FRUIT AND VEGETABLE CONSUMPTION AND ITS DETERMINANTS AMONGST MOROCCAN WOMEN, IN THE CONTEXT OF NUTRITION TRANSITION

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‘Beneath these green mountains where spring rules the year
The arbutus and loquat in season appear;
And feasting on lychee--three hundred a day--
I should not mind staying eternally here.’

(Su Shih, 1037-1101)

Abstract

Fruit and Vegetable consumption and its determinants amongst Moroccan women, in the context of Nutrition Transition

Purpose: Morocco is undergoing a nutrition transition, characterised by increasing prevalence non-communicable diseases (NCD), including obesity. In that context, it is crucial to focus on fruit and vegetable (F&V) intake as they may have a preventive effect on weight gain and NCDs.

Objectives: The objectives of the present work were: to develop an objective measure of F&V intake and to provide a holistic understanding of factors that may influence F&V consumption, such as socio-demographic and psychosocial factors.

Methods: The target population was Moroccan women (20-49 years), living in the urban area of Rabat-Salé. This PhD involved three different studies: the first was based on focus groups that yielded qualitative data of women's views of F&V; the second study involved validating a quantitative F&V Food Frequency Questionnaire (FFQ); the third a cross sectional population survey- which incorporated findings from studies 1 and 2 to assess dietary intake and the factors influencing F&V consumption.

Results: Validation analyses suggested that the quantitative FFQ developed was reliable and valid to measure F&V intake. The mean F&V intake was 213g per day. Women with higher education, higher economic status and better knowledge scores ate significantly larger amounts of F&V than others. Processed food consumption was inversely associated with vegetable intakes. In terms of psychosocial factors, the strongest predictor of intention to eat fruit was control beliefs. Normative beliefs were the strongest predictor of intention to eat vegetables. Intention was the strongest predictor of both fruit and vegetable consumption.

Conclusion: The data collected gave an overview of the amount of fruit and vegetables consumed by urban Moroccan women, and enabled a better understanding of the determinants of fruit and vegetable intake. As a consequence, data sheds light on possible avenues for policies and nutrition interventions to focus on in Morocco, in order to increase fruit and vegetable consumption.

Key words: Fruit, Vegetables, consumption, determinants, women, Morocco

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List of publications & communications

Oral communications

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Posters at conference

1. Landais E, Holdsworth M, Bour A, Choua N, Al Karim Y, McCullough F, Delpeuch F & the Obe-Maghreb Study Group. **Does good knowledge of fruit and vegetables predict intake in urban Moroccan women?** In *11th European Nutrition Conference*; 26-29 October 2011; Madrid, Spain.

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2. Landais E, Holdsworth M, Kidai A, McCullough F, Bour A & Delpeuch F. **Promoters and barriers to fruit and vegetable consumption among Moroccan women.** *International Society for Behavioural Nutrition and Physical activity Annual Meeting (ISBNPA 2009)* 17-20 June 2009, Cascais-Lisbon, Portugal.

3. Landais E, Holdsworth M, Bour A, McCullough F & Delpeuch F. **Building a short quantitative Food Frequency Questionnaire to assess fruit and vegetable intake in the context of the double burden of malnutrition in Morocco.** *International Conference on Diet and Activity Methods (ICDAM7)*, 5-7 June 2009, Washington, D.C., USA.

Journal articles submitted

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Journal articles in preparation

1. Fruit and Vegetable consumption in urban Moroccan women
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3. Measuring psychosocial determinants of fruit and vegetable, in urban Moroccan women

   Planned to submit in: *International Journal of Behavioural Nutrition and Physical Activity*

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List of abbreviations and acronyms

AICR	American Institute for Cancer Research
AR	Accurate Reporter
BB	Behavioural Beliefs
BCS	Budget and Consumption Surveys
BP	Blood Pressure
BMI	Body Mass Index
BMR	Basal Metabolic Rate
BRFSS	Behavior Risk Factors Surveillance System
CB	Control Beliefs
CVD	CardioVascular Disease
DAFNE	DAta Food NEtworking
DHS	Demographic and Health Survey
DDS	Dietary Diversity Score
DQI-I	Diet Quality Index-International
EFSA	European Food Safety Authority
EI	Energy Intake
EPIC	European Prospective Investigation into Cancer Nutrition
FAO	Food and Agriculture Organization
FBS	Food Balance Sheets
FDS	Fruit Diversity Score
FFQ	Food Frequency Questionnaire
Freshfel	European Fresh Product Association
FVDS	Fruit and Vegetable Diversity Score
FVQI	Fruit and Vegetable Quality Index
F&V	Fruit and Vegetables
GDP	Gross Domestic Product
GNP	Gross National Product
HBP	High Blood Pressure
HBS	Household Budget Survey
HDS	Health and Demographic Survey

HDI	Human Development Index
IASO	International Association for the Study of Obesity
ICC	IntraClass Correlation
IDF	International Diabetes Federation
IRD	Institute of Research for Development
LER	Low Energy Reporter
LMIC	Low- and Middle-Income Countries
MR	Misreporter
MS	Metabolic Syndrome
NB	Normative Beliefs
NCD	Non-Communicable Disease
NHANES	National Health And Nutrition Examination Survey
NHIS	National Health Interview Survey
OMS	Organisation Mondiale de la Santé
OR	Odds Ratio
PAL	Physical Activity Level
PUFA	PolyUnsaturated Fatty Acid
RMR	Resting Metabolic Rate
RRFSS	Rapid Risk Factor Surveillance System
se	standard error
SES	Socio-Economic Status
SFA	Saturated Fatty Acid
SU.VI.MAX	SUpplémentation en VItamines et Minéraux Anti-oXydants
TPB	Theory of Planned Behaviour
UK	United Kingdom
US	United States
VDS	Vegetable Diversity Score
WC	Waist Circumference
WCRF	World Cancer Research Fund
WHO	World Health Organization
24-hr	24-hour dietary recall

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Chapter 1: Introduction

The following chapter aims at presenting an overview of fruit and vegetable consumption issues, in that particular context that is the nutrition transition. Therefore, it investigates several concepts, such as the impact of the nutrition transition on fruit and vegetable intake, fruit and vegetable intakes and related potential health outcomes, assessment of fruit and vegetable intakes and determinants of fruit and vegetable consumption.

1.1 Literature review

1.1.1 Defining Nutrition Transition and its impact on fruit and vegetable intake

The nutrition transition has been defined as a sequence of nutritional and food profiles resulting from an overall modification in food patterns (Popkin, 1994). These modifications are associated with underlying changes, such as economic, social and demographic changes (Popkin, 1999; Kim *et al.,* 2000). These underlying changes are also linked with changes in physical activity and body composition patterns (Popkin, 1999). According to Popkin (1993) the nutrition transition can be characterized into five different stages: collecting food; famine; receding famine; degenerative disease; and behavioural changes. Each stage of the nutrition transition is characterized by specific nutritional, economic and demographic profiles. High-income countries lie in the fifth stage whereas most low- and middle-income countries[1] (LMIC) lie between the third and fourth stage.

The dietary changes arising from this transition are both qualitative and quantitative. Indeed, these changes include shifts in the structure of the diet towards a higher intake of energy-dense foods (especially from fat and added sugars), a higher consumption of processed foods, a higher consumption of animal protein, a lower intake of complex carbohydrates, dietary fibres, fruit and vegetables, an increase in food portion sizes consumed and an increased potential access to a wider variety of food. The enhanced dietary diversity that is observed with the nutrition transition can lead to improved nutritional status, but it can also lead to over-nutrition and thus an increase in calorie intake. These changes also include shifts in meal patterns towards a higher number of meals eaten out of home.

[1] Countries grouped by gross national income per capita: low income (≤825 US$), high income (≥10 066 US$)

The economic changes underlying the nutrition transition include agricultural and industrial revolutions that lead to mechanization and decreasing physical activity. Concomittant with these changes increasing income is also observed. The demographic changes underlying the nutrition transition include shifts in mortality and fertility towards a decreasing mortality due to infectious diseases and an increasing mortality due to non-communicable diseases (NCD); a decreasing fertility rate; an increasing life expectancy and population aging. Shifts in residential patterns are also observed towards an increased urbanization rate.

Altogether, these changes contribute to the development of diet-related NCDs, such as obesity, type 2 diabetes, cardiovascular diseases and certain kinds of cancer (Popkin, 2002; Astrup *et al.*, 2008).

Several studies have shown that urbanization, usually associated with higher incomes and economic growth, affects not only dietary patterns towards substantial increase in fat and sugar intake (Drewnowski and Popkin, 1997; Popkin, 1999; Popkin, 2000), but also influence physical activity patterns by decreasing physical activity levels and increasing sedentarity (Popkin, 1999; Assah *et al.*, 2011). One of the consequences of urbanization is the increase of the Body Mass Index (BMI) of the population as well as the increase in diet-related NCDs, with a higher prevalence of overweight in urban areas compared to rural areas (Popkin, 1999; van der Sande *et al.*, 2001; Kinra *et al.*, 2011). However, Mendez *et al.*, (2005) reported that with the increase in Gross National Product (GNP) these urban/rural disparities tended to decrease. Some authors (Solomons and Gross, 1995) predicted that in 2025 living in an urban area will be the norm in every African country, except the poorest, thereby representing an urban rise of 87%.

In 1998, the World Health Organisation (WHO) estimated that there were around 300 million obese adults worldwide, and amongst them 115 million lived in low-income countries (OMS, 1998). In a recent study, Kelly *et al.*, (2008) found that worldwide in 2005, 937 million adults were overweight and 396 million were obese. Thus, the overall prevalence of overweight in adults was 23.2%, with women slightly less overweight (22.4%) than men (24.0%) and that 9.8% of adults were obese (with a larger gap between women (11.9%) and men (7.7%)). In this study the authors predicted that by 2030, if secular trends remained the same, 2.16 billion adults will probably be overweight and 1.12 billion obese. It is worth noting that amongst these overweight and obese people, 80% will live in LMIC. According to weight status trends data from 42 countries over the 1990-2010 period, nowadays, at least 2 billion people are probably already overweight (Popkin *et al.*, 2012).

Studies conducted worldwide before the 1990's led to the conclusion that generally in high-income countries obesity was often found in rural areas and amongst the poor, whilst in LMIC, during the nutrition transition, excessive weight firstly concerns urban households with high socio-economic status before affecting those with low status (Delpeuch and Maire, 1997; Popkin, 1999; Popkin and Gordon-Larsen, 2004). In a review including studies conducted between 1988 and 2004 that investigated the relationship between obesity and socio-economic status, McLaren (2007) concluded that for women in high-income countries, obesity was most commonly linked with education and occupation (the most educated being the least obese), whereas in LMIC obesity was most commonly linked with income and material possessions (the wealthiest being the most obese).

However, according to a review of studies published between 1989 and 2003 and conducted on adult populations from developing countries, the previous link described between socio-economic status and obesity was no longer the case (Monteiro *et al.*, 2004). Indeed, the authors concluded that obesity in the LMIC was no longer only a problem of high socio-economic status and that there was a shift towards obesity in low socio-economic groups as the country's GNP increased.

Contrary to what was observed in high-income countries, the nutrition transition in LMIC is not gradual, it happens at a faster pace and at lower levels of GNP (Drewnowski and Popkin, 1997; Kim *et al.,* 2000). Indeed, the speed of dietary and activity pattern shifts is particularly great in these countries (Popkin, 2002; Popkin and Gordon-Larsen, 2004). In the early stage of the nutrition transition, under-nutrition has usually been associated with a high prevalence of infectious diseases. Then, as populations move to a more advanced stage of the nutrition transition, under-nutrition gives way to over-nutrition whilst infectious diseases give way to NCDs. In LMIC this transition, led to the coexistence of over-nutrition and under-nutrition and emergence of NCDs whilst prevalence of infectious diseases were still high. This phenomenon, called the double burden of malnutrition, has been well documented in developing countries such as China, Egypt, India, Mexico, Philippines and South Africa (Food and Agriculture Organization, 2006). In these countries over the past 30 years, whilst child undernutrition such as wasting and stunting decreased but remained relatively high, overweight increased over the same period of time. Whilst underweight decreased in adults, overweight increased, e.g. +109% in Chinese women between 1998 and 2000; +119% in rural Indian male between 1989 and 2000. At the same time, prevalence of micronutrient deficiencies remained relatively high, e.g. one-third of women and children in China and Philippines are anaemic; 26.5%

of Egyptian school-aged children suffer from vitamin A deficiency. In addition to increasing weight status these six countries face a high prevalence of NCDs, e.g. 9.3% of Egyptian adults had diabetes in 1995; 39.2% of Mexican males had hypertension in 2000 and 18.0% of Chinese females had hypertension in 2002 (all data from Food and Agriculture Organization, 2006).

The consequence of the nutrition transition in LMIC is a rise in the mortality rate due to diet-related NCDs, including type 2 diabetes, cardiovascular disease and certain kinds of cancer. It is worth noting that in LMIC, an increasing rate of NCDs is also due to low birth weight. Indeed, low birth weight, i.e. less than 2500g, has been identified as a risk factor for developing NCDs in later life (Barker, 2004).

The WHO has predicted that within the next 25 years, the prevalence of type 2 diabetes will be multiplied by 2.5 (World Health Organization, 2003). In 2002, Caballero and Popkin (2002) predicted that in 20 years of time, NCDs will be responsible for 60% of deaths in developing countries. In 2005, this has not only been confirmed by the WHO, but was seen to have worsened, as it reported that in 2005, 60% of all deaths were due to NCDs and that 80% of these deaths occurred in LMIC (World Health Organization, 2005). The WHO also predicted that within the next ten years, 388 million of people will die of a NCD (World Health Organization, 2005). For these countries, in terms of public health, the burden due to these NCDs will be enormous.

Definition of fruit and vegetables

There are several ways of considering fruit and vegetables: botanically, for culinary purposes and nutritionally.

In botanical terms, fruit is defined as: '*the ripened ovary of a flower together with any accessory parts associated with it*' (Lewis, 2002). In other words, fruit is the seed bearing structure derived from the flower. In that sense, plants such as pumpkins, squashes, tomatoes, cucumbers, green beans or bell peppers are botanically considered as a fruit. Culinary speaking, the term fruit generally refers to plants that are sweet and fleshy, such as plums, apples or oranges.

Vegetable is a culinary term, not a botanical one. Its definition has no scientific value and is somewhat arbitrary and subjective. A vegetable can be any parts of plants. Thus vegetables can include leaves (lettuce), stems (asparagus), roots (carrot, radish), flowers (broccoli, cauliflower), bulbs (garlic, onion), seeds (peas and beans), tubers (yam, potato), corm which are short underground stems (taro) and fruit (cucumber, squash, pumpkin, and capsicum) (Mingochi, 1998).

Apart from these botanical and culinary definitions, the definition of fruit and vegetable should be related to their nutritional properties. Hence, fruit and vegetables are defined as low-energy dense foods, rich in vitamins and minerals, rich in fibre and rich in bioactive compounds (WCRF/AICR, 1997). As a consequence, starchy roots and tubers should not be considered as vegetables.

In this thesis, fruit and vegetables are considered based on their nutritional definition.

Looking at the consequences of the nutrition transition in terms of fruit and vegetable consumption showed different patterns, probably depending on economic development. In LMIC such as China and Philippines, studies showed a decrease in fruit and vegetables consumption. Thus, in China, between 1989 and 2000 vegetable consumption slightly decreased from 375 to 361g per day and fruit consumption decreased from to 14 to 12g per day. In Philippines, from 1978 to 2003, vegetable intake decreased from 145 to 111g per day and fruit intake decreased from 104 to 54g per day. However, in other countries with a higher level of economic development such as Mexico, from 1989 to 2002, overall fruit and vegetable consumption increased, from 295 to 351g per day as purchased (Food and Agriculture Organization, 2006) and then dramatically decreased to 123g per day in 2006 (Ramírez-Silva *et al.*, 2009). In the same way, in South Korea, between 1969 and 1998, vegetable consumption increased from 217g to 284g per day whilst

fruit consumption increased from 19g to 198g per day (Lee *et al.*, 2002). In a country close to Mexico, such as Brazil, between 2006 and 2010 fruit and vegetables consumption tended to decrease (Ministério da Saude, 2006 and 2010). It is worth noting that methods used to measure fruit and vegetable intakes differed across countries and across time, resulting in comparability issues.

The extent of the nutrition transition in Morocco is discussed in section 1.2.3.

1.1.2 Health benefits of fruit and vegetables

The hypothesis of a protective effect of fruit and vegetables against diet-related NCDs, such as obesity, type 2 diabetes, cardiovascular diseases, hypertension and certain kinds of cancer, came from studies, either observational or interventional, conducted over the last four decades which at the beginning focused more on particular diet, such as the Mediterranean diet, rather than on particular foods or nutrients. Hence, many studies focused on the health benefits attributable to the Mediterranean diet, which is characterised by a high consumption of foods of vegetable origin (fruit, vegetables, beans and pulses, nuts and cereals), olive oil as the principal source of fat, and a low consumption of meat (Keys *et al.*, 1986; Goldstein, 1994; Trichopoulou and Lagiou, 1997; Trichopoulou *et al.*, 1999). Later, studies focused more particularly on fruit and vegetables and observed a correlation between a high consumption of fruit and vegetables and a reduced risk of developing diet-related NCDs. In other words, a high intake of fruit and vegetables was inversely associated with NCDs and therefore may have a protective effect against these diseases (Block *et al.,* 1992; Lock *et al.,* 2005; World Cancer Research Fund, 2007; Estaquio *et al.,* 2008; Benetou *et al.*, 2008; Marmot, 2011).

There are mainly three arguments that explain the health benefits of fruit and vegetables. Firstly, the large contribution of fruit and vegetables to micronutrients (especially provitaminic A carotenoids, vitamin C, folate and minerals, such as potassium or magnesium) and fibre intake, which are probably involved in beneficial health effects, i.e. a decrease risks of NCDs. Secondly, the protective effect, due to certain antioxidants, such as vitamin C, carotenoids and polyphenols, against NCDs such as cardiovascular diseases, neurodegenerative and metabolic diseases and certain cancers (Lampe, 1999; Bazzano, 2005; Barta *et al.*, 2006; Vainio and Weiderpass, 2006; World Cancer Research Fund, 2007). And lastly, a low energy density, due to a high dietary

fibre and water content, which is a crucial point regarding the development of overweight and obesity.

Based on evidence of the role of fruit and vegetables in the prevention of many health problems, such as diet-related NCDs, the WHO have recommended that people should eat at least 400g of fruit and vegetables per day (excluding potatoes and other starchy tubers) which corresponds to five servings of 80g for each portion (World Health Organization, 1990).

Many studies conducted worldwide that investigated whether people meet the WHO daily fruit and vegetables recommendations reported that most of people do not. For example, according to the 2002-2003 WHO Global Health Survey conducted in 52 mainly LMIC, 77.6% of men and 78.4% of women were considered as low consumers of fruit and vegetables, i.e. they consumed less than five servings of fruit and vegetables per day (Hall *et al.,* 2009). In 2010, in Brazil, an economically emerging country, even more adults (≥18 years) (81.8%) ate less than five fruit and vegetables per day (Ministério da Saude, 2010). Similarly in European countries, such as France and the United Kingdom (UK), 57% of French adults (≥18 years) and about three-quarters of English adults (≥16 years), consumed less than 400g of fruit and vegetables per day (USEN, 2007; The Health and Social Care Information Centre, 2010, respectively). In the United States (US), in 2009, 67.2% of adults (≥18 years) ate less than two fruit per day and even more (76.4%) ate less than three vegetables per day (CDC, 2010).

According to one survey, which investigated the burden of diseases attributable to low intake of fruit and vegetables and its association with different health outcomes, it was estimated that worldwide over 2.6 million deaths (4.9%) were attributable to low fruit and vegetable intake, placing low fruit and vegetable consumption amongst the top ten selected risks factors for mortality in the middle- and high-income countries (World Health Organization, 2009). Therefore, it was estimated that the total burden of diseases could be reduced by 1.8% by increasing fruit and vegetable intake up to 600g per day (Lock *et al.*, 2005). More precisely, the burden of disease attributable to ischemic heart disease and ischemic stroke could be reduced by 31% and 19%, respectively. In the same way, the burden of diseases attributable to diverse cancers could also be reduced (by 20% for oesophageal cancer, by 19% for gastric cancer, by 12% for lung cancer and by 2% for colorectal cancer) (Lock *et al.*, 2005).

1.1.2.1 The role of fruit and vegetables in preventing obesity

Overweight and obesity are the fifth leading risk for global deaths. In 2008, more than 1.4 billion adults were overweight (BMI≥25kg/m^2). Of these, more than 200 million men and nearly 300 million women were obese (World Health Organization, 2012). By 2030, if the secular trends remain the same, the absolute numbers of overweight people could reach 2.16 billion and the absolute numbers of obese individuals could reach 1.12 billion (Kelly *et al.*, 2008).

Most fruit and vegetables are low in energy density, due to high water and low fat content. Moreover they are usually fibre-rich, and fibres play a crucial role in satiety. As a consequence, their consumption could have a preventive effect on weight gain and therefore on obesity.

Into more details, in a systematic review including fifteen cross-sectional studies and one prospective study, Tohill *et al.*, (2004) concluded that only eight of these studies showed a significant association between a high consumption of fruit and vegetables and a lower body weight. Moreover, when associations were significant, they were often significant in one gender but not in the other. In an recent cross sectional study conducted amongst US based on the Behavior Risk Factors Surveillance System (BRFSS), Heo *et al.*, (2011) concluded that overweight, as well as obese subjects, consumed significantly less fruit and vegetables than normal weight subjects. In another study, also conducted amongst US adults and based on data from the National Health And Nutrition Examination Surveys (NHANES) 1999-2004, Keast *et al.*, (2011) concluded that dried fruit consumption was associated with lower body weight status.

More recently, in a review investigating the potential association between fruit consumption and body weight, which included eight prospective studies and five cross-sectional studies, Alinia *et al.*, (2009) concluded that the majority of the evidence from these studies led to the conclusion that fruit intake was possibly inversely associated with body weight. In other words, people eating more fruit tended to have lower body weight.

In a study conducted amongst adults from the European Prospective Investigation into Cancer Nutrition (EPIC) cohort, Buijsse *et al.*, (2009) investigated the association between fruit and vegetable intake and changes in body weight. The authors concluded that there was a weak and inverse association between fruit and vegetables consumption and subsequent changes in body weight. The same kind of study conducted amongst Spanish

adults led to the same conclusions for men but not for women (Bes-Rastrollo *et al.*, 2006).

Hence, according to several studies that investigated the role of fruit and vegetables in preventing obesity, in adults, the protective effect of fruit and vegetables appeared less evident when studies were cross-sectional rather than prospective. Indeed, whilst half of the cross-sectional studies did not find any relationship between fruit and vegetables and weight, most prospective studies found a potential beneficial effect of fruit and vegetable consumption on weight changes.

1.1.2.2 The role of fruit and vegetables in protecting against type 2 diabetes

According to Shaw *et al.*, in 2010 diabetes affected 6.4% of adults (aged 20 to 79 years) worldwide (which represented 285 million adults) and would increase to 7.7%, (which would represent 439 million adults) by 2030. Hence, between 2010 and 2030, there would be a 69% increase in numbers of adults with diabetes in LMIC and a 20% increase in high-income countries (Shaw *et al.*, 2010). These differencies are also a reflection of population growth in LMIC.

Fruit and vegetables are characterized by a high fibre, antioxidant and magnesium content (especially vegetables). Fibres are recognized as playing a role in delayed gastric emptying and antioxidant compounds increase the oxidative capacity. Several epidemiological studies have demonstrated that a high intake of magnesium is associated with a reduced risk of type 2 diabetes (Kao *et al.*, 1999; Lopez-Ridaura *et al*., 2004). Altogether these compounds could play a crucial role in the prevention of type 2 diabetes (Schröder, 2007).

Studies, either prospective or cross-sectional, which focused either on dietary patterns or on fruit and vegetable intakes *per se*, suggested that fruit and vegetables could have a protective effect against type 2 diabetes. Thus, a prudent pattern characterized by high consumption of vegetables, fruit, fish, poultry and wholegrains was associated with a modestly lower risk for type 2 diabetes in a prospective cohort study conducted amongst US men (van Dam *et al.*, 2002), as well as in a cross-sectional study conducted amongst Irish adults, (Villegas *et al.*, 2004). The EPIC Norfolk study conducted in the UK amongst adults followed-up for 12 years, concluded that plasma vitamin C level (a biomarker reflecting fruit and vegetable intakes) was strongly and inversely associated with the risk of diabetes (Harding *et al.*, 2008). The same association but weaker, was also found for fruit and vegetable intakes (Harding *et al.*, 2008), whereas other prospective cohort studies reported

different findings, such as a protective effect of vegetables only (Villegas *et al.*, 2008) or a protective effect rather due to variety than amounts of fruit and vegetables consumed (Cooper *et al.*, 2012).

In a recent systematic review that included six cohort studies, Carter *et al.*, (2010), concluded that there was no significant benefit of increasing the consumption of fruit, vegetables or fruit and vegetables combined to protect against type 2 diabetes. However, a greater intake of particular vegetables, such as green leafy vegetables was associated with a reduced risk of type 2 diabetes. A prospective cohort study conducted amongst Japanese adults led to the same kind of conclusions. Indeed, consumption of fruit or fruit and vegetables combined was not associated with a lower risk of type 2 diabetes. On the other hand, the consumption of green leafy vegetables, as well as cruciferous vegetables, was associated with a reduced risk of type 2 diabetes (Kurotani *et al.*, 2012). In a similar manner, in a cohort study conducted amongst Australian adults, Hodge *et al.,* (2007) concluded that a dietary pattern including salad and cooked vegetables was inversely associated with type 2 diabetes.

Hence, studies that investigated the role of fruit and vegetables in protecting against type 2 diabetes led to the conclusion that this potential protective effect was due to particular varieties of vegetables rather than overall fruit and vegetables, and that when investigating this relationship only prospective studies should be considered.

1.1.2.3 The role of fruit and vegetables in protecting against cardiovascular diseases

Cardiovascular diseases are the main causes of death worldwide. According to the WHO, in 2008, about one-third of deaths (17.3 million) worldwide were attributable to cardiovascular diseases, of which 7.3 million were due to coronary heart disease and 6.2 million to stroke. More than 80% of these deaths occurred in LMIC (World Health Organization, 2011). It is estimated that by 2030 the numbers of death attributable to cardiovascular diseases will rise to 23.4 million, driving such diseases to be the leading cause of deaths. According to the *World Health Report 2002* (World Health Organization, 2002), low fruit and vegetable intake was estimated to be responsible for 31% of ischemic heart diseases and 11% of stroke worldwide. In a more recent review, Lock *et al.,* (2005) estimated that an increased daily consumption up to 600g could reduce the burden of ischemic heart disease by 31% and stroke by 19% on a population level.

The mechanisms by which fruit and vegetables may operate to lower cardiovascular risk factors remain unclear. Even if several clinical trials have failed to convincingly demonstrate a protective effect of antioxidant vitamins, such as vitamin C, folate and carotenoids, on cardiovascular diseases, it is hypothesized that bio-active compounds from fruit and vegetables may be responsible for the protective effect against cardiovascular risk factors (Bazzano, 2005).

One systematic review focusing on fruit and vegetables and cardiovascular diseases and including ten ecological studies, three case-control studies and sixteen cohort studies, Ness and Powles, (1997) concluded that there is a strong protective effect of fruit and vegetables consumption on stroke and a more moderate effect on coronary heart disease. A more recent review focusing on associations between fruit and vegetables intakes with coronary heart diseases was carried out on 32 case-control studies and prospective cohort studies (Dauchet *et al.*, 2009). The authors found that cohort studies reported weak or no associations and that results from controlled trials did not show any clear protective effect of fruit and vegetable consumption on coronary heart diseases. However, when trial conditions were rigorously controlled, high fruit and vegetable consumption was associated with reduced blood pressure.

One recent study, based on EPIC data, (Crowe *et al.*, 2011), suggested that the consumption of at least eight portions of fruit and vegetables daily may reduce by 22% the risk of fatal ischemic heart disease. The trend was found in a cohort study conducted amongst French and Northern Irish men (50-59 years) followed-up for about ten years. Indeed, a higher intake of fruit and vegetables was associated with a lower risk of cardiovascular disease in smokers (but not in non or former smokers) (Dauchet *et al.*, 2010). Another cohort study conducted amongst adults followed-up for ten years, in the Netherlands with a particular focus on raw and processed fruit and vegetables showed that higher intake of raw fruit and vegetables may protect against stroke. The same kind of association was not found for processed fruit and vegetables (Griep, *et al.*, 2011).

Hence, studies that investigated the link between fruit and vegetable intake and cardiovascular diseases, reported inconsistent results. Most of studies conducted on that topic led to the conclusion that raw fruit and vegetables may have a protective effect on stroke, but not on coronary heart disease, and that this protective effect seems to be stronger for smokers compared to non smokers (Dauchet *et al.*, 2009; Dauchet *et al.*, 2010; Crowe *et al.*, 2011; Griep, *et al.*, 2011).

1.1.2.4 The role of fruit and vegetables in protecting against cancer

In 2008, 7.6 million deaths (around 13% of all deaths) worldwide were attributable to cancer, which was by that time one of the main leading causes of death. If the secular trends in cancer remain the same, in 2030 13.1 million deaths will be attributable to cancer. About 70% of all cancer deaths occurred in LMIC (World Health Organization, 2012).

Fruit and vegetables are sources of many minerals, vitamins, and bioactive compounds which play a crucial role in protecting individuals from oxidative stress (Barta *et al.*, 2006; Vainio and Weiderpass, 2006).

A large systematic review including cohort and case-control studies conducted since the 1990s concluded that a high intake of fruit and vegetables probably protect against certain types of cancers (WCRF/AICR, 2007). Indeed, several studies showed evidence that non-starchy vegetables probably reduced the risk of mouth, larynx, pharynx, oesophagus and stomach cancer. Moreover, particular vegetables, such as allium vegetables may protect against stomach cancer and garlic probably protects against colorectal cancer. In the same way, there was evidence that fruit probably lowered the risk of mouth, larynx, pharynx, oesophagus, lung and stomach cancer.

According to the EPIC study conducted amongst almost half a million of subjects who were followed-up for nearly nine years, eating five servings of fruit and vegetables per day has less effect on overall cancer prevention than reported in previous studies. Indeed, the EPIC study found that eating five servings of fruit and vegetables was associated with a 9% lower risk of cancer whilst eating two and a half servings was associated with a 3% lower risk of cancer (Boffetta *et al.*, 2010). The same kinds of results were supported by the NHANES study conducted between 1984 and 1998. Indeed, the NHANES surveys reported no significant association between fruit and vegetable intake and cancer incidence in the US (Hung *et al.*, 2004). More recently, a prospective cohort study also conducted in the US, led to the same results except that vegetable consumption was related to a significant decrease in risk of total cancer in men (George *et al.*, 2009). Another prospective study conduct in Japan amongst adults concluded that fruit and vegetable consumption did not lower risk of total cancer (Takachi *et al.*, 2008).

However, even if the EPIC study findings about fruit and vegetable intakes showed rather small benefits regarding overall cancer, they have shown greater protective effects on particular cancers such as mouth, oesophagus, bowel and lung (Gonzalez *et al.*, 2006; Linseisen *et al.*, 2007; Benetou *et al.*, 2008). In a case control study conducted in the US amongst

adults Millen *et al.* (2007) concluded that diets rich in fruit, dark-green vegetables and deep-yellow vegetables as well as diets rich in garlic and onions were modestly associated with reduced risk of colorectal adenoma.

Others authors investigated the association between fruit and vegetables and reduced risk of non digestive cancers, such as kidney cancer, thyroid cancer or breast cancer. In a case control study conducted amongst US adults, the authors concluded that intake of vegetables was associated with a decreased risk of renal cell carcinoma (Brock *et al.*, 2011). Another case control study, conducted in Seoul amongst adults, concluded to the probable association of high consumption of raw vegetables, persimmons and tangerines with decreased risk of thyroid cancer (Jung *et al.*, 2012). Other authors focusing on breast cancer concluded either that particular vegetable consumption was associated with a reduced risk of breast cancer (cruciferous vegetables and carrots (Boggs *et al.*, 2010); leafy and fruiting vegetables (Masala *et al.*, 2012)), or fruit and vegetables together were potentially associated with a reduced risk of breast cancer (Nelson *et al.*, 2010). In a meta-analysis of 15 prospective cohort studies investigating the relationship between fruit and vegetable consumption and the risk of breast cancer, Aune *et al.*, (2012) concluded that high fruit intakes, as well as high fruit and vegetable intakes, were associated with a significant but weak reduction in risk of breast cancer.

The role of fruit and vegetables in reducing the risk of cancers is less evident compared to other diet-related NCDs and depends on the type of cancers considered. Therefore the protective effect of fruit and vegetables on cancer remains controversial.

In conclusion, findings from studies that focused on the role of fruit and vegetables in preventing against obesity or NCDs, such as type 2 diabetes, cardiovascular diseases and cancers remain controversial. Indeed, whilst several studies have found a protective effect of fruit and vegetables, other did not. When looking into more detail at the literature, it seems that these protective effects might be due to particular fruit and vegetables, rather than overall fruit and vegetable intake.

1.1.3 Recommendations for fruit and vegetable consumption

Fruit and vegetable recommendations vary between different countries worldwide. Here, International recommendations delivered by the WHO, those given by high-income countries, such as the US, France and the UK, from an emerging country such as Brazil and from a middle-income country close to Morocco, such as Tunisia will be discussed[2] (Table 1.1). The recommendations within these five countries are not completely consistent with each other. The major differences are that in the US, potatoes are considered as vegetables, whereas in the UK, France, Brazil and Tunisia, as well as for the WHO, potatoes belong to the starchy food group. In all the countries, except for France, beans and pulses can be counted as vegetables. Indeed in France, beans and pulses belong to the so called 'cereals, potatoes and beans group'. The US recommendations are given according to age and gender, whereas in France, the UK, Brazil and Tunisia, recommendations are given overall. The five countries and the WHO agree that any kind of fruit and vegetables can be counted, i.e. fresh, canned, frozen or dried amongst these two groups. There is also a consensus regarding whether 100% fruit or vegetable juices can be counted as a fruit or a vegetable, except in Tunisia where fruit or vegetables juices do not count, however there is no consensus regarding the amount that can be counted (Table 1.1).

