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DEPARTMENT OF FOOD AND RESOURCE ECONOMICS
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IFRO Documentation

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Abstract

This documentation describes the development of a survey tool designed to: 1) measure how different levels of constraints on food budgets are associated to outcomes of healthy eating, environmental sustainability and life quality for individuals in Denmark, and 2) explore how these different outcomes are related to strategies people employ to cope with restricted food budgets. The resulting survey consists of a total of 63 question items. The paper lays out the various steps involved in the process of developing the survey tool, presents the final survey items included in the tool and discusses potentials for further improvements and applications in other national contexts. With this paper, the authors seek to inspire and support similar research in other country settings.

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Introduction

How does increasing restraint on food budgets in private households affect healthiness and climate impact of food consumption, and what are the effects on general wellbeing of the population? How do various strategies employed by households to cope with food budget restraint interrelate to such outcomes? In times of worldwide economic unrest affecting millions of households in Western societies, including households in Scandinavian welfare states, such questions are important to address for governments aiming to simultaneously fight socio-economic disintegration of societies, improve healthy eating patterns, and increase sustainable food consumption.

In the anticipation of a growing need for future food policy and market initiatives to target problems related to wellbeing, health and the environment in combination, there is a need to develop a combined tool to follow the development of these issues at population level. This tool should be sensitive to capture specific strategies that are employed to cope with restrained budgets, and furthermore, they should be cost efficient in order to enable continuous monitoring.

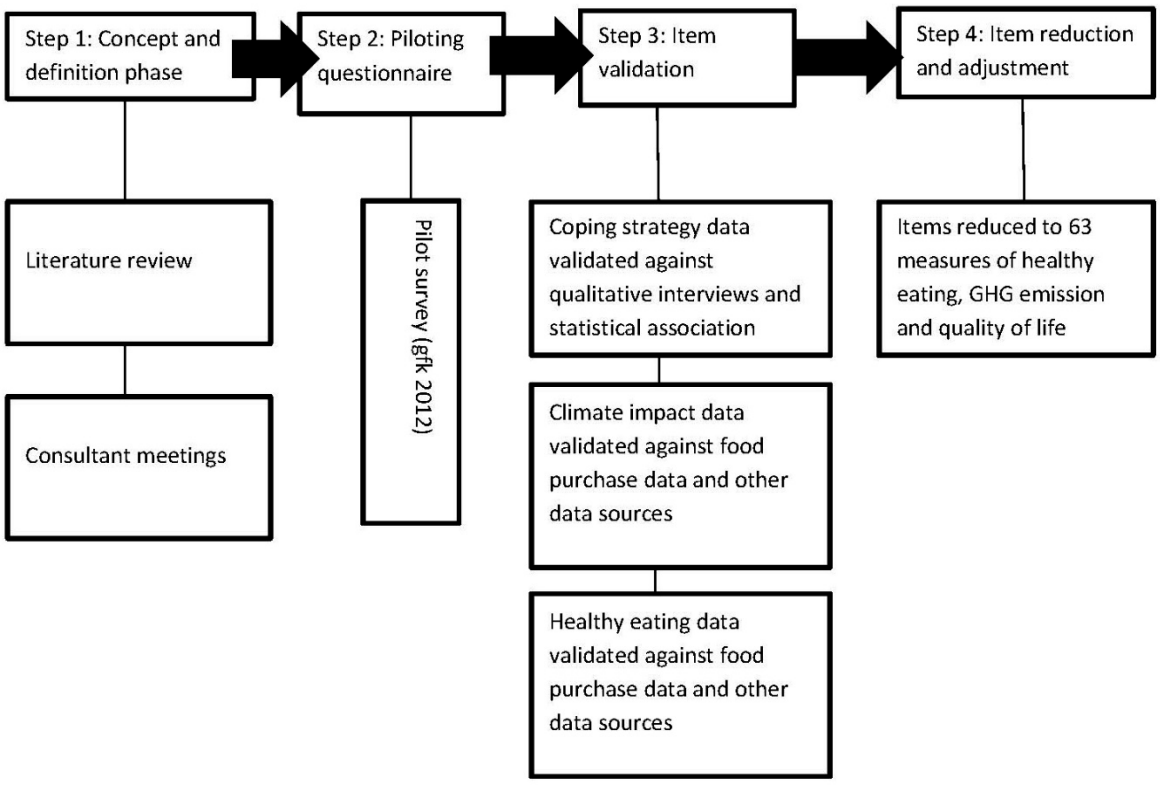
In the following we describe the development of a survey tool which we undertook as part of the Danish research project *Food in Turbulent Times* (2012-2016). The aims of the tool were: 1) to measure how different levels of constraints on food budgets are associated to outcomes of healthy eating, environmental sustainability and life quality for individuals in Denmark, and 2) to explore how these outcomes are related to different types of strategies employed to cope with restricted food budgets.

We developed the survey tool through a process involving four steps illustrated in fig 1 below. These include a concept and definition phase, a piloting phase, a validation phase, and an item reduction phase. The work of developing, selecting and adjusting measures to be included in the final survey tool was an iterative process of discussions, reflections and decisions in the research group. This process was informed by qualitative data and analysis of in-depth interviews which

were conducted as part of the FiTT project and by pilot data combined with food purchase data from the GfK panel[1].

In this paper, we describe the four steps in the process of constructing the survey tool. After this, we provide a short description of the final tool which was applied in a population survey in Denmark in 2015. We end the paper by providing some concluding remarks and reflections about potentials for further improvements and for adaption of the tool also to other national contexts.

