or delay the onset. You can focus on healthy lifestyle behaviours like keeping active and following a healthy diet. It is also important that you visit your doctor for regular check-ups.
Snacking patterns	You snack between meals. Controlled snacking is not bad for you and may even be healthy. Excessive snacking should be avoided to prevent gaining weight and developing a risk for disease. If you do snack, choose healthy varieties like fresh fruit, raw vegetables, wholegrain crackers, low-fat dairy products and controlled amounts of nuts and lean protein foods.
Oily fish	You seldom or never include oily fish in your diet. Oily fish is very healthy and is an important source of essential omega-3 fatty acids. As part of a healthy, balanced diet, you should try to include at least two servings of oily fish in your diet each week.
Other fish	Well done! You eat two or more servings of fish (other than oily fish) a week. Fish is a good source of lean protein, unsaturated fat and usually has a low total fat content.
Red meat	Well done. You eat red meat twice or less than twice a week. Although lean red meat can be included in a healthy, balanced diet, eating red meat regularly may contribute to your overall fat intake. The fat in red meat is at least 50% saturated (hard fat). Saturated fat is linked to an increased risk for chronic diseases like coronary heart disease, obesity, high blood pressure, diabetes and cancer. Aside from the fat content, eating red meat frequently is also linked to an increased risk for colorectal cancer. That's why you should always try to limit your red meat intake to twice a week and choose lean cuts of meat, trimmed of all visible fat before you cook it.
Spreads oils and dietary fats	You usually use salad dressings and mayonnaise. Salad dressings and mayonnaise can contribute to a higher fat and kilojoule intake which can lead to unnecessary weight gain and risk for chronic disease. To better control your overall fat and kilojoules intake you should try to reduce your intake of salad dressings and mayonnaise. Speak to your dietitian for ideas on what you can do to cut down on these foods but still keep your diet interesting and varied.
Spreads oils and dietary fats	Olive oil and canola oil are good sources of mono-unsaturated fat. It is important to include mono-unsaturated fats in a healthy proportion to the other fats (saturated and polyunsaturated) and macronutrients (protein and carbohydrates) in your diet.
Milk and milk products	Well done! You choose low fat (2%) milk and milk products. These dairy products are good sources of calcium, vitamin D and certain B-vitamins.
Water intake	You drink four to six glasses or cups of water a day. It is important that you drink more water every day in order to keep your body well-hydrated. Try to drink at least six to eight glasses or cups of water a day.
Whole grain products	You sometimes include less than three servings of whole grains in your daily diet. Research has shown that eating three or more servings of whole grains every day can reduce your risk of several chronic diseases and may even help you keep a healthy weight. Try to include whole grains in your diet more regularly.
Sugar: Cakes, cookies, pastries, donuts, muffins, chocolate, regular ice-cream, sweets, fruit gums	Well done! You never eat cakes, cookies, pastries, donuts, muffins, chocolates, ice-cream and other sweets. Many of these types of foods are high in fat and sugar. You should try to limit your intake of sugar and sugary foods as far as possible.
Fried foods	You rarely eat deep-fried foods. This is good, because eating deep-fried and fatty foods regularly contributes to a high-fat diet and a high kilojoule intake which poses certain health risks. You should continue to make healthy choices and not choose fried foods.
Processed meat	Well done! You eat high-fat, processed meats either occasionally or never. These

	foods are linked to an increased risk for lifestyle-related disease. You should continue to make healthy choices and not choose processed meat.
Salt	You tend to eat food that is lightly salted. Because too much salt is not good for you as it poses certain health risks, it is important to try to keep your salt intake low. Therefore, salty foods should be limited, and ideally, you should not add salt to foods at all.
Fast foods	You occasionally or never eat fast foods. This is great, because eating deep-fried and fatty foods regularly contributes to a high-fat diet and a high kilojoule intake which poses certain health risks. Continue making the healthy choice of not having fast foods.
Eating habits	You are happy with your current diet and your eating choices. Be sure that your diet keeps up with current best-practice dietary guidelines, visit the Discovery website.
Physical activity - strength exercises	Muscular strength and endurance will have a direct impact on your ability to perform daily living activities. Try doing some strength-training exercise once or twice a week. You don't have to visit the heavy weights section of your gym to enjoy the benefits of stronger muscles. Start off with simple body weight exercises or use very light weights. You may want to consider seeing a personal trainer for some advice on where to start. Increased muscle strength not only makes you look more toned, it also reduces your risk of developing chronic conditions such as osteoporosis, lower back pain, hypertension or diabetes.
Physical activity - flexibility exercises	Inflexibility and reduced muscle strength often have a negative impact on your ability to do activities of daily living without difficulty. Inflexible muscles and joints are also more prone to injuries. You should do slow, controlled stretches without bouncing. You'll feel a slight pull in the muscle you are stretching, but should never stretch it into severe discomfort. Try to follow a stretching routine two or three days a week.

For more information on making healthy choices, please visit www.discovery.co.za

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Addendum 5: Copy of Publication : Kant and Colleagues

Supplemental Material can be found at:
http://jn.nutrition.org/cgi/content/full/jn.109.104505/DC1

The Journal of Nutrition
Nutritional Epidemiology

Patterns of Recommended Dietary Behaviors Predict Subsequent Risk of Mortality in a Large Cohort of Men and Women in the United States[1–3]

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Abstract

Recommendations for intake of fruits and vegetables, whole grains, lean meats, and low-fat dairy form the underpinning of dietary guidance for health promotion. We examined the association of a summary index of food consumption behaviors compatible with the spirit of prevailing dietary guidance and mortality. We used data from the NIH-American Association of Retired Persons cohort (n = 350,886), aged 50–71 y and disease free at baseline in 1995–1996, to examine the association of a dietary behavior score (DBS) with mortality after 10.5 y of follow-up (deaths, n = 29,838). The DBS included 6 equally weighted components derived from responses to questions on usual dietary behaviors related to consumption of fruits, vegetables, low-fat dairy, whole grains, lean meat and poultry, and discretionary fat. The covariate-adjusted association of DBS and mortality from all causes, cancer, and coronary heart disease was examined using Cox proportional hazards regression methods. Compared with those in the lowest one-fifth of DBS, the multivariate-adjusted relative risk of mortality in the highest one-fifth of the DBS was 0.75 (95% CI, 0.70–0.80) in women and 0.79 (95% CI, 0.75–0.83) in men (P-trend < 0.0001). The inverse association of DBS and mortality was significant in both genders in nearly all categories of covariates. Similar trends were observed for DBS associations with mortality from cancer and heart disease. Nearly 12% of the covariate-adjusted population risk of mortality was attributable to nonconformity with dietary recommendations. Adoption of recommended dietary behaviors was associated with lower mortality in both men and women independent of other lifestyle risk factors. J. Nutr. 139: 1374–1380, 2009.

Introduction

Recent interest in understanding the association of health outcomes and dietary patterns reflects the increasing recognition of the multidimensional nature of diets consumed by free-living populations (1–3). The intent of the dietary pattern approach is to examine multiple food group and nutrient characteristics of the diet as a single exposure. Most published reports have used 1 of 2 methods to characterize dietary patterns: diet indexes or scores based on compliance with current dietary guidance, or empirically derived combinations of foods or nutrients from factor or cluster analysis (1–3). Complex dietary indexes such as the Healthy Eating Index and the Diet Quality Index, which evaluate diets for meeting quantitative goals for several individual nutrients and food groups, have generally shown weak or no association with major chronic diseases or mortality in U.S. cohorts (4–6). Dietary patterns based on characteristics of the Mediterranean diet were shown to predict all-cause mortality in European cohorts (1,7,8) and in the US (9). We and others found relatively simpler indexes that capture the spirit of dietary guidance to predict mortality in a screening cohort (10) and in 3 national cohorts (11–14). Data-driven dietary patterns from factor or principal components analysis predicted mortality in European, Japanese, and Chinese cohorts (1,15,16), but results were inconsistent in a national U.S. cohort (11). Cluster analysis-derived patterns did not predict mortality in a national U.S. cohort (11).

In the present study, we used a different approach to assess healthy diet patterns. With the continuing debate about possible limitations of FFQ to accurately determine dietary exposures, we wanted to avoid determination of dietary patterns using prevalent approaches based on frequency of consumption and amounts consumed of a large number of individual foods and nutrients (17–20). Also, given the evidence of the gap between dietary recommendations and self-reported dietary intakes

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[3] A Supplemental Appendix and Supplemental Tables 1 and 2 are available with the online posting of this paper at jn.nutrition.org.
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reported in national surveys in the US (21–24), it appears unlikely that the average consumer can understand and implement complex dietary guidance that includes numerical goals for nutrient and food group intake. Therefore, rather than focus on health characteristics of individual foods/nutrients and their reported amounts to assess overall dietary patterns, we focused on responses to global questions about key dietary behaviors to identify healthy dietary patterns. Consistent with our previous approaches (10,12,13) and in agreement with the proposal of Kristal et al. (18), we hypothesized that recall of usual dietary behaviors may be less prone to recall errors than specific types and amounts of foods; therefore, individuals who report adoption of food selection and consumption behaviors compatible with the spirit of the dietary guidance will have healthier diet patterns. In this study, we report on the association of one such indicator with the risk of mortality from all causes and specific major causes in a large cohort of American men and women.

Methods

The NIH-American Association of Retired Persons (AARP)[7] Diet and Health Study was initiated in 1995–1996 to address several methodological problems that affect the interpretability of results obtained from epidemiologic studies of diet and cancer (25). The Special Studies Institutional Review Board of the National Cancer Institute approved the study and all participants provided written consent. Baseline questionnaires were returned by 617,119 AARP members, aged 50–71 y, residing in 6 U.S. states (California, Florida, Louisiana, New Jersey, North Carolina, and Pennsylvania) and 2 metropolitan areas (Atlanta and Detroit). The vital status of cohort members was ascertained via annual linkage to the Social Security Administration's Master Death File on deaths in the United States through December 31, 2006. Relative accuracy of this data set for ascertainment of mortality status has been reported to be 89–96% (26–28). The underlying cause of death was determined by linkage with the National Death Index Plus of the National Center for Health Statistics.