[2] There are currently no fruit and vegetable recommendations in Morocco

Table 1.1 Comparison of fruit and vegetable recommendations

		International *World Health Organization* *who.int*	**USA** *US Department of Agriculture* *choosemyplate.gov*	**Brazil** *5aodia.com.br*	**UK** *Eat well plate* *nhs.uk*	**France** *French National Nutrition and Health Program* *mangerbouger.fr*	**Tunisia** *Ministry of Health*
Fruit 		**ANY FRUIT**, fresh, canned, chilled, frozen, dried, raw or cooked, plain or processed *					
Vegetables 		**ANY VEGETABLE**, fresh, canned, frozen, dried/dehydrated whole, raw or cooked, plain or processed, cut-up, or mashed *					
Potatoes 	**Do count**		French fries included				
	Do not count	✓		✓	✓	✓	✓
Beans and Pulses 	**Do count**	✓	✓ depends on meat group intake	✓	✓ but count as a max. of 1 portion/day		✓
	Do not count					✓	
100% juices  without added sugar	**Do count**	✓	✓	✓	✓ count as a max. of 1 portion/day (150 mL) smoothies count as a max. of 2 portions	✓ count as a max. of 1 portion/day (1 glass)	
	Do not count						✓
Amount recommended per day		at least **400g** (5 portions of 80g each), and of this, 30g should be pulses, nuts and seeds	**2 to 5 cups** ** depends on gender, fruit and vegetables expressed separately	**5 portions** of fruit and vegetables in ≥ 5 days/week (2 fruit and 3 vegetables) beans intake = 5 days/week	at least **5 portions**** of fruit and vegetables (or about 1/3 of the food eaten each day)	eating at least **5 fruit and vegetables** , eating fruit and vegetables during each meal and eating fruit and vegetables as snack during the day	at least **400g** of fruit and vegetables

*Most of the properties of the original product are preserved in canned, frozen and dried fruit and vegetables (Agudo, 2005)
** Examples of what counts as a cup, a portion or a serving are given in appendix 1

1.1.4 Measuring fruit and vegetable intake

The measurement of fruit and vegetable consumption can be considered at different levels. Indeed, fruit and vegetables can be measured at the national level using Food Balance Sheets (FBS), at the household level using Household Budget Surveys (HBS), and at the individual level using diverse dietary assessment methods.

1.1.4.1 Food Balance Sheets

FBS, representing food availability, also sometimes known as apparent consumption, have been released annually since 1961 under the responsibility of the Food and Agriculture Organization (FAO). They provide an estimate of food supplies at a country level.

The FBS are calculated as follows (Food and Agriculture Organization, 2012):

> *Food supply= (Total quantity of foodstuffs produced + total quantity imported and adjusted to any change in stocks) - (quantities exported + fed to livestock + used for seed + losses during storage and transportation)*

The FBS give information for 176 countries on approximatively 95 food items available for human consumption (Gibson, 2005). They are expressed in terms of quantity (kg/capita/year) and also in terms of dietary energy value (kcal/capita/day), protein and fat content (g/capita/day), by applying food composition factors (Food and Agriculture Organization, 2012).

They give useful information on the nutritional and agricultural situation of countries; they are useful for agricultural planning; and they provide information on dietary patterns. However, they give estimates for the country as a whole and therefore no patterns of variation within the country, with socio-economic indicators or with season can be identified. Moreover, all food items available for human consumption are not taken into account by the FBS, e.g. subsistence agriculture or game, and data given by countries are not always reliable. In spite of these weaknesses and even though FBS do not represent actual consumption and usually overestimate "consumption" per capita, they are still a useful measure for comparing countries and trends within a country across time (Gibson, 2005; Webster-Gandy *et al.*, 2012).

1.1.4.2 Household Budget Surveys

One other way to assess food consumption is to conduct HBS. HBS usually measure food intakes at the family or household level. Such surveys usually represent a position between the FBS and the individual dietary assessment surveys (Webster-Gandy *et al.*, 2012).

All food items purchased, eaten out of the household, harvested, grown or received as a gift at the household level are accounted for. The amount of different food groups at the household level is deducted from the price paid for each food group. Then the amount is divided into each household by the number of people living in the household according to their age and gender, e.g. one adult represents one portion and one child represents half a portion (Webster-Gandy *et al.*, 2012).

The objectives of the HBS are: to determine food items expenditure; to estimate the amount of food consumed at the individual and household level; to analyse food consumption regarding demographic and socio-economic characteristics; and lastly to evaluate the nutritional status of the population. These kinds of studies also provide data about households' living standards, about existing disparities between socio-economic status and also between different geographical areas within the country.

They are easily feasible at the national level and provide useful information on food consumption patterns. However, they do not provide actual individual food consumption, and sometimes they may not include food items such as sweets, alcohol or food eaten out of home (Webster-Gandy *et al.*, 2012).

1.1.4.3 Dietary assessment methods

A major challenge in nutritional epidemiology lies in the extremely complex nature of dietary intake. To estimate an individuals dietary intake several methods exist- mainly focusing on trying to assess intake using a range of 'dietary assessment methods'. These methods are commonly used for measuring food consumption of individuals or groups. They are generally divided into 2 types (Romon *et al.*, 2001; Rutishauser, 2005): *records* (prospective methods aiming at measuring current consumption, such as weighed records or menu records) and *recalls* (retrospectives methods aiming at measuring past consumption, such as Food Frequency Questionnaires (FFQ), 24-hour Recalls or diet history). Even if these methods can give a precise idea of individual's intake, none of them enables an exact evaluation of 'true' food intake (Rutishauser, 2005). This is mainly due to associated reporting bias: memory bias in the case of retrospective studies; intentionally

or not food misreporting; modification of eating behaviour due to the methodological associated burden when dealing with prospective studies. Another source of bias resides in the method used to quantify the amount of food consumed. Indeed, unless foods and ingredients can be weighted, indirect measures such as, household measures or photographs of food portion size are usually used.

Multiple 24-hour-Recalls and quantitative FFQ are the most widely methods used in nutritional epidemiology for large scale studies mainly due to low respondent burden. These two methods are feasible, suitable and appropriate in low-income countries where generally literacy rates may be low (Willett, 1998; Ferro-Luzzi, 2002; Webster-Gandy *et al.,* 2012). Thus, here, only the FFQ and the 24-hour Recall will be discussed.

- FFQ

The aim of a FFQ is to assess the frequency with which food items or food groups are consumed over a specific period of time- generally one week or one month, but sometimes over a one-year period (Willett, 1998; Romon *et al*., 2001) Thus, the FFQ consists of a list of foods/ food groups and corresponding frequency response categories, e.g. never, once per week, twice per month (Webster-Gandy *et al.,* 2012). The modalities of response need to ensure that all time categories are included for the target period, i.e. there are no gaps. The length of the food list depends on the focus of the questionnaire. Therefore, the questionnaire may contain only a few items, for example when focusing on particular nutrients, or it may need to contain many more, such as up to 200 items when focusing on energy intake or on dietary diversity. The choice of foods included in the FFQ depends on the objectives of the study and also on the population studied (Willett, 1998). Generally food items (or food groups) included in the questionnaire must be informative, i.e. each food item on the questionnaire should be widely consumed by the population of interest; it should contain a substantial number of items on the nutrient of interest and lastly, in order to be discriminatory its use should vary between individuals (Willett, 1998).

The FFQ was originally designed to provide descriptive qualitative information about usual food consumption patterns. With the addition of portion size, the FFQ has become semi-quantitative (when using standard/reference portions for quantity) or quantitative (when using household measures or photographs of food to estimate portion size) (Cade *et al.*, 2002; Webster-Gandy *et al.,* 2012). This permits the conversion of food intakes into nutrients and energy intakes, by multiplying the fractional portion

size of each food consumed per day by its energy and nutrient content. Appropriate and accurate food composition data are essential for this step.

FFQs provide a relatively inexpensive and standardized way of collecting data from a large number of individuals (Willett, 1998; Rutishauser, 2005). They can easily be self-administered (if respondents are literate) or even computer-administered. Data can be easily processed and computerised. Most questionnaires can be completed relatively quickly, depending on the length of the food list, and generally take between 15-30 minutes to complete, which is a low burden for respondents and so leads to better compliance.

One of the main disadvantages of FFQs is that their development requires validation , i.e. comparison with results obtained from a superior standard method such as weight record or multiple 24-hour recalls and calibration studies, which are very time consuming and burdensome. Another disadvantage of this method is its low capacity to obtain information about actual foods consumed, i.e. this type of questionnaire gives little information about how foods are consumed, such as cooking methods, and no information about food combinations within a meal (Rutishauser, 2005). Moreover, the Mean intake is dependent on the number of food items, i.e. the longer the food list, the more likely that intake will be overestimated (inversely, the shorter the list, the more likely that intake will be underestimated). Likewise, large random errors are associated with the FFQ. This is due to the complexity of the task that respondents completing such questionnaires are asked to perform. Large random errors implies an increase of the variance and so a decrease in the precision of the dietary estimates. However, the effects of random errors can be reduced by increasing the number of observations.

The underlying principle of the FFQ is to sacrifice precise measurement of food intake and therefore of nutrient intakes, for more crude information relating to an extended period of time. Thus, the FFQ approach is aimed at measuring the *usual* diet rather than *actual* intake (Romon *et al*., 2001; Gibson, 2005). FFQs are generally designed to rank individuals into broad categories rather than to calculate exact mean intakes. Thereby, they are mainly used to evaluate associations between dietary habits and risk of diseases, in cohort or case-control studies.

A FFQ can be either developed or adapted from other existing validated FFQs. The foods included in the FFQ must be widely eaten by the population under investigation and/or contain a large amount of a particular nutrient of interest. This step requires previous dietary information regarding the target population. Once the list of foods or food groups has been developed frequency categories must be determined according to the

timeframe of interest. Then, the reproducibility which refers to 'consistency of questionnaire measurements on more than one administration to the same persons at different time' (Willett 1998) as well as the relative validity which refers to 'the degree to which the questionnaire actually measure what it was designed to measure' (Willett 1998) must be evaluated. The reproducibility should be assessed by performing Bland and Altman plot or alternatively by computing Kappa statistics. The relative validity should be assessed by computing correlation coefficients coupled with Bland and Altman method (Bland and Altman, 1999) or alternatively by computing Kappa statistics or mean comparison tests (Cade *et al.*, 2002).

Most of the FFQs have been developed and validated in high-income countries (Cade *et al.*, 2004). A limited number of FFQ validation studies have been conducted in low-income countries (Chen *et al.*, 2004 in Bangladesh; Kusama *et al.*, 2005 in Vietnam; Merchant *et al.*, 2005 in Zimbabwe; Cardoso *et al.*, 2010 in Brazil). A range of brief FFQs have been developed to assess specifically fruit and vegetable intake in different countries but none of them have been developed in low-income countries (Domel *et al.*, 1994 for US children; Ling *et al.,* 1998 for Chinese adults; Cullen *et al.*, 1999 for US African-American boys and young adults; Thompson *et al.,* 2000 for US adults; Warneke, *et al.*, 2001 for US children; Van Assema *et al.*, 2002 for Dutch adolescents and adults; Traynor *et al.*, 2006 for Canadian adults; Di Noia and Contento, 2009 for US adolescents). Even if no brief FFQ to measure fruit and vegetable intakes has been developed in LMIC, it is worth noting that a rather long FFQ (110 items) focusing on fruit and vegetable was developed and validated for Iranian adults (Mohammadifard, *et al.*, 2011).

- 24-hour recall

The 24-hour recall is the most widely used method in LMIC for obtaining quantitative recall data in population surveys. This method generally consists of a face-to-face interview, or sometimes a telephone interview, conducted by a skilled trained interviewer, during which the interviewee is asked to provide detailed information about everything she/he ate or drank over the past 24-hours or over the previous day (Willett, 1998; Rutishauser, 2005). During the interview, in order to gather complete and accurate information, the interviewer may use open-ended questions, must maintain a neutral attitude towards the answers, and avoid leading questions and judgmental comments (Willett, 1998; Romon *et al.,* 2001).

A four step multiple-pass interviewing technique is often used (Gibson, 2005):

i) Firstly, a complete list of food and beverages consumed over the last 24-hours (or previous day) by the subject is established.

ii) Then, a detailed and precise description of each food and beverage consumed (including food preparation and cooking methods, brand name of commercial products) is collected.

iii) Next, estimates of the amount of food and drinks consumed are obtained, generally using household measures or food photographs. Information about ingredients of mixed dishes consumed by the interviewee must also be collected at this time.

iv) Lastly, the recall is reviewed to make sure that all food items have been recorded properly.

It is recommended that a 24-hour recall should be conducted in the respondent's home, because the familiar environment encourages participation and improves the recall of food consumed. Usually, adult interviewees are the subjects themselves. In some cases, where the subject cannot answer directly themselves, e.g. mentally incapacitated adults, or subjects unable to describe food eaten from memory, the respondent can be a carer.

One of the strengths of this type of method is that there is no need for the respondent to be literate which lends its use with illiterate populations in some developing country settings. Moreover, 24-hour recall interviews generally require around 30 minutes to be completed (Willett, 1998). Consequently, the respondent burden is relatively low and so the response rate is generally high. As 24-hour recalls are based on open-ended questions, this allows an unlimited level of specificity regarding descriptions of food: type of food, food preparation methods, cooking methods, food source, and so on. The major limitation of the 24-hour recall is its reliance on the participant's memory, both for identifying food and beverages consumed and the evaluation of portion sizes.

As 24-hour recalls assess the actual intake of individuals, they may be used to estimate absolute rather than relative intake (Willett, 1998). Therefore, if the objective of the study is to describe an individual's habitual intake or to estimate the distribution of individual intake within the population studied, then a single 24-hour recall is insufficient (principally due to day-to-day variability). Nevertheless, to achieve these kinds of objectives, multiple 24-hour recalls on the same individual over several non-consecutive days can be conducted. If repeated, 24-hour recalls may include both working and non working days, assuming differences in dietary intake on different

week days. Ideally, each day of the week should be equally represented within the population studied, but this is usually not feasible in population studies (Willett, 1998).

The 24-hour recall method has been used to assess fruit and vegetable intake in several studies essentially in high-income countries, including the Continuing Survey of Food Intakes by Individuals (CSFII) 1994-96 (US Department of Agriculture, 1994-96); the EPIC (Agudo, 2005) and the NHANES studies (Patterson *et al.,* 1990; Casagrande *et al.,* 2007).

- Reporting bias in dietary assessment

When measuring food intake, one of the most important sources of bias is the misreporting of food consumed by respondents, which can be either over or under-reporting. This misreporting can affect either the amount or type of food consumed. Indeed, respondents may not declare foods eaten (intentionally or not) nor declare accurately the amount of foods eaten. This bias is particularly true for recall methods, such as the 24-hour recall and the FFQ (Willett, 1998).

In a review including seven studies that aimed at finding whether under- and over-reporting was due to individuals or dietary assessment methods, Black and Cole, (2001) concluded that over- or under-reporting was characteristic of some individuals. Several studies reported that misreporting usually varies with socio-demographic characteristics and weight status. Hence, several studies conducted amongst diverse adults population that examined the characteristics of under-reporters concluded that higher BMI was significantly related to under-reporting (Lührmann *et al.*, 2001; Horner *et al.*, 2002; Amend *et al.*, 2007; Bailey *et al.*, 2007; Bothwell *et al.*, 2009). In the same way, studies reported that under-reporters were more likely to be less educated than accurate reporters (Johnson *et al.*, 1998; Lührmann *et al.*, 2001; Bailey *et al.*, 2007) and that women were more likely to under-report than men (Johansson *et al.*, 2001; Pikholz *et al.*, 2004).

To deal with reporting bias, two approaches can be considered: a conservative approach and an exclusion approach (Willet, 1998). With the conservative approach, all the subjects will be included, even with an improbable level of energy intake. Considering the conservative approach, some authors have advocated the need to include all subjects but adjust for energy. However, as under-reporting behaviour does not usually occur at the whole diet level but on the contrary occurs on particular foods, often foods with low social desirability, such corrections are insufficient to eliminate bias arising from selective under-reporting. With the exclusion approach, subjects

considered as under- or over-reporters will be excluded from the sample, but with the risk of modifying it. Usually in a population, under-reporting is much more prevalent than over-reporting. According to Goldberg *et al.*, (1991), under-reporting of energy intake can be due to 4 main reasons:

- Failure to record every item eaten, either done intentionally regarding foods with low social desirability or due to the method of collecting food data, for example methods that rely on memory such as FFQs and 24-hour recalls;
- Conscious or sub-conscious under-reporting;
- Modifications of eating patterns (observer effect);
- High level of day-to-day variability in humans. However, this generates as many over as under estimations of intake.

There are several approaches to identify misreporters. The first one is to define arbitrary thresholds outside of which subjects are considered as outliers. This method is used by several authors such as Willett who used an arbitrary allowable range of 500-3500 kcal/day for women and 800-4000 kcal/day for men, with adjustment of nutrient intakes for total energy intake to compensate for under- and over- reporting (Willet, 1998).

Another approach is to calculate the ratio of Energy Intake/Resting Metabolic Rate and to define a range of values outside of which subjects are considered as under- or over-reporters. Two methods can be considered, firstly from the FAO/WHO/UNU and secondly from Goldberg *et al.* (1991). According to the FAO/WHO/UNU consultation on Energy and Protein Requirements (1985), total energy intake (EI) would be <1.2 times the Resting Metabolic Rate (RMR) (calculated per capita according to gender, age and sex) and energy intake >4000 kcal/day are unlikely to be correct. In other words, subjects with a daily energy intake >4000 kcal are considered as over-reporters and subjects with a ratio EI/RMR <1.2 are considered as under-reporters. According to several authors (Willett, 1998; Gibson, 2005), using 1.2 as the criterion for excluding under-reporters may lead to an important loss of subjects and also to introduce a source of unknown bias.

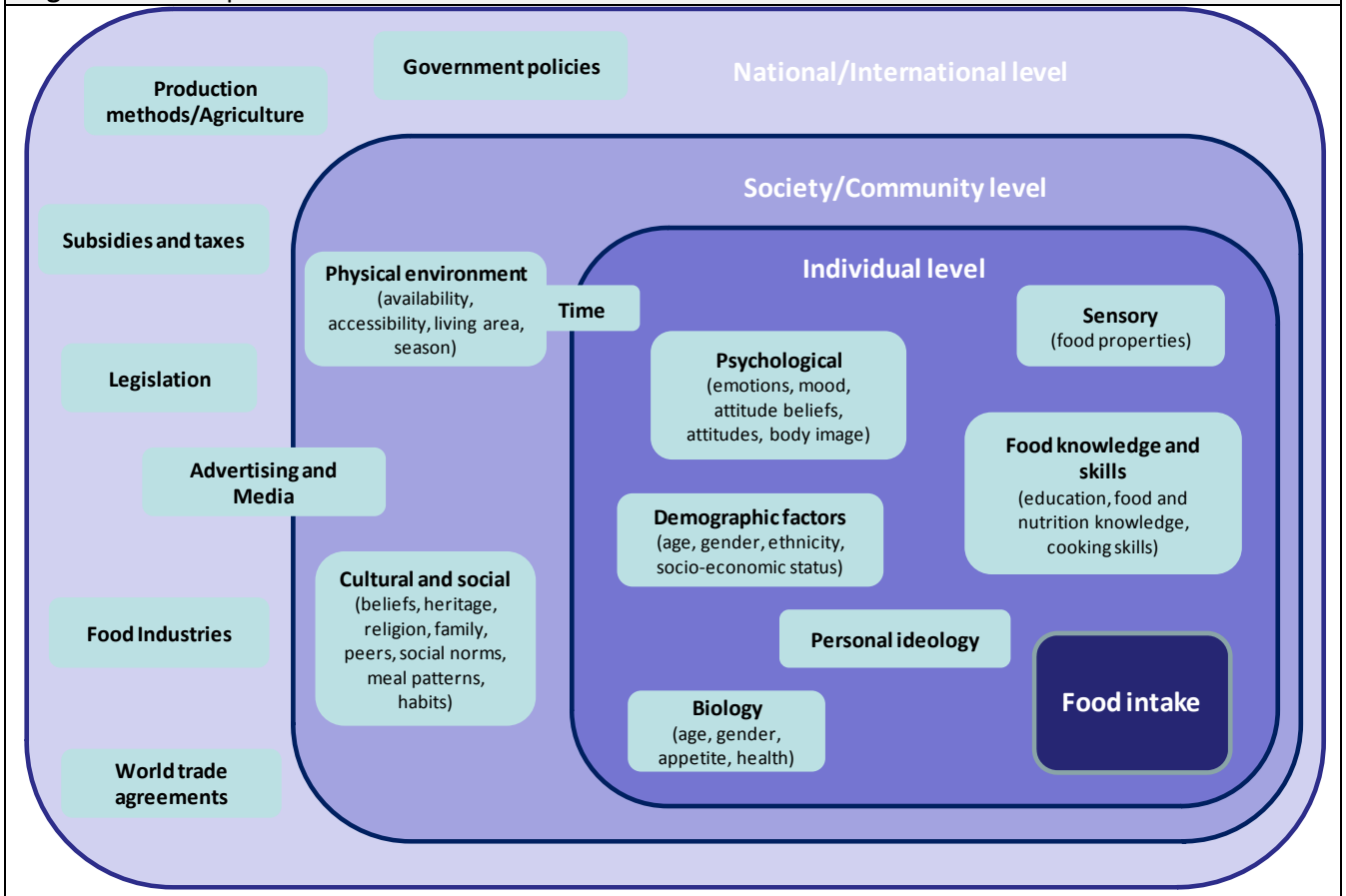
The RMR (also sometimes known as Resting Energy Expenditure or Basal Metabolic Rate (BMR)) can be calculated using different equations, depending on data collected (Appendix 2).

1.1.5 Influences on fruit and vegetable consumption

Food choices are not only driven by hunger or other physiological factors. On the contrary, they are determined by a large numbers of other determinants occurring at different levels. Thus, the determinants of food choices are usually considered at three levels: national and international; community and societal; and individual (Figure 1.1). In this section, only determinants at society and individual levels will be discussed.

In different systematic reviews focusing particularly on factors affecting fruit and vegetable intake, the following determinants were identified (Pollard *et al.*, 2002; Kamphuis *et al.*, 2006; Shaikh *et al.*, 2008; Guillaumie *et al.*, 2010): biological determinants, such as gender, age and food properties; economic determinants, such as income and cost; physical determinants, such as time, cooking skills, accessibility, availability and living area; social determinants, such as marital status, having children, education, family, peers, culture, habits and meal patterns; psychosocial factors:, such as self efficacy, social support, intention, attitudes and beliefs, stage of change, motivation and knowledge.

Figure 1.1 Conceptual model of the determinants of food choice for adults



Adapted from EUFIC, 2005; Webster-Gandy *et al.*, 2012

1.1.5.1 Societal determinants of fruit and vegetable intake

- Physical environment: living area, season, availability, accessibility

According to the FAO, food availability is defined as "the availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports" (Food and Agriculture Organization, 1996). If foods are neither available, nor accessible they cannot be consumed. Accessibility is an important physical factor influencing food choice reflecting the fact that there is an influence of the area where the people live. Hence, determinants such as urbanism, neighbourhood access to fruit and vegetables, and transport facilities to reach fruit and vegetables selling points may have an impact on fruit and vegetable consumption.

- Living area

The amount of fruit and vegetable consumed within a population can vary according to residential area. Hence in some countries, urban residents tend to be higher consumers of fruit and vegetables, whereas in others it is rural residents.

According to the World Health Survey, overall, living in urban areas was not associated with low fruit and vegetable consumption. However, when looking into more detail and considering countries separately, there were significant differences in fruit and vegetable intakes of urban and rural residents amongst 11 of the 52 countries under investigation. Amongst these 11 countries, people living in urban areas were more likely to have a low fruit and vegetable consumption in all but one (Bangladesh, Congo, Ivory Coast, Ecuador, Kenya, Paraguay, Philippines, Tunisia, Ukraine, and Zambia) (Hall *et al.*, 2009). A meta-analysis of household expenditure surveys conducted in ten sub-Saharan African countries reported that overall fruit and vegetable consumption was higher in urban areas compared to rural areas (Ruel *et al.*, 2005). In the same way, in the US, rural Americans were less likely than their urban counterparts to eat the recommended number of daily servings of fruit and vegetables (CDC, 2010). A study conducted in a middle-income country, such as Iran, reported no differences in fruit and vegetable consumption between individuals living in urban or rural areas (Esteghamati *et al.*, 2011).

- Season, availability and accessibility

Studies investigating the impact of availability of fruit and vegetables show mixed results. Indeed, whilst the impact of the season seems to vary across countries with different levels of economic development, having a

garden shows consistent findings and supermarkets access shows inconsistent results, depending on the country under investigation.

In a study of Dutch adults, Kamphuis *et al.* (2007) reported that the availability of a large variety of fruit and vegetables all year long was positively associated with fruit and vegetable consumption, particularly for people with higher socioeconomic status. Previous studies conducted in high-income countries reported no effect of season on fruit consumption, but a seasonal effect for vegetable consumption. Indeed, the winter season was associated with lower vegetable intakes (Kamphuis *et al.*, 2006). In low-income countries from sub-Saharan Africa, seasonal availability of many fruit and vegetables limited their consumption (Ruel *et al.* 2005).

Studies have shown a positive relationship between having a vegetable garden and fruit and vegetable consumption. For example, a study conducted in the US reported that adults with at least one family member participating in a community garden programme were more likely to consume more fruit and vegetables (Alaimo *et al.*, 2008). Equally, having one's own home garden was positively associated with fruit and vegetable consumption in US White adults (Devine *et al.*, 1999). More recently, a study conducted amongst US older adults suggested that compared to non gardeners, gardeners were more likely to consume vegetables, but not fruit (Sommerfeld *et al.*, 2010).

Several studies conducted in high-income countries have reported that supermarket users tended to eat more fruit and vegetables (Morland *et al.*, 2002; Zenk *et al.*, 2005). One study that investigated the link between the use of supermarket and diet quality in Tunisia, reported that regular supermarket users were more likely to have a good quality diet. However, this study found no particular effect on fruit and vegetable consumption (Tessier *et al.*, 2008). Other studies that have focused on the impact of neighbourhood access to supermarkets and convenience stores, reported that fruit and vegetables decreased with increasing distance to supermarket. Most of them were conducted in high-income countries. For example, one study conducted in New-Zealand amongst adults reported that neither fruit nor vegetable consumption was associated with living in a neighbourhood with better access to supermarkets or convenience stores (Pearce *et al.*, 2008). Another study conducted amongst US participants in the Food Stamp Programme reported that both easy access to supermarket, as well as a short distance from home to supermarket were significantly correlated with higher use of fruit, but not with use of vegetables (Rose and Richards, 2004). A more recent study, also conducted in the US, reported that neighbourhood residents with better access to supermarkets and other retail stores that provide healthy foods tend to have higher intakes of fruit and vegetables (Larson *et al.*, 2009).

- Cultural and social
    - Family, peers and habits

Dietary habits learnt during childhood seem to be predictive for fruit and vegetable intakes in adulthood (Kamphuis *et al.*, 2007). Therefore, individuals who ate a lot of fruit and vegetables during their childhood usually remain good consumers in adulthood.

In a literature review Shaikh *et al.*, (2008) reported from three cross-sectional studies and three prospective studies which investigated psychosocial predictors of fruit and vegetable in adults, social support was significantly associated with fruit and vegetable intakes. The same conclusion was reported by Watters *et al.*, (2007) in a study of African Americans.

- Meal patterns

Foods that can be purchased out of home, e.g. in fast-food restaurants or take-away restaurants, are often energy dense. This means that food offered in such restaurants is poor in fruit and vegetables. As a consequence, eating out of home may be related to a lower fruit and vegetable consumption. Several studies conducting in high-income countries have investigated this potential link. For African American adults living in California, eating at fast-food restaurants was related to eating significantly less fruit and vegetables (Keihner *et al.*, 2004). In the same way, studies conducted amongst Spanish and Belgian adults reported that consumption of fruit was inversely associated with increasing frequency of fast-food consumption (Schröder *et al.,* 2007; Vandevijvere *et al.*, 2009). Similarly, a study conducted amongst young Australian adults reported that subjects eating takeaway food at least twice a week were less likely to meet the dietary recommendations for fruit and vegetables (Smith *et al.*, 2009). These studies all suggested that eating take-away foods more often was linked with lower fruit and vegetable intakes.

Several studies focusing on children and adolescents reported that meal patterns, especially eating together as a family and TV watching during meals were related to fruit and vegetables consumption (Videon and Manning, 2003; Feldman *et al.*, 2007; Fitzpatrick *et al.*, 2007). According to these studies, watching television whilst eating was associated with lower fruit and vegetable intakes in both children and adolescents, and eating together as a family was associated with higher intake of fruit and vegetables.

Few studies focused on the consequences of such behaviour on adults, tending to focus on children. One study reported that a higher frequency of

television viewing during dinner was associated with lower fruit and vegetable consumption of adults in the US (Boutelle *et al.*, 2003).

1.1.5.2 Individual determinants of fruit and vegetable intake

- Biology: gender and age

Fruit and vegetable consumption is gender specific and age dependent in many countries. Within the literature it has been well described that women as well as older people belonging to high-income countries usually consume larger amounts of fruit and vegetables.

The 2002-2003 World Health Survey conducted amongst adults in 52 mainly LMIC, revealed that amongst these 52 countries, there were significant gender specific differences in fruit and vegetable consumption in 15 countries. Indeed, in five countries women ate less fruit and vegetables than men (Comoros, Dominican Republic, Guatemala, Morocco, and Paraguay) whereas in the other ten countries women ate more fruit and vegetables than men (Czech Republic, Estonia, Hungary, Slovakia, Slovenia, Spain, Swaziland, Ukraine, Uruguay, and Vietnam) (Hall *et al.*, 2009). According to the same study, older adults tended to eat less fruit and vegetables compared to younger adults in 26 countries.

Several studies conducted in different contexts reported that women consumed larger amounts of fruit and vegetables than men. This was reported in European countries (Baker and Wardle, 2003; Friel *et al.*, 2005; Estaquio *et al.*, 2008; Bofetta *et al.*, 2010), as well as in Iran (Esteghamati *et al.*, 2011), Canada (Azagba, and Sharaf, 2011) or US (CDC, 2010).

Most of studies investigating the relationship between fruit and vegetable consumption and age concluded that the amount of fruit and vegetable consumed increases with age (Johansson and Andersen, 1998; Agudo and Pera, 1999; Estaquio *et al.*, 2008; CDC, 2010). The same conclusions were found in Canada amongst obese and overweight adults (Godin *et al.*, 2010). On the contrary, in Iran, Esteghamati *et al.*, (2011) reported that older adults were more likely to be low consumers. In Canada a national representative survey reported that middle-aged adults consumed fruit and vegetables less frequently compared to younger and older adults (Azagba, and Sharaf, 2011).

- Sensory: food properties

Taste is a major influence on food choice and individual preference usually drive decisions that consumers make regarding what they choose to eat. For example, in a study conducted amongst older Irish adults, Appleton *et al.*, (2010), reported that greater fruit and vegetable intake was associated with greater liking for fruit and vegetables. The same kind of conclusion was reported in US young adults (Larson *et al.*, 2012).

In a systematic review Pollard *et al.*, (2002), reported findings from two studies focusing on the link between taste and fruit and vegetable consumption, one conducted in the Netherlands and one in the US. In both studies, a pleasant taste was a prerequisite for fruit consumption whilst it only influenced vegetable consumption in Dutch subjects.

- Demographic factors: socio-economic status, marital status, children
    - Economic status

The relationship between income and fruit and vegetable consumption has been widely described in the literature and usually studies led to the conclusion that people with higher income tend to consume more fruit and vegetables.

The most commonly reported obstacle to fruit and vegetable consumption is price (Cox *et al.,* 1996; Yeh *et al.,* 2008). The prohibitive cost is fundamentally due to a person's income or socio-economic status which is usually based on income, education and employment; therefore income and cost are linked and will not be treated separately.

According to the 2002-2003 World Health Survey, a significant relationship between fruit and vegetable consumption and income was found in 33 of 52 countries. For all these countries, except one (Ghana) the number of low fruit and vegetable consumers decreased with increasing income (Hall *et al.*, 2009). A meta-analysis of household expenditure surveys conducted in ten sub-Saharan African countries (Burundi, Ethiopia, Ghana, Guinea, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda) reported the same findings (Ruel *et al.*, 2005).

Several studies conducted in high-income countries have made the same conclusions. Thus, a higher socio-economic status was correlated with a higher consumption of fruit and vegetables in studies conducted in several countries, such as Australia (Ball *et al.*, 2006), Canada (Azagba and Sharaf, 2011); Finland (Lallukka *et al.,* 2007; Lallukka *et al.,* 2010), France (Estaquio *et al.,* 2008), and US (CDC, 2010).

Several studies have reported that people living in higher-income neighbourhoods tended to have a higher intake of vegetables (even after adjustments for individual income) (Diez-Roux *et al.*, 1999) and that on the contrary people living in most deprived areas tended to consume significantly less fruit and vegetables than people living in the most advantaged areas (Forsyth *et al.*, 1994; Shohaimi *et al.*, 2004).

- Marital status and children

Whilst there is a consensus concerning marital status and fruit and vegetable consumption, i.e. married people being more likely to consume more fruit and vegetable, this relationship is less evident for having children.