Fig 1: Steps involved in development of population survey



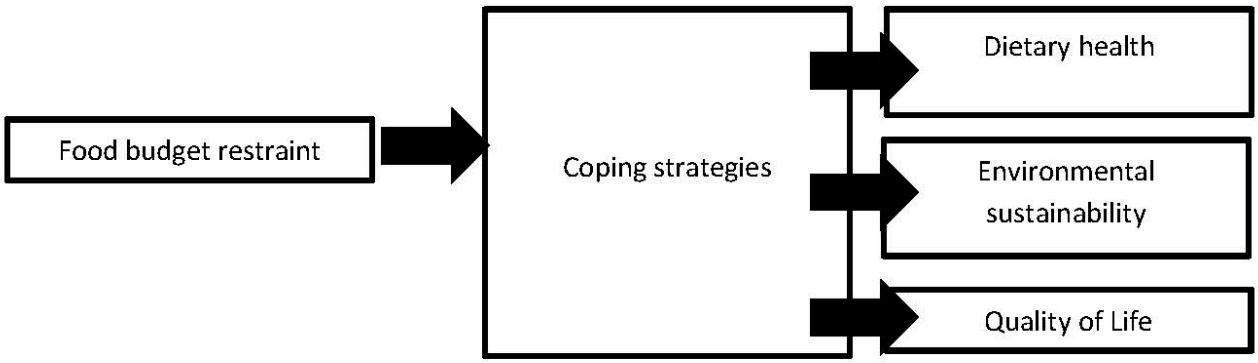
Step 1: Concept clarification and definition of measures

The ambition was to develop a survey instrument which could measure the factors illustrated in fig 2. As the figure highlights, there is a theoretical posited relationship between the factors, where *food budget restraint* can be seen as the main explanatory phenomenon under investigation that

[1] The GfK panel is a household panel with 3440 households that on a daily basis register food purchased (prices and quantities, store type and whether the product was on offer, and organic)

is expected to have influence on a number of outcome variables pertaining to *dietary health*, *environmental sustainability* and *quality of life*. Further, we also assume that the expected effect between food budget restraint and outcomes are explained to some extent by the everyday coping strategies that people develop in an effort to cope with a restrained food budget. Statistically speaking, coping strategies are also referred to as mediating variables.

Fig 2: Conceptual model of the project



The first step in the tool development process focused on making precise definitions of the core concepts to be measured, choosing relevant questionnaire items, and adjusting them to the Danish context. This process of definition and selection was based partly on targeted literature studies, partly on the research group's sociological knowledge about Danish food and eating practices, and partly on a series of consultations with national and international experts on nutrition surveys and environmentally sustainable consumption[2].

In order to narrow down our choice of measures and indices to be included in the final short survey tool, we developed an extended questionnaire (referred to as the pilot survey) for a pilot test (step 2). Below we go through the central considerations and choices made pertaining to each of the core concepts.

All of the selected items for these core concepts are also listed in the appendix, tables 1-4 column A.

[2] The consultants were Professor Inge Tetens from DTU Food,David Watson Copenhagen Resource Institute and Plan Miljø, Nokola Kiørboe, Copenhagen Resource Institute

Measures of food budget restraint. (See Table 1 column A)

Conceptually, the condition of food insecurity can be defined as a "continuum that progresses from uncertainty and anxiety about the food at household level to the extreme condition of hunger among children" (Kendall 1995: 2794). In high income countries with large income differences such as the USA, Australia, New Zealand and Canada, the level and extent of food insecurity has been measured regularly using monitoring tools developed mainly in response to rising levels of hunger and malnutrition in these countries, and mainly among low-income groups (Radimer et al. 1990; Köhler et al., 1997; Kirkpatrick & Tarasuk 2008). However, in European countries no systematic studies of food insecurity have been carried out and our understanding of food budget strain and coping strategies in European welfare societies such as Denmark is inadequate (Borch & Kjærnes 2016).

As the project aim was to investigate reactions at population level to the situation of constrained food budgets in a relatively wealthy welfare state with a relatively low level of social inequality we decided to not only focus on food insecurity, but to expand the conceptual category of restraint to include less severe forms of restraint in addition to the commonly applied definition of food insecurity (as e.g. provided by Radimer 2002).

To measure food insecurity and to enable international comparison, we adopted some of the US based "core module" question items (Bickel, Nord and Price, 2002). However, we selected and adapted these items to expected Danish conditions, by leaving out the items directed towards measuring more extreme forms of hunger and child hunger. For the pilot survey, we ended up replicating the US 6-item measure of food insecurity which focus on running out of food, and not being able to afford healthy meals or food (table 1: A5-7; A10, A11, A12).

In order to broaden the spectrum of food budget restraint and also catch milder forms, we supplemented the selected US "core module" food insecurity items with two other items, which do not necessarily imply the experience of direct shortage of food or inability to meet basic nutritional requirements. The first was adapted from “Index of Individual Deprivation” from New Zealand (Salmond et al. 2005),and asks the respondent to state to which extent within the past 12 months it was true that: I/We have been forced to buy cheaper food in order to be able to afford

other things'" (table 1, A3). We constructed a follow up question (A4) to this item for people who replied affirmative, in order to measure the duration of food budget restraint in more detail.

The second item (table1,A2) was also adopted from the USDA questionnaire on food insecurity (Bickel, Nord and Price, 2002) where it functions as a screening question outside the "core module". It asks the respondent to evaluate which statement best characterizes the food that has been eaten in the household during the past 12 months. Reply options include: "We always have enough to eat and the kinds of food we want"; "we have enough to eat but not always the kinds of food we want"; "sometimes we don't have enough to eat"; or "often we don't have enough to eat"?, and "Don't know".

On top of existing measures of food insecurity and deprivation, we constructed two additional items for the pilot survey, in order to catch the experiences of deprivation in relation to nutritional quality and social standards (affording a varied diet, and serving appropriate food for guests) (A8-9).

In order to measure the recent change in experience of restraint on food budget, we designed the question (A1): "Do you find that food has become more affordable to you over the past year? We offered a five point reply scale ranging from: "on the contrary" over "the situation is unchanged", "to a high degree".

Measures of coping strategies (See Table 2 column A)*:*

To adequately measure coping strategies in Danish welfare state context, there is a need to supply measures of coping under severe forms of restraint such as food insecurity and hunger with a set of strategies which may be employed by population segments experiencing less severe levels of food budget restraint. We constructed a set of 21 items for the pilot survey (table 2, column A). We operationalized general strategies pertaining to shopping, storing, cooking and eating. Further, we aimed to construct questions which captured the use of strategies at individual and household level as well as in broader social contexts. The items were inspired by qualitative studies about food insecurity and coping practices (Dowler, 1997; Hamelin *et al*., 2002; Radimer, 2002) and by our own research based knowledge concerning Danish food culture and eating patterns.

All items (table 2: A1-17, A19-22) were formulated as statements (strategies) and asked respondents about the frequency within the past 12 months (“how often”) with which these strategies had been used in order to save money on food. Response options ranged from "very often", 'often', 'some times', 'rarely' and ''never'. In addition the response option 'I don't know' was offered. Eight items inquired into change of shopping practices. Nine items inquired into strategies of storing, cooking, eating, and social life. Further, four items were directed to respondents with children below 18 years living at home (A19-22).