Dietary behavior score. The baseline questionnaire completed by the participants included a FFQ developed after extensive cognitive testing and calibration against 2 24-h dietary recalls (25,29–31). The FFQ queried about usual consumption of 124 food items over the past 12 mo. Also included were several questions on dietary behaviors pertaining to usual food group and fat intake. The FFQ defined "usual" as more than half the time. The dietary behavior score (DBS) developed for this study was mostly derived from responses to behavioral questions and reflects the key recommendations about intake of fruits, vegetables, whole grains, low-fat dairy, and low-fat meats of the Dietary Guidelines for Americans (32). The DBS included the following 6 categories: servings of vegetables (excluding salads and potatoes) consumed per week; servings of fruit (excluding juice) consumed per week; usual consumption of whole-grain cereals and breads as such or in sandwiches; usual consumption of lean meat and poultry without skin; usual consumption of low-fat dairy as a drink or in cereal; and usual practice of addition of solid fat after cooking or at the table to a number of commonly consumed foods (pancakes, waffles, French toast; potatoes; rice; pasta; cooked vegetables; and gravy to meat). There were no global behavior queries about cereal and milk use; we used responses to FFQ items on types of cereals and milk usually consumed to derive these components. We made all decisions about the potential DBS components and their scoring prior to the examination of any outcomes. The score for each individual component ranged from 0 to 6; the DBS was the sum of the scores of the individual components and ranged from 0 to 36. Further details about the 6 DBS components are provided in the Supplemental Appendix.

[7] Abbreviations used: AARP, American Association of Retired Persons; CHD, coronary heart disease; DBS, dietary behavior score; ICD, International Classification of Diseases.

Covariate information. Demographic, anthropometric (self-reported height and weight), self-assessed overall health status, history of disease, and health-risk behavior information was reported by respondents in the self-administered, mailed questionnaire at baseline in 1995–96. From this information we created variables that may be related to our exposure and outcome.

Analytic cohort. After exclusions for incomplete questionnaires, withdrawals, death, and move before entry, 566,402 respondents remained eligible for inclusion in our study. From this eligible cohort, we excluded: questionnaires completed by proxies (15,760); respondents with any self-reported cancer, except nonmelanoma skin (51,125); self-reported diabetes, stroke, or heart disease at baseline (100,523); poor self-reported overall health (8366); self-reported end-stage renal disease (769); death at entry (3); those with 1 or more errors or ≥5 missing responses on questions contributing to the estimation of the dietary exposure variable (25,510); and outliers (defined as individuals with >2 times the sex-specific interquartile ranges of Box-Cox log-transformed values of these variables) for energy intake (2731) and BMI (10,729). With these exclusions, the final analytic cohort comprised 199,874 men and 151,012 women.

Statistical analysis. The person-time (in years) was calculated from the date of return of the initial questionnaire in 1995–1996 to date of death or December 31, 2006, whichever came first. We used Cox proportional hazards regression analyses with age at entry as the underlying time metric to examine the independent association of DBS with sex-specific, age-adjusted, and multivariate-adjusted risk of mortality. The analyses used the PROC PHREG procedure in the SAS software package (version 9.1.3, SAS Institute). We categorized the DBS into quintiles based on its distribution in the entire analytic cohort, and the risk of mortality in each of the upper quintiles was compared with the risk in the first quintile. The tests for DBS-associated linear trend modeled DBS quintiles as a trend variable, as median DBS for each quintile as a trend variable, and as a continuous variable. All trends were very similar; the results presented are for the DBS quintiles as a trend variable.

All covariates in regression models were decided apriori based on known associations of these factors with diet and health. Multivariate regression models included: race-ethnicity, level of education, smoking status, level of physical activity, alcohol use, BMI, exogenous hormone use in women, and energy intake. To determine whether the association of DBS and mortality was modified by covariates, we also examined DBS and mortality associations stratified by categories of these covariates. We used the likelihood ratio test statistics to compare models with and without the cross-product of DBS and each covariate to test for interaction of DBS with the covariates mentioned above. The possibility of bias due to reverse causation was examined by stratifying follow-up time to identify events occurring in the first 5 y or after 5 y of follow-up. We also examined DBS and mortality association with adjustment for supplement use; results were similar to those included in the tables (without this adjustment). We determined the multivariate-adjusted population risk of all-cause mortality attributable to dietary moderation from Cox proportional hazards regression models (33).

We also examined the association of DBS with mortality from specific causes. The person-time (in years) was calculated from the date of return of the initial questionnaire in 1995–1996 to date of death or December 31, 2005, for death from cancer, coronary heart disease (CHD), and all other causes. The all-sites cancer mortality included all malignant cancers (International Classification of Diseases or ICD-9 codes 140–208 or ICD-10 codes C00–97); CHD included ICD-9 codes 410–414, 429.2, or ICD-10 codes I20–25. Analytic procedures followed were similar to those mentioned above.

Results

Respondents with higher DBS were slightly older, more likely to be non-Hispanic White, had lower BMI, were college graduates, more physically active, and were less likely to be current smokers (Table 1). DBS was a strong correlate of nutrient intake

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TABLE 1 Characteristics of men and women in the NIH-AARP cohort by quintiles of DBS

	Men					Women				
	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
Range	0–18	18.25–22.75	23–26	26.25–29.0	29.25–36.0	0–18	18.25–22.75	23–26	26.25–29.0	29.25–36.0
Median	15	20.7	24.5	27.5	31	15	21	24.5	27.5	31
n	45,995	44,333	41,216	35,984	32,346	23,810	27,255	30,948	32,526	36,473
Mean y of follow-up	10.05	10.17	10.22	10.27	10.31	10.19	10.29	10.33	10.36	10.39
Non-Hispanic White, %	90.5	93.2	94.0	94.8	94.8	86.2	90.1	91.5	92.7	93.5
Non-Hispanic Black, %	4.3	2.6	2.0	1.5	1.3	8.5	5.4	4.3	3.5	2.7
Hispanic, %	2.5	1.8	1.5	1.4	1.5	2.4	1.9	1.7	1.5	1.5
Others,[1] %	1.7	1.5	1.8	1.6	1.5	1.5	1.5	1.6	1.3	1.2
Baseline age 50–55 y, %	21.8	20.0	18.8	18.0	17.1	24.2	21.3	20.0	19.1	17.8
Baseline age 56–60 y, %	25.8	25.5	24.9	25.1	24.6	26.3	26.1	25.1	25.1	24.6
Baseline age 61–65 y, %	28.4	28.7	29.3	28.9	29.7	28.0	28.7	29.2	29.6	28.9
Baseline age 66–70 y, %	24.0	25.8	26.9	27.9	28.5	21.5	23.8	25.6	26.1	28.7
College and Postgraduate, %	33.2	44.2	49.9	55.1	60.6	18.7	26.6	31.8	36.5	41.7
Current smokers, %	20.4	12.3	8.0	6.0	4.0	28.8	18.5	12.6	9.8	7.1
BMI < 25, %	28.7	27.8	29.9	33.1	38.2	44.2	44.3	45.4	47.7	52.6
BMI 25–29.9, %	50.1	51.9	51.4	49.9	48.1	32.2	33.3	33.3	33.6	31.7
BMI ≥ 30, %	21.2	20.3	18.7	17.0	13.7	23.6	22.4	21.2	18.7	15.7
No physical activity, %	4.9	2.8	2.0	1.4	1.0	10.3	6.0	4.0	3.0	2.1
Physical activity ≥ 3–4 times/wk, %	37.2	44.9	50.8	57.2	64.5	26.3	33.9	41.4	47.3	56.5
Postmenopausal, %						92.9	93.0	92.6	92.8	93.0
Never used hormones, %						51.7	47.9	43.6	41.4	40.6

[1] Others include Asian, Pacific Islanders, and American Indians.

estimated from the FFQ (Table 2). DBS was an inverse correlate of total and saturated fat and alcohol intake but a positive correlate of estimated intakes of fiber, carotene, folate, vitamin C, potassium, and calcium ($P < 0.0001$). The DBS was a weak inverse correlate of energy intake in men only. The maximum scores on added solid fat and whole-grain components of DBS were reported by the smallest percentage of the cohort (<10% for added solid fat and <20% for whole grain), whereas maximum vegetable and fruit scores were reported by >60% of the cohort (Table 3).