Indeed, in systematic reviews focusing on a range of determinants of fruit and vegetable consumption, several studies (Pollard *et al.*, 2002; Kamphuis *et al.*, 2006) reported that overall being married was associated with better fruit and vegetable intakes than being single. Two studies conducted in Europe reported that marital status seemed to be a stronger determinant of fruit and vegetable consumption in men than in women (Friel *et al.*, 2005; Kamphuis *et al.*, 2007).

According to Kamphuis *et al.*, (2006), having children showed mixed associations. Indeed, whilst studies reported a negative relationship between having children and fruit and vegetable consumption, i.e. parents consume less fruit and vegetables (Wandel, 1995), others reported that in US population this relationship was depending on ethnicity (Devin *et al.*, 1999) and others conducted amongst the UK concluded that median intakes of fruit and vegetables were not significantly different between women who did or did not have children under the age of 16 years (Pollard *et al.*, 2001).

- Food knowledge and skills
  - Education

Generally people with higher education eat significantly more fruit and vegetables. This association is often dependent on income as usually higher education is related to having a higher income. There are many studies supporting a relationship between education and fruit and vegetable consumption. For example, in a study conducted amongst Swedish adults Elfhag *et al.*, (2008) reported positive associations between fruit and vegetable intakes and level of education. Studies conducted in Canada, reported that higher education was associated with purchasing greater amounts of fruit and vegetable (Ricciuto *et al.*, 2006) and with higher intakes

of fruit and vegetables (Azagba and Sharaf, 2011). Positive associations between fruit and vegetable consumption and education were also reported for Irish (Friel *et al.*, 2005), French (Estaquio *et al.*, 2008), US, (CDC, 2010), and Finnish adults (Paalanen *et al.*, 2011).

A study that examined the association of income with fruit and vegetable intakes at different levels of education concluded that Finnish adults with low education also reported higher fruit and vegetable intakes if they had higher income than individuals with intermediate or high education (Lallukka *et al.*, 2010). A meta-analysis conducted by Ruel *et al.*, (2005) on data from ten sub-Saharan countries reported contrary findings to what was reported in high-income countries. Indeed, in this meta-analysis, the authors found that in five countries, having at least one household member educated to secondary level was negatively associated with the household budget allocated to fruit and vegetables.

- Knowledge

A systematic review investigating the relationship between food consumption and dietary knowledge concluded that fruit and vegetable intake was positively associated with knowledge in adults living in high-income countries (Shaikh *et al.*, 2008).

Some studies, most of them conducted in high-income countries, have shown that a high level of nutrition knowledge, and particularly knowledge about the health benefits of high fruit and vegetable consumption and knowledge of associations between diet and diseases, was associated with larger amount of fruit and vegetable intakes (Wardle *et al.,* 2000; Moynihan *et al.,* 2007; Beydoun *et al.,* 2008; Shaikh *et al.*, 2008; Wolf *et al.*, 2008). One study of the factors influencing vegetable intake in the US found that consumers with higher nutritional knowledge made more healthy choices, choosing more dark-green and deep-yellow vegetables and tomatoes, and fewer fried potatoes, than other consumers (Lin *et al.,* 2004). In a study conducted amongst older adults in England, Baker and Wardle (2003) reported that older adults with better knowledge about the relationship between fruit and vegetable and diseases ate significantly more fruit and vegetables, in both men and women. Other authors, who focused on procedural nutrition knowledge which is defined as knowledge of how to eat a healthy diet, reported that Swiss men with higher number of correct answers consumed more fruit and vegetables (Dickson-Spillmann and Siegrist, 2011).

The only study conducted in LMIC found the contrary, i.e. no association between diet knowledge and fruit and vegetable intakes in South African Black adults (Peltzer and Promtussananon, 2004).

- Time and cooking skills

Lack of time is frequently mentioned as a barrier to fruit and vegetable consumption, as well as convenience and know-how to prepare and cook fruit and vegetables (Anderson and Cox, 2000; Yeh *et al*., 2008). As cooking vegetable require more cooking skills and more time, these obstacles are more important for vegetables than for fruit.

- Psychological: self-efficacy, intention, attitudes and beliefs, stages of change, motivation

A systematic review of studies mainly conducted in Europe and in the US, of the psychosocial predictors of fruit and vegetable consumption amongst adults, reported that self-efficacy, (also know as perceived behavioural control, which refers to people's perception of their ability to perform a given behaviour), was the strongest predictor of fruit and vegetable intake. However, depending on studies other factors such as barriers, attitudes and beliefs, stage of change and intention could also predict fruit and vegetable consumption but to a lesser extent. Nevertheless, this was less consistent in the different studies (Shaikh *et al.*, 2008). These findings are reinforced by recent studies, one focusing on obese Canadian adults (Godin *et al.*, 2010) and one on US students (Blanchard *et al.*, 2009) that reported that perceived behavioural control was a strong predictor of intention to eat fruit and vegetables or of fruit and vegetable consumption. Furthermore, a study conducted amongst US men and immigrants reported that lower perceived barriers as well as advanced stage of change were associated with a higher consumption of fruit and vegetables (Wolf *et al.*, 2008).

Usually, most of these psychosocial factors are used in psychosocial models, such as the Social Cognitive Theory, the Health Belief Model, the TransTheoritical Model or the Theory of Planned Behaviour (Guillaumie *et al.*, 2010). The aim of such models is either to predict intention to eat fruit and vegetable or to predict fruit and vegetable consumption. One of the most often used models is the Theory of Planned Behaviour developed by Ajzen (1991).

1.2 Study context

To put Morocco in a worldwide context made of contrasting countries and regions, the following section, whenever possible offers a comparison between these different countries/regions with Morocco, at different stages of the nutrition transition or at different levels of income. The countries/regions chosen are: the US, Europe and the more developed regions combined, representing high-income countries; Brazil representing an emerging country; the least developed countries, representing LMIC; and Northern Africa which is the region Morocco belongs to.

1.2.1 Geographical context

Morocco, a country of about 710,000 Km^2, belongs to the Northern African region called the Maghreb, along with Algeria and Tunisia. It shares a common frontier with Algeria to its East and it is bound at the North side by the Mediterranean Sea and by the Atlantic Ocean on the West (Figure 1.2).

Figure 1.2 Map of Morocco

1.2.2 Demographic, socio-economic indicators and Human Development Index

The Human Development Index (HDI) calculated by the United Nation Development Programme, provides a composite measure of three dimensions of human development: life expectancy, education and standard of living.

The HDI for Morocco, in 2011 was 0.582, which gave the country a rank of 130th out of 179 countries, which classified it amongst countries with medium human development (UNDP, 2011). For comparison, in the same year, the HDI for USA was 0.910 (4th), that of the UK was 0.863 (28th), that of Brazil was 0.718 (84th) and that of neighbouring Tunisia was 0.698 (94th).

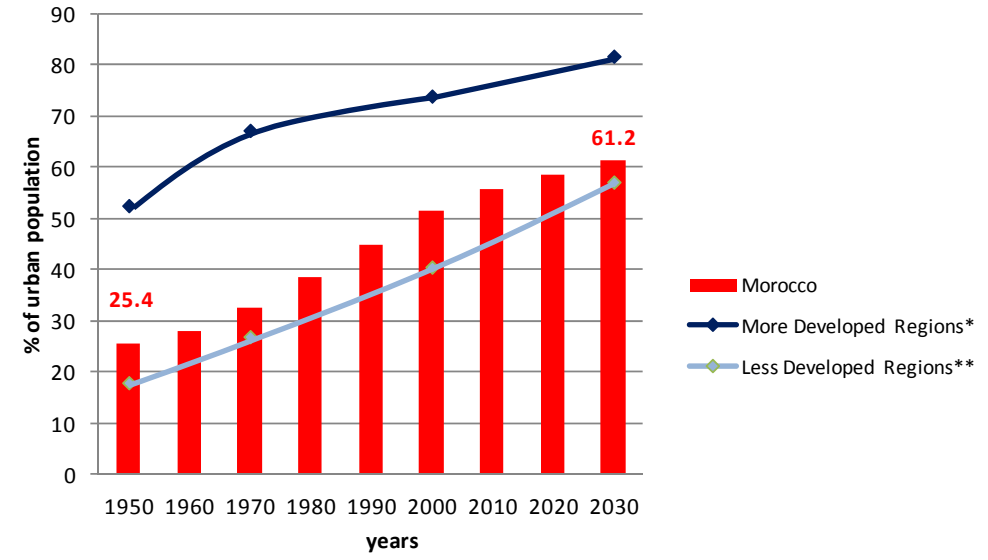
In Morocco, the life expectancy at birth, which is defined as the average number of years that a person at age zero will live if age-specific death rates remain constant, was 72.8 years (71.6 years for male and 74.2 for female) in 2009 (World Health Organization, 2010). In the UK, life expectancy at birth in 2007–09 was 77.7 years for males and 81.9 years for females (Office for National Statistics, 2009). In Morocco, the adult literacy rate was 56% in 2009 (World Health Organization, 2010), i.e. percentage of people over 15 years of age who can, with understanding, read and write a short, simple statement about their everyday life. This rate is higher for men than for women (69% vs. 44%) (World Health Organization, 2010). The Moroccan Gross Domestic Product (GDP) in 2009 was 2,834 US$ per capita and per year, which according to the World Bank, classified Morocco amongst the lower middle-income countries. For comparison the GDP in USA was 41,761 US$, in the UK it was 35,239 US$, in Brazil it was 9,414 US$, and in Tunisia it was 7,512 US$ (UNDP, 2010).

The last population census conducted in 2004 reported that more than 34 million people live in Morocco (BUCEN-IDB, 2009). The population growth rate, which is the rate of natural increase in a population plus the net migration rate, was 1.1% in 2009 (BUCEN-IDB, 2009). The percentage of people living in urban areas has more than doubled during these last six decades, ranging from 25% in 1950 to 56% in 2010, with a relatively fast increase until 2000 (*Géopolis*, 2011, Plan Bleu, 1999 and World Bank/WDI, 2005) (Figure 1.3). Nowadays, more than half of Moroccans lives in an urban area and the projections are that about two out of three Moroccans will live in urban areas by 2030.

In comparison, in the 1950's, only about one in five people living in the less developed countries (see Appendix 3 for the complete list of least developed countries) lived in urban areas, whereas half of the population of the more developed countries (Europe, North America, Australia, New

Zealand and Japan) lived in cities. Projections for 2030 suggest that in the less developed countries slightly less than six out of ten people will live in urban areas whilst in the more developed countries, more than eight out of ten people will live in urban areas (Cohen, 2006).

Figure 1.3 Evolution of urbanisation between 1950-2010 and projections, Morocco, more and less developed regions



*Europe, North America, Australia, New Zealand, Japan

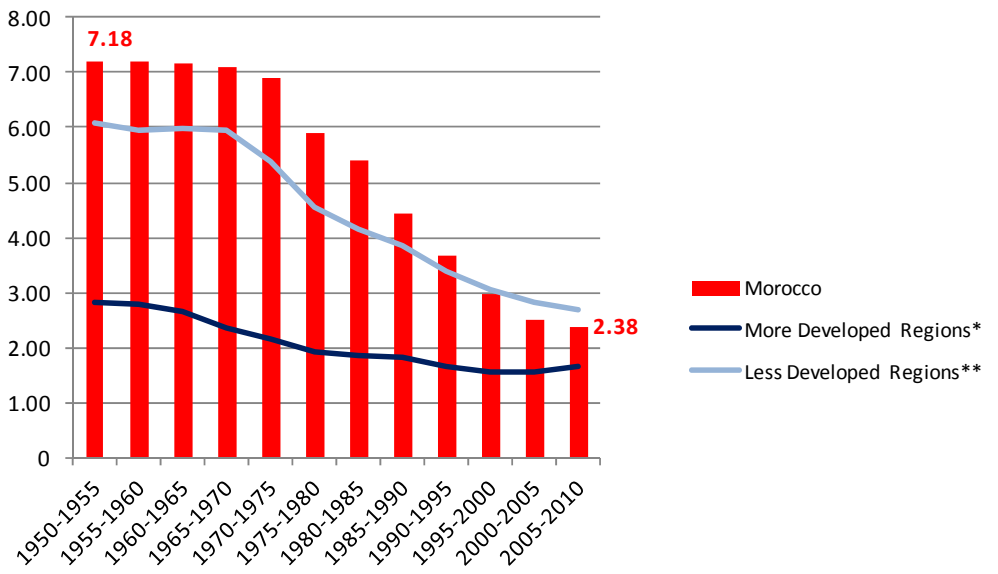
** see Appendix 4

Sources: eGeopolis 2011; Cohen, 2006

The total fertility rate, which is defined as the number of children a woman between 15-49 years will have during her lifetime if she were to bear children at the currently observed rates was 2.5 children per woman with less in (2.1) urban than in rural (2.8) (HDS, 2003-2004). In the last six decades, this rate has been cut by nearly 3. Indeed, in the 1950's the average was 7.2 children per woman whereas in 2010 the average number of children per women was 2.4 (Ministère de la Santé, 2004, United Nations, 2011) (Figure 1.4). In comparison, over the same period of time, the fertility rate decreased from 2.8 to 1.7 in more developed countries and from 6.1 to 2.7 in less developed countries.

As was observed for urbanization rates, fertility rate in Morocco falls in-between what is observed for the more and the less developed regions.

Figure 1.4 Evolution of fertility between 1950-2010, Morocco, more and less developed regions



*Europe, North America, Australia, New Zealand, Japan

** see Appendix 4

sources: United Nations, 2011

1.2.3 Epidemiological and Nutritional Transitions

Morocco is undergoing a nutrition transition with increasing over-nutrition amongst adults, and changes in food consumption patterns accompanied by rising rates of diet-related NCDs (Benjelloun, 2002).

1.2.3.1 Epidemiology of obesity and diet-related non-communicable diseases

Back in the 1980's, the HBS of 1984-1985, based on a representative sample of Moroccan adults (>20 years old), found that 21.4% of people were overweight (BMI ≥ 25 kg/m^2) with more women (25.5%) than men (16.9%) and that 4.1% of people were obese (BMI ≥ 30.0 kg/m^2) again more women (6.4%) than men (1.6%) (Direction de la Statistique, 1992). This was followed in the 1990's by the National Survey on Standard of Living, (1998-1999), also based on a representative sample of adults (>20 years old). The findings indicated an increase in both overweight and obesity, i.e. 25.2% of people were overweight and 10.3% were obese. The difference between men and women was still apparent. Indeed, women were more overweight (29.0%) than men (21.1%) and were almost four times as likely to be obese (16.0%)

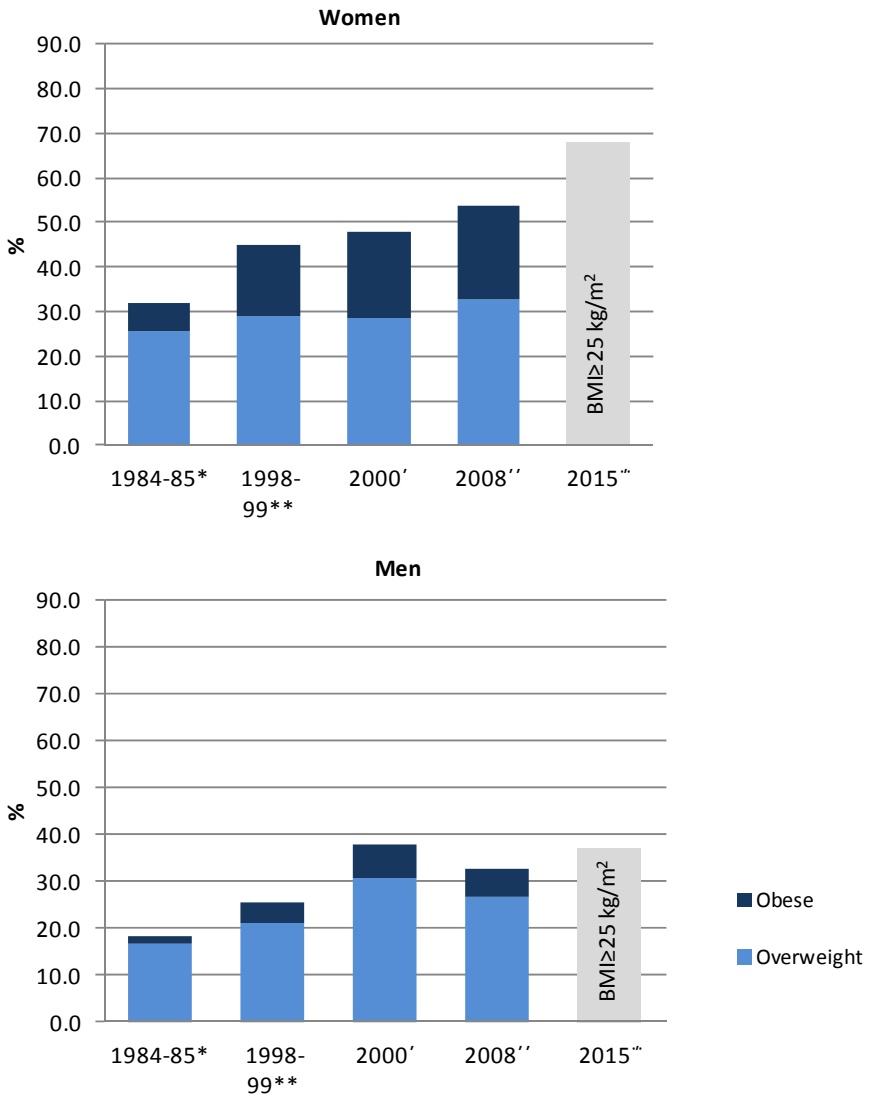
than men (4.3%) (Direction de la Statistique, 2000). Over this period of time, whilst pre obesity and obesity increased, underweight decreased in both men and women (from 10.5% to 5.7% in women and from 9.1% to 4.8% in men).

A national survey (2000) of adults (>20 years old) found higher estimates for obesity prevalence at 16.0% (again women were most likely to be obese). Indeed, 21.7% of adult women were obese and 8.2% of men were obese (Tazi *et al.,* 2003)

Another study using a representative sample of the Moroccan adult population (>18 years old) conducted in 2008 (El Rhazi *et al.,* 2011) stated that the prevalence of obesity was 20.9% in women and 6.0% in men, and that the prevalence of overweight was 32.9% in women and 26.8% in men. In 2005, the WHO made the following projections of anthropometric status of Moroccan adults (≥30 years old) for 2015 (World Health Organization, 2005): 68% of women and 37% of men will have a BMI ≥ 25 kg/m^2.

All the data regarding BMI trends are summarized in Figure 1.5.

Figure 1.5 Overweight (BMI≥25) trends between 1984-2008 and projections to 2015, Morocco



sources: *Direction de la Statistique, 1992; **Direction de la Statistique, 2000
'Tazi *et al*., 2003; ''El Rhazi *et al*., 2011; ‴WHO, 2005

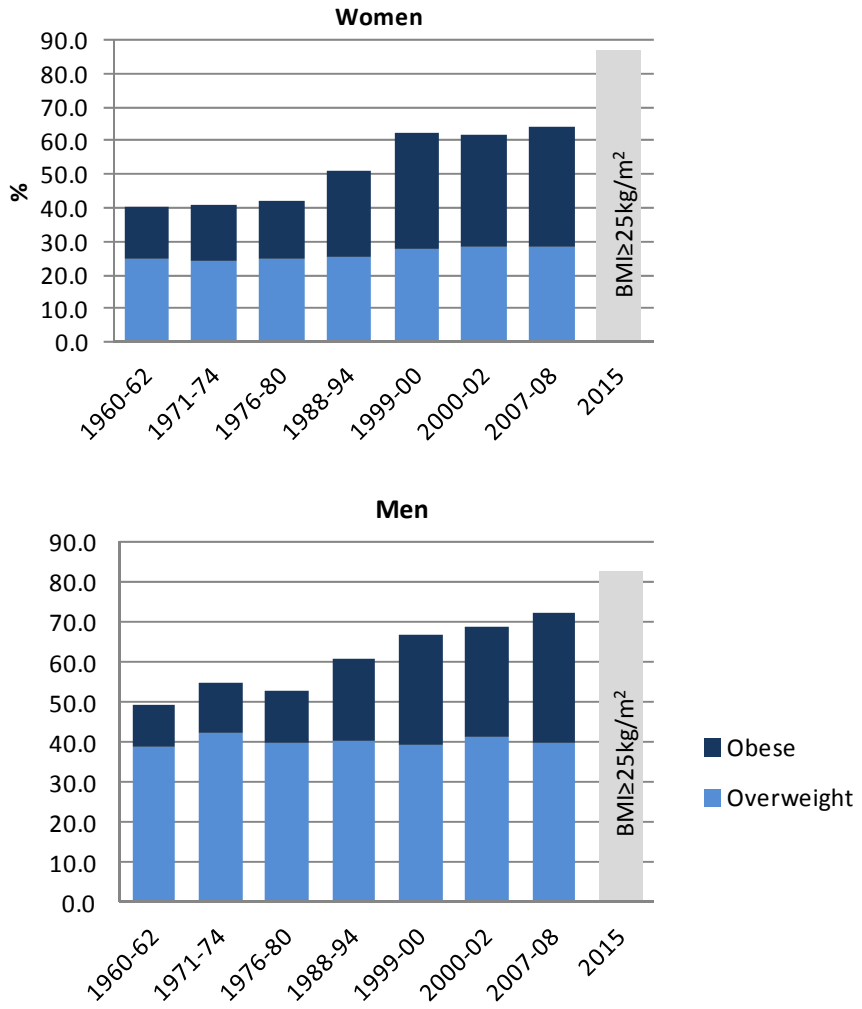
The overall trend is therefore that both obesity and overweight are increasing, and women are most susceptible, and the gender gap observed in all studies does not seem to be closing.

Looking at what happened in other parts of the world, for example in an industrialized country, such as the US (Figure 1.6) or region, such as Europe, and in an emerging country such as Brazil (Figure 1.7), the same tendency was observed, i.e. increasing prevalence of both overweight and obesity over time in both women and men.

According to the International Association for the Study of Obesity (IASO, 2008), in the 27 countries of the European Community overall 35.9% of the adults were overweight and 17.2% were obese. As observed in Morocco, European women were more likely to be obese than men (18.1% vs. 16.2%). European men were more likely to be overweight than women (42.8% vs. 29.5%).

In the US, women were more obese than overweight whereas it was the other way round for men. The WHO predicted that in 2015 more than eight out of ten Americans would be either overweight or obese (World Health Organization, 2005).

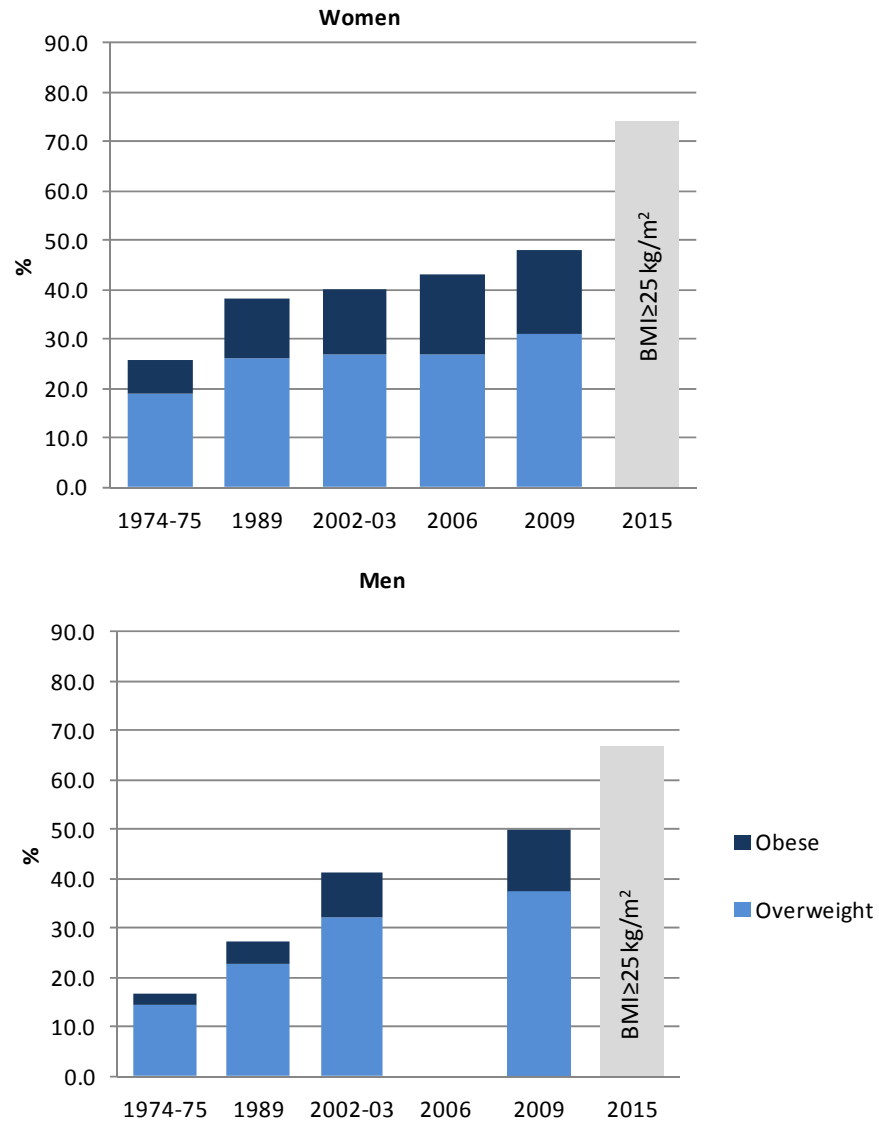
Figure 1.6 Overweight (BMI≥25) trends between 1960 and 2008 and projections to 2015, USA



sources: WHO, 2005; Wang & Beydoun, 2007; Flegal *et al.*, 2010

In Brazil, as observed in Morocco, the prevalence of obesity is greater in women than in men; since 2000 men tended to be more overweight than women. The WHO expects that in 2015, seven out of ten Brazilians will be either overweight or obese (World Health Organization, 2005). It is worth noting that whilst overweight and obesity increased, underweight decreased. Hence, from 1974 to 2006, underweight in Brazilian women decreased from 12.7% to 3.5%.

Figure 1.7 Overweight (BMI≥25) trends between 1974 and 2009 and projections to 2015, Brazil



source: WHO Global database on BMI, WHO, 2005

In 2000, a national survey in Morocco of adults (>19 years old), (Tazi *et al.,* 2003) revealed that hypertension affected 33.6% of adults, with females more likely to be hypertensive (37.0%) than males (30.2%); 6.6% of adults were diabetic (both types of diabetes taken together), with no differences between females and males; 29.0% of adults had hypercholesterolemia with females more likely to have hypercholesterolemia than males (32.0% vs. 25.9%) ; and the average BMI was 23.8 kg/m^2 in males and 25.6 kg/m^2 in females and was higher in urban than in rural areas. According to the same study, the prevalence of hypertension, diabetes and hypercholesterolemia increased with age (Table 1.3).

Table 1.2 Prevalence (%) by age group of the main cardiovascular risk factors in Morocco

Age (years)	Hypertension	Diabetes	Hypercholesterolaemia	Obesity
20-24	20.6	2.3	13.6	4.1
25-34	18.4	2.4	19.0	12.1
35-44	30.0	6.2	34.8	21.7
45-54	51.1	11.3	41.4	21.8
55-64	63.3	18.0	49.3	17.3
65-74	70.7	15.6	50.4	12.9
≥ 75	71.7	8.8	40.4	6.7

source: Tazi *et al.*, 2003

The prevalence of estimated type 2 diabetes was higher in Morocco than in Brazil but lower than in both the US and Europe (Table 1.4). The prevalence of hypertension was higher in Morocco compared to the US, Europe and Brazil. The prevalence of hypercholesterolemia was lower for Moroccan men compared to American men, but higher for Moroccan women compared to American women.

Table 1.3 Prevalence (%) of the main cardiovascular risk factors in different parts of the World

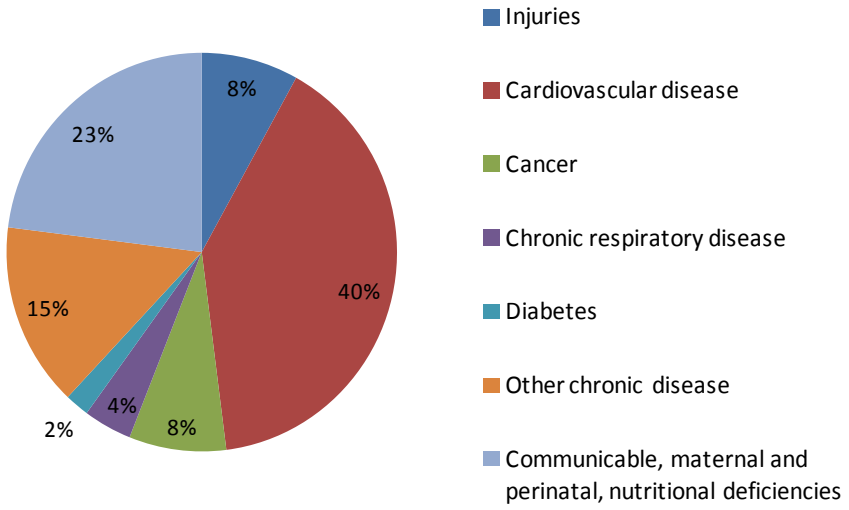
		USA	Europe	Brazil	Morocco
sources		1	2	3	4
		2007-2010	1990-1997	2010	2000
		≥20 years	35-64 years	≥18 years	≥19 years
Diabetes	Men	11.2%	8.4%*	5.4%	6.6%
	Women	10.2%		7.0%	6.6%
Hypertension	Men	31.3%	from 2 to 21%	20.7%	30.2%
	Women	29.6%	from 2 to 17%	25.5%	37.0%
Hypercholesterolaemia	Men	28.0%	from 8 to 53%	no data	25.9%
	Women	26.7%	from 15 to 40%		32.0%

* 20-79 years; 2007

sources: 1. National Center for Health Statistics, 2012
2. Allender *et al.*, 2008
3. Ministério da Saude, 2010
4. Tazi *et al.*, 2003

The WHO reported that NCDs were responsible for over two-thirds of all deaths in Morocco in 2002 (World Health Organization, 2005) (Figure 1.8) of which 40% were due to cardiovascular diseases, 8% to cancer and 2% to diabetes. This figure for NCD is higher than the global average of 60% of the reported deaths in the world and that amongst these deaths about half were attributable to cardiovascular disease (World Health Organization, 2003).

Figure 1.8 Mortality by cause, all ages in 2002, Morocco



source: World Health Organization, 2005

In comparison, in 2005, 38% and 32% of deaths were attributable to cardiovascular diseases in the US and in Brazil respectively (versus 40% in Morocco); 23% and 15% of deaths were attributable to cancer (versus 8% in Morocco); 3% and 5% of deaths were attributable to diabetes (versus 2% in Morocco) (World Health Organization, 2005). In summary, in Morocco compared to Brazil and the US, a greater numbers of deaths were attributable to cardiovascular diseases and a lesser numbers of deaths were due to diabetes or cancer.

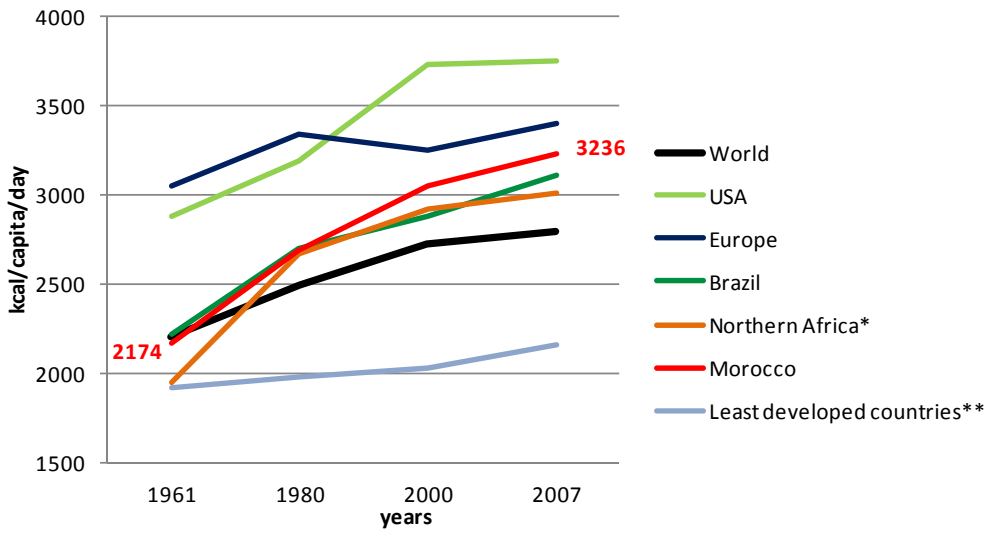
1.2.3.2 Transition in food consumption patterns

1.2.3.2.1 Food Balance Sheets

In Morocco there is a paucity of data about actual food consumption due to a lack of national surveys. However, data is available on food availability from the FAO in the form of FBS.

These data suggest that in Morocco the number of calories available for human consumption has continuously and rapidly increased from 1961 to 2007. Indeed, the number of calories available increased 1.5 fold ranging from 2174 kcal to 3236 kcal available per capita and per day (Figure 1.9). Worldwide over the same period of time, the number of calories available increased 1.3 fold, increasing more or less rapidly depending on the countries. Hence, in the less developed countries, even with a relatively low availability of calories, the number of calories has increased 1.1 fold over the last 46 years, whereas in an emerging country, such as Brazil, the increase has occurred more rapidly.