Measures of healthy eating (See Table 3 column A)

Nutritional sciences have produced several validated tools to assess the dietary quality at population level (Massari et al, 2004; Toft et al, 2007; Freisliing et al 2009; Schroder et al 2012; Pot et al, 2014; Bjørnarå et al. 2015; Daly et al. 2015). We based our index measuring healthy eating on a set of items developed by Toft et al (2007). These measures are listed in Table 3 (A1-3, A6-7, A9). This index is called the *dietary quality score (DQS*) and it has been successfully validated against risk indicators of cardio-vascular disease in the Danish population. However, the measure does not include the health effects of sugar and whole grain and thus we adjusted the index to include these foods. Based on advice from our consultant, we supplied the Toft index with questions about sugar rich foods (cake, confectionary (A5)), sugary beverages (A10), alcohol (A10) and wholegrain (A4). We also included an item to capture the intake of fast food (A11).

The pilot survey inquired into food intake among both adults and children in the household.

Measures of environmental sustainability (Table 3 column A)

Environmental sustainability of the food people consume can encompass many different dimensions, including bio-diversity, local and regional environmental consequences of foods produced with/without pesticides (organic vs non-organic), and climate effects.

Based on discussions with consultants, we decided to focus our measure of environmental *sustainability* on the climate effects of peoples’ diet: diet-related greenhouse gas (GHG) emissions. The reasons for this were that the consequence of global warming is the most important challenge the world is faced with and that most other adverse consequences of food production (including acidification and loss of bio-diversity) can be seen as closely related to GHG emissions. Further,

while the extent to which organic foods are purchased can be relatively easily identified through straight forward question items, the GHG impact that can be ascribed to peoples' diets is much more complex to delineate. Thus, the assessment of food-related greenhouse gas emissions has to date demanded extensive data material, and lengthy food frequency questionnaires developed to the study of dietary behavior have typically been (Temme et al., 2013; Scarborough et al., 2014). Developing a brief tool to assess diet-related GHG emissions would therefore be a very useful contribution to future research and an important part of the tool we aimed to develop in the project.

In order to capture diet-related GHG emission we added to the pilot survey, in addition to the food frequency questions already employed to measure the Diet Quality Score, a number of food frequency items which centred on the consumption of beverages (A10) (water, milk and alcohol), frozen foods (A8) types of meat and dairy (A1-2) (beef, pork, chicken, fish) and meat substitution products, as part of hot meals (A1). Further, as greenhouse gas emissions from food consumption cover a number of dimensions beyond the food consumed, the pilot survey also included items to investigate means of transport when shopping food, length of transportation, and amount and disposal of food waste (A12-15).

Measures of Quality of Life (See Table 4 column A)

Several generic short measures have been developed to assess life quality, well-being or happiness at population level. Validated measures such as SF37 and WHOQOL focus on dimensions such as mental health, physical well-being, and social inclusion. In addition to measuring life quality at a generic level, we also wanted to employ a measure which was of particular relevance to the field of food and food budget restraint. Such food related measures should capture individual as well as social aspects of quality of life in relation to food and eating. A final criteria of selection was that in the pilot test some measures should be included which had been used in previous surveys in the GfK panel, to enable comparison over time.

As a result of these priorities we selected a total of seven different measures from different quality of life survey batteries. The first measure was a stand-alone item used in multiple international surveys which focuses on general life satisfaction (table 4: A4). The second item we selected - also commonly applied in health surveys - focus on self-estimation of health (A5). A third item

replicated a question regarding feelings of stress (A17) taken from the Danish National Health Interview Survey (NIPH.dk). A fourth item replicated a question prompting about pain and discomfort (A15) from EuroQol (1990), and a fifth question replicated yet another question from EuroQOL (1990) about anxiousness and stress (A16). Response options were altered a little compared to the original questions and included five gradient response options (from “not at all” to “to a high degree”).

The sixth measure included nine of the 10 items from Kesslers 10 item measure on psychological distress (Kessler et al 2002)(A6-14). The seventh measure (A1-3) focused on food related life satisfaction, and was adopted from a 5 item validated measure by Grunert et al (2007). It involved three scale based statements: “I am generally pleased with my food“, “Food and meals give me satisfaction in daily life” and “Food and meals are positive elements“.

In addition to measures of mental health and life quality, a measure was included in the pilot survey which focused on social support and asked how often different types of assistance and help from others is accessible (A19-22). This item was adopted from Gjesfjeld et al (2008).

Step 2: Piloting the questionnaire

The items described above were tested in a pilot survey carried out in December 2012 among 1999 Danes who belonged to the GfK Household Consumer Panel (which totals approximately 3000 members). The composition of the entire panel is designed so as to represent Danish households. The survey was telephone and web based, and included a total of 169 items. Inclusion criteria for the Gfk survey was, that it should be a person in the household with responsibility for food shopping and cooking (gate keepers to the household food practices), which replied to the survey. Further, the questionnaire was only issued in Danish.

A total of 1,650 members responded to the questionnaire, resulting in a response rate of 82.5 per cent (55 per cent of the entire panel).

Apart from the measures and questionnaire items chosen for the core concepts described above, the questionnaire also included a number of standard items which enabled a comparison over time with previous questionnaire surveys conducted in the Gfk panel. Among such items were

attitude items, health indicator questions (height and weight of the respondent), and a number of sociodemographic back ground questions (items are not shown in tables in appendix).

Representativity of Gfk panel survey sample

The composition of the entire panel is designed so as to represent Danish households, however the panel suffers from an underrepresentation of men living alone and families with children. Couples without children and women living alone are overrepresented. In terms of respondent's age, people over 55 years are overrepresented and those below 35 years are underrepresented. In general women are by large overrepresented in the survey, reflecting that it is the main shopper who usually responds to surveys in the panel.