All-cause mortality. Over a median follow-up of 10.55 y (total of 3,596,491 person-years), there were 19,435 deaths due to all causes among men and 10,403 deaths among women in the analytic cohort. In age-adjusted models, men and women in the highest one-fifth of the DBS had ~50% (95% CI, 0.49–0.54)

TABLE 2 Age, BMI, and daily dietary nutrient intakes of men and women in the NIH-AARP cohort by quintiles of DBS[1]

	Men						Women					
	Q1	Q2	Q3	Q4	Q5	Pearson r^2	Q1	Q2	Q3	Q4	Q5	Pearson r^2
Range	0–18	18.25–22.75	23–26	26.25–29.0	29.25–36.0		0–18	18.25–22.75	23–26	26.25–29.0	29.25–36.0	
n	45,995	44,333	41,216	35,984	32,346		23,810	27,255	30,948	32,526	36,473	
DBS	15	20.7	24.5	27.5	31		15	21.0	24.5	27.5	31	
Age, *y*	61.4	61.8	62.2	62.3	62.5	0.05	60.9	61.5	61.9	62.0	62.4	0.07
BMI, *kg/m²*	26.6	26.6	26.5	26.3	25.8	−0.07	25.8	25.8	25.6	25.3	24.8	−0.07
Energy, *kJ*	7950	7950	8004	7933	7803	−0.04	5908	6016	6155	6167	6165	0.002
Energy from fat, %	34.2	32.5	31.0	29.0	25.5	−0.35	34.8	32.7	30.6	28.6	24.8	−0.43
Energy from saturated fat, %	10.9	10.1	9.5	8.7	7.5	−0.37	10.8	10.0	9.2	8.6	7.3	−0.41
Alcohol, *g*	4.3	4.7	4.5	4.8	4.4	−0.09	0.9	1.1	1.1	1.1	1.1	−0.06
Fiber, *g*	14.0	17.0	19.0	21.0	23.0	0.35	11.1	13.8	16.0	17.6	19.7	0.35
Folate, *μg*	245	284	311	333	360	0.26	193	231	260	279	306	0.28
Vitamin C, *mg*	97	124	143	157	176	0.25	84	112	131	144	161	0.24
Vitamin E,[3] *mg ATE*	7.8	8.4	8.7	8.8	8.5	0.06	6.5	7.0	7.3	7.3	7.1	0.04
Carotene,[3] *μg RE*	420	553	656	755	896	0.26	394	554	690	802	983	0.27
Calcium, *mg*	598	661	704	755	868	0.19	472	535	590	651	789	0.27
Potassium, *mg*	2938	3208	3416	3593	3846	0.23	2361	2651	2884	3060	3359	0.28

[1] Values are medians.
[2] Pearsons's *r*: Correlation of the variable in a row with DBS as a continuous variable. All correlations except that of DBS with energy intake in women were significant at $P <$ 0.0001.
[3] ATE, α tocopherol equivalents; RE, retinol equivalents.

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TABLE 3 Percentage of men and women reporting minimum and maximum score on the 6 dietary behavior components in the NIH-AARP cohort by quintiles of DBS

	Men						Women					
	All	Q1	Q2	Q3	Q4	Q5	All	Q1	Q2	Q3	Q4	Q5
Range		0–18	18.25–22.75	23–26	26.25–29.0	29.25–36.0		0–18	18.25–22.75	23–26	26.25–29.0	29.25–36.0
n		45,995	44,333	41,216	35,984	32,346		23,810	27,255	30,948	32,526	36,473
						% with minimum score of 0						
Vegetable servings/d	9.8	32.3	7.8	2.5	0.6	0.1	8.2	35.9	9.8	3.1	0.7	0.05
Fruit servings/d	27.2	72.5	35.1	11.2	2.0	0.1	18.0	68.8	28.6	8.3	1.2	0.05
Usually consume lean meat	4.3	12.7	4.3	1.9	0.4	0.01	1.7	7.3	2.1	0.7	0.1	0.01
Usually consume low-fat dairy	12.9	32.3	14.4	7.6	3.4	0.6	12.8	35.9	20.1	11.7	4.6	0.8
Usually consume whole grains	7.7	20.7	7.8	5.1	1.1	0.1	6.4	21.4	8.5	5.6	1.4	0.1
Usually no added solid fat	8.3	16.0	10.7	7.1	3.7	0.6	7.2	16.8	11.3	7.6	3.9	0.5
						% with maximum score of 6						
Vegetable servings/d	72.4	33.9	66.7	83.7	92.8	97.9	77.5	31.8	65.0	83.1	93.0	98.3
Fruit servings/d	55.3	9.2	36.5	66.6	87.0	97.1	67.9	11.0	43.6	73.2	91.1	98.2
Usually consume lean meat	31.8	11.0	21.8	29.9	41.9	66.6	41.6	15.8	27.1	35.9	47.2	69.1
Usually consume low-fat dairy	32.1	14.3	24.6	31.2	39.3	61.1	33.9	11.8	20.0	26.2	36.7	62.7
Usually consume whole grains	16.6	4.6	9.1	16.1	21.0	39.8	18.2	4.3	7.6	13.8	18.6	38.6
Usually no added solid fat	6.4	1.4	2.6	4.1	7.1	20.9	8.4	1.4	2.8	4.5	7.0	21.6

lower risk of mortality than those in the lowest one-fifth. After adjustment for potential confounders, the risk estimate was attenuated and the relative risk was 0.75 (95% CI, 0.70–0.80) in women and 0.79 (95% CI 0.75–0.83) in men (χ^2 for trend in women = 83.8, men = 99.02; *P*-trend < 0.0001) (Table 4). Approximately 12% of the covariate-adjusted population risk of mortality was attributable to poor compliance with recommended dietary behaviors.

The association of DBS and mortality was stronger in respondents aged 56–71 y at baseline than in those aged 50–55 y and in non-Hispanic Whites than in other ethnic groups (Supplemental Tables 1 and 2). Given the small numbers of respondents with ethnicities other than non-Hispanic White or Black, the number of cases in these groups were small and DBS was not associated with the risk of mortality ($P > 0.05$). DBS and risk of mortality were inversely related in all categories of follow-up time, education, BMI, and smoking status in both men and women. DBS was not associated with the risk of mortality in men and women who reported no physical activity and no alcohol use ($P > 0.05$). In all other categories of physical activity and alcohol use, the DBS and mortality associations were inverse and significant ($P \leq 0.001$).

Cause-specific mortality. The multivariate-adjusted relative risk of mortality from all malignant cancers, CHD, and all other causes declined with increasing DBS in both men and women (*P*-trend ≤ 0.003) (Table 5). Compared with the lowest quintile of DBS, the risk of all-sites cancer mortality in the highest quintile was ~20% lower and was ~23–30% lower for CHD and all other causes of mortality.

Discussion

The results of this study suggest that reported adoption of recommended dietary behaviors consistent with prevailing dietary guidance was associated with 20–25% lower risk of mortality after 10 y of follow-up in older men and women. Relative to respondents reporting the least amount of desirable dietary behaviors (first quintile), the risk reduction was noted in all categories of DBS. These results suggest benefits of even small changes in dietary behaviors in the expected direction as well as higher reduction in mortality risk with greater compliance.

All methods for assessing diet contain substantial measurement error (34). The accuracy of ascertainment of dietary exposures using FFQ in particular has been the subject of recent debate (17–20). In a commentary on this topic, Kristal et al. (18) suggested that individuals may more reliably provide information on general dietary behaviors than "the frequencies and portion sizes of a long list of foods." The DBS in the present study represents that approach, because it does not require frequency (or quantity) of consumption of individual items in the FFQ. All score components use responses to global queries about usual intake. Other published assessments of a "healthful diet pattern" contain multiple food and nutrient components with quantitative cutoffs and benchmarks. Nevertheless, the extent of reduction in the risk of all-cause mortality in the present study was consistent with that reported from other studies that utilized different methods and detailed food or nutrient intake information to determine dietary patterns (1,7–16).

Most published indexes of diet quality and "healthy" dietary patterns show a positive association with micronutrient intake (1). Because both the dietary patterns and nutrient intakes are based on the same dietary measurement, the reported positive associations of dietary patterns with micronutrients are not surprising. The DBS, however, is derived from estimates of reporting of certain dietary behaviors and does not utilize the reported amount of individual foods or nutrients from the FFQ but nevertheless predicted intakes of dietary fat, fiber, and protective micronutrients in the expected direction. Unlike the often-observed positive association of dietary patterns with energy intake (1), the relative independence of the DBS and energy intake suggests that higher micronutrient intakes associated with the DBS are not merely a result of variations in the amount of food consumed (energy intake) but are due to higher nutrient density of diets.

Expectedly, lower BMI and health risk behaviors such as smoking and physical activity were clustered with desirable dietary behaviors in this cohort. However, it is unlikely that the observed DBS and mortality associations are accounted for by

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TABLE 4 Age-adjusted and multivariate-adjusted risk of all-cause mortality by quintiles of DBS in men and women in the NIH-AARP Diet and Health Study cohort[1,2]

	Men						Women					
	Q1	Q2	Q3	Q4	Q5	*P*-trend[3]	Q1	Q2	Q3	Q4	Q5	*P*-trend[3]
Range	0–18	18.25–22.75	23–26	26.25–29.0	29.25–36.0		0–18	18.25–22.75	23–26	26.25–29.0	29.25–36.0	
n	45,995	44,333	41,216	35,984	32,346		23,810	27,255	30,948	32,526	36,473	
Deaths, *n*	5884	4469	3778	2922	2382		2328	2101	2119	1924	1931	
Age-adjusted mortality rate[4]	1327	1004	887	771	686		1024	768	660	562	468	
Age-adjusted relative risk	1.0	0.75	0.66	0.58	0.51	<0.0001	1.0	0.74	0.64	0.54	0.47	<0.0001
95% CI		0.72–0.78	0.64–0.69	0.55–0.60	0.49–0.54			0.70–0.79	0.60–0.68	0.51–0.58	0.44–0.50	
Multivariate relative risk	1.0	0.90	0.88	0.83	0.79	<0.0001	1.0	0.90	0.87	0.80	0.75	<0.0001
95% CI		0.86–0.94	0.85–0.92	0.79–0.87	0.75–0.83			0.85–0.95	0.82–0.93	0.75–0.86	0.70–0.80	
Length of follow-up <5 y [*n* = 199,874 (men), 151,012 (women); deaths 6489 (men), 3296 (women)]												
Deaths, *n*	2044	1525	1230	945	745		787	654	637	594	624	
Multivariate relative risk	1.0	0.91	0.86	0.81	0.76	<0.0001	1.0	0.84	0.80	0.76	0.75	<0.0001
95% CI		0.85–0.97	0.80–0.93	0.75–0.88	0.69–0.83			0.76–0.93	0.72–0.89	0.68–0.85	0.67–0.84	
Length of follow-up ≥5 y [*n* = 192,732 (men), 147,251 (women); deaths 12,946 (men), 7107 (women)]												
Deaths, *n*	3840	2944	2548	1977	1637		1541	1447	1482	1330	1307	
Multivariate relative risk	1.0	0.88	0.88	0.82	0.79	<0.0001	1.0	0.91	0.88	0.79	0.71	<0.0001
95% CI		0.84–0.93	0.83–0.92	0.77–0.86	0.74–0.84			0.84–0.98	0.81–0.94	0.73–0.86	0.66–0.77	

[1] Values are relative risk estimates and 95% CI from Cox proportional hazards regression models.