Figure 1.9 Calorie availability trends, in Morocco and different parts of the world, 1961-2007



sources: FAOSTAT Food Balance Sheets

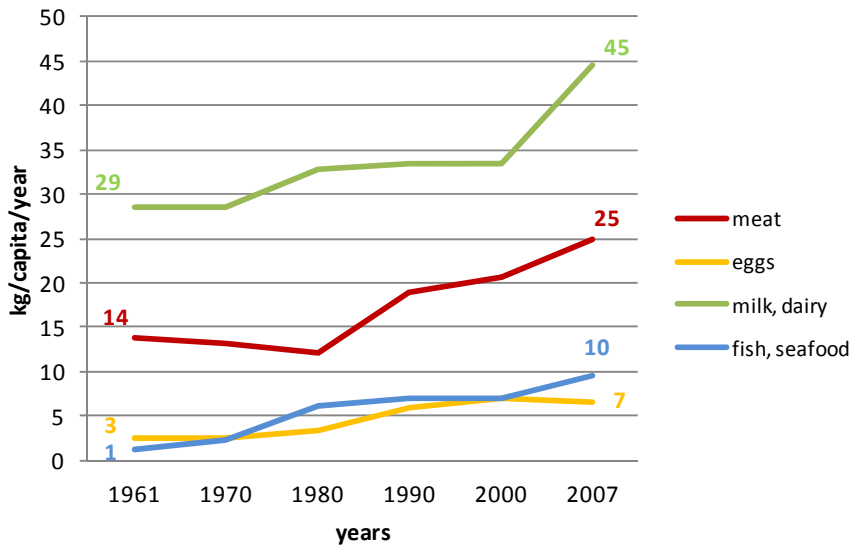
*Algeria, Egypt, Libya, Mauritania, Morocco, Sudan, Tunisia

** see Appendix 3

In Morocco, the availability of animal products (meat, eggs, milk and dairy, fish and seafood) has increased overall since 1961, with the most important increases regarding milk and dairy products (with a 157% increase) and meat intake, which has almost doubled, in four decades (Figure 1.10).

Meat availability in industrialized countries, such as the US and Europe, and in an emerging country (Brazil) significantly increased over the last forty six years, especially in Brazil (Figure 1.12). In the least developed countries, meat availability remained stable over the period whereas it regularly but slightly increased in northern Africa. The exact same tendency was observed in Morocco. Over the last four decades, eggs availability increased in every country or regions of interest, except, in the US where it decreased and remained stable in the least developed countries. Fish and sea food availability increased in every region or country of interest between 1961 and 2007. Since the 1980's milk and dairy foods availability was quite stable in the US, as well as in Europe, whereas it increased in Northern Africa and Brazil. In the least developed countries, as well as in Morocco, milk and dairy foods availability remained low (<50kg/capita/year) and more or less stable (Figure 1.12).

Figure 1.10 Animal products availability trends, Morocco, 1961-2007

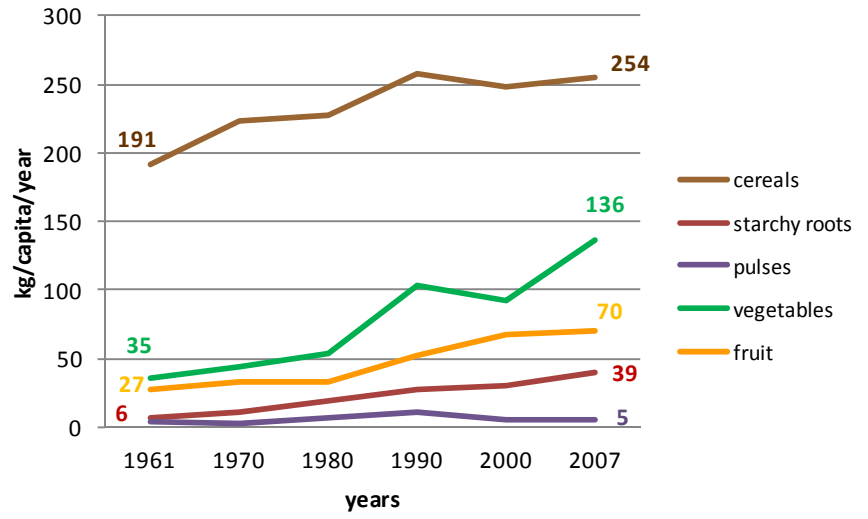


sources: FAOSTAT Food Balance Sheets

The availability of cereals, starchy roots, vegetables and fruit has globally increased overall since 1961 in Morocco (Figure 1.11), whereas the availability of pulses has remained relatively stable over the same period. The most important increase concerned vegetables, for which availability has nearly quadrupled in the last 4 decades.

Beans and pulses availability decreased over the last four decades in Brazil and in Europe, whereas it slightly increased in the US and in Northern Africa. Over the same period of time, beans and pulses availability remained almost stable in the least developed countries and in Morocco. Between 1961 and 2007, whilst cereals availability decreased in Europe, it increased in Northern Africa, in Morocco, in the US and in Brazil. In the least developed countries cereals availability remained stable over this period of time. In Europe as well as in Brazil, starchy roots availability decreased whereas it increased in Northern Africa and in Morocco. In the US as well as in the least developed countries, starchy roots availability remained stable over the last four decades. From 1961 to 2007, vegetables availability increased, more or less rapidly, in every part of the World investigated. Fruit availability increased during the last 46 years in every part of the World investigated except in the least developed countries where it did not changed. Since 2000 in the US and Brazil, fruit availability has been decreasing (Figure 1.12).

Figure 1.11 Plant products availability trends, Morocco, 1961-2007

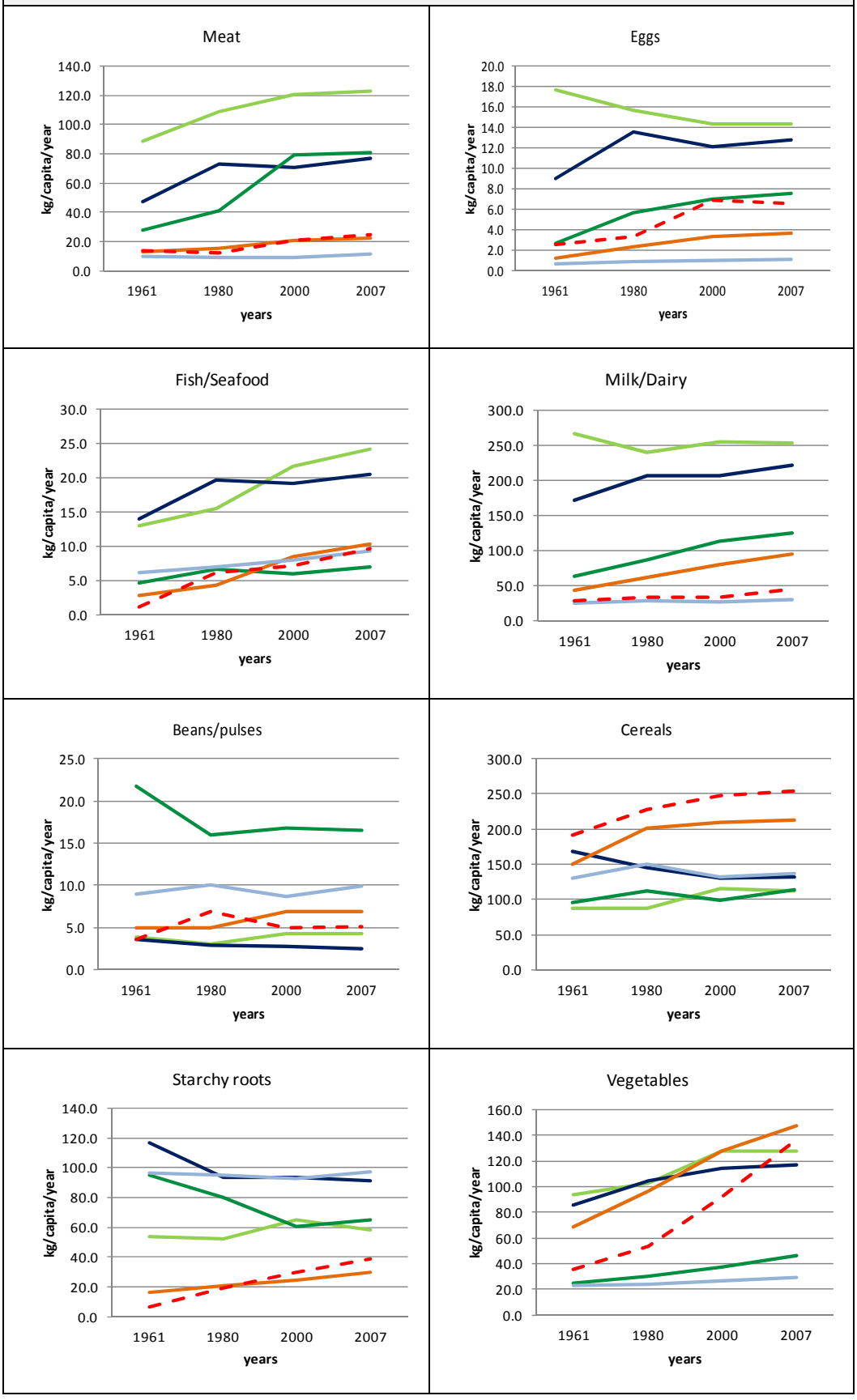


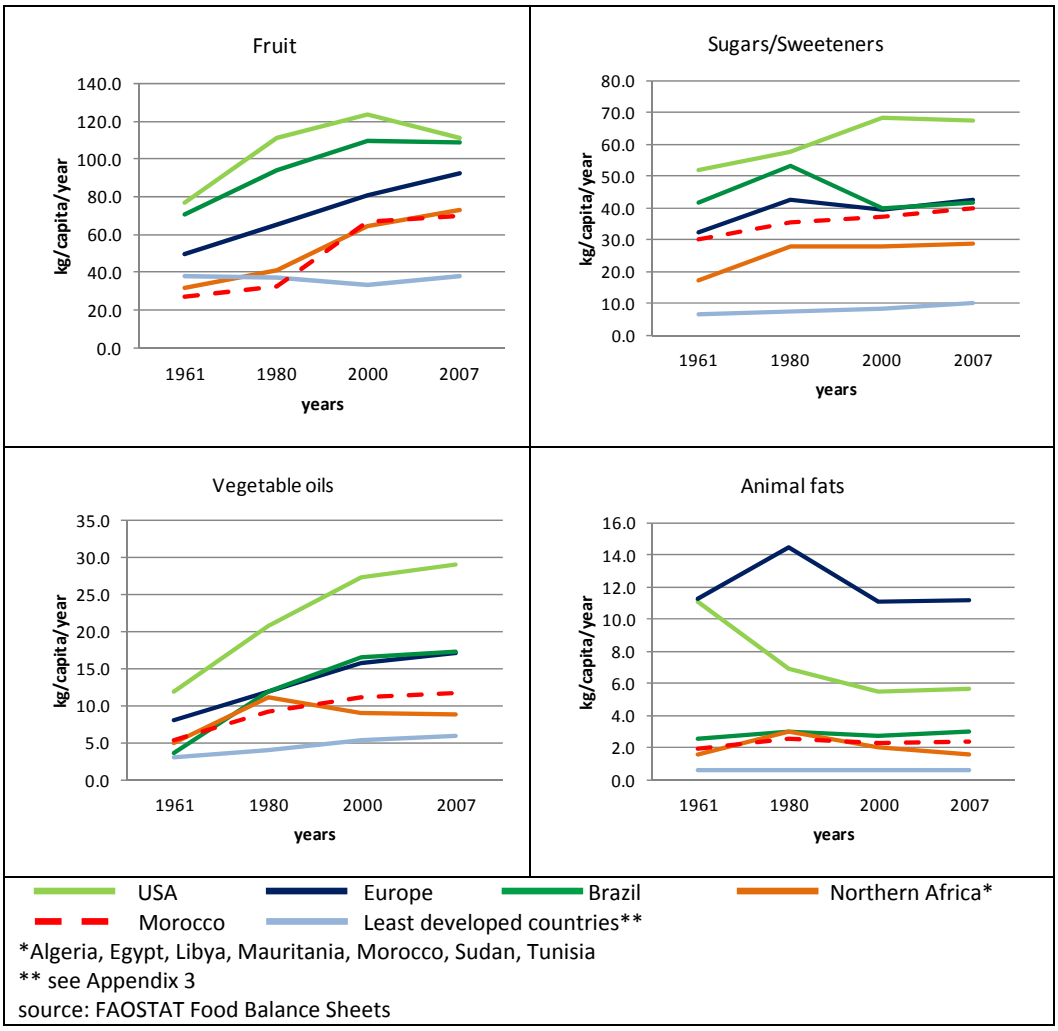
sources: FAOSTAT Food Balance Sheets

In Morocco, from 1961 to 2007, sugar availability (sugar and honey) increased from around 30kg/capita/year to 40kg/capita/year, which represented an average of 109g available per capita and per day. During this period, the availability of vegetable oils has more than doubled, increasing from around 5kg/capita/year to more than 11kg/capita/year, representing an average of 30g available per capita and per day.

Since the 1960's sugar and sweeteners availability increased in every region of the World which was investigated except in Brazil where after an initial increase until the 1980's it has since decreased. Over the last four decades, vegetable oils availability increased, rapidly in the US, Europe and Brazil and less rapidly in Northern Africa, Morocco and in the least developed countries. Whilst the availability of animal fats has decreased since the 1960's in the US, its availability remained stable in the other parts of the World investigated (Figure 1.12).

Figure 1.12 Diverse food groups availability trends in different parts of the World, 1961-2007





*Algeria, Egypt, Libya, Mauritania, Morocco, Sudan, Tunisia

** see Appendix 3

source: FAOSTAT Food Balance Sheets

1.2.3.2.2 Household Budget Surveys

In Morocco, HBS are under the responsibility of the National Statistics Department. Samples used are representative of the Moroccan population based on a two stage cluster sampling method. All food items bought, eaten out of the household, harvested, grown or received as a gift at the household level are accounted for. The amount of different food groups at the household level is deducted from the price paid for each. Then the amount is divided into each household by the number of people living in the household.

The food groups concerned are the followings: grain and grain products, milk and dairy products, eggs, fats, meat, fish, vegetables, fruit, sugar and sweets, tea and aromatic plants, alcoholic and non alcoholic beverages.

The recall period depends on the type of food concerned, i.e. items kept in storage are recalled on a yearly basis, e.g. grain, legumes, oil; whereas wholesale items are recalled ’every two months‘, e.g. flour, sugar; items

frequently bought or items individually bought out of home are recalled on a weekly basis; items bought everyday are recalled on a daily basis.

According to the national HBS conducted by the Statistics division of the 'Haut Commissariat au Plan', it appears that between 1970-1971 and 2000-2001, the consumption of cereals decreased (including grains, flour, semolina, bread and pasta), which used to be the staple food of the Moroccan diet (Direction de la Statistique, 1971, 1992, 2001). Both meat and fish consumption increased, as well as intakes of dairy products and eggs. The consumption of fats (butter and oils) has broadly increased, whereas that of sugar (sugar and honey included) has slightly fallen. It also appears that fruit (since 1985) and vegetable (since 1971) consumption has increased (Table 1.5).

Table 1.4 Food consumption trends, Morocco, 1971-2001

Food groups in kg/year/capita	1971	1985	2001	
Cereals	216.40	210.44	185.20	↘
Meat and fish	21.40	22.19	27.35	↗
Dairy	28.30	30.26	37.75	↗
Eggs	1.30	2.90	3.90	↗
Fats (butter and oils)	13.10	15.87	19.55	↗
Sugar	29.70	27.20	24.76	↘
Fruit	46.10	31.81	38.55	↘
Vegetables	88.70	89.19	103.49	↗
Potatoes		22.25	31.55	↗

note: data on vegetables for 1971 included potatoes

Overall, both HBS and FBS showed an increased availability of meat and fish, milk and dairy products, eggs, fats, vegetables, and potatoes over time. Differences in observed amounts between the two methods are due to differences in the way availability was calculated. Regarding cereals, the FBS showed an increase over time whereas the HBS showed a decrease. The same apparent contradiction is observed for sugar. This can be explained by the fact that cereals and sugar are widely used in processed foods. Thus they appeared in the FBS as available but at the household level they are included in foods and do not appear *per se*.

Within Europe, HBS data were gathered by the DAta Food NEtworking (DAFNE) initiative which created a European databank, based on the food, socio-economic and demographic data from nationally representative HBS. The third databank gave data for nine countries (Belgium, France, Greece, Ireland, Italy, Norway, Portugal, Spain and the United Kingdom) from 1985 to

1999. Over this period of time, the evolution of the daily availability of different food groups was as follows (DAFNE, 2003):

- The availability of cereals and cereal products decreased in all countries except Belgium where it increased and Ireland where it remained stable.
- The availability of meat and meat products decreased in every country except in Norway, Portugal and Ireland.
- The availability of fish and seafood remained relatively stable.
- The availability of milk and milk products increased in Belgium, France, Ireland, Portugal and Italy, whereas it decreased in Norway, Spain and in the UK.
- The availability of eggs decreased over time in all countries.
- Total fat availability (butter and oils) either remained steady or decreased in all countries.
- The availability of pulses decreased over time in all countries.
- Nuts availability either increased substantially (Belgium), moderately (Greece, Norway, the Republic of Ireland and United Kingdom) or remained stable (France, Italy and Portugal).
- The availability of vegetables increased in Northern and Central European countries, whereas it decreased in Southern European countries.
- The availability of fruit decreased in all countries except Ireland, Norway and the UK.
- The availability of potatoes and other starchy roots decreased in all countries.
- The availability of sugar and sugar products decreased in all countries.

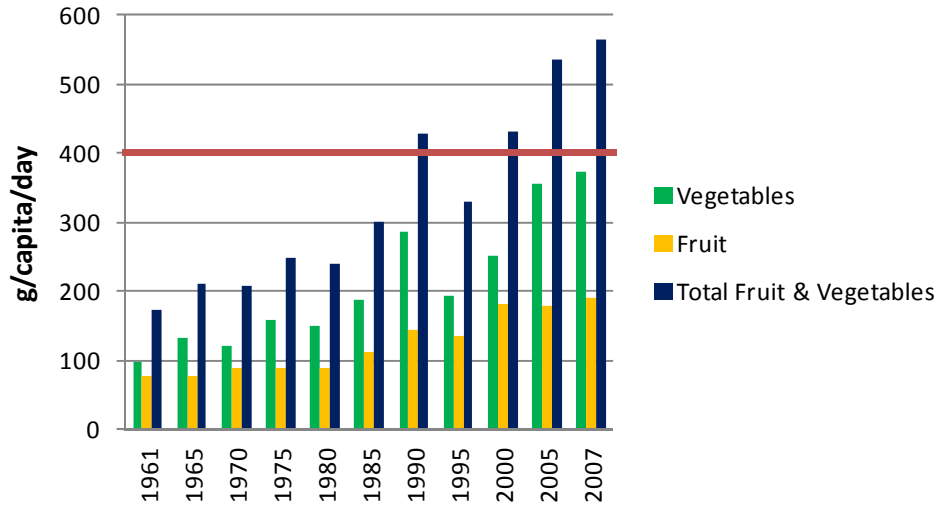
1.2.4 Fruit and vegetable consumption

1.2.4.1 Food Balance Sheets

Within the context of nutrition transition, studies in other countries (CDC, 2010; Ministério da Saude, 2010) have shown a decrease in fruit and vegetable intake, therefore this study investigated whether this was also the case for Morocco. There is no published data about actual fruit and vegetable consumption in Morocco, but data are available on fruit and vegetables from the FAO's FBS. These data suggested that in Morocco overall, since 1961 the availability of fruit and vegetables has increased (from 76g per capita and per day in 1961 to 191g per capita and per day in 2007 for fruit; from 97g per capita and per day in 1961 to 374g per capita and per day in 2007 for vegetables) (Figure 1.13). As a result over 500g of fruit and vegetables were

potentially available for consumption per day and per person by 2003. It is important to note that this kind of data does not measure utilization of foods, harvested or grown plant foods and that estimates are not always consistent with socio-economic indicators (Webster-Gandy *et al.,* 2012).

Figure 1.13 Fruit and vegetable availability trends, Morocco, 1961-2007

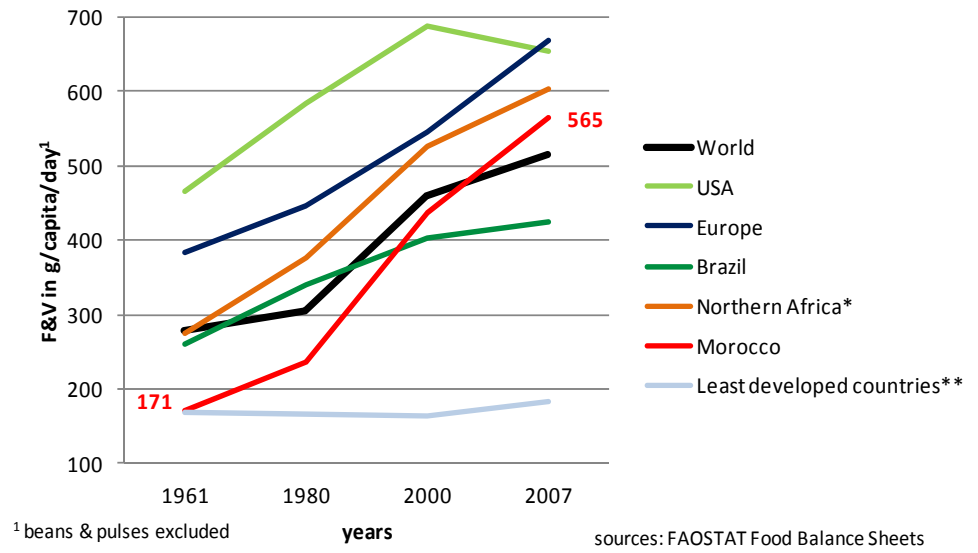


sources: FAOSTAT Food Balance Sheets

Over the last four decades, contrary to what was observed in the least developed countries where the amount of fruit and vegetables available for human consumption did not significantly increase and in the US where fruit and vegetable availability has decreased between 2000 and 2007, in the rest of the world fruit and vegetable availability increased widely (Figure 1.14). In Europe as well as in Morocco and North Africa the increase occurred at a fast pace, whereas in Brazil the increase was more gradual.

More recently, data published by the European Fresh Product Association (Freshfel, 2012), reported that across the 27 countries of the European Union, a sharp decrease in fresh fruit and vegetable availability was observed in 2009 and that this decrease continued in 2010 bringing the amount of available fresh fruit and vegetables to 458g/capita/day.

Figure 1.14 Fruit and vegetable availability trends, in Morocco and in different parts of the World, 1961-2007



[1] beans & pulses excluded

sources: FAOSTAT Food Balance Sheets

*Algeria, Egypt, Libya, Mauritania, Morocco, Sudan, Tunisia
**see Appendix 3

1.2.4.2 Household Budget Surveys

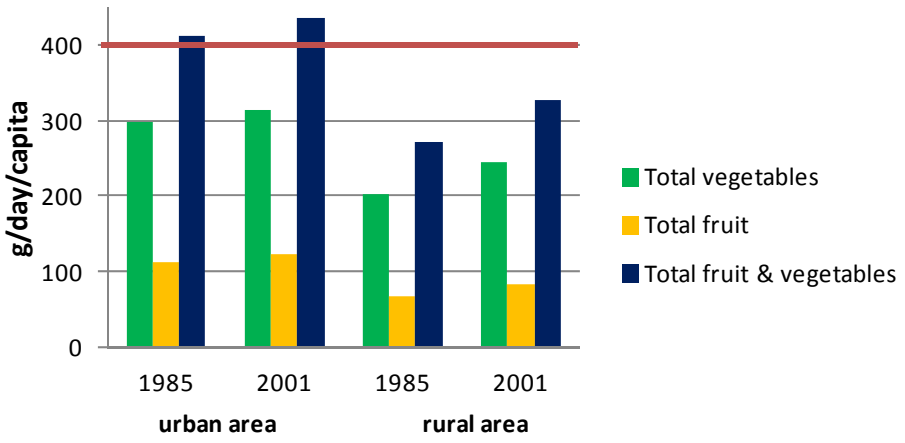
Household Budget Surveys in Morocco (1985) have suggested that around 331g of fruit and vegetables were available for consumption per day and per capita at national level (Direction de la Statistique, 2001). This had risen slightly in 2001, with around 388g of fruit and vegetables available for consumption daily per capita at national level (Table 1.6 and Figure 1.15). Between 1985 and 2001 the amount of fruit and vegetables available for consumption increased by 1.7, with a higher increase for fruit than for vegetables. There was more fruit and vegetables available in urban than rural areas, whatever the year (410g in urban versus 271g in rural in 1985; 437g in urban versus 328g in rural in 2001). Between 1985 and 2001 the increase in fruit and vegetables availability was more important in rural than in urban areas, i.e. 1.06 in urban areas and 1.21 in rural areas.

Table 1.5 Fruit and vegetable consumption in urban and rural Morocco, in g/day/capita, 1985-2001

	1985			2001		
	urban	**rural**	**national**	**urban**	**rural**	**national**
Fresh vegetables	246	163	199	259	201	233
Dried or canned vegetables	52	41	46	55	45	50
Total Vegetables	**298**	**204**	**244**	**313**	**246**	**284**
Citrus fruit	48	21	32	44	27	37
Other fruit	65	47	54	70	53	62
Tropical fruit	0	0	0	7	1	4
Prepared fruit	1	0	0	3	1	2
Total Fruit	**113**	**68**	**87**	**124**	**82**	**106**
Total Fruit & Vegetables	**411**	**271**	**332**	**437**	**328**	**389**

source: Direction de la Statistique, 2001

Figure 1.15 Evolution of fruit and vegetable consumption in urban and rural Morocco, 1985-2001



source : Direction de la Statistique, 2001

According to the results from the DAFNE project, in Europe from 1985 to 1999, vegetables availability increased in Northern and Central European countries whereas it decreased in Southern European countries; and fruit availability decreased in all countries except Ireland, Norway and the UK (see section 1.2.3.2.2). Both HBS and FBS showed an increased availability of fruit and vegetables with time. Once again, differences between the 2 methods are due to differences in the way of calculating availability. The data in both these studies is limited as it does not involve assessing real fruit and vegetable intake on an individual level.

1.2.4.3 Dietary assessment surveys

There is no available data about trends in actual fruit and vegetable intake in Morocco. However, according to the 2002-2003 World Health Survey (Hall *et al.*, 2009) eight out of ten Moroccans ate less than five servings of fruit and vegetables per day (79.4% of men and 85.7% of women).

In neighbouring Tunisia, a national representative study conducted amongst adults (35-70 years), reported that the mean daily fruit and vegetable intake, based on FFQ, was 559g and that 33.7% of the adults did not meet the WHO recommendations (2005, Tahina study, data not published).

According to the NHANES study conducted in 1988-1994 and 1999-2002 in US adults (≥18 years) using 24-hour recalls, the mean number of vegetables servings consumed per day significantly decreased over this period of time, ranging from 1.83 to 1.71; whereas the number of fruit servings did not change (Casagrande *et al.*, 2007). Several BRFSS surveys conducted in US adults (≥18 years) between 2000 and 2009 indicated that overall the number of adults who consumed fruit two or more times per day slightly but significantly fell, ranging from 34.4% to 32.5%; whereas no significant changes were reported for vegetable consumption other the same period (26.3% of adults consumed vegetables three or more times per day in 2009) (CDC, 2010).

In 2008, the European Food Safety Authority compiled data from national food consumption surveys conducted in 19 European countries and revealed that the average fruit and vegetable consumption was 386g/day (220g/day for vegetables and 166g/day for fruit). A gradient of consumption was observed across these countries. Indeed, in the South people tended to eat more vegetables than people in the North whereas in Central and Eastern Europe people tended to eat more fruit than in the rest of Europe.

According to the Risk Factors Surveillance for Non-Communicable Diseases Prevention Surveys (Ministério da Saude, 2006 and 2010) conducted in Brazil between 2006 and 2010, the percentage of adults (≥18 years) who consumed at least five fruit and vegetables per day decreased from 23.9% to 18.2% (women being more likely to consume more fruit and vegetables than men).

1.3 Objectives of the study

The objectives of the present study (summarised in Figure 2.1) are the following:

(i) To develop and validate a short quantitative Food Frequency Questionnaire to assess fruit and vegetable intake

Research questions and associated [hypotheses]

Is a short quantitative Food Frequency Questionnaire a valid tool for assessing daily intake of fruit and vegetables (total quantity of fruit and vegetables)?

[Compared to 24-hour recall, the Food Frequency Questionnaire is a reliable and valid tool to measure fruit and vegetable intakes]

(ii) To quantify fruit and vegetable intake, diversity and overall dietary quality

What is the average Mean portion size for fruit and for vegetables? Is one occurrence equivalent to one portion?

[The Mean fruit portion size is larger than 80g]

[The Mean vegetable portion size is smaller than 80g]

Do Moroccan women eat the daily amount of fruit and vegetables recommended by the WHO?

[Moroccan women meet the WHO daily recommendations for fruit and vegetables]

What is the importance of fruit and vegetables in contributing to macro- and micronutrient intake in women's diets?

[Fruit and vegetables are the major contributors to certain vitamins and minerals]

Is fruit and vegetable intake of Moroccan women diversified and of good quality?

[Moroccan women eat a greater variety of vegetables than fruit]

[Moroccan women have a fruit and vegetable intake of good quality regarding both amount and diversity]

Is the overall diet of Moroccan women diversified and of good quality?

[Moroccan women have high dietary diversity and diet quality scores]

Is overall diet quality related to fruit and vegetable intakes?

[Moroccan women with higher overall diet quality eat more fruit and vegetables]

(iii) To determine socio-demographic factors, as well as particular eating behaviours that may have an impact on fruit and vegetable consumption and to a lesser extent on the overall diet quality

Does fruit and vegetable consumption vary with socio-demographic characteristics?

[Women with high socio-economic status eat more fruit and vegetables]

[Married women eat more fruit and vegetables]

[Older women eat more fruit and vegetables]

Are certain behaviours related to a lower fruit and vegetable consumption?

[Women who eat more processed foods eat less fruit and vegetables]

[Women who eat more often out of their home eat less fruit and vegetables]

Does overall diet quality vary with socio-demographic characteristics?

[Women with high socio-economic status have better overall diet]

[Women with high education level have better overall diet]

(iv) To determine factors (potential mediators and obstacles) that may have an impact on fruit and vegetable consumption based on key psychosocial constructs

What are the obstacles to fruit and vegetable consumption?

[Price is an important obstacle to fruit and vegetable consumption]

[Convenience is a key obstacle to fruit and vegetable consumption]

What are the promoters of fruit and vegetable consumption?

[The health aspects of fruit and vegetables is a promoter of their consumption]

Is a good level of knowledge about fruit and vegetables associated with a high level of fruit and vegetable intake?

[Women with a better knowledge about fruit and vegetables eat more of them]

Which psychosocial constructs predict best the intention to eat fruit or vegetables?

[Perceived Behavioural Control is the best predictor of intention to eat fruit or vegetables]

Which psychosocial constructs predict best fruit or vegetable intakes?

[Intention is the best predictor of fruit or vegetable intakes]

(v) To determine the impact of fruit and vegetable consumption on weight status and diet-related NCDs

Does anthropometric status as well as diet-related non-communicable diseases vary with fruit and vegetable consumption?

[Women with higher intakes of fruit and vegetables tend to be less obese]

[Women with higher intakes of fruit and vegetables are less likely to have diet-related NCDs]

To answer these hypothesises several studies were designed: a focus groups study, a validation study and a population study. All the questionnaires used in these three studies were designed according to the research questions that were associated with the present objectives.

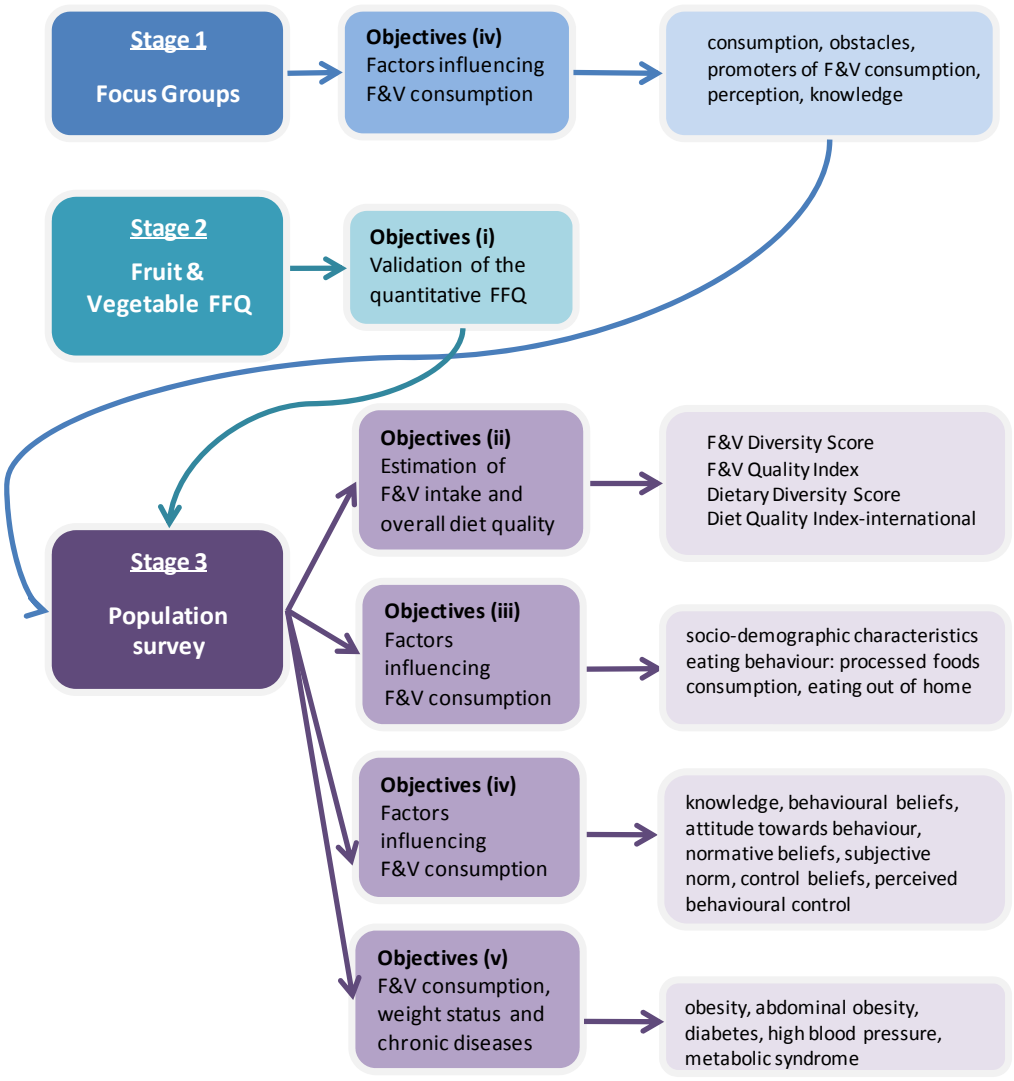
Chapter 2: Methodology

This study was part of a larger project regarding the double burden of malnutrition called Obe-Maghreb: 'Understanding the nutrition transition in the Maghreb to contribute to the prevention of obesity and non communicable diseases.' This project was conducted in Morocco and Tunisia (November 2007 to November 2011), in collaboration between the University of Nottingham in the UK, the Institute of Research for Development (IRD) in France, The University of Kenitra in Morocco and the National Institute for Nutrition and Food Technology in Tunisia.