Step 3: Validation of measures

The data from the pilot survey served as the basis for testing and validating measures with the aim to select, combine, and reduce the items to be applied in the final survey tool. Within measurement theory (Drost, 2011) the process of addressing the suitability of quantitative measures (typically questionnaire based) includes tests of reliability and validity, where reliability is defined as ensuring that a measure is consistent and reproducible, and validity as ensuring that the measure in fact represents the underlying construct the researcher aims to tap. When addressing validity, a distinction is often made between translational validity and criterion validity. Translational validity asks whether the items used to measure a construct also reflects the underlying construct. This can be divided into, first, face validity, which are subjective assessments provided by lay persons and experts as to whether the questionnaire items/responses are relevant, and secondly, content validity. Content validity is a more formal procedure where clear definitions of the underlying dimensions of a construct must be defined and it requires ways to ensure that the employed items also represent the dimensions. Criterion validity addresses whether a construct is valid by asking whether it is associated with other measures (the criteria variables), in the manner and to the extent which is hypothesized. We use concurrent validity, which is a particular type of criterion validity where the expectation is that there is an association between the construct and the criterion measures.

When we developed the main measures it was not always relevant or possible to go through all the listed components of reliability and validity. Below we outline the measures in more detail, and the reasoning behind the choices that were made.

Validation of measures of food budget restraint and food insecurity in a Danish context

The suitability of the developed measures of food budget constraint was addressed in different ways. First, we found it important to employ an already existing measure (USDA 6-item measure of food insecurity) in order to ensure cross-country comparability. However, this is only feasible insofar as the USDA measure is empirical relevant to adopt into a Danish context. Looking at the question items, we were of the opinion that there was quite good content validity, also in a Danish context. Having concluded this, we then primarily made use of the principle of concurrent validity to assess criterion relevance. Here we found good concurrent validity, as the prevalence of food insecurity was very different across different levels of household income (adjusted for number of adults and children in the household). This was expected theoretically and follows findings from international studies. Further, food insecurity was significantly associated with unhealthy diets (cf. the DQS measure described earlier), higher probability of obesity (only in women) and poorer mental health. Again, similar associations have been identified in international studies. Finally, coping strategies were more extreme in the food insecure households (see section *Validation of coping strategy items)*, as was also theoretically expected from the literature and from the qualitative interviews carried out earlier in the research phase of the Food in Turbulent Times project.

It was also planned to widen the operationalization of budget constraints so at to also include less severe conditions than food insecurity. Our evaluation as to whether the categorization of a "severly" budget restricted group was relevant was basically based in the same reasoning about concurrent validity. Here we found, as expected, that the use of coping strategies was higher in comparison to the "mildly" budget restricted group but clearly lower and less extreme in comparison to the food insecure groups.

Validation of coping strategy items

In the pilot survey and in the subsequent final tool we measured coping strategies by probing the respondents for the frequency with which they had adopted a series of practices in the attempt to save money on the food budget (by means of five response options (and a 'don't know' option): 'never', 'seldom', 'sometimes', 'often', 'very often').

Below we describe our approach to investigating how well the constructed items worked in the Danish context.

Validation of coping strategy items against qualitative interview data

In the winter of 2012 and 2013, 30 qualitative interviews were conducted with individuals who were recruited from two geographical areas: a rural low-income area, *Lolland-Falster*, and the greater Copenhagen area. Individuals belonging to households of various income levels, educational levels and family composition as illustrated in Table A below were interviewed.

Table A: Overview of socioeconomic segmentation of 30 recruited households for qualitative study in the FiTT project. Educational level and disposable annual household income.

Educated above public school level		**Low range income[1]**	**Middle range income[2]**	**High range income[3]**
	Single	2	1	1
	Single parent	2	1	1
	Couple with children	2	3	0
	Couple without children at home	0	1	0
No academic education after public school				
	Single	2	1	0
	Single parent	2	2	1
	Couple with children	1	4	0
	Couple without children at home	1	1	1

[1] <DKK 125.000 (USD 19.600),
[2]DKK125.001-300.000 (USD 19.600-47.200)
[3] DKK300.001-2 mill (USD 19.601-314.500)

Potential participants were contacted by telephone and were screened based a set of criteria for inclusion and exclusion. All had to agree to a statement which expressed that within the past 12 months and due to either less money or an increase in food prices they had changed their way of either shopping for food, eating at home, or eating outside of the home. Recruited persons had to agree to more of these changes than merely a change of shopping place. People with both long term (>2 years) and short term experience with food budget restraint were recruited. Exclusion criteria were, the person 1) did not have access to cooking facilities in their home, 2) had no (important) influence on what food is bought or served for them either out of lack of resources or lack of interest/ power, 3) had a very high income (above 2 million DKK a year), 4) were students supported by government grant (SU).

The interviews were semi-structured and open ended and invited the interviewees to talk about the financial situation of the household and recent causes of change. They were asked to describe in detail how they had changed their habits of shopping, cooking, storing and eating food in order to reduce their spending. Further, they were prompted to reflect on the motives, consequences and experiences connected with these changes.

Results from the pilot survey were compared to coping strategies identified in the qualitative interview study. As has been reported elsewhere (Nielsen et al. 2015), the findings in both studies showed many similarities, pointing at considerable content validity of the survey items.

Validation of coping strategies through internal statistical testing/associations

In the process of discerning the quality of the items that were developed to assess coping strategies, we made use of a number of procedures. With a combination of exploratory factor analysis (EFA) and subsequent confirmatory factor analysis we identified four unique coping dimensions. Consistent with expectations, a copings strategy was identified that involves altering ones shopping practices: going for "cheaper food". Another strategy centers on "increasing frugality" in the domestic use of foods. The two last strategies involve "decrease in quality" of food intake, and "decrease in socializing", respectively (for details see Lund et al. *forthcoming*). These dimensions, by and all, resembled the findings from the qualitative studies (Nielsen et al. 2015) – see former section. As expected, the propensities to use these coping strategies were very different in the budget restricted groups. In general, the strategies were employed more frequently as food budget restrictions grew (from mild budget restrictions over severe budget restrictions to food insecure). However, the less budget restricted groups primarily adopted strategies regarding purchasing "cheaper food" and "increased frugality". The more extreme coping strategies ("decrease in quality" of food intake, and "decrease socializing") were clearly most frequent in the more extreme end of food budget restricted households (i.e. in the food insecure households). As these differences were expected we concluded that our measures of coping strategies exhibit good concurrent validity. On this background, items that were indicators of the four underlying dimensions described above were included in the final tool.