[2] Multivariate models included: race (non-Hispanic white, non-Hispanic black, Hispanic, Asian/Pacific/Islander/American Indian/Alaskan native, unknown); education (<8, 8–11, 12 y, some college, college/postgraduate, unknown); 30-level smoking status (nonsmoker, former smoker, stopped ≥10 y ago, 1–10 cigarettes/d; former smoker, stopped ≥10 y ago, 11–20 cigarettes/d; former smoker, stopped ≥10 y ago, 21–30 cigarettes/d; former smoker, stopped ≥10 y ago, 31–40 cigarettes/d; former smoker, stopped ≥10 y ago, 41–60 cigarettes/d; former smoker, stopped ≥10 y ago, >60 cigarettes/d; former smoker, stopped 5–9 y ago, 1–10 cigarettes/d; former smoker, stopped 5–9 y ago, 11–20 cigarettes/d; former smoker, stopped 5–9 y ago, 21–30 cigarettes/d; former smoker, stopped 5–9 y ago, 31–40 cigarettes/d; former smoker, stopped 5–9 y ago, 41–60 cigarettes/d; former smoker, stopped 5–9 y ago, >60 cigarettes/d; former smoker, stopped 1–4 y ago, 1–10 cigarettes/d; former smoker, stopped 1–4 y ago,11–20 cigarettes/d; former smoker, stopped 1–4 y ago, 21–30 cigarettes/d; former smoker, stopped 1–4 y ago, 31–40 cigarettes/d; former smoker, stopped 1–4 y ago, 41–60 cigarettes/d; former smoker, stopped 1–4 y ago, >60 cigarettes/d; former smoker, stopped within last year, 1–10 cigarettes/d; former smoker, stopped within last year, 11–20 cigarettes/d; former smoker, stopped within last year, 21–30 cigarettes/d, former smoker, stopped within last year, 31–40 cigarettes/d; former smoker, stopped within last year, 41–60+ cigarettes/d; current smoker 1–10 cigarettes/d; current smoker 11–20 cigarettes/d; current smoker 31–40 cigarettes/d; current smoker 51–60 cigarettes/d; current smoker >60 cigarettes/d; unknown smoking status); BMI (<18.5, 18.5–24.9, 25–29.9, ≥30 kg/m^2); physical activity lasting ≥20 min and resulting in sweating or increased breathing and heart rate over the past 12 mo (never, rarely, 1–3 times/mo, 1–2 times/wk, 3–4 times/wk, ≥5times/wk); alcohol intake in g/d (0, 0.01–4.9, 5.0–14.9, ≥15); energy intake (quintiles); and in women only, hormone use (never used, current user, former user, unknown user).

[3] *P*-trend DBS quintiles as a trend variable, 1–5.

[4] Mortality rate is per 100,000 person-years and standardized to the age distribution of men and women in the AARP cohort.

confounding, as these associations were observed in virtually all BMI, smoking, and physical activity categories. However, similar to other such observational studies, all data were self-reported and thus are subject to reporting errors and possible misclassification. The extent to which our results reflect residual confounding due to poorly measured or unknown confounders cannot be determined from the available data.

The DBS was not associated with risk of mortality in race/ethnic groups other than non-Hispanic Whites and Blacks and those who reported no alcohol intake or who never exercised in the past year. At least 2 possible explanations for the lack of a DBS-mortality association in ethnic groups other than non-Hispanic Whites and Blacks can be considered. First, due to small number of Hispanics, Asians, Pacific Islanders, American Indians, and Alaskan natives in our cohort, the study may have insufficient power to examine the DBS-mortality association in these ethnic groups. Second, questions about food behaviors in the baseline FFQ may not be representative of culture-specific dietary patterns of these ethnic groups. The reasons for the lack of any DBS-associated risk reduction in respondents who reported that they never engaged in any physical activity or reported no alcohol intake are not clear. We can speculate that respondents without any physical activity may have such an aggregation of poor risk behaviors as to preclude the benefits of dietary moderation. And those reporting no alcohol intake in our study may include those with a previous history of heavy alcohol use. The possibility that respondents in categories of no physical activity and no alcohol use may be in poor health relative to other categories cannot be excluded.

Our analytical sample excluded all who considered their health to be poor or reported clinical conditions such as diabetes, cancer, and heart disease at baseline. Therefore, the possibility of reverse causation where higher mortality but poor dietary intakes in this group may account for the observed associations is not likely. We further explored the possibility of preclinical disease confounding the DBS-mortality association by stratifying follow-up time; the DBS mortality association remained virtually unchanged when follow-up was limited to deaths within the first 5 y or deaths after 5 y or later.

The large size of the AARP cohort is a strength of our study; however, the study cohort is more likely to be non-Hispanic White and has a higher level of education. The reference period for usual dietary behaviors and food intake queries in the FFQ was for the past 1 y. It is evident from the results that the profile of dietary behaviors over this time period among middle aged men and women was related to survival. Nevertheless, we are aware that there is likely to be variability in the duration of compliance to recommended dietary behaviors before the study baseline and some respondents may change their dietary behaviors over the ~10-y follow-up period. We were unable to examine the possible survival differential due to this variability. Some misclassification of respondents into DBS categories remains a possibility and may have attenuated the DBS-mortality associations. Finally, due to the large number of subgroup

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TABLE 5 Multivariate-adjusted risk of cause-specific mortality by quintiles of DBS in all men and women in the NIH-AARP Diet and Health Study cohort[1]

	Men						Women					
	Q1	Q2	Q3	Q4	Q5	*P*-trend[2]	Q1	Q2	Q3	Q4	Q5	*P*-trend[2]
Range	0–18	18.25–22.75	23–26	26.25–29.0	29.25–36.0		0–18	18.25–22.75	23–26	26.25–29.0	29.25–36.0	
n	45,995	44,333	41,216	35,984	32,346		23,810	27,255	30,948	32,526	36,473	
All-sites cancer[3] [*n* = 199,874 (men), 151,012 (women); deaths = 7422 (men), 4274 (women)]												
Multivariate relative risk[3]	1.0	0.90	0.93	0.88	0.79	<0.0001	1.0	0.84	0.88	0.81	0.81	<0.0001
95% CI		0.84–0.96	0.87–0.99	0.81–0.94	0.73–0.86			0.76–0.92	0.80–0.97	0.73–0.89	0.73–0.90	
CHD[4] [*n* = 199,874 (men), 151,012 (women); deaths = 2895 (men), 951 (women)]												
Multivariate relative risk	1.0	0.91	0.79	0.74	0.77	<0.0001	1.0	0.95	0.92	0.90	0.70	0.003
95% CI		0.82–1.01	0.71–0.89	0.65–0.84	0.67–0.88			0.78–1.16	0.75–1.12	0.73–1.11	0.56–0.87	
All-other causes [*n* = 199,874 (men), 151,012 (women); deaths = 5541 (men), 3270 (women)]												
Multivariate relative risk	1.0	0.90	0.85	0.79	0.77	<0.0001	1.0	0.92	0.82	0.76	0.67	<0.0001
95% CI		0.84–0.97	0.78–0.92	0.72–0.86	0.70–0.84			0.83–1.02	0.74–0.92	0.68–0.85	0.59–0.75	

[1] Values are relative risk estimates and 95% CI from Cox proportional hazards regression models. Multivariate models included: race (non-Hispanic white, non-Hispanic black, Hispanic, Asian/Pacific/Islander/American Indian/Alaskan native, unknown); education (<8, 8–11, 12 y, some college, college/postgraduate, unknown); 30-level smoking status (nonsmoker, former smoker, stopped ≥10 y ago, 1–10 cigarettes/d; former smoker, stopped ≥10 y ago, 11–20 cigarettes/d; former smoker, stopped ≥10 y ago, 21–30 cigarettes/d, former smoker, stopped ≥10 y ago, 31–40 cigarettes/d; former smoker, stopped ≥10 y ago, 41–60 cigarettes/d; former smoker, stopped ≥10 y ago, >60 cigarettes/d; former smoker, stopped 5–9 y ago, 1–10 cigarettes/d; former smoker, stopped 5–9 y ago, 11–20 cigarettes/d; former smoker, stopped 5–9 y ago, 21–30 cigarettes/d; former smoker, stopped 5–9 y ago, 31–40 cigarettes/d; former smoker, stopped 5–9 y ago, 41–60 cigarettes/d; former smoker, stopped 5–9 y ago, >60 cigarettes/d; former smoker, stopped 1–4 y ago, 1–10 cigarettes/d; former smoker, stopped 1–4 y ago,11–20 cigarettes/d; former smoker, stopped 1–4 y ago, 21–30 cigarettes/d; former smoker, stopped 1–4 y ago, 31–40 cigarettes/d; former smoker, stopped 1–4 y ago, 41–60 cigarettes/d; former smoker, stopped 1–4 y ago, >60 cigarettes/d; former smoker, stopped within last year, 1–10 cigarettes/d; former smoker, stopped within last year, 11–20 cigarettes/d; former smoker, stopped within last year, 21–30 cigarettes/d, former smoker, stopped within last year, 31–40 cigarettes/d; former smoker, stopped within last year, 41–60+ cigarettes/d; current smoker 1–10 cigarettes/d; current smoker 11–20 cigarettes/d; current smoker 31–40 cigarettes/d; current smoker 51–60 cigarettes/d; current smoker >60 cigarettes/d; unknown smoking status); BMI (<18.5, 18.5–24.9, 25–29.9, ≥30 kg/m^2); physical activity lasting ≥20 min and resulting in sweating or increased breathing and heart rate over the past 12 mo (never, rarely, 1–3 times/mo, 1–2 times/wk, 3–4 times/wk, ≥5times/wk); alcohol intake in g/d (0, 0.01–4.9, 5.0–14.9, ≥15); energy intake (quintiles); and in women only, hormone use (never used, current user, former user, unknown user).