This PhD included three different studies that have been developed separately. The first was a qualitative study, involving focus group discussions. The results obtained from these focus groups were used to develop the population survey (study 3). The second study involved validating a quantitative fruit and vegetable Food Frequency Questionnaire as a measure of the usual intake (Figure 2.1).

Even though the studies included in this PhD were within the framework of the Obe-Maghreb project, EL was responsible for developing the objectives of the study, selecting the appropriate methodology, as well as validating tools, training the interviewers, organizing and supervising data collection, coding, entering data, analysing and interpreting data.

Figure 2.1 Summary of study objectives and methodology[1]



[1]The numbering of objectives is based on classification outlined in section 1.3
F&V: fruit and vegetable

2.1 Ethical considerations

Approval from the "Ethical and Deontological Consultative Committee" of the IRD was obtained in June 2008.

The project was also submitted to the ethical committee of the Faculty of Medicine in Rabat. The Ministry of Health approved the project in March 2009 (letter n°623, 16th of March 2009). The Home Office also gave approval for the study through the Wilaya of Rabat-Salé (authorizations n°1823 for Salé and n°1824 for Rabat, 7th of April 2009).

All ethical procedures of the Helsinki declaration were respected. The aim of the study and all its implications, in terms of duration, the kinds of questions to be asked, anthropometric measurements to be conducted, as

well as confidentially of data collection were explained to all women that were selected to participate in the studies. Women were also told that they were free to not take part in the study and that if they accepted they would still have the option to withdraw from the interview at anytime, without having to give a reason. For each woman who agreed to participate, informed oral or written consent was obtained during the recruitment. Then a document, written either in Arabic or French, explaining the project (aims and implications for the subject) and containing the project coordinator's telephone number and address was given to all women. Each woman had at least 24-hours between the recruitment process and the interview.

2.2 Study 1: Focus groups

The aim of the focus groups was to identify potential factors influencing fruit and vegetable consumption of Moroccan women (see section 1.3 objectives (iv)). Once these factors were highlighted they were used to build the knowledge and attitudinal scales questionnaires.

2.2.1 Study design and sampling

Before commencing focus groups with women, the most appropriate composition of these had to be decided. As it was expected that both age and socio-economic status might have an impact on fruit and vegetable consumption patterns and perception (Ball and Mishra, 2006; Lallukka *et al.,* 2007; Estaquio *et al.,* 2008), 50 women of childbearing age were recruited in different areas of Rabat and were divided into 6 homogenous groups according to their age, socio-economic and literacy status for the focus group's progress. Homogeneity within each group is recommended as it usually makes people more comfortable to speak and thus maximizes interaction between them and capitalises on people's shared experiences (Kitzinger, 1995; Krueger, 2000; Green and Thorogood, 2004). The recruitment was conducted by Moroccan academics that used their discretion to determine socio-economic status from the neighbourhood the women lived.

Thereby, the groups were as follows:

- 9 women aged from 20 to 25 years from low socio-economic status
- 8 women aged from 26 to 35 years from low socio-economic status
- 8 women aged from 36 to 49 years from low socio-economic status
- 9 women aged from 20 to 25 years from high socio-economic status
- 8 women aged from 26 to 35 years from high socio-economic status
- 8 women aged from 36 to 49 years from high socio-economic status

All women from high socio-economic status were literate. Those from low socio-economic status were a mixture of literate/illiterate women. The number of focus groups is never decided *a priori*, but usually each focus group should be repeated until a clear pattern emerges and until the discussions about the theme of interest become redundant. Commonly, focus groups are repeated 3-4 times (Moreau *et al.,* 2004). Contrary to what is advocated in the literature only one focus group discussion was conducted in each category because of time and logistical constraints.

2.2.2 Interview guide

The focus groups were conducted by an experienced bilingual speaker (Arabic and French), who was a Professor of Social Sciences in Morocco, using an interview guide. EL trained the facilitator to apply the interview guide developed for this study. At the beginning of each session the facilitator explained that the aim of focus groups is to encourage people to talk to each other rather than to address themselves to the researcher. The themes and questions of interest in the interview guide can be seen below (Table 2.1):

Table 2.1 Focus group interview guide

General consumption:
When do you usually eat fruit?
When do you usually eat vegetables?
At home, who usually prepares fruit and vegetables?
Are there certain periods of the year when you feel you are eating more fruit?
Are there certain periods of the year when you feel you are eating more vegetables?
Promoters and obstacles to consumption:
How tasty do you find fruit?
How tasty do you find vegetables?
What could make you eat more fruit?
What could make you eat more vegetables?
What stops you eating more fruit?
What stops you eating more vegetables?
Price, availability and convenience:
What do you think about the price of fruit and vegetable?
How easy do you think it is to prepare and cook fruit?
How easy do you think it is to prepare and cook vegetables?
Do you think it is easy to eat fruit at home?
Do you think it is easy to eat vegetables at home?
Would you say that you eat more or less fruit when you eat out of home?
Would you say that you eat more or less vegetables when you eat out of home?
Perception of health benefits:
In your opinion, is there any difference between fresh, dried and canned fruit?
In your opinion, are there any unhealthy fruit?
In your opinion, are there any unhealthy vegetables?
Who should eat fruit and vegetables?
Recommendations:
Have you heard about fruit and vegetables consumption recommendations?
How many fruit and vegetables do you believe you need to eat each day?

2.2.3 Food photographs

In addition, a book containing photographs of key plant foods eaten in Morocco was developed to assess whether there were any misconceptions about which food group they belong to. This work was useful in order to develop the fruit and vegetable Food frequency Questionnaire (see section 1.3 objectives (i)). After the focus group, women were asked to classify each photograph into one of the following groups: fruit, vegetable, neither a fruit, nor a vegetable or don't know. The foods presented were selected because they were the most common fruit and vegetables available, based on FAO FBS, and using data from neighbouring Tunisia, assuming that in Morocco it would be similar. Eleven fruit and vegetables were selected: apple, banana, grapes, orange, dates, carrots, sweet pepper, tomato, peas, onions and pumpkin. Then in order to test women's knowledge about what can be classified as a fruit or a vegetable it was arbitrarily decided to add four pictures of plant foods, i.e. almonds, olives, fresh mint leaves and potato. Each picture was randomly numbered and for each focus group the facilitator was instructed to show the pictures in the same order.

2.2.4 Data collection

EL organised the focus groups but was not physically present during the focus group because her presence could have disturbed the women, as she is not Moroccan. She waited close to the room where they were conducted, in case of problems.

The six focus groups were conducted in April and May 2008 by the same facilitator. Each focus group lasted between 45-60 minutes. Half of the focus groups took place at the University of Social Sciences in Rabat, where the facilitator worked, and the others took place in a meeting room at the National Centre of Energy Nuclear Sciences and Technologies in Rabat were some of the project collaborators were based.

All discussions were tape recorded with two digital tape recorders (one was used as a backup). The discussions were fully transcribed and translated from Arabic into French by the facilitator under supervision from EL. Then, the translations were back translated by two different bilingual speakers in order to avoid misinterpretation and mistranslation.

2.2.5 Data analysis

One of the most common approaches used in qualitative research, known as thematic content analysis (Moreau *et al.,* 2004) was employed to analyse the interview transcripts, mainly based on the themes defined *a priori* in the interview guide. The analysis was performed manually, using the 'scissors and paste' method, by categorizing the recurrent themes and by putting together all sentences covering the same idea or theme (Green and Thorogood, 2004).

2.3 Study 2: Fruit and vegetable Food Frequency Questionnaire validation study

2.3.1 Study design

The aim of the present validation study was to validate the use of a short quantitative fruit and vegetable Food Frequency Questionnaire to measure fruit and vegetable intakes (see section 1.3 objectives (i)).

The fruit and vegetable FFQ intended to estimate consumption of fruit and vegetable groups rather than individual foods. It was designed to measure the usual fruit and vegetable intake over a one week period.

Usually, the reference method for validating a FFQ is the multiple diet records (Willett *et al.,* 1985). The advantages of such a method are that it does not rely on subject memory and that it is the most accurate method to measure food intake when quantities consumed as well as ingredients of recipes are weighed. In the context of the present study, where most of the dishes are consumed in a shared bowl, portioning out and weighing food would have introduced a bias. Therefore multiple 24-hour recalls were preferred as the reference method to validate the fruit and vegetable FFQ.

Several authors demonstrated that usually between two and five replicate measurements per subject is reasonable for a validation study (Willett, 1998) and that consecutive days may not be independent of one another, i.e. there is a lack of independence of intake on consecutive days (Morgan *et al.,* 1987; Larkin *et al.,* 1991). Therefore, it was decided to conduct three 24-hour recalls on non consecutive days.

Because of the low level of literacy amongst women in Morocco of 44% (World Health Organization, 2010), the questionnaires were administered by four trained bilingual Moroccan dietitians (Arabic and French). Each subject completed the fruit and vegetable FFQ twice (once at the beginning of the validation study period and once at the end of this period). During this time, the four trained dietitians administered the 24-hour recalls on three non consecutive occasions. The recalls were administered every two days and included two week-days and one week-end day.

2.3.2 Sampling

Several authors have demonstrated that usually a sample size between 100 to 200 subjects is reasonable for a validation study (Willett, 1998). Therefore the sample size of 100 was chosen for this validation study.

As a representative sample is not necessary for such a validation study, 100 women from a convenient sample based on quotas were interviewed. The quotas used for this validation study were based on age and educational level of the women from the population survey to reflect the demographic and socio-economic diversity of the population and also because answers to such a questionnaire can be influenced by age and education. Thereby the resulting sample was the following:

- 7 women 20-29 years who never went to school
- 15 women 20-29 years with a primary or partial secondary education
- 6 women 20-29 years with a secondary or university education
- 13 women 30-39 years who never went to school
- 17 women 30-39 years with a primary or partial secondary education
- 5 women 30-39 years with a secondary or university education
- 20 women 40-49 years who never went to school
- 14 women 40-49 years with primary or partial secondary education
- 3 women 40-49 years with a secondary or university education

2.3.3 Questionnaire

For the validation study, the questionnaire consisted of five sections: (i) consent form; (ii) socio-economic characteristics of the household; (iii) socio-demographic characteristics of the woman; (iv) anthropometry (height and weight); (v) food consumption: one 24-hour recall questionnaire repeated three times and one fruit and vegetable FFQ repeated twice.

2.3.3.1 Socio-economic characteristics of the household

This section concerned household characteristics such as employment of household members, accommodation and equipment characteristics, i.e. kitchen, bathroom, fridge, washing machine, dish washer, satellite dish, internet access, television, heating, air conditioning, telephone, car, computer, and was developed on the basis of questions asked in national surveys such as, Demographic and Health Surveys or Household Budget Surveys used in Morocco (Direction de la Statistique, 2001; DHS, 2003).

2.3.3.2 Socio-demographic characteristics of woman

In this section, data about date of birth, relationship with the head of the household, marital status, level of education and number of children were investigated.

2.3.3.3 Food consumption section

2.3.3.3.1 24-hour recall

A quantitative 24-hour recall was developed, i.e. each food or beverage consumed during the last 24-hours had to be quantified. Three different methods of quantification were chosen. Firstly the amount of food or beverage could be quantified using two food portion size books (Su.Vi.Max, 1994 and CIRIHA, 2008). Secondly, when a photograph of the food did not exist (or one similar), the amount of food was quantified using household measurement, such as a glass, spoon, cup, or a piece, e.g. for fruit and vegetable. The third possibility was estimating the amount of food consumed if the subject knew its exact weight. In this case the interviewer reported the amount expressed in grams directly on the questionnaire.

As there were no average Moroccan recipes available for this study, all recipes cooked and consumed in each household were recorded. The way of estimating the amount of ingredients was the same as for the food consumed. At the end of the 24-hour recall, subjects were asked if they had consumed the same, less or more than usually, if yesterday was a typical day and if they usually eat on a separate plate or in a common bowl.

2.3.3.3.2 Fruit and vegetable Food Frequency Questionnaire

The aim was to develop a short quantitative FFQ which would give an acceptable assessment of usual fruit and vegetable intake. Either just the frequency (and in that case one occurrence would count as one portion), or with both frequency and quantity.

The short fruit and vegetable FFQ (Table 2.2) was constructed by examining what was already published in the literature and more particularly based on the Rapid Risk Factor Surveillance System (RRFSS) questionnaire from Canada (Appendix 4) and the National Health Interview Survey (NHIS), from the US (Appendix 5) which both contain a specific component on fruit and vegetable intake.

The first six questions were based on the NHIS and the RRFSS questionnaires, except that the recall period was the last week instead of the last month. Potatoes are not vegetables (see definition of fruit and vegetables section 1.1.1) and were not counted as such; they were included in the FFQ as they are mostly considered by Moroccan women as a vegetable, therefore asking about their consumption separately was a way to avoid women counting them in the vegetables category.

As vegetables are generally consumed in two different ways in Morocco, i.e. as a starter and as a garnish with a main course, it was decided to ask two questions to differentiate these two ways of consumption (questions 7 and 8) so that intake was reasoned more accurately.

For each item of the FFQ, subject were asked if they ate or drank each of the item during the last seven days, and if so, they were asked to indicate the number of times per day or per week. Then, they were asked to quantify the amount of fruit and vegetables consumed using photographs of portion size of pre-selected fruit and vegetables, from the French SU.VI.MAX study (Su.Vi.Max, 1994). These photographs were selected for use because: they include 8 portion sizes for each fruit/vegetable; include most of the fruit and vegetables consumed in Morocco.

Table 2.2 Quantitative fruit and vegetable Food Frequency Questionnaire developed for the study

During the last 7 days, how many times per day or per week, did you eat or drink:

Foods		**Consumption**	**Frequency**	**Amount**			
			times /day	times /week	photo	Code photo	Portion
1	100% fruit juices such as orange, grapefruit, i.e. juices without added sugar	1 yes 2 no	__|__	__	237 238	__|__|__	__
2	Fruit (fresh, cooked, canned or frozen), **NOT counting** fruit juice	1 yes 2 no	__|__	__	220	__|__|__	__
3	Dried fruit (plums, raisins, apricots, dried figs)	1 yes 2 no	__|__	__	228	__|__|__	__
4	Green salad (including salad with or without other ingredients)	1 yes 2 no	__|__	__	58	__|__|__	__
5	Potatoes, boiled, baked, mashed, French fries, fried potatoes, potato chips	1 yes 2 no	__|__	__	160 162 164	__|__|__	__
6	Cooked dried pulses such as beans, lens, chickpeas, green peas	1 yes 2 no	__|__	__	156	__|__|__	__
7	Cooked vegetables, **NOT counting** potatoes, green salad, and pulses	1 yes 2 no	__|__	__	145	__|__|__	__
8	Vegetables consumed as starter, **NOT counting** potatoes, green salad, and pulses	1 yes 2 no	__|__	__	47	__|__|__	__

2.3.4 Data collection

Data were collected in March and April 2011 according to the following plan (Figure 2.2)[3].

At the first day of the first week of data collection each dietitian interviewed four women. On this first interview, the consent form was signed, and the sections about the household, the woman, the first 24-hour recall, as well as the first fruit and vegetable FFQ (FFQ1) were completed. Then two days later, the dietitian interviewed the same four women and filled out the second 24-hour recall. Two days after the second interview, the dietitian interviewed the four women again and completed the third 24-hour recall, the second fruit and vegetable FFQ (FFQ2) and the section about eating out of home habits.

The same logic was used on the second day of the first week in such a way that by the end of each week, every dietitian had interviewed 8 women.

This process was repeated each week until one hundred women were interviewed.

Weight was measured using digital scales BodyUp accurate to 100 g, (Tefal™, France) which were verified daily. Height was measured using a portable stadiometer (Seca® 214) to the nearest millimetre (Seca®, Germany). All the anthropometric measurements were performed by the dietitians. BMI was assessed from measured weight and height, and data were classified into four groups based on the WHO classification (World Health Organization, 1995).

[3] This validation study should have been conducted before the population study but for logistic constraints this was not possible and therefore the validation study was set up after the population survey.

Figure 2.2 Validity and reliability schedule of the fruit and vegetables Food Frequency Questionnaire							
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Women group 1	Socio-demography	✓					
	F&V FFQ1	✓					
	24-hour recall	✓		✓		✓	
	F&V FFQ2					✓	
	Eating out of home					✓	
Women group 2	Socio-demography		✓				
	F&V FFQ1		✓				
	24-hour recall		✓		✓		✓
	F&V FFQ2						✓
	Eating out of home						✓

2.3.5 Data entry and data management

2.3.5.1 Data entry

A data entry file was set up by EL with EpiData entry (version 3.1, 2003-2004, A comprehensive tool for validated entry and documentation of data. EpiData Association, Odense Denmark). Data from questionnaires were entered twice, into two separate files, by the same operator (EL) and then compared for errors.

When data entry errors were found between the first file and the second entry file, the reasoning was to come back to the questionnaire to check in which file the errors were located. Then errors were corrected in the said files. The comparison between the two files was done until no differences existed anymore between them.

2.3.5.2 Data management

After looking for data entry errors, food data were systematically scrutinized in order to search for coding errors using the same procedure as for the population survey.

The first step was to look for food codes entered in the data files which did not exist in the reference file. The reference file contained all the food

codes used during data collection. For this step, the two files were matched. When food codes from the data entry file did not match with food codes from the reference file, the reasoning was to come back to the questionnaire to check what the name of the food item was and to correct the food code in the data entry file.

In a second step, the food quantification data were searched for errors. Food codes from the data entry files were compared with codes of household measures, codes of book photographs and codes of photographs of food items. For consistency the resulting associations was systematically checked, i.e. it was verified that the food code used did actually correspond to the household measure, book or photograph and vice versa. When a food code used did not correspond to the expected photograph or household measure the reasoning was to go back to the questionnaire in order to check if the mistake was from the food code or the other code. Once the origin of the error was clarified the code was corrected in the data file, using a programme.

All errors detected into the different files were corrected using programmes written with EpiData Analysis (version 2.2.1.171, 2001-2009, Data management and statistical analysis package, EpiData Association, Odense, Denmark), according to standard traceability procedures. When all the possible coding errors were searched and corrected, data from the single 24-hour recall were converted from food to nutrients and calories using a Moroccan food composition table developed within the Obe-Maghreb study (to be published in 2012).

Each fruit and vegetable consumed was classified into the eight food groups of the FFQ: 100% juices, fruit, dried fruit, green salad, potatoes, beans/pulses, cooked vegetables and vegetable consumed as starter. The amount of fruit and vegetable consumed during each of the three days of the recalls was converted in a Mean daily intake by averaging the amount consumed during each of the three days.

For each item of the fruit and vegetable FFQ when the frequency was expressed in “times per week” the frequency was converted into a daily frequency by dividing the weekly frequency by seven. Then, each daily frequency was multiplied by the consumed amount of each food group in order to obtain a daily amount for each food group.

For fruit, as for vegetable, a daily average was computed by summing amounts estimated across all questions except the question about potatoes. For fruit and vegetables a daily average was computed by summing the amount of fruit and the amount of vegetable consumed.

2.3.5.3 Mean recipes

During the 24-hour recall interviews, household recipes of all dishes and beverages consumed during the last 24-hours were collected. For certain respondents who ate out of home, recall of recipes was not possible. In such cases the name of the recipes was recorded as precisely as possible. At the end of the data management step, a list of missing recipes was established and Mean corresponding recipes were calculated from recipes collected during the 24-hour recalls from women who ate at home. Then, Mean recipes were added to the food data files of the 'out of home eaters'.

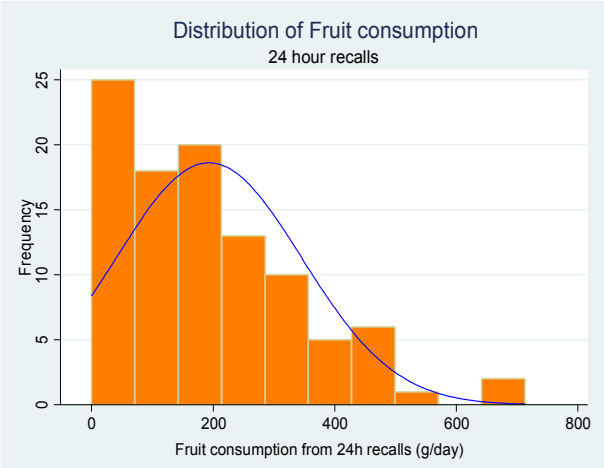
Mean recipes were calculating using STATA/SE 11.2 for windows (STATA corp., Texas, USA) as follows: after applying edible portion and weight yield factors to the raw ingredients when needed, the contribution of each ingredient towards the recipe was calculated. If more than 10 recipes were available, 10 recipes were randomly selected using The Hat software (version 1.5, 2002 Harmony Hollow software) and the Mean proportion of each ingredient was calculated. If less than 10 recipes were available, all the recipes available were taken into account for the calculation of the Mean recipe.

2.3.5.4 Data analysis: normality, reproducibility and relative validity

All the statistical analyses were conducted using STATA/SE 11.2 for windows (STATA corp., Texas, USA).

The first step was to look at the distribution of fruit and vegetable consumption to check if data from both fruit and vegetable FFQs and the 24-hour recalls were normally distributed. Thus, an empirical approach was using by plotting histograms with a normal density curve. Then, the normality of each distribution was statistically tested by computing Shapiro-Wilk tests. Then Q-Q plots, which plot the quantiles of fruit and vegetable consumption against the quantiles of the normal distribution (Figures 2.3, 2.4 and 2.5).

Figure 2.3a Distribution of fruit consumption from 24-hr, Q-Q plot and associated Shapiro-Wilk test (n=100)



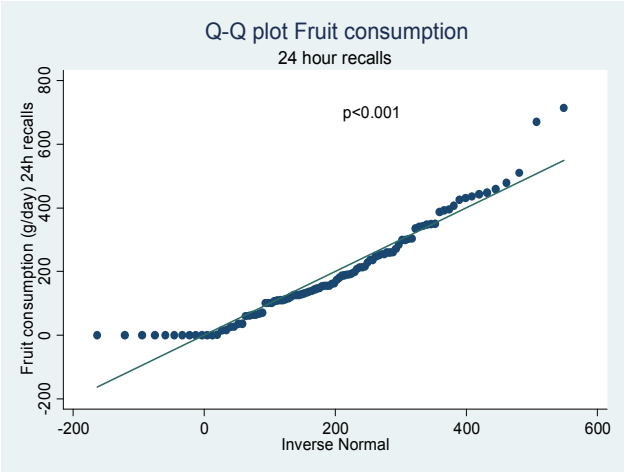
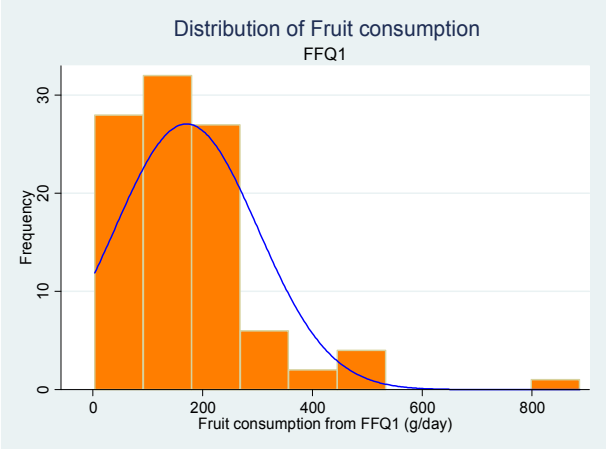


Figure 2.3b Distribution of fruit consumption from FFQ1, Q-Q plot and associated Shapiro-Wilk test (n=100)



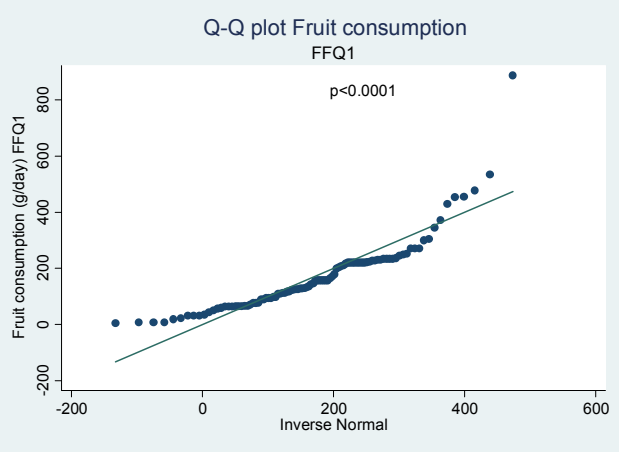
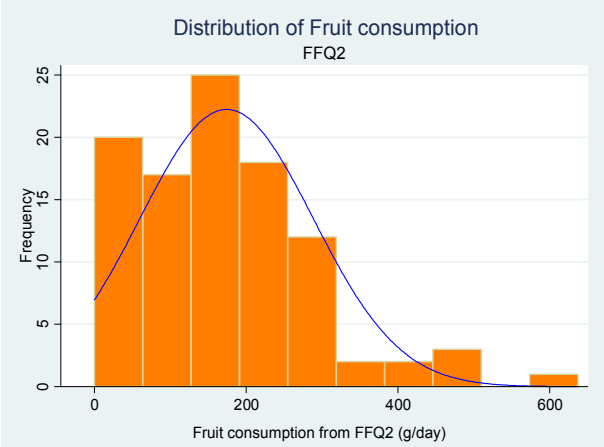


Figure 2.3c Distribution of fruit consumption from FFQ2, Q-Q plot and associated Shapiro-Wilk test (n=100)



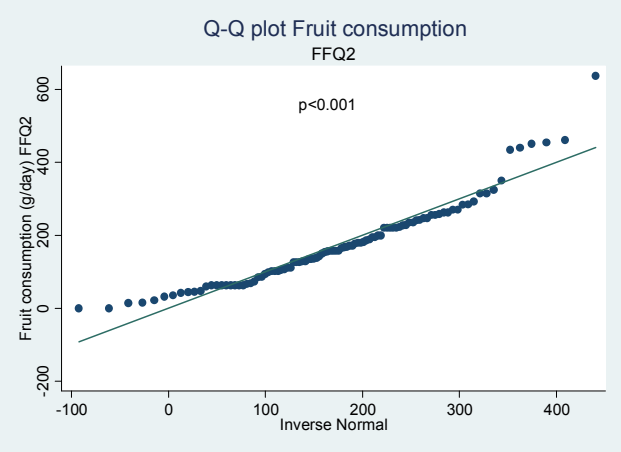
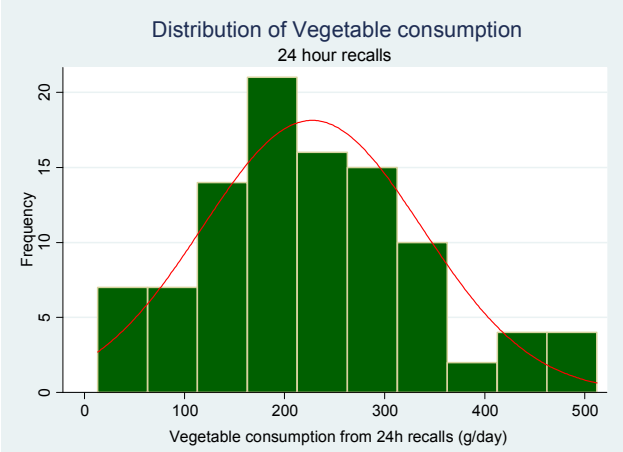


Figure 2.4a Distribution of vegetable consumption from 24-hr, Q-Q plot and associated Shapiro-Wilk test (n=100)



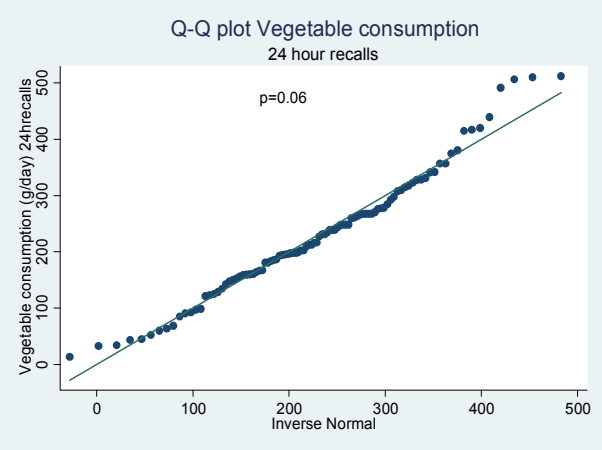
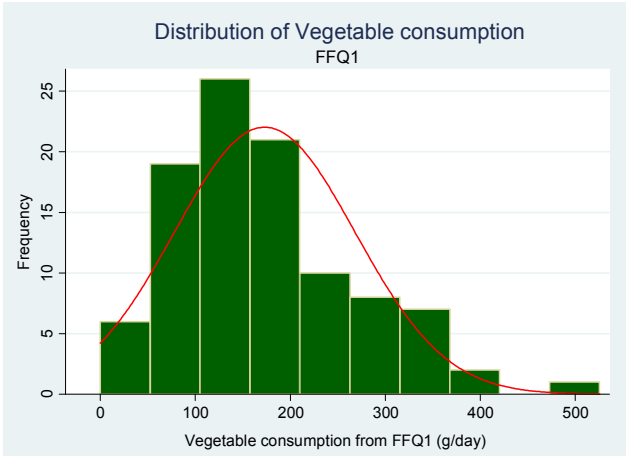


Figure 2.4b Distribution of vegetable consumption from FFQ1, Q-Q plot and associated Shapiro-Wilk test (n=100)



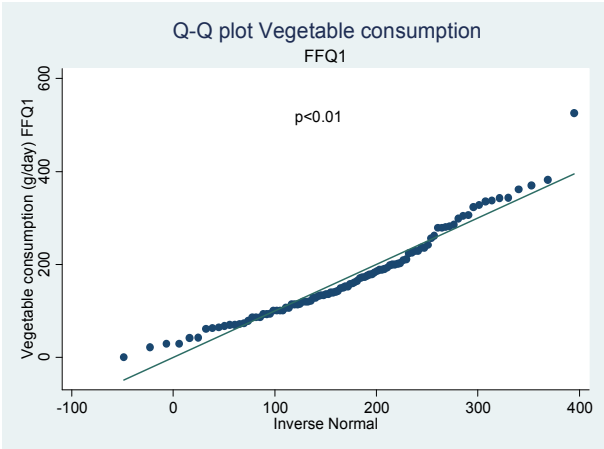
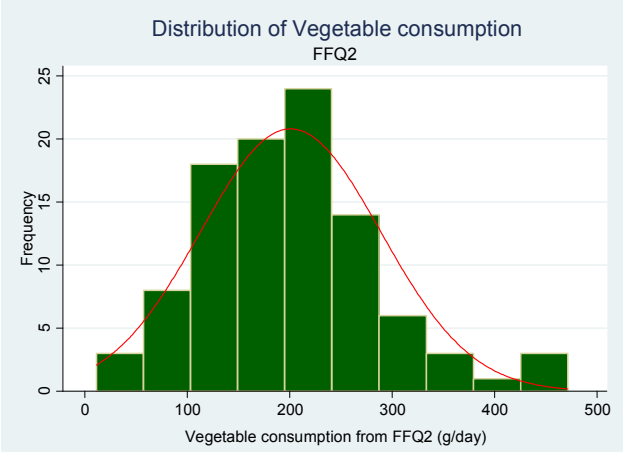


Figure 2.4c Distribution of vegetable consumption from FFQ2, Q-Q plot and associated Shapiro-Wilk test (n=100)



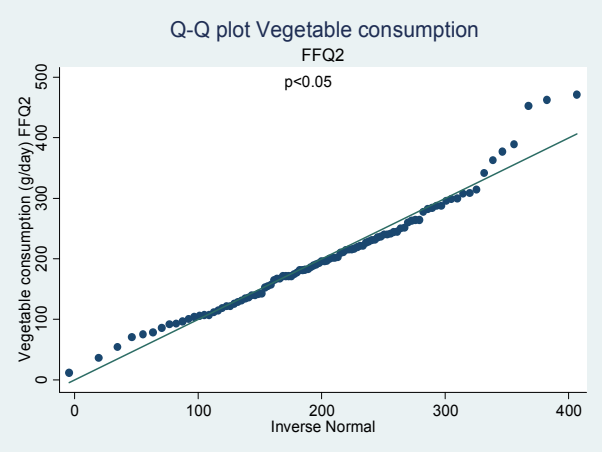
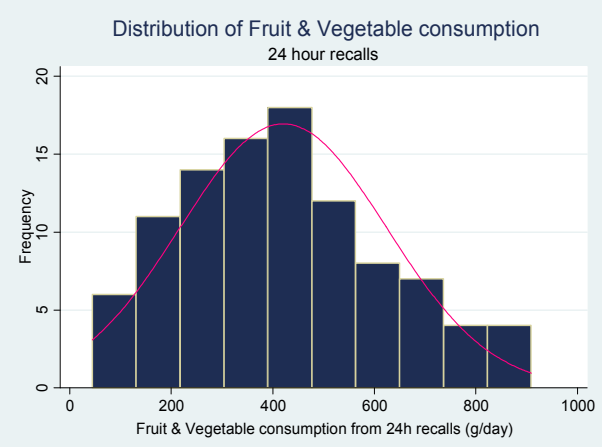