Development and validation of a diet-related GHG index and items to measure intake of particular food groups

We developed an index of diet-related GHG emissions. The index consists of 13 food frequency questions (FFQ). The validity of this measure was assessed using the pilot questionnaire and coupling this to the GfK food consumption data. The details of this are described in Lund et al. (2016). In brief, the development of the index involved an examination into whether the FFQs that mostly prompted for individual food consumption was compatible with the food purchase data reported by the Gfk panel, which is based on household level data. We also examined whether the GfK data converges with other data sources with respect to the composition of food group intake in the Danish population, food expenditure across 13 food groups, and CO2 emission levels across the 13 food groups. Aiming to further assess the compatibility of the food frequency questions and household food purchase data, we analysed whether the two data types produce patterns similar to what is identified in other research based on food frequency questions. Using various registers these food purchase data were coupled to data on nutritional content and GHG emissions. The Danish Food Composition Databank, maintained by the National Food Institute http://www.foodcomp.dk/v7/fcdb_search.asp) contains information about the nutrient content of 1049 different foods (as of January 2013). The food types were collapsed into 104 groups, which were assigned a CO2 kg equivalent emission per kg food unit. GHG emission levels for different food types were drawn from studies and databases which use the principle of Life Cycle Assessment. Relevant Danish or regional level data were obtained primarily from a Danish LCA food database (LCA, 2004), secondarily from Audsley et al. (2009), Halberg et al. (2006), Carlsson-Kanyama (2003), Mogensen (2009), and Wallén (2009).

When looking at eating patterns (in kg) the average annual shares of the purchased food groups also match the intake of an average adult Dane, as observed in the Danish dietary surveys (Fagt et al. 2008), quite well. The largest deviation is found in the beverage group. The share of GHG emission across food groups is also quite close to that identified in an earlier study of GHG emission across food groups in Denmark (Vad Mathiesen et al. 2009). It was confirmed that Dietary Quality Score is positively associated with kg purchase of fish (Spearman's rho=0,275; p<0.000; N=1216), fruits (Spearman's rho='0.311; p<0.000; N=1216), and vegetables (Spearman's rho=0.282; p<0.000; N=1216), which was also the case in Toft et al. (2007a).

Following this, we developed a Diet-related GHG Index based on food frequency questions and assessed its validity by examining whether the index explains variation in actual diet-related GHG emission. The validity assessment also checked for correlation with the same sociodemographic and relevant attitudinal factors as actual diet-related GHG emission. The result of this endeavor was a valid and brief index to measure diet-related GHG effects. This makes it possible in the future to follow the impact of dietary and attitudinal changes on diet-related GHG emission in a cost-efficient way.

The pilot questionnaire that was developed and issued to the panel in December 2012 makes it possible to combine actual purchase data with the relevant food frequency items. We combined food purchase data for an entire year, namely 2012, with the questionnaire data to assess whether any of the questions (described above) can be used as a brief way to measure differences in intake of added sugar and carbohydrate (although, only in those cases where it was reasonable to postulate a link between food item / group prompted about in the questionnaire and discernable food groups / macro nutrients in the GfK purchase data). Results from this analysis (unpublished) showed that the item focusing on intake of "*cakes and biscuits*" reflects kg purchase of biscuits/cakes/buns and share of energy from carbohydrates and added sugar quite well. Even though the question does not explain a large degree of the variation in energy share from carbohydrates and added sugar the difference identified nevertheless is substantial insofar as added sugar is concerned. This item can then be used as a brief measure of energy share from carbohydrates and added sugar. The questionnaire item regarding frequency in intake of "*soda/soft drink*" worked very well as an indicator of kg purchase of soda/juice/soft drinks. It did not, however, significantly explain variation in E% carbohydrates and added sugar. The questionnaire item regarding frequency in intake of "*alcohol*" worked very well as an indicator of kg purchase of alcohol. Further, the question item also clearly explained variation in E% alcohol.

Validation of Quality of Life measures

The items included in the pilot survey to measure different dimensions of quality of life were adopted from already validated questionnaires, and on this basis we did not pursue further validation. With the purpose of measuring *life satisfaction,* however, we constructed a composite

variable, which included three validated items. The theoretical expectation that these items in combination were suited to measure life satisfaction was tested statistically in the data set using Pearson's r, 1st pca component, and Cronbach's alpha tests. When comparing Gfk survey data from 2008 and 2012 it was found that the three questions were positively correlated and expressed one underlying factor in both data set (reported in Lund et al. *forthcoming*).

Step 4: Item reduction and adjustment

In this phase the questionnaire was shortened. Whereas the pilot questionnaire included a total of 169 items, the final survey tool included a total of 79 items. Of the 79 items 16 items did not relate directly to the measures discussed here, as they were either background questions, attitude questions, questions about physical features (height and weight), or questions about social context of eating, which were not formulated as coping strategies. In this section we will focus on providing an overview of the abbreviation down to the 63 items, which were selected to be included in the operationalization of the core concepts illustrated in figure 2 above: food budget restraint, coping strategies, diet quality, GhG emissions from food and quality of life.

The shortening process was framed by a set of demands related budget and the ambition to obtain an acceptable response rate. As the intention was that the tool should be suited for a potential future regular monitoring of the relation between food budget constraint and dietary health, quality of life and environmental sustainability, the maximum budget of the survey was set to 550.000 DKK (73.990 EURO) including the cost of coupling survey data to socio-demographic register data. An overview of how the items were adjusted and reduced is presented in the Appendix Tables 1-4 column B.

Reduction and adjustment of items to measure food budget restraint

As shown in Table 1 column B/C, we ended up with a total of seven items and a follow up item including the US and New Zealand based items for measuring food insecurity and food deprivation. The method of assessing various levels of food budget restraint through these measures showed good explanatory power across the pilot survey, and the items involved in this assessment were therefore retained in the short questionnaire. In addition to better enable future

cross European comparison, it was decided to include a question used in Eurostat surveys of deprivation (Table 1: B13).

Based on insights from the qualitative study, a new shorter version of one item from the pilot survey was added to assess the causes of food budget restraint. This item was a follow up question to respondents affirming the statement "I have been forced to buy cheaper food in order to be able to afford other things" (B3).

For the short tool, we decided to omit measuring the dimension of anxiety, as we cover anxiety and stress as part of the outcome variable (life quality) measure. Also we omitted the questions from the pilot survey related to deprivation in variation in food consumption and serving food for guests (Table 1: A8-9), as these issues were partly covered by our coping strategy items. Further due to the need of shortening we decided to leave out the question about the length of experience with budget restrictions in the final tool.

Reduction and adjustment of items to measure coping strategies.

As shown in table 2 column B/C, of the 21 items included in the Pilot survey, 17 items were selected for the measure of coping strategies.