[2] *P*-trend: DBS quintiles 1–5 as a trend variable.

[3] Cancer = ICD-9 codes 140–208 or ICD-10 codes C00–97.

[4] CHD = ICD-9 codes 410–414, 429.2 or ICD-10 codes I20–25.

analyses completed in this study, it is possible that some of the observed associations may be due to chance.

Of all the examined dietary behaviors, compliance with advice about avoiding discretionary solid fat and consuming whole grains was lowest in both men and women (reported by <20% of the cohort) (Table 3). The reasons for relatively poor compliance with these 2 recommendations cannot be explored with the data available for this study but may reflect the importance of taste and cost of whole grains as determinants of food selections (35,36). The dietary information for this study was collected over 10 y ago. Recent studies on secular trends in dietary intake in the U.S. population have found little evidence of major improvements in key dietary behaviors related to fruit, vegetable, and fat intakes since 1995 (21,23,24).

The findings of this study have practical implications for nutrition interventions. Emphasizing simple approaches to dietary change by promoting generally desirable behaviors that consumers may find easier to understand and implement may lead to higher compliance. The dietary guidance messages may need to specifically target men, as they were less likely to report all desirable dietary behaviors than women. Researchers interested in studying diet and health associations, should consider the inclusion of global dietary behavior questions along with other dietary assessments that are more prone to dietary measurement error.

In conclusion, reported adoption of recommended dietary behaviors was associated with lower risk of mortality in older men and women in the NIH-AARP cohort and these associations were not modified by other risk factors of mortality.

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Literature Cited

1. Kant AK. Dietary patterns and health outcomes. J Am Diet Assoc. 2004;104:615–35.
2. Togo P, Osler M, Sorensen TI, Heitmann BL. Food intake patterns and body mass index in observational studies. Int J Obes Relat Metab Disord. 2001;25:1741–51.
3. Kant AK. Indexes of overall diet quality: a review. J Am Diet Assoc. 1996;96:785–91.
4. McCullough ML, Feskanich D, Rimm EB, Giovannucci EL, Ascherio A, Variyam JN, Spiegelman D, Stampfer MJ, Willett WC. Adherence to the Dietary Guidelines for Americans and risk of major chronic disease in men. Am J Clin Nutr. 2000;72:1223–31.
5. McCullough ML, Feskanich D, Stampfer MJ, Rosner BA, Hu FB, Hunter DJ, Variyam JN, Colditz GA, Willett WC. Adherence to the Dietary Guidelines for Americans and risk of major chronic disease in women. Am J Clin Nutr. 2000;72:1214–22.
6. Seymour JD, Calle EE, Flagg EW, Coates RJ, Ford ES, Thun MJ, American Cancer Society. Diet quality index as a predictor of short-term mortality in the American Cancer Society Cancer Prevention Study II Nutrition Cohort. Am J Epidemiol. 2003;157:980–8.
7. Knoops KT, Groot de LC, Fidanza F, Alberti-Fidanza A, Kromhout D, van Staveren WA. Comparison of three different dietary scores in relation to 10-year mortality in elderly European subjects: the HALE project. Eur J Clin Nutr. 2006;60:746–55.
8. Lagiou P, Trichopoulos D, Sandin S, Lagiou A, Mucci L, Wolk A, Weiderpass E, Adami HO. Mediterranean dietary pattern and mortality among young women: a cohort study in Sweden. Br J Nutr. 2006;96:384–92.

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9. Mitrou PN, Kipnis V, Thiébaut AC, Reedy J, Subar AF, Wirfält E, Flood A, Mouw T, Hollenbeck AR, et al. Mediterranean dietary pattern and prediction of all-cause mortality in a US population: results from the NIH-AARP Diet and Health Study. Arch Intern Med. 2007;167:2461–8.
10. Kant AK, Schatzkin A, Graubard BI, Schairer C. A prospective study of diet quality and mortality in women. JAMA. 2000;283:2109–15.
11. Kant AK, Graubard BI, Schatzkin A. Dietary patterns predict mortality in a national cohort: the National Health Interview Surveys, 1987 and 1992. J Nutr. 2004;134:1793–9.
12. Kant AK, Schatzkin A, Ziegler RG. Dietary diversity and subsequent cause-specific mortality in the NHANES I epidemiologic follow-up study. J Am Coll Nutr. 1995;14:233–8.
13. Kant AK, Schatzkin A, Harris TB, Ziegler RG, Block G. Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. Am J Clin Nutr. 1993;57:434–40.
14. Kaluza J, Håkansson N, Brzozowska A, Wolk A. Diet quality and mortality: a population-based prospective study of men. Eur J Clin Nutr. 2007;63:451–7.
15. Bamia C, Trichopoulos D, Ferrari P, Overvad K, Bjerregaard L, Tjønneland A, Halkjaer J, Clavel-Chapelon F, Kesse E, et al. Dietary patterns and survival of older Europeans: the EPIC-Elderly Study (European Prospective Investigation into Cancer and Nutrition). Public Health Nutr. 2007;10:590–8.
16. Cai H, Shu XO, Gao YT, Li H, Yang G, Zheng W. A prospective study of dietary patterns and mortality in Chinese women. Epidemiology. 2007;18:393–401.
17. Byers T. Food frequency dietary assessment: how bad is good enough? Am J Epidemiol. 2001;154:1087–8.
18. Kristal AR, Peters U, Potter JD. Is it time to abandon the food frequency questionnaire? Cancer Epidemiol Biomarkers Prev. 2005;14:2826–8.
19. Willett WC, Hu FB. Not the time to abandon the food frequency questionnaire: point. Cancer Epidemiol Biomarkers Prev. 2006;15:1757–8.
20. Kristal AR, Potter JD. Not the time to abandon the food frequency questionnaire: counterpoint. Cancer Epidemiol Biomarkers Prev. 2006;15:1759–60.
21. Basiotis PP, Carlson A, Gerrior SA, Juan WY, Lino M. The Healthy Eating Index: 1999–2000. Washington, DC: USDA, Center for Nutrition Policy and Promotion. 2002; CNPP-12.
22. Rafferty AP, Anderson JV, McGee HB, Miller CE. A healthy diet indicator: quantifying compliance with the dietary guidelines using the BRFSS. Prev Med. 2002;35:9–15.
23. Kant AK, Graubard BI. Secular trends in the association of socio-economic position with self-reported dietary attributes and biomarkers in the US population: National Health and Nutrition Examination Survey (NHANES) 1971–1975 to NHANES 1999–2002. Public Health Nutr. 2007;10:158–67.
24. Lee S, Harnack L, Jacobs DR, Steffen LM, Luepker RV, Arnett DK. Trends in diet quality for coronary heart disease prevention between 1980–1982 and 2000–2002: the Minnesota Heart Survey. J Am Diet Assoc. 2007;107:213–22.
25. Schatzkin A, Subar AF, Thompson FE, Harlan LC, Tangrea J, Hollenbeck AR, Hurwitz PE, Coyle L, Schussler N, et al. Design and serendipity in establishing a large cohort with wide dietary intake distributions: the National Institutes of Health-American Association of Retired Persons Diet and Health Study. Am J Epidemiol. 2001;154:1119–25.
26. Hill ME, Rosenwaike I. The Social Security Administration's Death Master File: the completeness of death reporting at older ages. Soc Secur Bull. 2001–2002;64:45–51.
27. Hauser TH, Ho KK. Accuracy of on-line databases in determining vital status. J Clin Epidemiol. 2001;54:1267–70.
28. Schisterman EF, Whitcomb BW. Use of the Social Security Administration Death Master File for ascertainment of mortality status. Popul Health Metr. 2004;2:2.
29. Subar AF, Thompson FE, Smith AF, Jobe JB, Ziegler RG, Potischman N, Schatzkin A, Hartman A, Swanson C, et al. Improving food frequency questionnaires: a qualitative approach using cognitive interviewing. J Am Diet Assoc. 1995;95:781–8.
30. Thompson FE, Subar AF, Brown CC, Smith AF, Sharbaugh CO, Jobe JB, Mittl B, Gibson JT, Ziegler RG. Cognitive research enhances accuracy of food frequency questionnaire reports: results of an experimental validation study. J Am Diet Assoc. 2002;102:212–25.
31. Thompson FE, Kipnis V, Midthune D, Freedman LS, Carroll RJ, Subar AF, Brown CC, Butcher MS, Mouw T, et al. Performance of a food-frequency questionnaire in the US NIH-AARP (National Institutes of Health-American Association of Retired Persons) Diet and Health Study. Public Health Nutr. 2008;11:183–95.
32. U.S. Department of Health and Human Services and USDA. Dietary Guidelines for Americans, 2005. 6th ed. Washington, DC: U.S. Government Printing Office; 2005.
33. Graubard BI, Flegal KM, Williamson DF, Gail MH. Estimation of attributable number of deaths and standard errors from simple and complex sampled cohorts. Stat Med. 2007;26:2639–49.
34. Thompson FE, Subar AF. Dietary assessment methodology. In: Coulston AM, Rock CL, Monsen ER, editors. Nutrition in the prevention and treatment of disease. San Diego: Academic Press; 2008. p. 3–39.
35. Glanz K, Basil M, Maibach E, Goldberg J, Snyder D. Why Americans eat what they do: taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. J Am Diet Assoc. 1998;98:1118–26.
36. Raine KD. Determinants of healthy eating in Canada: an overview and synthesis. Can J Public Health. 2005;96:S8–15.