Figure 2.5a Distribution of fruit and vegetable consumption from 24-hr, Q-Q plot and associated Shapiro-Wilk test (n=100)



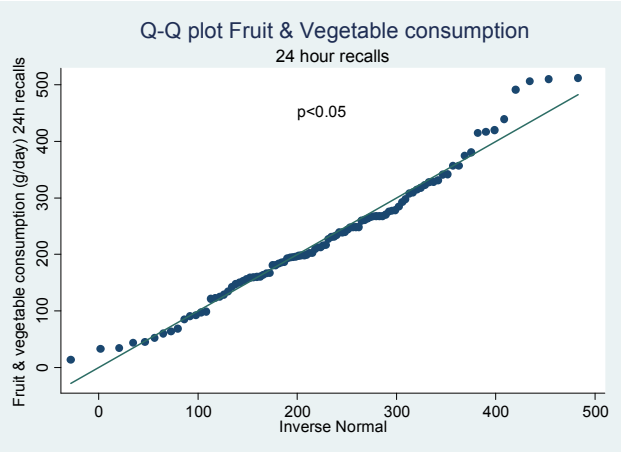
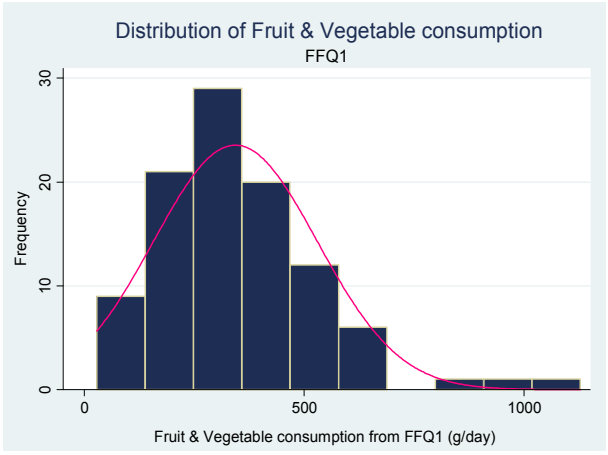


Figure 2.5b Distribution of fruit and vegetable consumption from FFQ1, Q-Q plot and associated Shapiro-Wilk test (n=100)



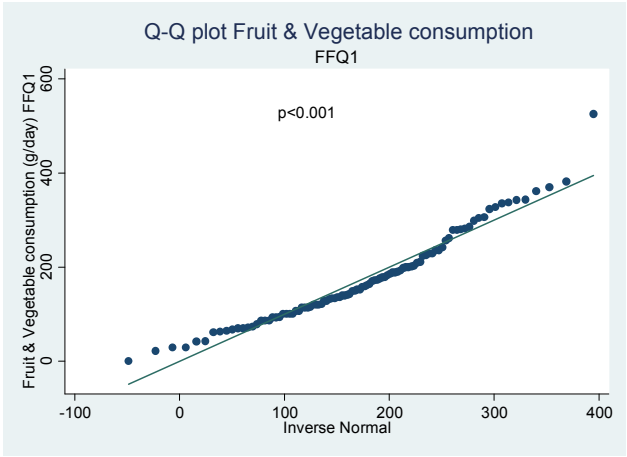
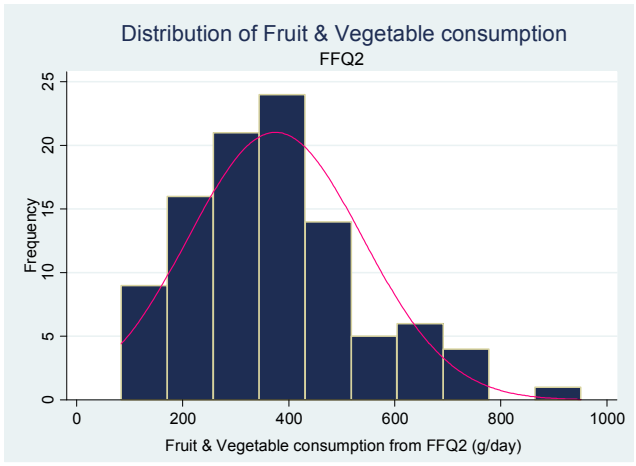
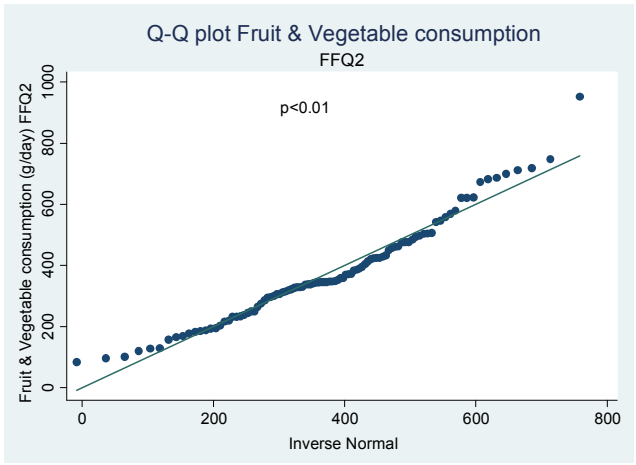


Figure 2.5c Distribution of fruit and vegetable consumption from FFQ2, Q-Q plot and associated Shapiro-Wilk test (n=100)





As data were non-normally distributed they were log-transformed. Then, the normality of log-transformed data was tested (Table 2.3). The p-values for all variables tested were <0.0001 except for fruit and vegetables considered together from FFQ2 where $p<0.05$ and from FFQ1 where $p<0.01$. As log-transformed data were even less normally distributed than data before log-transformation, the analyses were performed with non log-transformed data. Hence, all the statistical tests applied were non parametric tests.

Table 2.3 Shapiro-Wilk test for log-transformed data

Fruit	*p-value*
24-hr	*<0.00001*
FFQ1	*0.00001*
FFQ2	*<0.00001*
Vegetables	
24-hr	*<0.00001*
FFQ1	*<0.00001*
FFQ2	*<0.00001*
Fruit and vegetables	
24-hr	*0.00011*
FFQ1	*0.00104*
FFQ2	*0.02015*

For the validation study, both reproducibility and relative validity were investigated.

The reproducibility, also known as reliability, refers to 'consistency of questionnaire measurements on more than one administration to the same persons at different time' (Willett, 1998). The reproducibility was assessed by comparing data from the FFQ1 with data from the FFQ2 and by:

- *Spearman's correlation coefficients* to evaluate the degree to which the two administrations of the FFQs are related

Spearman's correlation coefficient assesses the strength of the relationship between values derived from the two methods and is interpreted as follow: a Spearman's coefficient <0.50 is interpreted as weak relationship, a value between 0.50 and 0.80 as a moderate relationship, and a value greater than 0.80 as a strong relationship.

- *Shrout-Fleiss IntraClass Correlation coefficient*s (ICC) (Shrout and Fleiss, 1979) to measure the agreement between FFQ1 and FFQ2 on continuous data

The ICC coefficient reflects the consistency or reproducibility of quantitative measurements from different methods measuring the same quantity. The ICC is the ratio of the variance due to subjects with the overall variance and is calculated as follows:

$$ICC=\sigma_b^2/(\sigma_b^2+\sigma_m^2)$$

where: $\boldsymbol{\sigma_b}$ is the variance due to subjects

$\boldsymbol{\sigma_m}$ is the variance due to methods

The ICC coefficients are interpreted as follows: 0-0.2 indicates a poor agreement; 0.3-0.4 indicates a fair agreement; 0.5-0.6 indicates a moderate agreement; 0.7-0.8 indicates a strong agreement; and >0.8 indicates an almost perfect agreement.

- *Kappa statistics*, to evaluate the level of agreement between FFQ1 and FFQ2 on categorized data

The Kappa's coefficient measures the inter-rater agreement, i.e. the agreement between two raters, when classifying individuals into categories. In other words, Kappa is a measure for agreement between observers corrected for the agreement expected to occur by chance and is calculated as follows:

$$K=(P_0-P_e)/(1-P_e)$$

where: $\mathbf{P_0}$ is the observed proportion of agreement

$\mathbf{P_e}$ is the expected proportion of agreement by chance

For such statistical method, it is commonly accepted that categories are related to the distribution of dietary intake (usually terciles or quintiles). Thus, for fruit as well as for vegetable consumption, subjects were classified into terciles according to the distribution of fruit and vegetable intakes. However, for fruit and vegetables considered together, subjects were either classified into two or three classes according to their level of consumption. For the two classes classification, the cut-off point used was 400g (which corresponds to the daily recommended amount). For the three classes' classification, the cut-off points were 280g (which corresponds at the level below which subjects are considered as low consumers) and 400g.

The Kappa's coefficient indicates how strong the agreement is between the two methods and is interpreted as follows: a Kappa-value <0.20

is interpreted as poor agreement, a value between 0.21 and 0.40 as fair agreement, a value between 0.41 and 0.60 as moderate agreement, a value between 0.61 and 0.80 as good agreement and a value >0.80 as very good agreement (Landis and Koch, 1977).

Weighted Kappa's coefficients were also calculated, giving more importance to subjects classified in the concordant category, i.e. subjects within the diagonal, and less importance to subject misclassified. The weights applied were 1.0 for complete agreement, i.e. subjects classified into the same third or class, 0.5 for partial agreement, i.e. subjects differing by one category and 0.0 for complete disagreement, i.e. subjects classified into the opposite third or class (Table 2.4).

Table 2.4 Applied weights for weighted Kappa calculation

		Method 1		
	category	**1**	**2**	**3**
Method 2	**1**	1.0	0.5	0.0
	2	0.5	1.0	0.5
	3	0.0	0.5	1.0

Relative validity refers to 'the degree to which the questionnaire actually measures what it was designed to measure' (Willett, 1998). Validity was assessed by comparing data from the 24-hour recalls with data from the FFQ2 and by:

- *Spearman's correlation coefficients* (see previous section)

- *Wilcoxon signed-rank tests*, which is based on the order in which the observations from 24-hour recalls and FFQ2 fall and which assess whether mean ranks differ

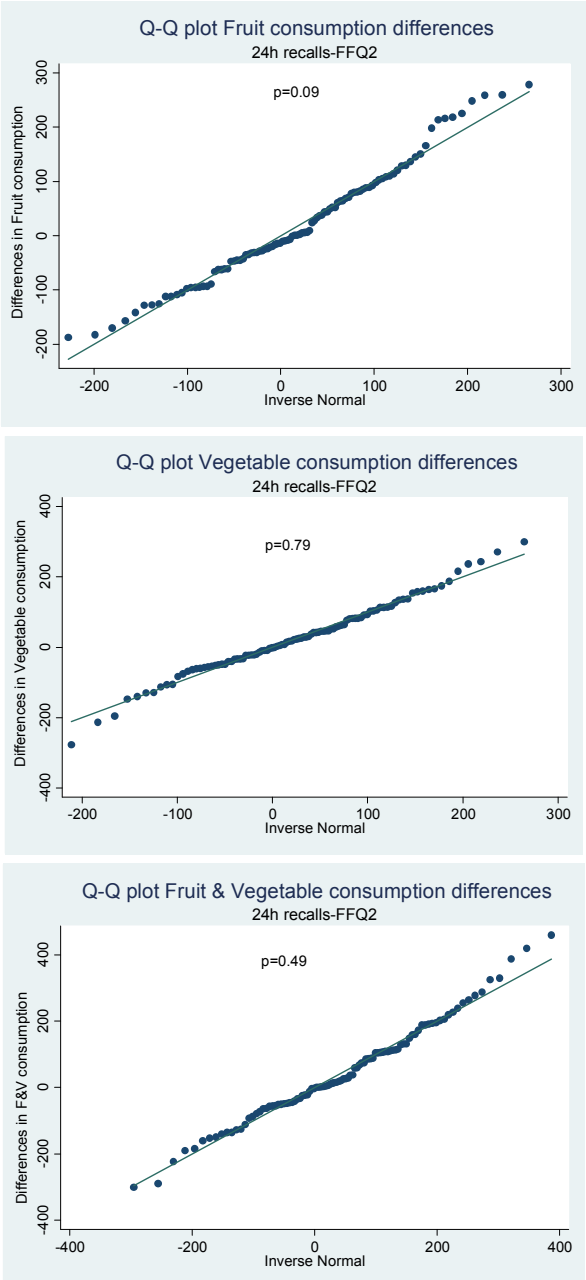
The null hypothesis H_0 associated with the Wilcoxon rank test is: intakes from 24-hour recalls are equal to intakes from FFQ2. A p-value <0.05 leads to the rejection of H_0 and the conclusion is that there is no difference between data from the 24-hour recalls and the FFQ2.

- *Bland and Altman method* (Bland and Altman, 1999) to assess how 24-hour recalls and FFQ2 closely agree in measuring fruit and vegetable intakes

For the Bland and Altman method, average values of the 24-hour recalls and the FFQ2 were plot against the difference in intake between the two methods, i.e. intake from 24-hour recalls - intake from FFQ2. The *sine qua*

none condition to use the Bland and Altman method is that these differences are normally distributed (the measurement themselves do not have to follow a normal distribution). Shapiro-Wilk tests were performed on these differences and led to the conclusion that differences were all normally distributed (p=0.09 for fruit; p=0.79 for vegetables; and p=0.49 for fruit and vegetables) (Figure 2.6).

Figure 2.6 Q-Q plots of fruit and vegetable differences between the 2 methods and associated Shapiro-Wilk test (n=100)



The next step was to look at the Bland and Altman plots to investigate whether the differences did vary in any systematic way over the range of measurements. For fruit, as well as for vegetables and fruit and vegetables considered together, scatters of the differences increased as the measurements of consumption increased (for fruit and vegetables combined r=-0.29, *P*=0.0036; for fruit r=-0.38, *P*=0.0001; and for vegetables r=-0.24, *P*=0.0144). In that particular case, Bland and Altman suggest log-transforming the data. To do so and as some of the subjects did not consume fruit one portion was assigned to them.

Then the limits of agreement (Mean difference intake ± 1.96 Standard Deviation) were calculated. The limits of agreement define the limits within which 95% of these differences are expected to fall. Once the limits of agreement computed, they were back log-transformed and interpreted as ratios, as antilog of a difference between two log-transformed variables is a ratio.

2.4 Study 3: Population survey

2.4.1 Study design

The population survey was cross-sectional, based on a semi-structured questionnaire. Because of the low level of literacy amongst women in Morocco of 44% (World Health Organization, 2010), the questionnaires were administered by trained bilingual interviewers (Arabic and French).

2.4.2 Sampling

The sample size was calculated with the following formula:

$n = Z^2 \times p\,(1-p) / C^2$

where: **Z** = Z value (here 1.96 for 95% confidence level was used)
p = prevalence of the disease in the population (here as no data were available for the prevalence of the double burden the higher hypothesis, i.e. 50% was used)
c = precision also expressed as confidence interval (here 0.05 was used)

With this formula, the sample size calculated was 384. Then a cluster effect of 2 was applied on the primarily sample size and the secondary sample size calculated was 768. To this secondary sample size, a further 5% was added to be able to deal with any recruitment/non-response issues encountered during the survey. The final sample size was 807. It was decided for convenient reasons to round up this number to 900.

The target population was non-pregnant Moroccan women (because of anthropometric measurements), aged 20-49 years, and living in an urban area. The sampling frame was the district of Rabat-Salé, because it is an area with a high rate of urbanization (10% rural-90% urban).

Within the area of Rabat-Salé, 45 clusters (called secondary units) of around 50 households were randomly selected amongst census enumeration areas by the Ministry of Statistics and Planning. Five additional clusters were randomly selected to replace one of the 45 clusters in case of problem. In each cluster, addresses were numbered. Then in each cluster a starting point, based on the address list, was randomly selected using the Hat software (version 2.3 2008, Harmony Hollow Software). From this starting point,

investigators proceeded to adjacent households until 20 eligible households, i.e. with at least one non-pregnant woman aged 20-49 years, were selected. If several women were eligible in a household, one woman was randomly selected to participate.

2.4.3 Questionnaire development for population survey

The questionnaire was developed in French and translated into Arabic, which was the language used for interviews, and was then translated back into French to check that none of the meaning had been lost. The questionnaire consisted of five sections: socio-demography; dietary assessment; meal patterns; knowledge and attitudinal scales.

2.4.3.1 Socio-demographic section

This section was divided into two sub-sections. The first one concerned the census of all members belonging to the selected household. The second sub-section, concerning household characteristics such as employment of household members, accommodation characteristics and health care system, was developed on the basis of questions asked in national surveys such as Health and Demographic Surveys (HDS) or HBS used in Morocco (Direction de la Statistique, 2001; DHS, 2003).

2.4.3.2 Dietary assessment section

For this study, the aim was to obtain precise information about the quantity of fruit and vegetables consumed per day and also information about fruit and vegetable consumption habits. As a result, two different quantitative methods were used to evaluate fruit and vegetable intake, i.e. the 24-hour recall and the food frequency questionnaire.

These two methods were exactly the same as those used for the validation study. They have been previously described in section 2.3.3.3.

2.4.3.3 Meal patterns section

In this section of the questionnaire, the aim was to assess the number of eating occasions women had out of a possible three meals and three snacks during week days and during weekend days. When women declared having a meal or a snack, it was also recorded where and with whom they ate (Table 2.5).

Table 2.5 Eating occasion patterns

Usually, during week days		**Do you have…**			**Where?**			**Who with?**			
		Yes	No	At home	In office	Restaurant	Fast food	Family	Alone	Friends, Neighbours	Colleagues
1	Breakfast	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
2	Mid-Morning	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
3	Lunch	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
4	Mid-Afternoon	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
5	Dinner	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
6	Bedtime	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
Usually, during the weekend		**Do you have…**			**Where ?**			**Who with ?**			
		Yes	No	At home	In office	Restaurant	Fast food	Family	Alone	Friends, Neighbours	Colleagues
7	Breakfast	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
8	Mid-Morning	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
9	Lunch	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
10	Mid-Afternoon	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
11	Dinner	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
12	Bedtime	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4

Several studies have shown that eating away from home impacts on fruit and vegetable consumption (Bowman *et al.,* 2004; Crawford *et al.*, 2007; Beydoun *et al.,* 2008; Vandevijvere *et al.*, 2009). Indeed, out of home eating is generally associated with lower fruit and vegetable intake. So for this reason questions about eating out of home were added (Table 2.6).

Table 2.6 Eating out of home

13	During the last month, did you eat out of home? (1) Yes (2) No							
If yes, where and how often?		**Frequency**						
		never	**1-3 times/ month**	**once/ week**	**2-4 times/ week**	**5-6 times/ week**	**once/ day**	**+ than once/ day**
14	**Works canteen / restaurant/ work place**	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
15	**Fast food restaurant**	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
16	**At friends / member of my family's home**	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
17	**Restaurant**	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

2.4.3.4 Knowledge section

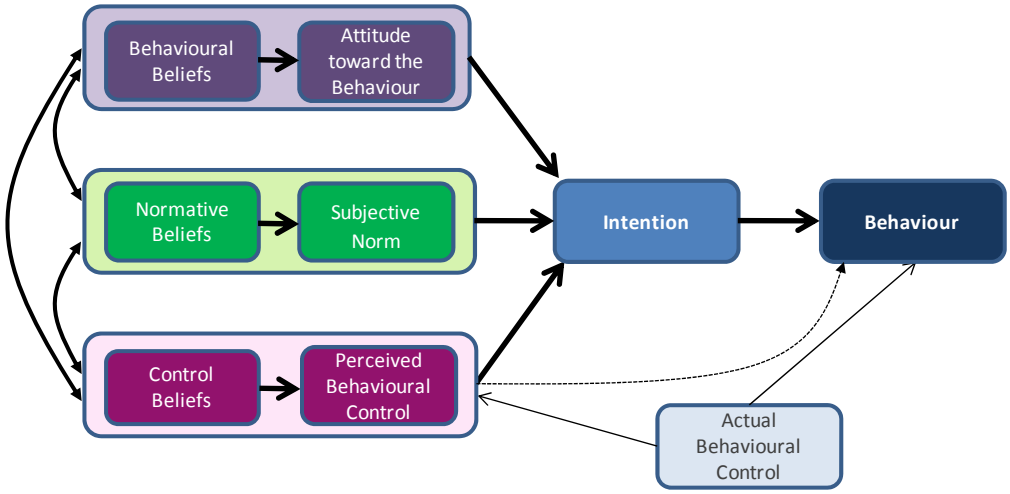
All of the 24 items of this section were either taken from previous studies or developed from what emerged in the focus group discussions (Appendix 7). Items from the knowledge section evaluated three domains: (i) knowledge about fruit and vegetable consumption related to NCDs; (ii) knowledge about fruit and vegetable recommendations; and (iii) knowledge about fruit and vegetable nutrient content (Table 2.7). For each item, three categories of answer were possible: 'true, false and don't know'. The latter was included to discourage bias from guessing (Parmenter and Wardle, 2000).

Table 2.7 Items of the knowledge section		
Items	**Domain measured**	**References**
1. Low intake of fruit can contribute to heart problems	a	1
2. Low intake of fruit can contribute to obesity	a	1
3. Low intake of fruit can contribute to certain cancers	a	1
4. Low intake of vegetables can contribute to heart problems	a	1
5. Low intake of vegetables can contribute to obesity	a	1
6. Low intake of vegetables can contribute to certain cancers	a	1
7. Fruit and vegetables should be eaten daily	b	3
8. Dried fruit contains more vitamins than fresh fruit	c	2
9. Vegetables are high in protein	c	3
10. Fruit contains lots of vitamins and minerals	c	3
11. Fruit is high in protein	c	3
12. Fruit is high in fibre	c	3
13. Vegetables contain lots of vitamins and minerals	c	3
14. Vegetables are high in fibre	c	3
15. Fruit is high in calories	c	3
16. Vegetables are high in calories	c	3
17. Fruit is low in fat	c	3
18. Vegetables are low in fat	c	3
19. Canned vegetables have lost all their vitamins	c	2
20. It is recommended to eat at least 5 fruit and vegetables a day	b	
Amongst these 5 fruit and vegetables :		
21. Almonds count as a fruit	b	2
22. Potatoes count as a vegetable	b	2
23. Olives count as a vegetable	b	2
24. Dates count as a fruit	b	2
a Items concerning knowledge about fruit and vegetable consumption related to NCDs b Items concerning knowledge about recommendations c Items concerning knowledge about fruit and vegetable nutrient content 1 Holdsworth *at al*., 2006 2 From the focus groups discussion findings 3 Taken and adapted from the Food Choice Questionnaire (Eertmans *et al.*, 2006)		

2.4.3.5 Attitudinal scales section and the underlying Theory of Planned Behaviour model

In this section, attitudes and beliefs to fruit and vegetables were assessed using the underlying constructs in health behaviour change models, specifically the Theory of Planned Behaviour model (Ajzen, 1991). In this model, behaviour can be predicted according to several underlying psychosocial constructs (Figure 2.7).

Figure 2.7 Conceptual framework of the theory of Planned Behaviour



From Ajzen 2006 ©

The seven constructs are: (i) Attitude towards the behaviour (direct measure of attitude) which are learnt disposition to respond in a favourable or unfavourable manner to respect to a given behaviour; (ii) Behavioural beliefs (indirect measure of attitude, also considered as determinant of attitudes) which represents the perceived consequences or other attributes of a given behaviour; (iii) Subjective norms (direct measure) which represent the perceived social pressure to engage or not to engage in a behaviour; (iv) Normative beliefs (indirect measure of subjective norm, also considered as determinant of subjective norm) which refer to the perceived behavioural expectations of such important referent individuals or groups; (vi) Perceived behavioural control (direct measure, also known as self efficacy) which refers to people's perceptionof their ability to perform a given behaviour; (vii) Control beliefs (indirect measure, also considered as determinant of perceived behavioural control) which are the perception of factors likely to facilitate or inhibit the performance of the behaviour; and (viii) Intention, also known as stage of change, which is an indication of a person's readiness to perform a given behaviour and includes five stages: precontemplation (not yet acknowledging that there is something that needs to be changed); contemplation (acknowledging that there is something to change but not yet ready or sure of wanting to make a change); preparation (getting ready to change); action (changing behaviour); and maintenance (maintaining the behaviour change).

As data from the focus groups indicated that attitudes towards fruit and vegetables were different, separate items for fruit and vegetables were developed (Table 2.8).

Table 2.8 Items of the attitudinal scales section		
	Construct	References
To me, fruit is : Tasty/Tasteless/Neither tasty/tasteless	**Attitudes towards behaviour**	1
Bad for health/Good for health/Neither bad for health/good for health		
Pleasant/Unpleasant/Neither pleasant/ unpleasant		
To me, vegetables are : Tasty/Tasteless/ Neither tasty/tasteless		
Bad for health/Good for health/Neither bad for health/good for health		
Pleasant/Unpleasant/Neither pleasant/ unpleasant		
Eating fruit makes me feel good	**Behavioural beliefs**	2
Eating fruit helps me control my bodyweight		
Eating fruit helps me have nice skin		
Eating fruit makes me healthy		
I may develop health problems if I do not eat enough fruit		
Eating vegetables makes me feel good		
Eating vegetables helps me control my bodyweight		
Eating vegetables helps me have nice skin		
Eating vegetables makes me healthy		
I may develop health problems if I do not eat enough vegetables		
My family and friends want me to eat fruit	**Normative beliefs**	1
I feel under pressure from my family and friends to eat fruit		
My family and friends expect me to eat fruit		
My family and friends want me to eat more vegetables		
I feel under pressure from my family and friends to eat vegetables		
My family and friends expect me to eat vegetables		
I should eat more fruit than other people because I am a woman	**Subjective norm**	3
Obese people should not eat fruit		
Growing children are those who should eat fruit most		
Men should eat fruit most		
Everybody should eat fruit		
As a woman, I should eat more vegetables than other people		
Obese people should not eat vegetables		
Growing children are those who should eat vegetables most		
Men are those who should eat vegetables most		
Everybody should eat vegetables		
Eating fruit is entirely up to me	**Perceived behavioural control**	1
I cannot increase my consumption of fruit		4
When I eat at home, I can eat more fruit		1
When I eat away from home, I can eat more fruit		1
Eating vegetables is entirely up to me		1
I cannot increase my consumption of vegetables		4
When I eat at home, I can eat more vegetables		1
When I eat away from home, I can eat more vegetables		1
I can eat more vegetables if they are well prepared		3

Fruit is easy to prepare	**Control beliefs**	2
Fruit can be brought in shops close to where I live or work		2
Fruit is cheap		2
I do not eat fruit because they are full of pesticides		2
I do not like the taste of fruit		2
Fruit is expensive		2
It is time consuming to prepare fruit		2
At home, fruit is always available		2
In the past, fruit tasted better		3
Vegetables are easy to prepare		2
Vegetables can be brought in shops close to where I live or work		2
Vegetables are cheap		2
I do not eat vegetables because they are full of pesticides		3
I do not like the taste of vegetables		2
Vegetables are expensive		2
It is time consuming to prepare vegetables		2
At home, vegetables are always available		2
In the past, vegetables tasted better		Focus groups
I am not thinking about eating more fruit	**Intention**	5
I am thinking about eating more fruit		
I am definitely planning on eating more fruit		
I am trying to eat more fruit		
I already eat fruit, at least twice a day		
I am not thinking about eating more vegetables		
I am thinking about eating more vegetables		
I am definitely planning on eating more vegetables		
I am trying to eat more vegetables		
I already eat vegetables, at least 3 times a day		

1 Developed for this study
2 From Eertmans *et al.*, 2006
3 From focus groups findings
4 From *Glanz et al*., 1998
5 From Contento, 2007

All the items of this section are in Appendix 8. In this section, a 5-point Likert scale (Likert, 1932) was used. For each statement, the respondents would then have the possibility to choose the answer which would best suit how far they agree or disagree with it. The possible response modalities were: 'strongly agree'; 'agree'; 'neither agree nor disagree'; 'disagree' and 'strongly disagree'.

All the statements of this section were based either on those in the literature (Eertmans *et al.*, 2006; Contento, 2007; Glanz *et al*., 1998), especially statements about behavioural beliefs, control beliefs and stages of change; or developed from findings that emerged from the focus groups (Table 2.8).

2.4.4 Pre-test

In November 2008, all the sections of the questionnaire were reviewed by members of the teams involved in the Obe-Maghreb project in order to avoid misinterpretation of certain items and also to assess the cultural acceptance and relevance of certain questions in the Moroccan context. Ambiguous and confusing questions were identified and re-phrased. Particular attention was given to ensure cultural pertinence. Following this, the knowledge and attitudinal scales were tested on ten women to assess their understanding and acceptance.

2.4.5 Validation of the psychosocial part of the questionnaire

2.4.5.1 Validation of the knowledge section

Based on what is advocated in the literature, the knowledge questionnaire developed at the beginning of the study was validated amongst 100 women aged from 20 to 49 years (50 Moroccan women and 50 Tunisian women, as the same survey was conducted in Tunisia). The validation was performed by computing coefficients of Cronbach's α that reflect the internal consistency (Cronbach, 1951) and by evaluating the item difficulty (Streiner and Norman, 2003), using STATA/SE 10.0 for windows (STATA corp., Texas, USA).

The internal consistency measures the reliability of each set of items in measuring each domain. In other words, the internal consistency reflects the homogeneity of a set of items. The Cronbach's α varies between 0 and 1; the higher the value, the higher the reliability. The internal consistency of a set of items is considered acceptable if the Cronbach's α is above the cut-off point of 0.70 (Streiner and Norman, 2003).

To assess item difficulty the percentage of correct answer has to be calculated. For each item the frequency of correct versus incorrect answers should fall within the recommended range of 20–80% of correct responses (Streiner and Norman, 2003). If the percentage of correct answer is <20%, then the item is considered too difficult. On the contrary, if the percentage of correct answer >80%, then the item is considred too easy.

The first step of the validation was to calculate the knowledge score as follows: correct response = 1; incorrect response= 0; unsure/don't know = 0. Then, items were regrouped into 3 constructs measuring 3 knowledge domains: knowledge about fruit and vegetable consumption related to NCDs (6 items); knowledge about recommendations (6 items); knowledge about fruit and vegetables nutrients content (12 items).

The internal consistency using Cronbach's α was calculated in order to eliminate items which did not measure what they were supposed to measure.

The overall Cronbach's α (i.e. the Cronbach's α calculated for all the items together) was 0.74 which is good (Table 2.9).

No items were eliminated concerning the construct about knowledge related to NCDs, nor for the construct regarding nutrient content of fruit and vegetables. However two items were deleted regarding recommendations, i.e. 'Olives count as a vegetable'; 'Dates count as a fruit', but two other items were added in their place, i.e. 'It is recommended to eat only dark green vegetables' and 'It is recommended to eat preferentially yellow fruit'. Twenty four items remained at the end of the validation (Appendix 9).

Table 2.9 Internal consistency of knowledge constructs

Construct	Number of items	Cronbach's α
knowledge related to NCDs	6	0.68
knowledge related to recommendations	6	0.40
nutrient content of fruit and vegetables	12	0.76
All items	24	0.74

Amongst the 24 items, two items were too difficult (16.0% correctly answered 'Low intake of fruit can contribute to obesity'; and 16.0% correctly answered 'Low intake of fruit can contribute to certain cancers'). Nevertheless, we decided to keep these items on the grounds of content validity, as they were testing an important facet of fruit and vegetable consumption and NCDs. Four items were too easy (93.0% correctly answered 'Dates count as a fruit'; 95.0% correctly answered 'fruit contains lots of vitamins and minerals'; 92.0% correctly answered 'vegetables contain lots of vitamins and minerals'; 94.0% correctly answered 'fruit and vegetables should be eaten daily'). In the case of dates, this finding reinforced the conclusion based on the internal consistency that this item should be removed from the questionnaire. As the others three 'too easy' items were still of interest to know for developing future public health nutrition programmes, they were kept, but rephrased (Table 2.10).

Table 2.10 Knowledge items difficulty	
Knowledge items	% of correct answer
Low intake of fruit can contribute to heart problems	19.2
Low intake of fruit can contribute to obesity	16.0
Low intake of fruit can contribute to certain cancers	16.2
Low intake of vegetables can contribute to heart problems	36.4
Low intake of vegetables can contribute to obesity	27.0
Low intake of vegetables can contribute to certain cancers	30.3
Fruit and vegetables should be eaten daily	94.0
Dried fruit contains more vitamins than fresh fruit	20.0
Vegetables are high in protein	34.0
Fruit contains lots of vitamins and minerals	95.0
Fruit is high in protein	41.0
Fruit is high in fibre	60.0
Vegetables contain lots of vitamins and minerals	92.0
Vegetables are high in fibre	71.0
Fruit is high in calories	28.0
Vegetables are high in calories	39.0
Fruit is low in fat	56.0
Vegetables are low in fat	63.0
Canned vegetables have lost all their vitamins	28.0
It is recommended to eat at least 5 fruit and vegetables a day	69.0
Almonds count as a fruit	43.0
Potatoes count as a vegetable	21.0
Olives count as a vegetable	48.0
Dates count as a fruit	93.0

2.4.5.2 Validation of the attitudinal scales section

The validation of the attitudinal scales questionnaire was conducted with 100 women (the same women as for the validation of the knowledge questionnaire). The validity of the attitudinal scales was assessed by computing coefficients of Cronbach's α and item-total correlation, using STATA/SE 10.0 for windows (STATA corp., Texas, USA).

The item-total correlation corresponds to the correlation of the individual item with the total construct omitting that item. Streiner and Norman, (2003) has advocated that item-total correlation should be >0.20.

Coefficients of Cronbach's α and item-total correlation were calculated for each construct and separately for fruit and vegetables (Table 2.11).