Based on data from the qualitative interviews and on the results from the pilot survey we decided that in order to more adequately capture relevant aspects of how Danish households react to food budget restraint, some additional and adjusted survey items had to be included to the final tool. In order to focus on how parents use food to compensate for children's lack of access to other more expensive pleasurable activities, an item about confectionaries and crisps were re-formulated in to the following statement *"[within the past 12 months in order to save money on food I have…] Served confectionary, ice cream or similar to the children because we could afford other types of pleasures"* (B20). Another statement from the pilot was reformulated to better catch the effect of restraint on children's food related life. It said: " *Cut away some of the things that the children usually eat"* (B21). On the other hand we cut away an item addressing the limiting of children's fruit and vegetable intake.

We also decided that an additional form of coping needed further coverage in the population survey: external dependence in the form of either receiving food or borrowing money to purchase

food (B17, B18). We speculated that these strategies were probably only found to a limited extent in the qualitative interview data, because the informant sampling strategy did not focus on the most extreme budget restricted groups. However, as we identified a relatively high proportion of food insecure in the pilot study we assumed that this coping strategy could be relevant also in Denmark (Nielsen et al. 2015).

Results from the qualitative study were further used to improve the wording of some question items to better align with the strategies as reported by interviewees. For instance, in the pilot survey respondents were requested to state if they had increased the intake of "cheap seasonal fruit and vegetables". However the interviews indicated that it was more common to alter the intake of fruit and vegetables by cutting down on those types which could not be stored for very long, sometimes by substituting frozen for fresh options. As a consequence, a new question was formulated which prompted the respondent to state to what extent they had *"cut down on the intake of fresh fruit and vegetables"* (B8), which would capture both strategies.

The described considerations and changes meant that in comparison to the pilot survey the number of items addressing reducing socializing around eating were reduced from three items to one item stating that the responding in order to save money on food had *"kept from inviting visitors over to eat in our home"* (B16).

Reduction and adjustment of items to measure healthy eating and diet related GHG emission

The shortening process resulted in a total of 29 items to measure outcomes in terms of healthy eating and GHG emissions from foods consumed, displayed in Table 3 columns B/C.

In order to exploit the synergies between the indices measuring healthy diet and sustainability, it was decided to base both of these indices on food frequency questions, thereby enabling an integration of the items to measure healthy eating and GHG emission. As described earlier, the correspondence between individual-level food frequency questions and Gfk household-level food purchase data was very good. In this respect, the developed and employed measures discern individual-level diet behavior. It is important to stress, however, that this decision makes it

impossible to study diet behavior at the household level or to study diet behavior in children, as many of the food frequency questions are reported at individual level.

As noted, the pilot survey included a number of items to assess GHG emissions related to food practices, such as means of transportation, amount and use of food waste. We decided to omit this part from the final tool because of constraints of costs and number of items.

Reduction and adjustment of items to measure quality of life

From 23 items in the pilot survey, we ended up with a total of nine items measuring different dimensions of quality of life. These are shown in Table 4 columns B/C.

Two generic measures were included to measure general quality of life (B4-5), and one multi-item measure of anxiety and depression (B6-11).

From the original three items about food related life satisfaction, adopted from Grunert (2007), it was decided for the short tool to only include the most general question item about overall satisfaction with food (B1).

Application of the tool: Population survey

Statistics Denmark carried out the first population survey using this tool. As preparation they conducted a telephone-based pilot test of the questionnaire with 15 individuals from the relevant population. This resulted in reformulation of a few question items. In order to improve response rates and keep down costs a mixed mode design was chosen including both web based interviews (CAWI) and telephone assisted interviews (CATI). Further, invitees participated in a prize draw if they responded to the questionnaire. The total value of the prizes was 20.000 DKK (2.690 EURO).

We employed a disproportional random stratified sampling design where single parents and low income households were oversampled.

The survey was carried out in October and November 2015. The gross sample was 4.164 families. A total of 1877 responses were collected, corresponding to a response rate of 45%.

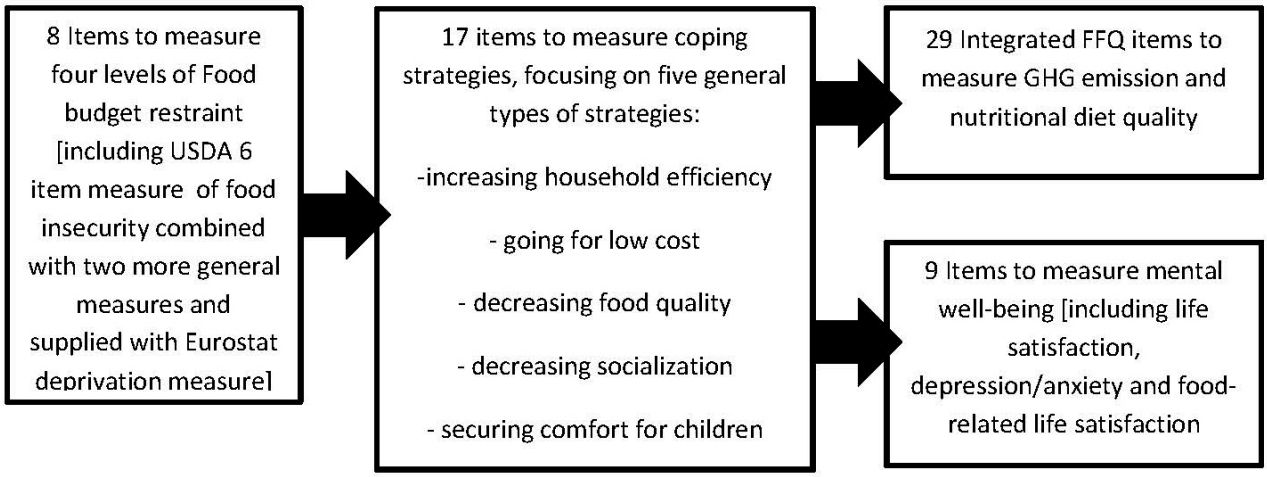
Following the population survey, register data regarding the sociodemographic background was provided from Statistics Denmark and coupled with the responses from the survey.

Conclusion

We started out from the original aim of constructing a tool to measure the statistical relationship between the independent variable of food budget restraint, the intermediate variables of coping strategies and the outcome variables of dietary health, environmental sustainability and quality of life.