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Addendum 6: Extraction worksheet for PHR data with Discovery ID codes

Extraction sheet

Members who have complete the PHR 1 Feb 2010 and 31st January 2011

	Member details				Biographical data			Anthropometrics			Lifestyle			Diet - PHR										DBS
	Member Number	Family Membership Identifier	Principle /Spouse	Vitality Status (Bl, Br, S, Gold-Diamond)	Age	Gender (M/F)	HFB/N-HFB	Weight	Height	BMI	Min Exercise per week	Smoking Status	Alcohol Drinks/ week	Fruit & Veg Daily	Wholegrain intake	Milk& Dairy	Red Meat (eat/not	Red Meat Lean & Fat	Chicken (eat/not)	Chicken Skin	Soft Marg	Brick Marg	Butter	Calculated DBS
Discovery Attribute - ID					66	69		1	2	3	63	19	466	35	793	617	786	615	784	614	186	192	193	
Member 1																								
Member 2																								
Member 3																								
Member 4																								

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Addendum 7 : Explanations and Details of Extracted Data

Data to be extracted from PHR for proposed research

	Extraction Worksheet for PHR data	
	Item of Interest	Member 1
1	Age (years)	
2	Gender (M = Male, F = Female)	
3	Weight (kg)	
4	Height (m)	
5	Calculated BMI (kg/ m^2)	
6	Number of Times Per Week Engaging in Regular Exercise	
7	Number of Minutes per exercise session (minutes)	
8	Number of minutes of exercise per week, calculated (minutes)	
9	Smoking Status (S (1)= Smoker, FS (2)= Former Smoker, NS (3) = Never Smoked)	
10	Alcohol Consumption per Week (number of drinks consumed each week)	
	Usual Dietary Behaviour	
11	Number of Fruit and Vegetables Servings consumed daily	
12	Wholegrain servings per day (LW = < 3 servings, AW = ≥ 3 servings; Never =NW)	
13	Milk and Dairy Products (None = N, Full Cream = F, Fat Free or Skim = Sk, Low Fat = LF)	
14	Red Meat (Don't eat = NR, <2 x/ week = LRM; ≥ 2 x/ week = HRM)	
15	Red Meat (Lean = LM, With Fat = FM)	
16	Chicken or Poultry (Do Eat = Ch, Don't eat = NCh)	
17	Skin (Without Skin = WOS, With Skin = WS)	
	Solid Fat	
18	Soft margarine (0 = don't eat, 1 = eat SM)	
19	Brick margarine (0= don't eat, 1 = eat BM)	
20	Butter or Fat (0= don't eat, 1 = eat Butter and fat)	
	Calculation BDS Score	

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	Extraction Worksheet for PHR data	
21	Fruit and veg intake (3 servings or more daily = score 12, 2 servings daily = score 6, 1 serving daily = score 0, 0 servings daily = score 0)	
22	Whole grain intake (AW= 3 or more servings daily = score 6, LW= 3 or less servings daily = score 3; NW = 0)	
23	Milk and Dairy Products (None = score 0, Full Cream = score 0, Low fat = score 6, fat free = score 6)	
24	Red Meat (NR = score 4, LRM + LM = score 4; HRM+ LM = score 2; HRM+FM = score 0)	
25	Chicken or Poultry (NCh = score 2; Ch+WOS = score 2; Ch+ WS = score 0)	
26	Added Solid Fat (0 for soft margarine = Score 1,); (0 for Brick Margarine = score 2.5), (0 for butter or fat = score 2.5; Response 1 for any answer = score 0)	
27	TOTAL DBS^{PHR} SCORE	

Description of extraction sheet

- The extraction worksheet was developed to obtain data as follows:
- Extraction line items 1 – 2, provided demographic data on age and gender. Other demographic data such as socio-economic status, marital status, race, and standard of education standard, was not available for extraction.
- Extraction line items 3-4, provided anthropometric data for weight and height.
- Extraction line item number 5 is a calculation of Body Mass Index (BMI) – calculated as weight in kilograms divided by height squared. i.e. $(Wt(kg)/height(m)^2)$.
- Extraction line items 6-7 provided information on frequency of exercise and the duration (in minutes) of each exercise session.
- Extraction line item number 8 was a calculation of the number of minutes of exercise completed each week.
- Extraction line item number 9 referred to smoking status. Answers were coded as S- for smoker, FS for former smoker, and NS for never smoked.
- Extraction line item 10 referred to a participant's usual behaviour related to the consumption of alcohol. Answers were provided as to the number of standard alcoholic beverages consumed on average per week. When

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completing the questionnaire the member was provided with a list of "standard units" of alcohol. For example; one can of beer (340mls), one small glass of wine (120mls), one metric tott of spirits (25mls) or one small glass of sherry or liqueur (50mls). This allowed the member to estimate the number of alcoholic drinks consumed per week.

- Extraction line items 11-20, referred to self-reported usual dietary behaviours. Each response on the PHR was coded to allow for data to be interpreted and in turn to calculate the DBS^{PHR}.
- Extraction line 11 item referred to the number of servings of fruit and vegetables consumed daily. When completed on-line the member was provided with a list of what constitutes a portion of fruit or vegetables. For fruit, it was suggested by the Discovery Vitality website, that one serving is equivalent to a quarter cup of dried fruit, one small to medium fresh fruit such as an apple, half a cup of canned fruit or half a cup of fruit juice. For vegetables was suggested that one serving was equivalent to one cup of raw vegetables, half a cup of cooked vegetables or a small bowl of mixed salad. Serving sizes are generally consistent with those advocated by dietary exchange lists used by the American Dietary Guidelines of 2005 and 2010.
- Extraction line item 12 – referred to the number of servings of wholegrain consumed daily. The PHR on-line assessment lists foods that are considered to be whole-grains, such as wholegrain bread or cereal, oats, barely millet, whole corn (mealies), wholegrain crackers, brown rice and whole-wheat pasta. The member was prompted to indicate if he/she consumes on average: three or more servings of whole grains per day, or less than three servings daily, or "never", which indicates that the member does not consume wholegrain foods or their products. Answers were coded as follows: three or more servings = adequate whole-grains (AW), less than three servings = low intake of whole grains (LW), and "never" = no whole-grains are consumed = NW.
- Extraction line item 13 refers to the consumption of dairy products. In the PHR members were prompted to indicate if they consume milk and dairy products and whether the dairy they usual consume is low fat, fat free, or full cream. Answers were coded as follows: No dairy products are used = N (none); full cream dairy is used = F (full cream); fat free or skimmed milk products are used = Sk (skimmed) or low fat dairy products are used = LF (low fat). Unfortunately the PHR did not ask about the quantities of dairy products used and this could therefore not be included as part of the DBS^{PHR} or nutritional risk assessment. Nonetheless it is worth while noting the type of

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milk that is used, as this has been report to have merit in terms of reducing dairy fat intake and in turn the risk for NCD specifically coronary heart disease.

- Extraction line items 14-15 referred to the reported consumption of red meat and poultry specifically chicken. Members were asked if they consume red meat either; never, less than twice per week or more than twice per week. Extraction codes to be used include; no red meat = NR, less than 2x /week = less red meat (LRM), and more than 2 x / week = higher red meat intake (HRM). Members who reported eating red meat were further asked to report on if the red meat usually consumed is lean or with fat. Codes were allocated for responses as; lean meat (LM) and with fat (FM).
- With regard to chicken, members were asked if they do or do not eat chicken. Codes regarding chicken consumption were as follows; Do eat chicken = Ch, Do not eat chicken = NCh. If members indicated that they do eat chicken, they are then asked if they eat it with or without the skin, codes were allocated as follows; without skin = WOS and with skin WS.
- Extraction line items 18-20 referred to added solid fat. In the PHR members were asked to indicate which fats they like to add to food. If members indicated they do eat any solid fat such as soft margarine, butter or fat, or brick margarine, they were coded with “1”. When any of these solid fat foods were not selected by the member a code of “0” was given.
- Line items 21- 26, were used to calculate the DBS^{PHR}, as per Table 2.4 and Addendum 6 (extraction sheet).

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Addendum 8: List of ID Attribute Discriptions

ATTRIBUTE_ID	ATTRIBUTE_DESCR	ATTRIBUTE_VALUE	ATTRIBUTE_VALUE_DESCR
1	Height (meters)		
2	Weight (kilograms)		
3	Body Mass Index (BMI)		
19	Smoking status	1	Never smoked
19	Smoking status	2	Not smoking, but used to smoke before
19	Smoking status	3	Current smoker
35	How many servings of fruit and vegetables do you eat per day?		
63	Average minutes of physical activity per week		
66	Age		
69	Gender	F	
69	Gender	M	
186	Intake - Added fat - Soft Tub Margarine (lite or regular),	1	Yes
186	Intake - Added fat - Soft Tub Margarine (lite or regular),	2	No
186	Intake - Added fat - Soft Tub Margarine (lite or regular),	3	more than or equal to 3 x / week
186	Intake - Added fat - Soft Tub Margarine (lite or regular),	4	1 x / daily
186	Intake - Added fat - Soft Tub Margarine (lite or regular),	5	> 2 x / daily
192	Intake - Added fat - Brick Margarine, e.g. Stork, Rama, Holsum	1	Yes
192	Intake - Added fat - Brick Margarine, e.g. Stork, Rama, Holsum	2	No
192	Intake - Added fat - Brick Margarine, e.g. Stork, Rama, Holsum	3	more than or equal to 3 x / week
192	Intake - Added fat - Brick Margarine, e.g. Stork, Rama, Holsum	4	1 x / daily
192	Intake - Added fat - Brick Margarine, e.g. Stork, Rama, Holsum	5	> 2 x / daily
193	Intake - Added fat - Butter, Ghee, Lard, Meat Drippings	1	Yes
193	Intake - Added fat - Butter, Ghee, Lard, Meat Drippings	2	No
193	Intake - Added fat - Butter, Ghee, Lard, Meat Drippings	3	more than or equal to 3 x / week
193	Intake - Added fat - Butter, Ghee, Lard, Meat Drippings	4	1 x / daily
193	Intake - Added fat - Butter, Ghee, Lard, Meat Drippings	5	> 2 x / daily
466	Alcohol consumption frequency per week		
614	Poultry Intake Type	1	With Skin
614	Poultry Intake Type	2	Without Skin
615	Red Meat Intake Type	1	Fatty Meat
615	Red Meat Intake Type	2	Lean Meat
617	Dairy Intake Type	1	2% or low fat
617	Dairy Intake Type	2	Skim/Fat Free
617	Dairy Intake Type	4	None
617	Dairy Intake Type	5	Full cream
784	Eating Habits Poultry	1	Yes
784	Eating Habits Poultry	2	No
786	Eating Habits Red Meat	1	Never
786	Eating Habits Red Meat	2	Less than twice a week
786	Eating Habits Red Meat	3	More than or equal to twice a week
793	Eating Habits Wholegrain	1	Less than three servings a day
793	Eating Habits Wholegrain	2	Three or more servings a day
793	Eating Habits Wholegrain	3	Never

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Addendum 9: Health Research Ethics Committee (HREC) Approval Letter

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Approved with Stipulations
New Application

14-Sep-2012
TILL, Anne Mary

Ethics Reference #: S12/04/101
Title: Dietary Risk Assessment of Discovery Health Medical Aid's Vitality Members in South Africa.