The internal consistency for the construct measuring attitudes towards behaviour for fruit was very low (α = 0.33) so it was decided to reformulate all the items from this sub-section. Regarding the same construct, but for vegetables the internal consistency was acceptable to good (α = 0.68) but as items about fruit had to be rephrased the same was undertaken for vegetables for consistency.

Internal consistency for constructs measuring both behavioural beliefs and subjective norm were acceptable, i.e. were above the suggested cut-off point of 0.70 (Table 2.11), so no items were removed.

Table 2.11 Internal consistency of attitudinal constructs

Construct	Coefficient of Cronbach's α[1]
Attitudes towards behaviour, fruit	0.33
Attitudes towards behaviour, vegetable	0.68
Behavioural beliefs, fruit	0.73
Behavioural beliefs, vegetable	0.75
Subjective norm, fruit	0.87
Subjective norm, vegetable	0.89
Normative beliefs, fruit	0.34
Normative beliefs, vegetable	0.42
Perceived behavioural control, fruit	0.36
Perceived behavioural control, vegetable	0.48
Control beliefs, fruit	0.46
Control beliefs, vegetable	0.43

[1] to assess internal consistency

Internal consistency for constructs measuring normative beliefs for both fruit and vegetable were low (α = 0.34 and α = 0.42, respectively) so the following six items were removed from these constructs: 'Obese people should not eat fruit'; 'Growing children are those who should eat fruit most'; 'Everybody should eat fruit and Obese people should not eat vegetables'; 'Growing children are those who should eat vegetables most'; 'Everybody should eat vegetables'. Indeed, for these items the coefficients of item-total correlation calculated were below the recommended cut-off point of 0.20. Moreover, items regarding subjective norm about fruit were combined with remaining ones regarding normative beliefs about fruit. The coefficient of Cronbach's α was recalculated and was 0.68. The same was done for vegetables and the coefficient of Cronbach's α was 0.77.

The internal consistency for constructs measuring perceived behavioural control for both fruit and vegetables were low (α = 0.36 and α = 0.48, respectively). For these constructs four items were added (two items for fruit and two items for vegetables): 'To me eating fruit daily is difficult'; 'If I wanted I could eat more fruit'; To me eating vegetables daily is difficult'; 'If I wanted I could eat more vegetables', to improve the homogeneity of the construct.

The internal consistency for constructs measuring control beliefs for fruit was low (α = 0.46). This was probably due to a large heterogeneity within the construct. Thus, only items regarding convenience, price and availability were kept, which meant that the two items concerning taste were removed ('I

do not like the taste of fruit' and 'In the past, fruit tasted better'). Moreover, in order to reinforce this construct one item regarding price was added ('If fruit was less expensive I would eat more'). For vegetables the same approach as for fruit was applied. The two items regarding taste were removed, one item regarding price was added ('If vegetables were less expensive I would eat more') and one item regarding convenience was added ('I have no time to prepare vegetables'). For items removed from the constructs for both fruit and vegetables, the coefficients of item-total correlation were below 0.2.

2.4.6 Pilot study

A pilot study was conducted in mid-March 2009 in two clusters especially chosen for that purpose in the city of Rabat, in order to examine the acceptability and the understanding of the questionnaire by women and also to evaluate time needed in each household and to organise the data collection team. Fourteen women were interviewed and as no problems in understanding the questions were found, no further modifications were made.

2.4.7 Final version of the questionnaire

After the pilot study of the whole questionnaire and the validation study regarding the psychosocial section of the questionnaire, some items were deleted and others rephrased. The final version of the questionnaire is presented in Appendix 9.

2.4.8 Data collection

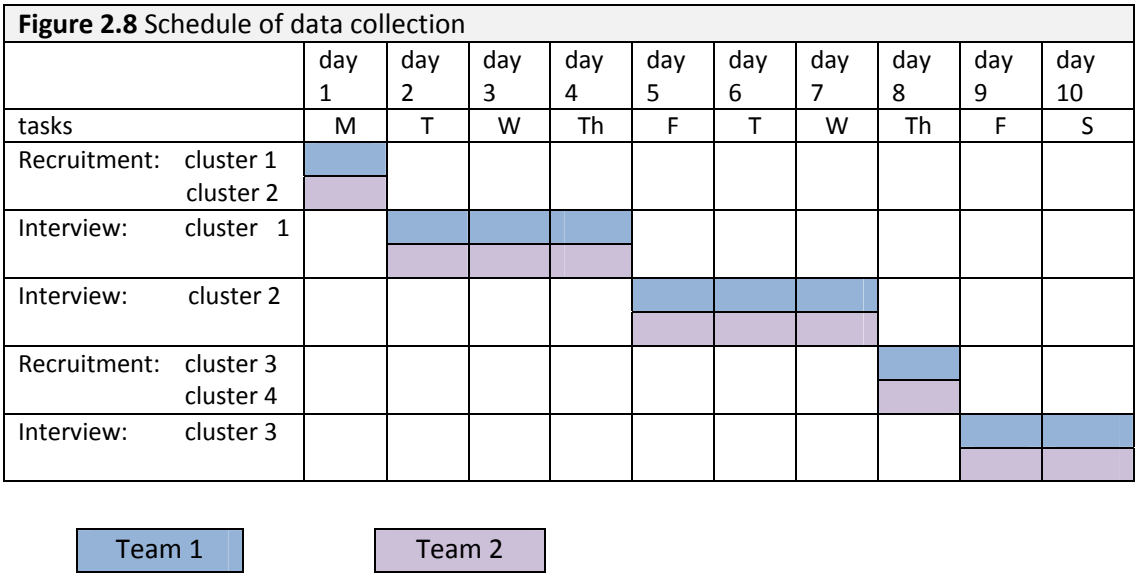
895 women were interviewed within 45 clusters. Data collection was conducted in two different waves. The first wave of data collection was conducted between the 23rd of March and the 26th of June 2009. The second wave was conducted between the 2nd of October 2009 and the 31st of March 2010, as a break was needed between July and September because during summer holidays, it is hard to find people at home and also because of Ramadan, during which food habits may change.

Data were collected in Arabic; therefore interviewers need to be employed for this task. Two teams of three local interviewers were trained to complete the questionnaire. During training periods an interviewer guide was developed in order to help the interviewers remember the main points of the data collection process.

The rhythm of data collection was as follows: on the first working day the two teams worked in two different clusters in order to recruit 20 women; then from the second to the fourth working day the two teams interviewed the subjects in the same cluster (each team interviewed 3-4 women per day); from the fifth to the seventh working day the two teams interviewed the subjects in the next cluster; on the eighth working day the two teams recruited women in two new clusters, and so on.

As dietary intake data were also collected using 24-hour recall, it was necessary to recall Friday's intake (because in terms of diet Friday is a special day where most people eat a traditional dish called *couscous*) as well as weekend day's intake. Therefore, the two teams worked one week from Monday to Friday and the following week from Tuesday to Saturday (Figure 2.8).

Figure 2.8 Schedule of data collection



Data collection was supervised by EL and an assistant. All the questionnaires were prepared before recruitment (numbering the questionnaire, data stamping and pre-coding numbers of the clusters). When questionnaires were returned from field, EL and the assistant checked that no data had been forgotten and checked data consistency.

2.4.9 Data entry and data management

2.4.9.1 Data entry

A data entry file was set up by EL with help from a statistician with EpiData entry (version 3.1, 2003-2004, A comprehensive tool for validated entry and documentation of data. EpiData Association, Odense Denmark). Data from questionnaires were entered twice, into two separate files, by different operators and then compared for errors.

When data entry errors were found between the first and second entry file, the reasoning was to come back to the questionnaire to check in which file the errors were located. Then errors were corrected in the said files. The comparison between the two files was done until no differences were found between them.

2.4.9.2 Data management

The exact same procedures were used for data management as those used for the fruit and vegetable FFQ validation study (see section 2.3.5.2).

2.4.9.3 Mean recipes

As for the fruit and vegetable FFQ validation study, Mean recipes for the 24-hour recalls were calculated using the same procedures as for missing recipes (see section 2.3.5.3). A total of 156 Mean recipes out of 595 different recalled recipes were established.

2.4.9.4 Under- and over-reporting

When measuring food intake, one of the most important sources of bias is the misreporting of food consumed by respondents which can be either over-or under-reporting. For this study it was decided to use an exclusion method, of which three different approaches to exclude outliers were considered. The first one is based on the Goldberg cut-off (with PAL calculated for each woman[4] and n=1). The second approach is based on Willett's recommendations which are <500 kcals per day for under reporters and >3500 kcals per day for over reporters (Willett, 1998). The third technique is based on the exclusion of the lower and upper 5% of the distribution.

[4] Within the Obe-Maghreb project Physical Activity was assessed with a validated Physical Activity frequency questionnaire. For the needs of the present study data about Physical Activity Level were borrowed.

The approach proposed by Goldberg *et al.*, (1991) uses equations in order to define cut-off outside of which subjects were classified as outliers, i.e. too low or too high estimated intakes. To calculate the Goldberg cut-off limits several components have to be taken into account:

- The Physical Activity Level (PAL) for the considered population;
- The average value of within-subject variation in energy;
- The within-subject variation in measured or estimated BMR;
- The total between-subject variation in PAL.

The Goldberg cut-off is calculated as follows:

Cut-off value= PAL × exp [SD_{min} × (S/100)/√n]

where : **SD_{min}**=-2 if 95% confidence limit and SD_{min}=-3 if 99.7% confidence limit

n=number of subjects

S=√ (CV^2_{wEI} /d + CV^2_{wB} + CV^2_{tP})

where: **CV_{wEI}** is the within-subject variation in energy intake

d is the number of days

CV_{wB} is the within-subject variation in measured or estimated BMR

CV_{tP} is the between-subject variation in PAL

Previously Goldberg (Goldberg *et al.*, 1991) used the following values for the components of interest to calculate the cut-off limits. These values were revised in 2000 by Black (Table 2.12).

Table 2.12 Values for the component of the Goldberg equation

	Goldberg *et al.*, 1991	**Black, 2000**
PAL	1.55	According to population PAL
CV_{wEI}	23%	23%
CV_{wB} in		
measured BMR	2.5%	4%
estimated BMR	8%	8.5%
CV_{tP}	12.5%	15%

Once the cut-off limits have been calculated it is important to look in detail at the characteristics of the under-reporters (also called Low Energy

Reporters (LER)). To do so and when no objective measures of the PAL have been performed, several authors use a PAL associated with sedentary life-style of 1.55 and n=1 to calculate the cut-off limit. At the individual level, it is pertinent to look at characteristics of the LER using 1.55 as the value for the PAL and n=1 to determine the cut-off limit. At the population level, the knowledge of physical activity is needed to assign an appropriate PAL value for the population of concern.

To assist in choosing the most appropriate approach, the socio-demographic characteristics (age, marital status, number of children, employment, educational level, economic level) as well as BMI of the remaining samples, after exclusions, were compared to those of the total sample.

2.4.9.5 Development and calculation of food scores and indices

To be able to describe the overall healthiness of the diet, as well as the quality of fruit and vegetable intake, several scores and indices were calculated from the 24-hour recall data. Some of them specifically focused on fruit and vegetable intake, such as the Fruit and Vegetable Diversity Score (FVDS) and the Fruit and Vegetable Quality Index (FVQI) whereas others gave an estimate of the overall diet quality, such as the Diet Quality Index International (DQI-I) (Kim *et al.*, 2003) and the Dietary Diversity Score (DDS). The FVDS and the FVQI were developed for the present study. The DDS was borrowed from the literature (Food and Agriculture Organization/International Food Policy Research Institute/World Health Organization, 2004) but adapted to the Moroccan context whereas the DQI-I was borrowed from the literature and used as was. Both types of indexes were calculated because it was useful from the 24-hour recall to look at the global quality of the diet and also to look into more detail at the quality of fruit and vegetable intake.

The indices were developed to answer research objectives (ii) (see section 1.3), i.e. to estimate fruit and vegetable quality intake, as well as overall dietary quality.

For each type of index, two approaches were used: a simpler index based on count of food items, such as the DDS and FVDS; and a more sophisticated index based on food items and nutrients, such as DQI-I and FVQI. The performance of each type of index could be explored with socio-demographic characteristics, anthropometric status or diet-related NCDs. In other words, the aim was to investigate whether simple indices were sufficient to discriminate between women or whether more complex indices were needed.

All the scores and indices are summarized in Table 2.13

Table 2.13 Summary of scores and indices	
Score/Index	**Related study objectives**
Fruit and Vegetable Diversity Score	(ii) To quantify fruit and vegetable intake, diversity and overall dietary quality
Fruit and Vegetable Quality Index	(ii) To quantify fruit and vegetable intake, diversity and overall dietary quality
Dietary Diversity Score	(ii) To quantify fruit and vegetable intake, diversity and overall dietary quality
Diet Quality Index-International	(ii) To quantify fruit and vegetable intake, diversity and overall dietary quality
Processed foods score	(iii) To determine particular eating behaviours that may have an impact on fruit and vegetable consumption

2.4.9.5.1 Fruit and Vegetable Diversity Score

The health benefits of fruit and vegetables is not only a question of quantity but also a question of diversity (Thompson *et al.*, 2006; Bhupathiraju and Tucker, 2011). Indeed, for the moment no studies conducted on fruit and vegetables has permitted to clearly identify why or how the benefits of eating fruit and vegetable occurs, neither what fruit or vegetables are effective (Padayatty and Levine, 2008). Therefore it is recommended to eat a wide variety of fruit and vegetables from different colours including red, green, yellow, white, purple and orange (WCRF/AICR, 2007). As a consequence, a Fruit and Vegetable Diversity Score was developed. The FVDS was defined as the number of different fruit and vegetables consumed over the last 24-hours. To be counted, at least half of the reference portion size had to be eaten. Thus, for fresh fruit and vegetables (beans and pulses included) the reference portion size is 80g, therefore a minimum of 40g had to be consumed to be counted in the score. For dried fruit, as the reference portion size is 30g, a minimum intake of 15g had to be consumed to be counted. For 100% fruit or vegetables juices, the reference portion size is 150ml, therefore to be counted a minimum of 75ml had to be consumed.

The relationship between the FVDS and the socio-demographic characteristics of women were investigated as well as the relationship between anthropometric characteristics and diet-related NCDs and FVDS.

2.4.9.5.2 Fruit and Vegetable Quality Index

A Fruit and Vegetable Quality Index was developed in order to assess the overall quality of fruit and vegetable intake, both in terms of quantity and diversity. This index was divided into two components: *recommendations* and *diversity*. Hence, on the one hand, this index was based on the compliance to the WHO recommendations and on the other hand, it was based on the number of different fruit and vegetable consumed per day (Table 2.14).

The *recommendations* componenent is based on WHO recommendations which state that 400g of fruit and vegetables should be eaten daily and that amongst this 400g, 30g should be legumes and pulses. Therefore the maximum score is given when these two recommendations are achieved.

The *diversity* component is based on the 'five a day' concept. Indeed, the maximum score is given when the subject consumed at least two fruit and three vegetables per day. An extra point is given for woman who consumed at least half portion of a vitamin A rich fruit or vegetable. To be counted, at least half portion of each fruit, vegetable or beans/pulses had to be consumed, i.e. 40 g for fresh fruit, vegetables and beans/pulses, 15g for dried fruit and 75 ml of 100% juices.

Then FVQI was created by summing the points given to each subject.

When the score reached six out of ten possible points, fruit and vegetables intake was considered as good quality. Therefore women were classified into two classes according to their score: ≥6 points and <6 points.

Table 2.14 Components of the Fruit and Vegetable Quality Index

		points
Recommendations /5		
Amount of fruit and vegetables consumed per day	≥400g	3
	[280-400[	1
	<280g	0
Amount of beans/pulses consumed per day	≥30g	2
	[15-30[	1
	<15g	0
Diversity /5		
Number of different fruit consumed per day (at least half portion)	2 and more	2
	1	1
	0	0
Number of different vegetables consumed per day (at least half portion)	3 and more	2
	1 or 2	1
	0	0
Consumption of fruit or vegetable rich in vitamin A per day (at least half portion)	Yes	1
	No	0

The relationship between the FVQI and women's socio-demographic characteristics were investigated, as well as its relationship with anthropometric characteristics and diet-related NCDs.

2.4.9.5.3 Dietary Diversity Score

A Dietary Diversity Score was developed from the 24-hour recall data based on the nine food groups commonly used to assess diversity (cereals/roots and tubers, beans/pulses and nuts, vitamin A rich fruit and vegetables, others vegetables, other fruit, meat and fish, eggs, milk and dairy products, oils and fats) (Food and Agriculture Organization/International Food Policy Research Institute/World Health Organization, 2004) (Table 2.15). To calculate this score, the nine initial food groups were used, but certain groups were split into two or three groups and three others groups were added: pastry and biscuits, sugar and sweets, soft drinks. Thus, the cereals/roots/tubers group was divided into two sub-groups (cereals and roots/tubers); the beans/pulses/nuts group was split into two sub-groups (nuts/seeds and beans/pulses); the meat/fish group was split into three sub-groups (fatty meat/offal, non fatty meat and fish/shellfish); the milk/dairy was split into two sub-groups (milk/yogurt and cheese), finally the oils/fats group was divided into 2 sub-groups (animal fats and vegetable oils). In addition to these groups, a sugar/sweets group and a soft drinks group were added. This score (DDS-18) was composed of 18 groups (Table 2.15).

This score was defined as the number of different food groups consumed over a 24-hour period. Neither the frequency of consumption, nor a minimal amount of food was taken into consideration for the scores. The DDS was used as quantitative variable and was also categorised into three groups to distinguish diets of high, medium and low levels of diversity. To define the three levels of diversity score the following cut-off, based on the distribution, were used:

- <9: low DDS
- 9-10: medium DDS
- ≥11: high DDS

The relationship between the DDS-18 and the socio-demographic characteristics of women were investigated.

Table 2.15 Components of the 9 groups and the 18 groups Dietary Diversity Score

	18 groups	food items
Cereals/roots/tubers	cereals	pasta, breads, flours, breakfast cereals, Viennese pastries
	roots/tubers	potatoes and sweet potatoes
Beans/pulses/nuts	nuts/seeds	nuts, seed, olives
	beans/pulses	
Vitamin A rich F&V	vitamin A rich F&V	carrot, pumpkin, spinach, fennel, green cabbage, mango, cantaloupe melon, apricots
Other vegetables	other vegetables	vegetables
Other fruit	other fruit	fruit, 100% fruit juices
Meat/fish	fatty meat/offal	mutton, cooked meats, beef, offal
	non fatty meat	poultry, game
	fish/shellfish	
Eggs	eggs	
Milk/dairy products	milk/yogurt	any kind of milk and yogurts
	cheese	any kind of cheese
Oils/fat	animal fats	butter, tallow, 'smen'*
	vegetable oils	margarine, vegetable oils
	pastry/biscuits	
	sugar/sweets	sugar, honey, jam, sweets, chocolate, chocolate spread, iced cream, custard
	soft drinks	Fizzysweet drinks, non 100% fruit juice

*smen=traditional clarified butter

2.4.9.5.4 Diet Quality Index-International

The Diet Quality Index-International (DQI-I) (Kim *et al.*, 2003) is a synthetic index that aims to capture the overall quality of the diet focusing on NCDs as well as aspects of under-nutrition. Therefore this index is particularly pertinent in the context of nutrition transition. It integrates information both at the nutrient level, e.g. iron, sodium and Saturated Fatty Acids and at the food level, e.g. fruit, vegetables, cereals (Table 2.16).

The DQI-I is divided into 4 components: *variety*, *adequacy*, *moderation* and *overall balance*. The *variety* component evaluates the overall diversity of the diet (regarding the consumption of the major 5 food groups: cereals, vegetables, fruit, dairy/beans and meat/fish/eggs) and variety within the protein sources (regarding the number of different sources of protein). Beans/pulses have been purposefully grouped with dairy products because in North Africa, beans and pulses can be an important source of calcium. For this component the maximum score is given when foods from all of the five food groups are consumed and when protein comes from at least three different sources.

A*dequacy* evaluates how well the diet conforms to food and nutrient recommendations, therefore maximum points are given when the recommendations are met. For this study, as there are currently no Recommended Dietary Allowances for the Moroccan population, it was decided to use those developed by the FAO/WHO (Food and Agriculture Organization/World Health Organization, 2004).

Moderation focuses on nutrients for which the consumption should be limited because of their relationship with the development of NCDs. For this component, the maximum points are given when nutrient intake is below the lower cut-off.

Lastly, *overall balance* aims at evaluating the relative proportion of carbohydrates, protein and fats to energy intake, and also at evaluating the ratios between the different fatty acids. For this component, the maximum score is given when the optimum balance is achieved.

All the possible points are summed together, giving a 100 point scale score. Above 60 points the diet is considered as a good quality diet (Kim *et al.*, 2003). The relationship between the DQI-I and the socio-demographic characteristics of the women in the study were investigated.

T able 2.16 Components of the Diet Quality Index International (DQI-I)

	Scoring criteria	Score
Variety 0-20 pts		
*overall food groups 0-15 pts	≥1 serving from each food group	15 pts
cereals; fruit; vegetables	any 1 food group missing	12 pts
beans/pulses, dairy;	any 2 food group missing	9 pts
meat, fish, poultry, eggs	any 3 food group missing	6 pts
	≥4 food group missing	3 pts
	none from any food group	0 pt
*source of protein 0-5 pts	≥ 3 different sources/day	5 pts
(meat, fish, poultry, eggs,	2 different sources/day	3 pts
beans/pulses, dairy	from 1 source/day	1 pt
	none	0 pt
Adequacy 0-40 pts		
* vegetables 0-5 pts	3- 5 serving/day*	5 pts
	0 servings	0 p
* fruit 0-5 pts	2-4 servings/day*	5 pts
	0 servings	0 pt
*grain 0-5 pts	6-11 servings/day*	5 pts
	0 servings	0 pt
*fibres 0-5 pts	20-30g/day	5 pts
	0g/day	0 pt
* protein 0-5 pts	≥10% ofenergy/day	5 pts
	0% of energy/day	0 pt
* iron 0-5 pts	100% RNI**	5 pts
	0% RNI **	0 pt
*calcium 0-5 pts	100% RNI **	5 pts
	0% RNI **	0 pt
* vitamin C 0-5 pts	100% RNI **	5 pts
	0% RNI **	0 pt
Moderation 0-30 pts		
* total fat 0-6 pts	≤20% of total energy/day	6 pts
	>20-30% of total energy/day	3 pts
	>30% of total energy/day	0 pt
*FSA 0-6 pts	≤7% of total energy/day	6 pts
	>7-10%of total energy/day	3 pts
	>10% of total energy/day	0 pt
*cholesterol 0-6 pts	≤300 mg/day	6 pts
	>300-400 mg/day	3 pts
	>400 mg/day	0 pt
*sodium 0-6 pts	≤2400 mg/day	6 pts
	>2400-3400 mg/day	3 pts
	>3400 mg/day	0 pt
* empty calories 0-6 pts	≤3% of total energy/day	6 pts
	>3-10% of total energy/day	3 pts
	>10% of total energy/day	0 pt
Overall balance 0-10 pts		
*macronutrient ratio 0-6 pts	G=55-45; P=10-15; L=15-25	6 pts
(carbohydrate:protein:fat)	G=52-68; P=9-16; L=13-27	4 ps
	G=50-70; P=8-17; L=12-30	2 pts
	otherwise	0 pt
* FA ratio (PUFA:MUFA:SFA)	PUFA/SFA=1-1.5 et MUFA/SFA=1-1.5	4 pts
	PUFA/SFA=0.8-1.7 et MUFA/SFA=0.8-1.7	2 pts
	otherwise	0 pt

*Based on 1700 kcal/2200 kcal/2700 kcal diet; **RNI: Recommended Nutrient Intakes

2.4.9.5.5 Processed foods score

In the context of nutrition transition it is crucial to look at consumption of processed foods as this gives an indication of how much the diet has shifted from one based on raw ingredients. Thus, five groups of processed food were defined as follows: biscuits, cooked meats, cream cheeses (such as The Laughing cow®), yogurts and soft drinks. Each time one of the items belonging to the five groups of processed foods was consumed one point was given. Then a processed food score was created by summing the points given to each subject.

The relationship between this score of processed foods and the socio-demographic characteristics of women were investigated by considering the socio-demographic variables as independent variables. The relationship between fruit and vegetable consumption and the score of processed foods were also investigated in order to see whether the consumption of processed foods could have an impact on fruit and vegetable consumption.

2.4.9.6 Psychosocial and cognitive questionnaires

Before analysing the attitudinal scales the response categories 'strongly agree' and 'agree' were grouped together as were 'strongly disagree' and 'disagree'. For each item the percentage of women who agreed, disagreed or neither agreed/disagreed was calculated. For each item the mean degree of agreement was also calculated in order to have an overview of the global agreement of the respondents on a 5 point scale. As for the validation step of the questionnaire, Cronbach's α (Cronbach, 1951) coefficients, measuring internal consistency, were computed.

For each of the three domain of knowledge, internal consistency, item difficulty and item discrimination were investigated.

The internal consistency which measures the reliability of each set of items in measuring each domain was assessed by computing Cronbach's α coefficient (Cronbach, 1951). According to Streiner and Norman (2003) Cronbach's α above 0.70 were considered as acceptable.

The item difficulty is based on the recommended range of 20-80% of correct responses (Anderson, 2002). In a given population, items for which more than 80% of the respondents would respond correctly, items would be considered too easy. On the contrary, items for which less than 20% of the respondents would answer correctly, items would be considered too difficult. In both cases, items either too easy or too difficult should be removed.

The item discrimination measures the ability of each individual item to discriminate between women with different levels of knowledge. In other words item discrimination is a measure of how well an item is able to distinguish between respondents who were knowledgeable and those who were not. For an item that is highly discriminating, in general the respondents who answered correctly also did well on the test. On contrary, the respondents who answered incorrectly also tended to do poorly on the overall test. One of the most common way to compute the item discrimination is to look at the relationship between respondent's performance (highest 27% versus lowest 27%) on the given item and the respondent's score on the overall test. i.e. to correlate the response on each item with the score (Kelley, 1939). An item-to-overall score correlation above 0.2 is generally considered as acceptable (Streiner and Norman, 2003).

Based on results for internal consistency, item difficulty and item discrimination, knowledge items could be removed from latter analyses.

Then the knowledge scores were attributed as follows: correct response=1; incorrect response=0; unsure/don't know=0. The 'unsure/don't know' category was included to discourage bias from guessing (Parmenter and Wardle, 2000). All the points obtained were summed to define a total knowledge score. The points were also summed for each domain of knowledge. Each of the three domains of knowledge scores investigated and the total knowledge score were standardised on a 100 points scale so that they could be compared. The total knowledge score was then divided into tertiles corresponding to high, medium and low level of knowledge.

The relationship between knowledge score and women's socio-demographic characteristics were investigated, as well as its relationship with fruit and vegetable consumption.

2.4.9.7 Anthropometric and biological factors

As explained previously (see section 2) this study was part of a larger project (the Obe-Maghreb study) in which anthropometric measurements such as height, weight and waist circumference were measured as well as biological factors. Anthropometric measures were used to calculate BMI and therefore to classify women as 'underweight'; 'normal weight'; 'overweight'; or 'obese' and waist circumference was used to define abdominal obesity. Biological factors where used to determine diabetes and risk factor for cardiovascular diseases such as High Blood Pressure (HBP). Finally a combination of anthropometric and biological factors was used to define the metabolic syndrome, which is a risk factor for cardiovascular disease, as well as for type

2 diabetes, based on the definition of International Diabetes Federation (IDF, 2006).

As anthropometric status and diet-related NCDs were not the core subject of the present work, the choice of the cut-off points used to define them are not expanded upon but are summarized in Table 2.17. Nevertheless, as there was an interest to look at these diseases as well as the anthropometric status in regard to fruit and vegetable consumption the BMI, abdominal obesity, diet-related NCDs and the metabolic syndrome were investigated as dependent variables of fruit and vegetable consumption.

Table 2.17 Summary of cut-off points used to define nutritional status, abdominal obesity, High Blood Pressure, diabetes and metabolic syndrome

Measures		Cut-off points	Outcomes	Reference
Height Weight	BMI	<18.5 kg/m^2 [18.5-25.0[[25.0-30.0[≥30.0 kg/m2	Underweight Normal Overweight Obese	WHO, 2003
Waist Circumference		≥80 cm ≥88 cm	Increased risk of metabolic complications Substantially increased risk of metabolic complications	WHO, 2003
Blood Pressure	or systolic diastolic	≥140 mmHg ≥90 mmHg	High Blood Pressure	Whitworth, 2003
Glycaemia		≥1.26 g/L or ≥7.0 mmol/L	Diabetes	WHO, 2006
WC[1] + Blood Pressure		systolic BP[2] ≥ 130 or diastolic BP ≥ 85 mmHg previously diagnosed hypertension	Metabolic syndrome	IDF, 2006
WC[1] + Triglycerides		≥150 mg/dL (1.7 mmol/L) specific treatment for this lipid abnormality	Metabolic syndrome	IDF, 2006
WC[1] + Glycaemia		≥100 mg/dL (5.6 mmol/L) previously diagnosed type 2 diabetes	Metabolic syndrome	IDF, 2006
WC[1] + Cholesterol		<50 mg/dL (1.29 mmol/L) in females specific treatment for this lipid abnormality	Metabolic syndrome	IDF, 2006

[1] Waist Circumference
[2] Blood Pressure

2.4.10 Data Analysis

All statistical analysis were conducted using STATA/SE 11.2 for windows (STATA corp., Texas, USA).

For the variables of interest such as the amount of fruit and vegetables consumed, the design effect due to the sampling design was computed. The design effect is defined as the ratio of the variance of an estimator under a sample design to that of the estimator under simple random sampling (Kish, 1965). If this ratio is <1, this means that not taking into account the sampling design would lead to an over estimation of the variability of the value, i.e. to a greater imprecision. Inversely, a ratio >1 would lead to an under estimation of the variability of the value. In other words, if the ratio is not one, then the sampling design should be taken into account. In the present study, for data based on the FFQ, the design effects were: 1.59 for fruit, 1.87 for vegetables and 1.80 for fruit and vegetables. For data based on 24-hour recall the design effects were: 1.42 for fruit, 1.16 for vegetables and 1.37 for fruit and vegetables. As a consequence, all analyses took into account sampling design and thus data presented were 'weighted data'.

Regarding the amount of fruit and vegetables consumed, women were divided into three groups: low, medium and high consumers to explore the relationship between fruit and vegetable intake and socio-demographic characteristics. Women who ate <280g of fruit and vegetables per day were considered as low consumers. Women who ate ≥280g and <400g per day were considered as medium consumers. Finally, women who consumed ≥400g per day were considered as high consumers.

An economic index was calculated from six variables concerning housing (number of person per room, presence of toilets, source of drinking water, kitchen and bathroom at home) and eleven variables concerning equipment at home (fridge, washing machine, dish washer, satellite dish, internet access, television, heating, air conditioning, telephone, car, computer). Correspondence analysis was performed and the first axis was interpreted as a gradient of economic level of the household and then was considered as a proxy of the economic level of the household after coding it into tertiles, corresponding to low, medium and high economic level.

Associations between: socio-demographic characteristics, overall food consumption, fruit and vegetable consumption, eating behaviour, knowledge, nutritional status, diet-related NCDs were tested using either linear regression or logistic regression that were either univariate for crude associations or multivariate for adjusted associations. The adjustment variables were the socio-demographic variables (age, marital status, number of children, educational level, employment, economic level and living area); when dealing

with data from the 24-hour recall, energy was also included in the model as an adjustment variable; and when relationships between nutritional status or diet-related NCDs and fruit and vegetable consumption were investigated, the physical activity level was also included within the models. When the resulting p-values were <0.05, the associations were considered significant.

The framework of these analyses is summarized in Table 2.18.

Table 2.18 Summary of investigated associations

Explanatory variables	Dependent variables	Adjustment variables
Socio-demographic characteristics	Fruit and vegetable consumption	Socio-demographic , energy
	Overall consumption	Socio-demographic
	Processed food consumption	Socio-demographic, energy
	Eating out of home behaviour	Socio-demographic
	Knowledge	Socio-demographic
Processed food consumption	Fruit and vegetable consumption	Socio-demographic, energy
Eating out of home behaviour	Fruit and vegetable consumption	Socio-demographic
Fruit and vegetable consumption	Nutritional status	Socio-demographic, PAL[1]
	Diabetes, HBP[2], MS[3]	Socio-demographic, PAL[1]
Knowledge	Fruit and vegetable consumption	Socio-demographic

[1]PAL: Physical Activity Level; [2] High Blood Pressure; [3] Metabolic Syndrome

For multivariate analysis, potential interactions between explanatory factors that had an impact on dependent variables of interest were investigated. When interactions remained significant after adjustment for all the variables of the model, disaggregated data were presented and adjusted means or adjusted Odds Ratios were calculated.