We embarked on a process of a) defining relevant concepts, and b) operationalizing these concepts by either adopting existing measures (of dietary quality, quality of life, and food insecurity) or developing and validating novel measures (diet-related GHG-index, single-items measuring sugar and alcohol intake, and coping strategies employed in households that are food budget restricted). In the end we selected a total of 63 items to measure the constructs presented in figure 3 below.

Fig. 3: Short tool items related to FiTT conceptual framework



The tool described above can be adjusted to other national contexts. Adjustments of healthy eating measures can be based on national food intake data. Adjustment of measures to capture relevant levels of food budget restraint and coping strategies can be based on existing research in national contexts or on qualitative studies. Depending on the possibility to couple survey data to

register data, the tool as a whole (the 79 items) may be further abbreviated by omitting question items about socio-demographic characteristics. Further, items inquiring into attitudes may be omitted to abbreviate the tool.

We recommend in future studies to add more items about coping strategies related to reducing socializing around food.

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Appendix: Tables 1-4: overview of survey items in pilot survey and population survey

Table 1: Selection of items to measure food budget restraint and food insecurity

	A	B	C
	Questions in pilot survey	**Questions in short tool (CAWI) (total items: 8)**	**Response options in short tool**
1	Do you find that food has become more affordable to you over the past year?		
2	Which of the following statements best describe the food that has been eaten in your household during the past 12 months? *- we always have enough to eat and the kinds of food we want* *- we have enough to eat but not always the kinds of food we want;* *- sometimes we don't have enough to eat* *- often we don't have enough to eat* *- Don't know*	Which of the following statements best describe the food that has been eaten in your household during the past 12 months? *- we always have enough to eat and the kinds of food we want* *- we have enough to eat but not always the kinds of food we want;* *- Sometimes I/we cannot afford to get enough to eat* *- Often I/we cannot afford enough food to eat*	(Only one reply option is chosen)
3	To which extent is the following statements true about your situation during the past 12 months? *I/We have been forced to buy cheaper food in order to be able to afford other things*	To which extent is the following statements true about your situation during the past 12 months? *I/We have been forced to buy cheaper food in order to be able to afford other things*	- Often - sometimes - never
4	(sub) During how long have you been forced to buy cheaper food?		

5	To which extent is the following statements true about your situation during the past 12 months? *you simply ran out of food and there was no money to buy any?*	During the past 12 months, how often have you experienced that: *You simply ran out of food and there was no money to buy any?*	- often - sometimes -never
6	*I/ We could not afford to eat healthy meals?*	*You could not afford to eat healthy meals?*	- often - sometimes -never
7	*I worried about not being able to afford to buy food*		
8	*Because of economy our diet is not sufficiently varied*		
9	*I felt pressured because I could not serve my guests what I wanted*		
10	In the past 12 months, have you (or other adults in the household) ever *cut the size of a meal or skipped a meal because there was not enough money for food?*	In the past 12 months, have you (or other adults in the household) ever *cut the size of a meal or skipped a meal because there was not enough money for food?* (if yes) has it happened at least once within the past	Y/N - 1-2 months - 3-9 months -10-12 months
11	Within the past 12 months have you ever: *Eaten less than you felt you needed, because there was not enough money to buy food*	Within the past 12 months have you ever: *Eaten less than you felt you needed, because there was not enough money to buy food*	Y/N
12	*Experienced hunger, because there was not enough money for food?*	*Experienced hunger, because there was not enough money for food?*	Y/N
13		*Is your household able to afford a meal with meat, chicken or fish every second day, if you want it?*	Y/N

Table 2: Items to measure coping strategies (questions are only posed to respondents who experience some degree of restraint)

	A	B	C
	Questions in pilot survey	**Questions in short tool (CAWI) (total items:17)**	**Response options in short tool**
1	How often have you done the following to save money on your food budget? *Shopped in cheaper places than I usually do*	Within the past 12 months, how often have you done the following to save money on your food budget? *Shopped in cheap places*	(For all items) 1 Very often 2 Often 3 in between 4 Rarely 5 Never
2	*Shopped more when thing were on sale*	*Shopped when thing were on sale*	
3	*Bought cheaper varieties of same food*		
4	*Reduced purchase of organic produce*	*Refrained from buying organic produce*	
5	*Reduced purchase of luxury foods*		
6	*Bought less red meat*		
7	*Bought minced meat instead of whole cuts*	*Bought minced meat instead of whole cuts*	
8	*Bought the cheap fruit and vegetables of the season*	*Cut down on purchase of fresh fruit and vegetables*	
9	*Been careful to store and use leftovers*	*Been careful to store and use leftovers*	
10	*Streched food to make it last longer*	*Streched food to make it last longer*	
11	*Kept from expimenting with new foods which I was unsure we were going to eat*	*Kept from expimenting with new food products*	
12	*Made dishes from foods which are cheap and filling*	*Made dishes from foods which are cheap and filling*	
13	*Compromised with the healthiness of my food*	*Compromised with the healthiness of my food*	
14	*Compromised with the tastiness of the food/dishes*	*Compromised with the tastiness of the food/dishes*	
15	*Reduced how often I/we go out to eat (e.g. at cafés and restaurants)*		

16	*Made sure we had fewer visitors over to eat in our home*	*Kept from inviting visitors over to eat in our home*	
17	*Eaten at friends and family's place*	*Received food from family, friends or others to relief you from a pressured food budget?*	
18		*Borrowed money (e.g. from friends or family) to ensure that there was enough money for food towards the end of the month?*	
	Question posed to households with home living children (below age 19)		
19	*Put a limit to how much fruit the children are allowed to eat*		
20	*Put a limit to how much confectionary and crisps is allowed*	*Served confectionary, ice cream or similar to the children because we could afford other types of pleasures*	
21	*Served food which I am certain the children will eat*	*Cut away some of the things that the children usually eat*	
22	*Reduced my own food intake to ensure that the children can eat as they are used to*	*Reduced my own food intake to ensure that the children can eat as they are used to*	

Table 3: Shortening of food frequency items to measure healthy eating and GHG emission

	A	**B**	**C**
	Questions in pilot survey	**Questions in short tool (CAWI items shown) (total items: 29)**	**Response options in short tool**
1	Q1 How often do you eat the following type of hot foods: *- dishes with beef or veal* *- dishes with pork* *- dishes with poultry (chicken, turkey e.g.)* *- dishes with fish* *- vegetable/vegetarian dishes* *- dishes with tofu, seitan, quorn e.g.*	Q1. How often do you eat the following type of hot foods: *-Hot dishes with beef or veal* *- Hot dishes with fish* *- Hot vegetable and vegetarian dishes*	(Reply given for each option) 1=More than 1 time per day 1=5-7 times per week 1=3-4 times per week