Dear Mrs Anne TILL,

The **New Application** received on **18-Apr-2012**, was reviewed by members of **Health Research Ethics Committee 2** via Expedited review procedures on **03-Sep-2012**.

Please note the following information about your approved research protocol:

Protocol Approval Period: **05-Sep-2012 -05-Sep-2013**

The Stipulations of your ethics approval are as follows:
1. On page 2 (in 4) of the applicant's response letter it is mentioned that Discovery may publish results in marketing materials. The committee requests that all such publications be submitted for approval.
Also, given the investigators' responsibility to disseminate data (as per Department of Health regulations), it would be inappropriate to use data in this way before the dissemination in peer reviewed publications/ or congresses.

Please remember to use your **protocol number** (**S12/04/101**) on any documents or correspondence with the REC concerning your research protocol.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:
Please note a template of the progress report is obtainable on www.sun.ac.za/rds and should be submitted to the Committee before the year has expired.
The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number projects may be selected randomly for an external audit.
Translation of the consent document in the language applicable to the study participants should be submitted.

Federal Wide Assurance Number: 00001372
Institutional Review Board (IRB) Number: IRB0005239

The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Helene Visser at City Health (Helene.Visser@capetown.gov.za Tel: +27 21 400 3981). Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.
For standard REC forms and documents please visit: www.sun.ac.za/rds

If you have any questions or need further help, please contact the REC office at 0219389207.

Included Documents:
Application Form
Protocol
Checklist
Investigators Declaration

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Synopsis

Sincerely,

Mertrude Davids
REC Coordinator
Health Research Ethics Committee 2

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Investigator Responsibilities

Protection of Human Research Participants

Some of the responsibilities investigators have when conducting research involving human participants are listed below:

1.Conducting the Research. You are responsible for making sure that the research is conducted according to the REC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research.

2.Participant Enrollment. You may not recruit or enroll participants prior to the REC approval date or after the expiration date of REC approval. All recruitment materials for any form of media must be approved by the REC prior to their use. If you need to recruit more participants than was noted in yourREC approval letter, you must submit an amendment requesting an increase in the number of participants.

3.Informed Consent. You are responsible for obtaining and documenting effective informed consent using **only** the REC-approved consent documents, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least five (15) years.

4.Continuing Review. The REC must review and approve all REC-approved research protocols at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period.** Prior to the date on which the REC approval of the research expires, **it is your responsibility to submit the continuing review report in a timely fashion to ensure a lapse in REC approval does not occur.** If REC approval of your research lapses, you must stop new participant enrollment, and contact the REC office immediately.

5.Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, number of participants, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the REC for review using the current Amendment Form. You **may not initiate**any amendments or changes to your research without first obtaining written REC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.

6.Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research related injuries, occurring at this institution or at other performance sites must be reported to the REC within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the RECs requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch Universtiy Health Ethics Committee Standard Operating Procedures www.sun025.sun.ac.za/portal/page/portal/Health_Sciences/English/Centres%20and%20Institutions/Research_Development_Support/Ethics/Application_package All reportable events should be submitted to the REC using the SAE Report Form.

7.Research Record Keeping. You must keep the following research related records, at a minimum, in a secure location for a minimum of fifteen years: the REC approved research protocol and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the REC

8.Reports to MCC and Sponsor. When you submit the required annual report to the MCC or you submit required reports to your sponsor, you **must** provide a copy of that report to the REC. You may submit the report at the time of continuing REC review.

9.Provision of Emergency Medical Care. When a physician provides emergency medical care to a participant without prior REC review and approval, to the extent permitted by law, such activities will not be recognized as research nor the data used in support of research.

10.Final reports. When you have completed (no further participant enrollment, interactions, interventions or data analysis) or stopped work on your research, you must submit a Final Report to the REC.

11.On-Site Evaluations, MCC Inspections, or Audits. If you are notified that your research will be reviewed or audited by the MCC, the sponsor, any other external agency or any internal group, you must inform the REC immediately of the impending audit/evaluation.

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Addendum 10: Permission Letter to use Discovery Data

9 March 2011

Attention: Ms L Du Plessis

Division of Human Nutrition
Faculty of Health Sciences
Stellenbosch University
Francie van Zijl Avenue
Tygerberg
7505
South Africa

Dear Ms Du Plessis,

RESEARCH PROJECT (MINI THESIS) MASTERS IN NUTRITION :
MRS AM TILL. STUDENT 15172518
PERMISSION TO USE DISCOVERY VITALITY DATA

Mrs. Anne Till has been a nutrition consultant for Discovery Vitality since 2004. She has been involved with a number of initiatives and more recently the Discovery HealthyFood™ Benefit HFB. She has proposed to conduct research to assess the "usual dietary behaviour" of Discovery Vitality members who have activated the HFB and compare this data the "usual dietary behaviour" of Discovery Vitality members who have not activated the HFB.

The assessment of usual dietary behaviour will be completed by making use of self reported data that is collected as part of the "Personal Health Review" (PHR) assessment that is completed by a large number of Discovery Vitality members. She has also proposed to validate the PHR by making use of the Vitality Nutrition Assessment (VNA).

This letter confirms that Discovery Vitality will allow Mrs. Anne Till access to the required data via our actuarial department, and will allow our actuary Adam Noach or a member of his team to extract this data on her behalf.

Kind regards

Dr Craig Nossel
Head of Vitality Wellness

155 West Street, Sandton; P.O. Box 652687, Sandton 2146 Vitality Healthstyle Services
0860 99 88 77 or 083 123 8877 www.discovery.co.za

Directors: M I Hilkowitz (Chairperson), A Gore* (Group CEO), A Pollard* (CEO), Dr B A Brink, P Cooper, S B Epstein (USA), R Farber*, H D Kallner*, N S Koopowitz*, Dr T V Maphai, H P Mayers*, V Mufamadi, A L Owen (UK), J M Robertson* (CIO), S E Sebotsa, T Slabbert, B Swartzberg*, S V Zilwa (*Executive). **Secretary:** M J Botha.

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2010-06

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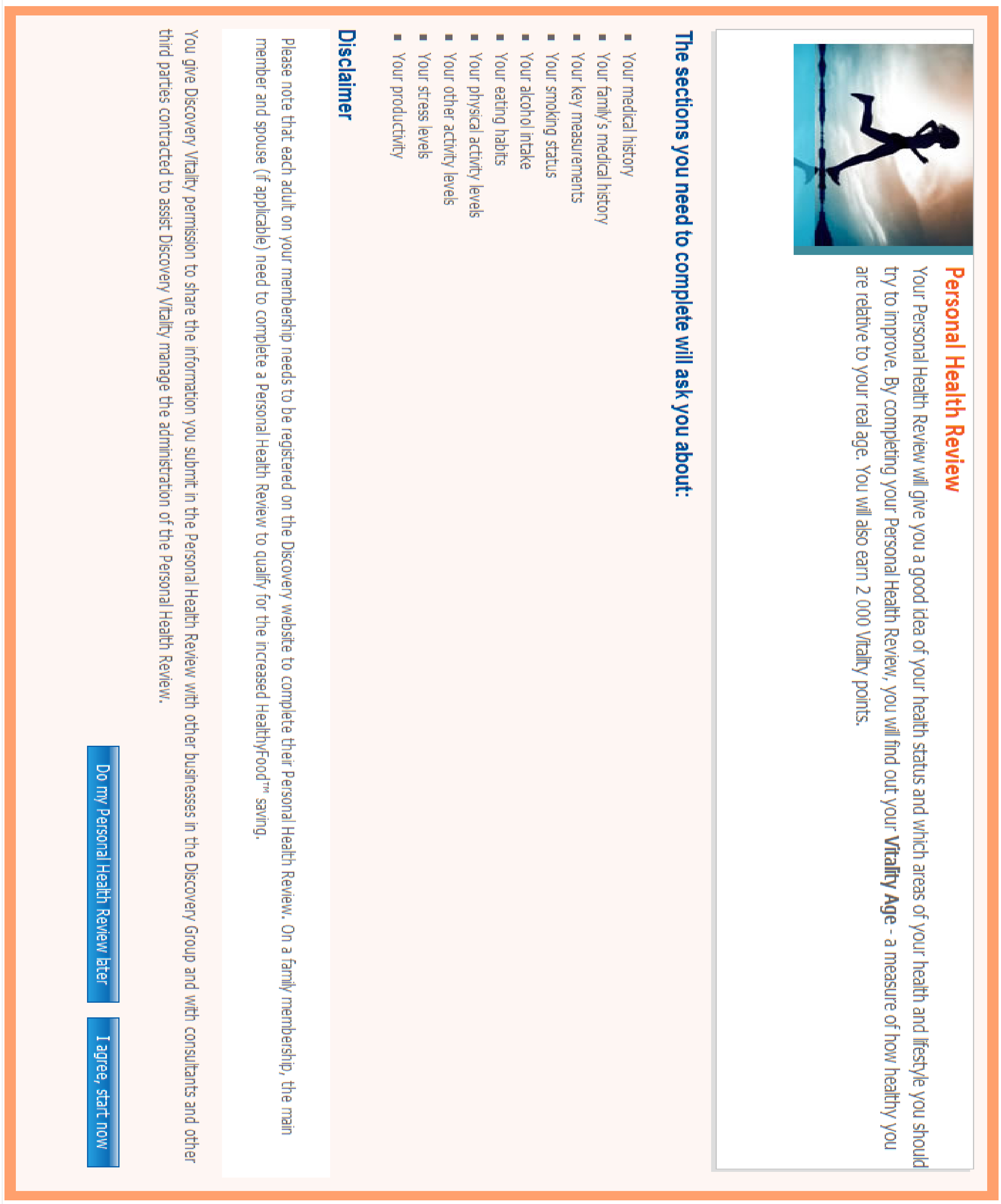
Addendum 11: Disclaimer