			1=1-2 times per week 0=Less often/never
2	Q2. How often do you eat the following types of bread filling? *- lean cheese* *- high fat cheese (+ 30 eller derovre)* *- Fish spread (e.g. herring, makrell in tomato sauce, fish balls)* *- meat cuts, lever paté*	Q2. How often do you eat the following types of bread filling: *-High fat cheese (+ 30%)* *- Fish spread (e.g. herring, makrell in tomato sauce, fish balls)* *- Meat cuts, lever paté*	Same
3	Q3 How often do you eat the following type of vegetables *- mixed salads* *- other types of raw vegetables* *- prepared vegetables (boiled, baked, fried)*	How often do you eat the following type of vegetables: *- Mixed salads* *- Other types of raw vegetables* *- Prepared vegetables (boiled, baked, fried)*	Same
4	How often do you eat the following types of bread: *- rye bread* *- white bread,buns* *-groft franskbrød / grovboller*	How often do you eat the following types of bread: *-Wholegrain bread/bun*	Same
5	How often do you eat: *- cakes/biscuits* *-snacks (crisps, popcorns or the like)* *- Confectionary, chocolate, larkish, ice cream*	How often do you eat: *-Cakes/biscuits* *-Snacks (crisps, popcorns or the like)* *-Confectionary, chocolate, larkish, ice cream*	Same
6	Q8. Which types of fat do you spread on bread? - *Nothing* *(80-86)* *- Butter* *- Kærgården or similar* *- Minarine*	How often do you used the following types of fat on bread? *- Butter, fat* *- Kjærgården or similar on bread* *- Minarine or plant magarine*	Same

	- Plant margarine *- Fat* *- other options*	*- Bread without fat*	
7	Q9 and Q10: What types of fats do you or others in the household use when *preparing food*? - *nothing* *(172-193)* *- frying margarine* *- food/salad oil* *- butter* *- corn/sunseed/grape seed oil* *- fat/ cocopalm fat (palmin)* *-plant margarine* *- Olive oil* *- Kærgården* *- other* *- don't know*	Q9 and Q10. What types of fats do you or others in the household use when *preparing food*? *- Plant margarine, liquid margarine* *- Frying margarine* *- Butter, Kjærgården or similar* *- Olive oil* *- Other types of cooking oil (e.g. salad, corn, sun seed, grape seed)* *- Cook without fats*	Same
8	How often do you or other in the household use: *- frozen barriers* *- frozen vegetables* *-frozen baguette or bread* *- frozen potatoes or French fries*	How often do you or other in the household use frozen baguette or bread?	Same
9	How many servings of fruit do you normally eat within a day/ week?	How many servings of fruit do you normally eat within a day/week?	1 More than 6 a day 2 5-6 a day 3 3-4 a day 4 1-2 a day t 5 5-6 **a week** 6 3-4 **a week** 7 1-2 **a week** none/almost none
10	Q11. . How often do you drink the following beverages? *- tap water* *- bottled water* *- soda pop, fruit juice, frugt saft* *- te/kaffe* *- milk in tea and coffee* *- whole fat og semi fat milk*	Q11. How often do you drink the following beverages: *-Tea/coffee (all kinds)* *- Soda pop, fruit juice, frugt saft with sugar* *-Wine (rød-, hvid, rosé, mousserende,*	1 more than twice a day 2 1-2 times a day 3 4-6 times a week 4 1-3 times a week

	- skimmed og semi skimmed milk *- beer* *- wine* *- spirits(e.g. snaps, wiskey)*	*og hedvin)* *-Spirits* (*fx snaps, whiskey, cocktails, shots)*	5 1-3 times a month 6 less often / never
11	How often do you eat fast food (pizza, burgers, sharwama, sausages or similar)?		
12	How many kilometers do you usually drive every week by car to shop for food?		
13	In total, how much food do you waste?		
14	How is food waste treated on your household?		
15	Do you do anything yourself to fight global warming?		

Table 4: Selection of items to measure quality of life

	A	**B**	**C**
	Questions in pilot survey	**Questions in short tool (CAWI) (total items: 9)**	**Response options in short tool**
1	When you think of the food and meals that you eat presently, how much do you agree to the following statements: *In general, I am very content with my food*	When you think of the food and meals that you eat presently, how much do you agree to the following statements: *In general, I am very content with my food*	1 Totally agree 2 partly agree 3 neither agree nor disagree 4 partly disagree 5 Completely disagree
2	*Food and meals is the cause of much satisfaction in my everyday life*		
3	*Food and meals are highlights in my life*		
4	*Everything considered, how satisfied are you with your life?*	*Everything considered, how satisfied are you with your life?*	0 Very unsatisfied 1 2 3 4 5 6 7 8 9

			10 completely satisfied
5	*How would you characterize your physical health in general, in comparison to others at your own age?*	*How would you describe the status of your health in general*	1 excellent, 2 good, 3 acceptable 4 bad, 5 very bad
6	Within the past month, how often have you: *Felt so depressed that nothing could cheer you up?*	Within the past month, how often have you: *Felt so depressed that nothing could cheer you up?*	1 All of the time 2 Most of the time 3 Some of the time 4 A little of the time 5 Never
7	*Felt without hope*	*Felt without hope*	Same
8	*Felt restless or fidgety?*	*Felt restless or fidgety?*	Same
9	*felt that everything required an effort?*	*Felt that everything required an effort?*	Same
10	*felt worthless?*	*Felt worthless?*	Same
11	*felt nervous?*	*Felt nervous?*	Same
12	*Felt shamefull?*		
13	*Felt guilty?*		
14	*Felt inferior?*		
15	The following questions are about your general wellbeing: *Are you in pain or feel discomfort*		
16	*Are you anxious or depressed?*		
17	*Do you feel stressed in everyday life?*		
18	*Do you feel that in general you control what you do at work?*		
19	How often can you rely on assistance of the following kind if you need it: *Help with daily chores in case of illness*		
20	*someone to talk to or receive advice from regarding personal problems*		
21	*Someone to have fun with*		
22	*someone to care for and who values you*		