Member Gives Discovery Holdings and Related Businesses permission to use Data as required


Personal Health Review
Your Personal Health Review will give you a good idea of your health status and which areas of your health and lifestyle you should try to improve. By completing your Personal Health Review, you will find out your Vitality Age - a measure of how healthy you are relative to your real age. You will also earn 2 000 Vitality points.
The sections you need to complete will ask you about:
Your medical history
Your family's medical history
Your key measurements
Your smoking status
Your alcohol intake
Your eating habits
Your physical activity levels
Your other activity levels
Your stress levels
Your productivity
Disclaimer
Please note that each adult on your membership needs to be registered on the Discovery website to complete their Personal Health Review. On a family membership, the main member and spouse (if applicable) need to complete a Personal Health Review to qualify for the increased HealthyFood™ saving.
You give Discovery Vitality permission to share the information you submit in the Personal Health Review with other businesses in the Discovery Group and with consultants and other third parties contracted to assist Discovery Vitality manage the administration of the Personal Health Review.
Do my Personal Health Review later
I agree, start now

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Addendum 12: Letter from Discovery Vitality - No Prejudice

12 July 2012

Human Research Ethics Committee
Stellenbosch University

Research Project: MS Nutrition Student - Mrs A Till, RD (SA), Application Ref #S12/04/101

Title: Dietary Risk Assessment of Discovery Health Medical Aid's Vitality Members in South Africa

Dear Committee Members,

This letter serves to confirm that the results of the proposed study by Mrs Till, RD (SA) will not be used to prejudice Discovery Vitality members in anyway. In South Africa it is illegal to underwrite health insurance premiums based on individual risk, so there is no risk of prejudicing members in this regard. The data from the calculation of a Dietary Behavior Score (DBS^{PHR}), may potentially be used in the future to motivate for the product enhancements that may benefit members.

Yours Sincerely

Dr Craig Nossel

Head of Vitality Wellness

155 West Street, Sandton; P.O. Box 652687, Sandton 2146 Vitality Healthstyle Services
0860 99 88 77 or 083 123 8877 www.discovery.co.za

Directors: M I Hilkowitz (Chairperson), A Gore* (Group CEO), A Pollard* (CEO), Dr B A Brink, P Cooper, JJ Durand, S B Epstein (USA), R Farber*, H D Kallner*, N S Koopowitz*, Dr T V Maphai, H P Mayers*, V Mufamadi, Dr A Ntsaluba*, A L Owen (UK), J M Robertson* (CIO), S E Sebotsa, T Slabbert, B Swartzberg*, S V Zilwa (*Executive). **Secretary:** M J Botha.

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2012-04

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Addendum 13: Memorandum of Understanding between
Stellenbosch University and Discovery Vitality regarding A Till's research

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27 July 2012

To: Discovery Vitality Management team

RE: Research project – "Dietary Risk Assessment of Discovery Health Medical Aid's Vitality Members in South Africa", Master of Nutrition Student – Anne Mary Till (Student number: 15182517)

The research protocol of the above mentioned project served before the Human Research Ethics Committee of the Faculty of Medicine and Health Sciences (Ref nr: S12/04/101). One of the recommendations made was that an official memorandum of understanding should be drawn up between the University of Stellenbosch and Discovery before this research could commence.

A memorandum of understanding will serve to ensure that the student will be allowed to use the data, do the statistical analysis, write the results, formulate the discussion and complete the dissertation as well as publish an article from the research, without Discovery requesting or insisting on an embargo on the use of the data to this effect. It will also allow Discovery Health to publish the results from the research on the company's website and the company's newsletter/magazine, after the dissertation has been completed and the article/s published, with dual recognition to Stellenbosch University.

Please see Addendum 1 for your consideration and signature.

Sincerely,

Lisanne du Plessis
Study leader

Fakulteit Geneeskunde en Gesondheidswetenskappe • Faculty of Medicine and Health Sciences

Verbind tot Optimale Gesondheid • Committed to Optimal Health
Division of Human Nutrition • Department of Interdisciplinary Health Sciences
PO Box 19063 • Tygerberg 7505 • South Africa
Tel.: +27 21 938 9259 • Faks/Fax: +27 21 933 2991
Webblad / Web page: www.sun.ac.za/nutrition; www.sun.ac.za/nicus

A7.

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Addendum 1

Memorandum of Understanding

The partners herein, **Discovery Vitality** and **Anne Mary Till** desire to enter into a Memorandum of Understanding as set out below.

I) Description of Partners

Discovery Vitality, Division: Research and Development

Anne Mary Till, Stellenbosch University, Master of Nutrition Student, Student Number: 15182517

II) History of Relationship

Anne Mary Till has served on Discovery Vitality HealthyFood™ Benefit Expert Panel since January 2009. Prior to this, she worked as a nutrition consultant to Discovery Health and Vitality, since 2004. Discovery Vitality is a science based wellness program, and is interested in conducting research around a number of their wellness incentive initiatives. The Discovery Vitality program collects data on members continuously through the administration of health assessments and questionnaires, which are completed voluntarily and usually on-line by members in order to gain feedback on health status, and to receive rewards. A particular assessment called the Personal Health Review (PHR) collects data on the usual dietary behaviours of members, as well as lifestyle practices and health indicators. It was therefore proposed by Mrs A Till that this data be used for research purposes to assess the usual dietary behaviour of Discovery Vitality members who have completed the PHR in South Africa and compare this to advocated dietary guidelines for different groups of members. Research has been conducted by - Kant, Leitzmann and colleagues in 2009, on patterns of recommended dietary behaviours and predicted subsequent risk of mortality. Kant and colleagues used usual dietary behaviours to compute a dietary behaviour score (DBS) which was in turn correlated with risk for chronic disease mortality. The basis of the DBS calculation was the American Dietary Guidelines from 2005. Anne Till has had discussions with management at Discovery Vitality and this led to the identification of the proposed topic for research, namely; "What is the computed "Dietary Behaviour Score"(DBS^{PHR}) and considered dietary risk profile of all Discovery Vitality members who have completed the on-line Personal Health Review (PHR) questionnaire?". Data available in the PHR is similar to data used to compute the DBS as completed by Kant, 2009, thus it will be possible to compute a DBS from the PHR for Discovery Vitality members. Discovery Vitality was positive about the proposed research and was interested in the profile of computed DBS^{PHR} of different member groups. Results may assist Vitality in developing additional tools for members to promote overall health and prevent disease.

III) Development of research question

Following discussions between the partners mentioned above, it was decided that the topic "Dietary Risk Assessment of Discovery Health Medical Aid's Vitality Members in South Africa" could become a Master of Nutrition research project. This research could answer the following questions:

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- Do the DBS^{PHR} members who have activated the HealthFoodTM Benefit (HFB) differ from members who have not activated the benefit (N-HFB) at the time of completing the PHR?
- Does the DBS^{PHR} of members differ between Vitality status groups; namely blue, bronze, silver, gold and diamond?
- How does the DBS^{PHR} of the group of members who are current smokers compare to non-smokers and ex-smokers?
- How does the DBS^{PHR} of the group of members who consume alcohol in excess of recommendations compared to those who comply with recommendations?
- How does the DBS^{PHR} of the group of members who are inactive and/or who participate in less exercise than the recommended 150 minutes of exercise per week, compare to those members who comply with exercise recommendations?
- How does the DBS^{PHR} of the group of members who have a BMI greater than 30kg/m^2 compare to those who are overweight, normal body weight or underweight?

IV) Roles and Responsibilities

It is hereby agreed by and between the partners as follows:

That Anne Mary Till will be allowed to use the data, do the statistical analysis, write the results, formulate the discussion and complete the dissertation as well as publish an article from the research, without Discovery requesting or insisting on an embargo on the use of the data to this effect.

That Discovery Health will be allowed to publish the data on the company's website as well as the Discovery newsletter/magazine after the dissertation has been completed and the article/s published, with dual recognition to Stellenbosch University

V) Timeline

The roles and responsibilities described above are contingent on **Anne Mary Till** receiving the data for the project described. Responsibilities under this Memorandum of Understanding would coincide with the finalisation of the research report, anticipated to be September 2012 through September 2013.

VI) Commitment to Partnership

We, the undersigned have read and agree with this MOU.

Signed on this 3 day of August day of .....(month) 2012, on behalf of:

Discovery Vitality
Name: (Please print) D.PATEL
CLINICAL SPECIALIST

Stellenbosch University
Name: A.M. Till
Anne Mary Till