For the analysis of the Theory of Planned Behaviour model, fruit and vegetables were considered separately as two distinct behaviours. Analyses were based on Spearman correlation matrices between the different construct of the model and knowledge score, age, education and economic level. For constructs that were correlated, path regressions analyses were performed (Figure 2.9). The resulting β coefficients, that correspond to the standardized regression coefficients for each variable included in the model, were used to conclude about which construct was the best predictor of intention or of behaviour. The resulting R^2 represents the variance explained by the model. Then, as advocated by Cohen (1992), in addition to the report of p-values, the effect size was calculated. Indeed, p-values assess the significance of the relationship between variables but do not give information

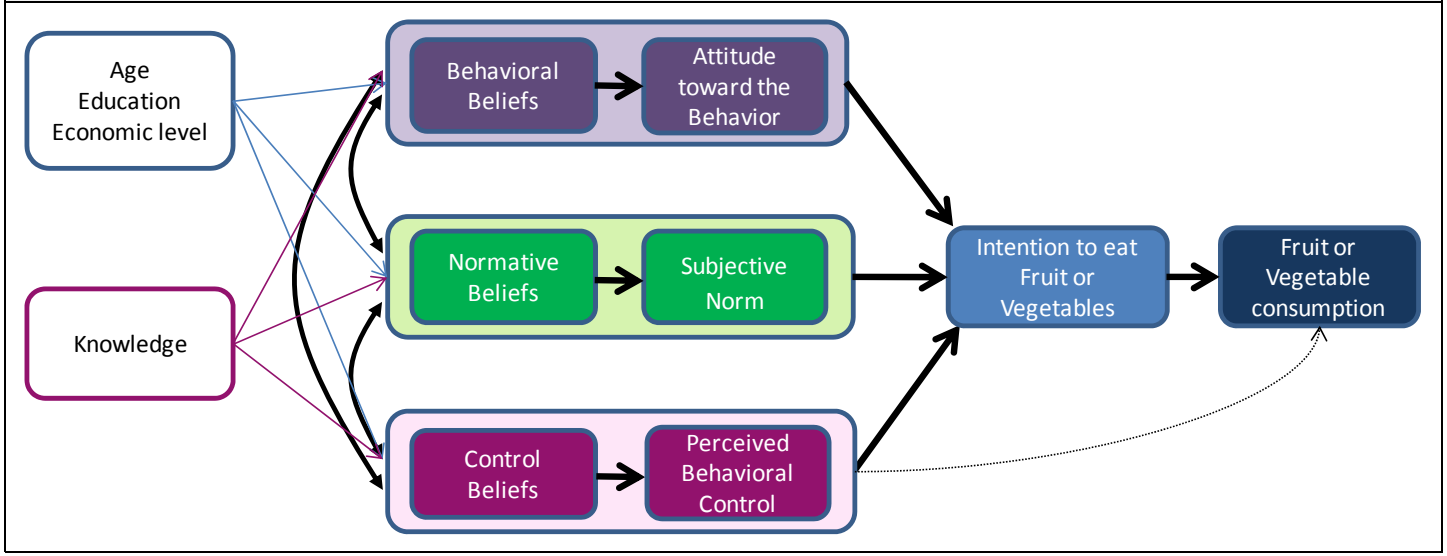
about the strength of the correlations. Moreover, p-values depend on sample size and effect size. The effect size assesses how strong is the relationship between variables.

According to Cohen's procedure (Cohen, 1992) the effect size (*f)* was calculated as follows:

$$f^2=R^2/(1-R^2)$$

According to recommendations from Durlak (2009), as no other studies computing the same kind of analyses about fruit and vegetables reported effect size values, the benchmarks suggested by Cohen for interpreting effect size were used. Cohen considered an f^2 of 0.02 to be a small effect, 0.15 a medium effect, and 0.35 a large effect.

Figure 2.9 Summary of Theory of Planned Behaviour framework analyses



Chapter 3: Results

3.1 Study 1: Focus groups

The main objectives of the focus groups were to investigate women's perception of fruit and vegetable and to identify potential factors that may influence fruit and vegetable consumption.

Several themes emerged regarding the influences on consumption of fruit and vegetables (timing, frequency, seasonality, out of home intake, social norms), their preparation (gender roles), views on fresh, dried and canned fruit and vegetables, promoters and obstacles to consumption (cost, taste, convenience), and beliefs and perceptions of their health benefits.

3.1.1 Fruit and vegetable consumption patterns

Time to eat fruit and frequency of consumption

The majority of women who reported eating fruit state that they generally do so after a major meal, either lunch or dinner.

> *"We eat fruit once our stomach is full, […], it's just a habit."* 15-25 years, low Socio-Economic Status (SES)
> *"We generally have fruit just after meal, […]."* (36-49 years, high SES)

But for certain women, fruit is not eaten at a particular time of day, reporting that fruit can be consumed at any time:

> *"I do not have a fixed time to eat fruit; I eat them whenever I want."*
> (26-35 years, high SES)
> *"Whenever we want, there is no particular time."* (36-49 years, low SES)

Whereas fruit consumption for women of high SES is almost daily, it should be noted that for women with low SES, fruit consumption is less frequent and is seen to primarily depend on household income.

> *"Fruit consumption depends on my budget."* (26-35 years, low SES)
> *"We eat fruit whenever we can afford it, […]."* (36-49 years, low SES)

Whereas fruit consumption seems very irregular and is related to SES, vegetable consumption is usually daily and less influenced by household income.

"*In general vegetables are consumed daily, not like fruit which is consumed only from time to time.*" (36-49 years, low SES)
"*We eat vegetables every day, it is a main course, and we always cook them even if our financial situation is difficult*." (26-35 years, low SES)

Vegetables seem impossible to avoid when constructing meals, even though there is a difference according to SES. Indeed, women with low SES state that they consume vegetables mainly at lunchtime, whereas women of high SES eat vegetables at lunch and dinner.

"*Vegetables are consumed more during lunch, because it is the main meal.*" (15-25 years, low SES)
"*Vegetables are very important, with both lunch and dinner*." (49 years, high SES)

Consumption and season

Most of the women that took part in the focus group discussions stated that they consume more fruit during summer than during the rest of the year. The reasons given were that during this period fruit is more available, there is more variety and when the weather is hot, fruit is refreshing.

"*During summer, it's hot and fruit refreshes the body*." (15-25 years, low SES)
"I would say that during summer, people consume more fruit because it is more available." (26-35 years, high SES)

It should be noted that certain women belonging to the high SES group, sometimes specified that they ate more fruit during summer but that they also consumed fruit during the rest of the year. Unlike fruit, which women report eating more frequently during summer, vegetables are consumed with the same frequency whatever the period of the year. Indeed, women declare that vegetables are generally consumed in all seasons but the way of cooking them varies. Thus during summer, vegetables are more often prepared as salad, and therefore consumed raw, whereas in winter vegetables are more likely to be cooked.

"*I believe that vegetables are consumed all year long, one cannot do without them*." (15-25 years, low SES)
"*Vegetables are consumed during every season, but they are cooked differently depending on the season, […].*" (26-35 years, low SES)
"We always eat a lot of vegetables, but we prepare them differently according to the season, for example when it is cold, we prepare cooked vegetables and hot dishes [tajines] and when it is hot, we prefer salads." (26-35 years, high SES)

Out of home consumption

Concerning out of home consumption, the majority of women state that they consume more fruit when they are at home than when that they eat away from home.

> "*We eat more fruit at home than out of home.*" (26-35 years, high SES)
> *"We eat more fruit at home."* (15-25 years, low SES)

However, certain women, with low SES and for whom fruit is not affordable, state that they consume more fruit when they eat out of home in particular circumstances, i.e. when they are invited to eat with friends or family.

> "*We never eat fruit away from home, except if we visit our family or friends; in this case we eat more fruit than at home."* (26-35 years, low SES)

As is the case for fruit, women also report consuming more vegetables when they eat at home, than when they eat away from home.

> "*I consume more vegetables at home compared to outside [away from home]*." (15-25 years, high SES)
> *"We eat them [vegetables] more at home*." (15-25 years, low SES)

Women put two main reasons forward for eating more vegetables at home. On the one hand, when they are invited to eat with close relations (friends or family) the main course is usually meat.

> "*Away from home and when we are invited to our close relations, we eat fewer vegetables, above all with the main course, because this course is generally prepared with meat and dried Fruits.*" (36-49 years, low SES)

In addition, it seems that food available out of home is low in vegetables.

> "*Vegetables are consumed more at home than away from home, because the majority of meals available are meat based*." (36-49 years, high SES)

Who? (social norms)

When women were asked to specify who, according to them, should consume fruit and vegetables, a large number answered everyone, but the majority answered vulnerable people, i.e. women, children and elderly people.

> "*The truth it is that everyone needs fruit and vegetables, because they are essential for a healthy diet*." (15-25 years, low SES)

Concerning women, it is important to say that fruit and vegetables are quoted as important at different life stages in relation to pregnancy, breastfeeding and periods of menstruation.

> "*It is women because they have less energy during their period, pregnancy and breast feeding*." (15-25 years, high SES)

The reason that women emphasised children was related to their rapid growth:

> "*Children, they are in a period of development and they need natural vitamins*." (26-35 years, low SES)

3.1.2 Preparation of fruit and vegetables

It was noted that whether women are from low or high SES, it is always women who prepare fruit and vegetables in households.

> "W*omen prepare everything at home*." (36-49 years, low SES)

There is however a slight difference between these two types of group, namely that in the highest socio-economic groups, it is generally a cook or a maid who prepares the meals and therefore the fruit and vegetables, whereas in the lowest socio-economic groups, it is the women who live in the household who prepare everything.

> "*Personally, I do not do anything at home; there are other people who do this kind of task for me*." (36-49 years, high SES)
>
> "*Us, we do not work, and our only task is to prepare meals and tidy the house…*" (36-49 years, high SES)

3.1.3 Consumption of fresh, dried and canned fruit

Most of the women stated that they do not consume canned fruit.

> "*We never buy canned fruit; we only eat fresh fruit* […]."(15-25 years, high SES)

The principal reason given is that women believe that canned fruit are bad for health.

> "*Fruit loses all its nutritious value once canned*." (36-49 years, low SES)

Regarding dried fruits, women state that they are generally eaten cooked (mainly in tajines) with meat.

> "*Dried fruits are used in dishes like tajines, we do not eat them as fresh fruits, and they are used cooked."* (36-49 years, low SES)

3.1.4 Promoters and barriers to fruit and vegetable consumption

3.1.4.1 Perception of health outcomes

The large majority of the women, whether they were from high or low SES, pointed to the healthy aspect of fruit, and more particularly the fact that fruit contains vitamins, as a motivation for their consumption.

> "*Because fruit contains vitamins that are essential for the body and health*." (26-35 years, low SES)
>
> "*Because fruit is rich in vitamins*." (26-35 years, high SES)

Just as was found for fruit, the view that vegetables are healthy and/or nutrient rich is often put forward by women as an argument in favour of their consumption. Indeed, the majority of the women declare that vegetables are good for health.

> "*Vegetables are important for health, they are full of vitamins*."
> (36-49 years, low SES)

This argument in favour of eating vegetables is often proposed in opposition to meat consumption which is perceived as bad for health.

> *"It is necessary to consume more vegetables than meat, especially red meat which is not good for health, as it causes several diseases like cancer and cholesterol."* (26-35 years, high SES)

The majority of them affirm that eating too much fruit can have a negative effect on health and in particular on digestive disorders. Plums, melons, and bananas are mainly seen to be implicated in digestive problems.

> "*All fruit is good for health, it is just essential not to consume too much in order to avoid health problems*." (36-49 years, high SES)

In certain cases, in particular for people suffering from certain diseases, (essentially digestive problems and diabetes), fruit was seen as posing a problem and was therefore perceived by the women in a rather negative way regarding the health of these individuals.

> "*There are patients for whom certain fruits are prohibited, those that cause gastric acidity: oranges, strawberries and plums*." (26-35 years, low SES)

Certain women also raised the problem of food allergies, particularly by blaming strawberries.

> "*There are fruits that cause allergy in children, like strawberries*."
> (26-35 years, low SES)

Contrary to fruit, women clearly cite a certain number of vegetables that they regard as bad for health, independently of health status. Indeed, vegetables like cabbages, cauliflowers, turnips and sweet peppers were considered as bad for health as they are seen as being responsible for bloating.

> "*There are vegetables that are not good for health, it is necessary for example to avoid sweet peppers, cauliflowers, cabbages...*" (36-49 years, high SES)

3.1.4.2 Cost

Lack of money was the principal reason that women with low SES did not consume enough fruit.

> "*Low budget prevents us from eating fruit."* (15-25 years, low SES)

For women with a high SES, lack of money was not mentioned. In these groups the main reason for not eating fruit was their availability, whether at home or at the market.

"*The only thing that stops me eating fruit is when I can't find them*."
(36-49 years, high SES)

As was the case for fruit, the main reason for women of low SES not eating vegetables was the price.

"The increase in the price of vegetables prevents us from eating them."
(15-25 years, low SES)

All the women declared that fruit and vegetables are expensive, and that their prices have increased over recent times.

"*Excessively expensive!"* (26-35 years, low SES)

Women with high SES status also spoke about the high cost of fruit and vegetables, not for themselves but for households having modest incomes.

"*Recently the price of fruit and vegetables has risen substantially, which has affected the purchasing power of low income households.*"
(36-49 years, high SES)

It should be noted that generally fruit is more expensive than more commonly consumed vegetables.

*"Fruit is more expensive than vegetables, […]." (*36-49 years, low SES)

3.1.4.3 Convenience

Women as a whole stated that it is very easy to prepare fruit, and for some women it does not require any effort when fruit is consumed as it is.

"*It is easy to prepare fruit; you just need to wash them.*" (36-49 years, low SES)

For other women, who prefer consuming fruit salad, a traditional Moroccan habit, this requires a little more effort but does not constitute an obstacle to consumption. The majority of women think that compared to fruit, vegetables are more difficult to prepare.

"*It is not difficult to prepare vegetables, but they take a little more time and effort than fruit*." (15-25 years, low SES)

"*Compared to fruit, vegetables are more difficult to prepare, that requires more effort.*" (15-25 years, high SES)

3.1.4.4 Taste

When women were asked what they think of the taste of fruit, they unanimously answered that fruit is generally sweet and tasty, and stated that such characteristics of the fruit was a promoter for their consumption.

"*Fruit seduces consumers, by its colour, shape and taste…"*
(36-49 years, high SES)
"*If I like the taste of fruit that's enough for me to eat it.*" (15-25 years, high SES)

However, most of them stated that taste of fruit has changed and that these days they are not as tasty as before. For the majority of women the reason for this change of taste is related to agricultural techniques, in particular use of pesticides and insecticides.

"*The taste of fruit is not the same any more, the quality of the taste has fallen, and it is due to the use of pesticides*." (26-35 years, low SES)

"*Generally speaking, the taste of fruit and vegetable has changed, before it was better, but today it is not so good […].*" (36-49 years, high SES)

Contrary to fruit, for which there was a kind of consensus around the sweet taste, for vegetables, things are much less obvious. Indeed for a large majority of women, the taste of vegetables depends on the way they are cooked. In other words, taste seems to have a real influence on whether women consume vegetables.

"*The way vegetables are cooked determines their taste, […]."*
(26-35 years, low SES)

"*The way vegetables are cooked is a determinant for their consumption*."
(36-49 years, high SES)

For certain women, the addition of spices to the preparation of vegetables is essential and is sometimes the corollary of their consumption, i.e. without spices vegetables are not eaten.

> "Spices are necessary, without them, dishes would be tasteless."
> (26-35 years, low SES)

For other women, on the contrary, spices make vegetables lose their taste and should be consumed in a more moderate way. Moreover, for these women spices can have negative effects on health.

> "*In my opinion we should not overuse spices because the risk is that vegetables lose their taste, with risks of diseases and problems of intestinal transit*."
> (15-25 years, high SES)

3.1.5 Knowledge towards fruit and vegetables

Generally, all the women questioned state that they had heard of recommendations for fruit and vegetable intake.

3.1.5.1 Sources of information about fruit and vegetable

Concerning nutrition in general and fruit and vegetables in particular, television seems to be the main source of information. Indeed, the majority of women in the study report watching television programmes on food and health, whether they are Moroccan or foreign programmes, accessible via satellite.

> "*There are several programmes about nutrition and health on the national channels. For example, there is the programme called "sehati koula yaoum" (my daily health) on 2M.*" (26-35 years, high SES)

In addition, women cite radio programmes, school books, childcare lessons and finally magazines as sources of information.

> "*On the radio, a morning programme called 'likaa maftouh', where they receive doctors and nutritionists*." (15-25 years, low SES)
> "*There are also recommendations in school books and the childcare programmes in Moroccan schools that are very interesting*." (15-25 years, high SES)

3.1.5.2 Knowledge about recommendations for fruit and vegetable intake

Although all of the women mentioned that they had heard about fruit and vegetable recommendations, when they were asked for more specific detail about these, only three women answered correctly, i.e. mentioning 5 fruit and vegetables per day. It can also be noted that these three women that answered correctly all belong to the high socio-economic group.

> "*Five fruit and vegetables is recommended by nutrition experts*."
> (26-35 years, high SES)

Most of the other women in the study did not have any idea of the number of fruit and vegetables that should be eaten.

> "*I do not know the daily amount of vegetables and fruit that one can take, that depends on what the person desires.*" (15-25 years, low SES)
> "*For vegetables 5 and for fruit, 3 fruits are enough.*" (15-25 years, high SES)

3.1.5.3 Classification of fruit and vegetables

As mentioned (section 2.2.3), at the end of the sessions of focus groups, pictures of plant food were shown to the women. They were asked to give the name of each food that was presented to them and to classify this food in the following categories: vegetable, fruit, neither a fruit nor a vegetable, or don't know. The foods (randomly selected for order) were presented as follows: almonds, fresh mint, green pepper, carrots, marrows, dates, onions, bananas, olives, grape, tomatoes, peas, orange, apples, and potatoes. Overall, women correctly classified the foods that were presented to them. Foods that were misclassified were: potato, which was systematically classified in the vegetable group; fresh mint that was sometimes classified in the vegetable group; olives that were considered by certain women as a vegetable, and lastly almonds that were considered as a fruit.

3.1.5.4 General knowledge about fruit and vegetables

A large majority of women, whatever their socio-economic status, knew that fruit and vegetables contain vitamins, and that vitamins are important for health.

> "*Fruit contains a lot of vitamins*." (26-35 years, high SES)
> *"Vegetables are important for health, they are full of vitamins*."
> (36-49 years, low SES)

Certain women, belonging to the high socio-economic group, seem to have good knowledge of the health benefits of fruit and vegetables. Indeed, beyond the vitamin content of fruit and vegetables, these women also mentioned their mineral and fibre content again in relation to the healthy aspect of fruit and vegetables.

> "*Fresh fruit contains lots of water and minerals, that's why it is important for health*." (15-25 years, high SES)
> "*Vegetables are important for the body as they contain vitamins and fibres*."
> (36-49 years, high SES)

3.1.6 Beliefs about fruit and vegetables

3.1.6.1 Differences between fresh, dried and canned fruit

The majority of participants believed that fresh fruit has a better nutritional value compared to dried or canned fruit. They also believed that canned fruit lose all their nutritional value and also that they could even be harmful for health.

> *"Canned fruits lose their vitamins; they are not good for health."*
> (15-25 years, low SES)
> "*[…] there is a huge difference, nothing can replace fresh fruits."*
> (36-49 years, high SES)

3.1.6.2 Fruit, vegetables and farming

Certain women reported that fruit and vegetables can be bad for health because of their 'chemical' content.

> *"In most locally grown fruit, there is a large quantity of chemicals that are harmful for health."* (15-25 years, high SES)

The use of chemicals like pesticides is also incriminated in the change in taste of fruit and vegetables. Indeed, according to women, the use of such products explains why fruit and vegetables taste worse than in the past.

"*From using insecticides and chemical treatments, fruit and vegetables have lost their taste; they do not have their natural and original taste anymore*."
(36-49 years, low SES)

3.2 Study 2: Fruit and Vegetable Food Frequency Questionnaire validation study

One of the objectives of the present study was to develop and to validate a short quantitative FFQ which in eight items would give an accurate measure of fruit and vegetable intakes (see section 1.3 objectives (i)).

3.2.1 Sample description

As the sample of the validation study was based on quotas deduced from the population survey (see section 2.3.2), the socio-demographic characteristics of women were similar, except that women of the present sample were more likely to work.

Sixty percent of the respondents were married and 61.0% had at least one child (Table 3.1). Two out of five women never went to school (40.0%) and slightly more than half of the women were unemployed (53.0%). Two-thirds of respondents were either overweight or obese (68.0%).

Table 3.1 Sample description (n=100)

	n	%	[CI 95%]
Age			
20-29y	28	28.0	19.0-37.0
30-39y	36	36.0	26.4-45.6
40-49y	36	36.0	26.4-45.6
Marital Status			
married	60	60.0	50.2-69.8
Number of children			
none	39	39.0	29.3-48.7
1 or 2	34	34.0	24.6-43.4
3 and over	27	27.0	18.1-35.9
Educational level			
none	40	40.0	30.2-49.8
primary or partial secondary	45	45.0	35.1-54.9
secondary/ university	15	15.0	7.9-22.1
Employment			
unemployed	53	53.0	43.0-63.0
BMI			
underweight/normal	32	32.0	22.7-41.3
overweight	32	32.0	22.7-41.4
obese	36	36.0	26.4-45.6

All women interviewed (n=100) completed the three 24-hour recalls as well as the two fruit and vegetables Food Frequency Questionnaires (FFQ1 and FFQ2).

3.2.2 Reproducibility

The mean daily intakes for fruit was similar at both time periods (Time 1-170g and Time 2- 174g), whereas there was more of difference regarding vegetable intake (Time 1-173g and Time 2-201g) (Table 3.2). From FFQ1 the mean daily fruit and vegetables intake was 344g and from FFQ2 this intake was 375g.

Compared to FFQ1, FFQ2 slightly overestimated overall fruit and vegetable intakes, especially for vegetables (4g for fruit; 28g for vegetables; 31g for both fruit and vegetables).

Table 3.2 Daily amount of fruit, vegetables and fruit and vegetables based on FFQ1 and the FFQ2, Spearman's correlation coefficient and ICC (n=100)

	FFQ1			**FFQ2**			**Spearman's coefficient**		**ICC**[1]
	mean ± se	min	max	mean ± se	min	max	r	*p*	
Fruit	170±13.0	4	887	174±11.4	0	637	0.54	*<0.0001*	0.71
Vegetables	173±9.5	0	526	201±8.8	11	471	0.48	*<0.0001*	0.47
F&V	344±18.6	29	1129	375±16.5	84	951	0.56	*<0.0001*	0.68

[1] IntraClass Correlation coefficient

The Spearman's correlation coefficients were all highly significant ($p<0.0001$) and ranged from 0.48 for vegetables to 0.56 for fruit and vegetables considered together which indicated a moderate relationship between data from FFQ1 and FFQ2 (Table 3.2).

The ICC coefficient for vegetables was 0.47 indicating a moderate agreement between FFQ1 and FFQ2. For fruit, the ICC was 0.71 indicating a strong agreement between the amounts of fruit consumed measured by both FFQ1 and FFQ2. The overall ICC for fruit and vegetables considered together was 0.68 indicating a strong agreement between FFQ1 and FFQ2 and thus that the developed fruit and vegetable FFQ is reliable (Table 3.2).

The proportion of subjects in FFQ1 terciles correctly classified by the FFQ2 into the same tertile and into the within-one tercile ranged respectively from 59% for fruit, to 42% for vegetables (Tables 3.3a and 3.3b). Gross misclassification, i.e. subjects classified into extreme terciles ranged from 8% for fruit to 10% for vegetables.

The weighted Kappa coefficient for fruit was 0.43 indicating a moderate agreement whereas the weighted Kappa coefficient for vegetables was 0.24, indicating a fair agreement.

Table 3.3a Cross-classification by tercile, fruit consumption (n=100)

		Fruit consumption from FFQ2			
		1st tertile	2nd tertile	3rd tertile	total
Fruit consumption from FFQ1	1st tertile	22	7	5	34
	2nd tertile	10	21	6	37
	3rd tertile	3	10	16	29
	total	35	38	27	100

Agreement=59%
Clasification in extreme tertile: 8%
Kappa=0.38
Weighted Kappa=0.43

Table 3.3b Cross-classification by tercile, vegetable consumption (n=100)

		Vegetable consumption from FFQ2			
		1st tertile	2nd tertile	3rd tertile	total
Vegetable consumption from FFQ1	1st tertile	16	13	5	34
	2nd tertile	13	9	11	33
	3rd tertile	5	11	17	33
	total	34	33	33	100

Agreement=42%
Clasification in extreme tertile: 10%
Kappa=0.13
Weighted Kappa=0.24

When dividing the distribution of fruit and vegetable consumption into three levels of consumption according to recommendations, the agreement reached 49%, the gross classification was 7% and the weighted Kappa coefficient was 0.36 indicating a fair level of agreement (Table 3.3c).

When dividing the distribution of fruit and vegetable consumption into two classes (<400g/day and ≥400g/day) the agreement rose to 74% and the weighted Kappa coefficient reached 0.42 indicating a moderate agreement (Table 3.3c).

Table 3.3c Cross-classification by level of consumption, fruit and vegetables (n=100)

		Fruit & Vegetable consumption from FFQ2			
		<280g/day	[280-400[	≥400g/day	total
F&V[1] consumption from FFQ1	<280g/day	18	17	6	41
	[280-400[	8	11	11	30
	≥400g/day	1	8	20	29
	total	27	36	37	100

Agreement=49%
Classification in extreme category: 7%
Kappa=0.24
Weighted Kappa=0.36

		Fruit & Vegetable consumption from FFQ2		
		<400g/day	≥400g/day	total
F&V[1] consumption from FFQ1	<400g/day	54	1	71
	≥400g/day	9	20	29
	total	63	37	100

Agreement=74%
Kappa=0.42

[1] fruit and vegetable

3.2.3 Validity

According to the 24-hour recalls, the Mean daily intakes for fruit and for vegetables were respectively 193g and 228g, whereas from the FFQ2 the Mean daily intakes were 174g and 201g (Table 3.4). From the 24-hour recalls the mean daily fruit and vegetables intake was 421g and from the FFQ2 this intake was 375g.

Compared to data from the 24-hour recalls, the FFQ2 slightly underestimated fruit and vegetables intakes (19g for fruit; 27g for vegetables; 46g for both fruit and vegetables).

Table 3.4 Daily amounts of fruit, vegetables and fruit and vegetables based on 24-hour recalls and the FFQ2 , Spearman's correlation coefficient and Wilcoxon signed-rank test (n=100)

	24-hour recalls			**FFQ2**			**Spearman's correlation**		**Wilcoxon test**
	mean ± se	min	max	mean ± se	min	max	r	*p*	*p*
Fruit	193±15.3	0	713	174±11.4	0	637	0.67	*<0.0001*	*0.194*
Vegetables	228±11.0	13	512	201±8.8	11	471	0.48	*<0.0001*	*0.012*
F&V[1]	421±20.3	45	909	375±16.5	84	951	0.69	*<0.0001*	*0.006*

[1] fruit and vegetable

The Spearman's correlation coefficients were all highly significant ($p<0.0001$) and ranged from 0.67 for fruit, indicating a moderate relationship

between data from 24-hour recalls and data from FFQ2, to 0.48 for vegetables, indicating a rather weak relationship (Table 3.4, Figure 3.1a and Figure 3.1b). The Spearman's correlation coefficient for fruit and vegetables considered together was 0.69, indicating a moderate relationship (Table 3.4 and Figure 3.1c).

The difference between fruit intake from 24-hour recalls and fruit intake from FFQ2 was not statistically significant ($p>0.05$), whereas significant differences were observed for vegetables as well as for fruit and vegetables considered together ($p<0.05$).

Figure 3.1a Correlation between fruit consumption obtained from 24-hour recalls and FFQ2 (n=100)

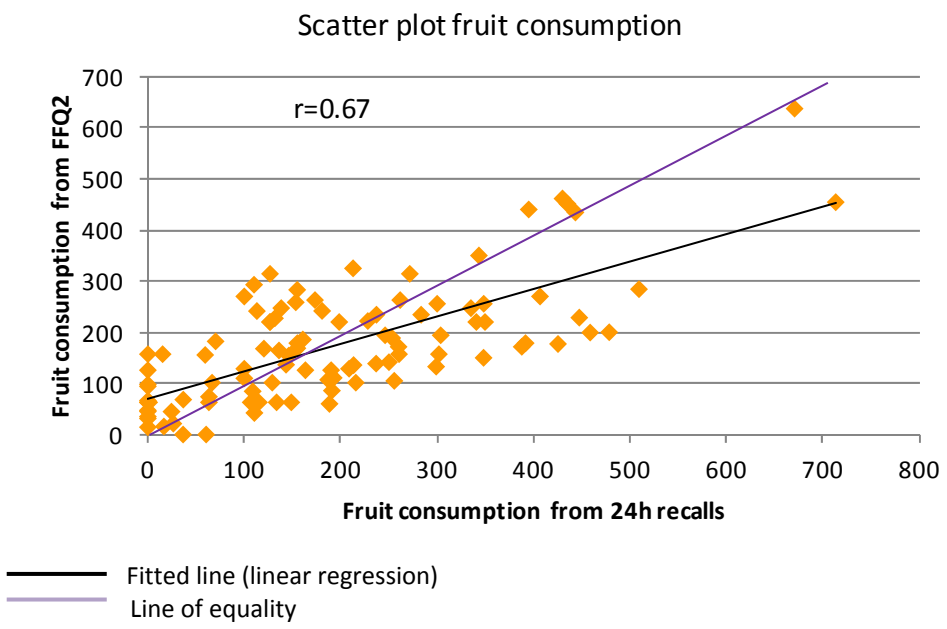


Figure 3.1b Correlation between vegetable consumption obtained from 24-hour recalls and FFQ2 (n=100)

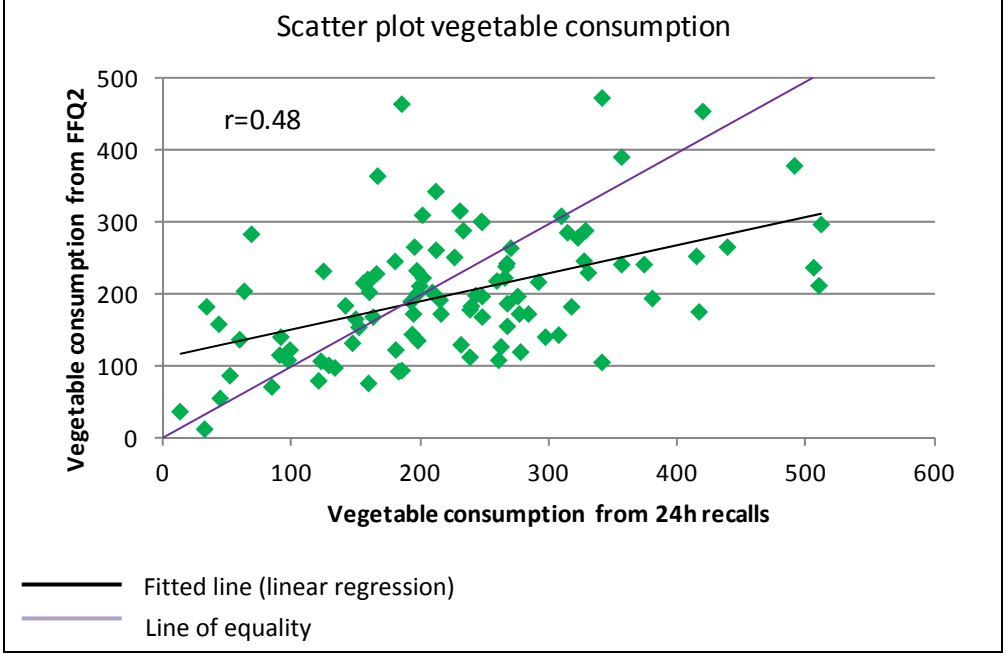
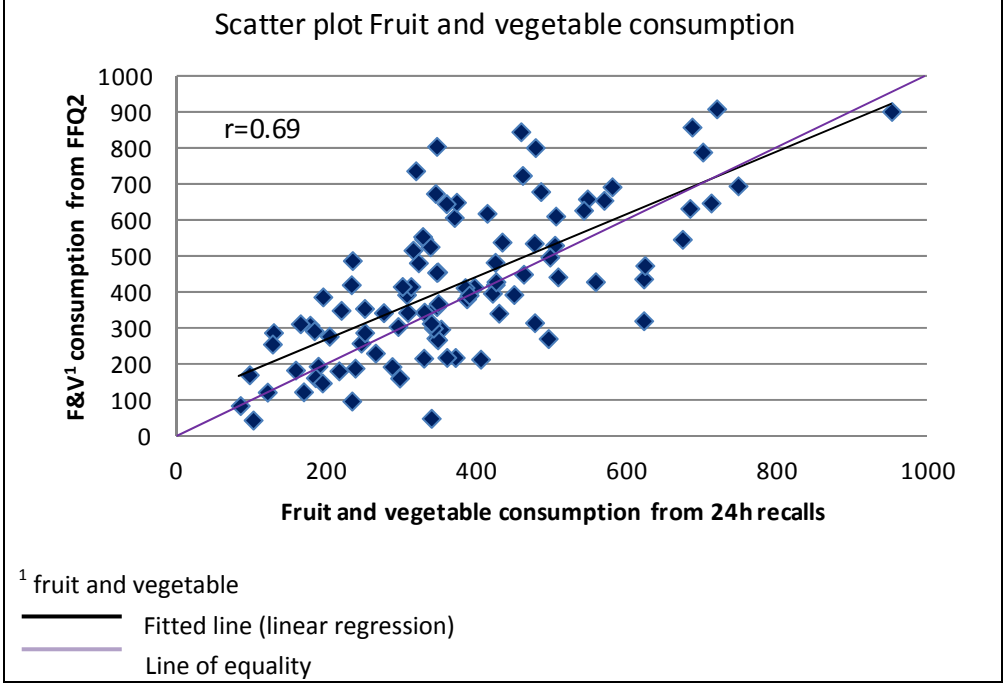


Figure 3.1c Correlation between fruit and vegetable consumption obtained from 24-hour recalls and FFQ2 (n=100)



The 95% limits of agreement for fruit were rather large and ranged from -1.516 to 1.371 (Table 3.5 and Figure 3.2a). Once back log-transformed the mean difference for fruit, expressed as a ratio was 0.93 which corresponded to an overall difference of 7%. The limit of agreement when back log-transformed ranged from 0.22 to 3.94, indicating that the difference varied between -88% and +294%.

The limits of agreement for vegetables ranged from -1.143 to 0.976 (Table 3.5 and Figure 3.2b). Once back log-transformed, the mean difference for vegetables was 0.92 which corresponded to an overall difference of 8%. The limit of agreement when back log-transformed ranged from 0.32 to 2.65, indicating that the difference varied between -68% and +165%.

The limits of agreement for fruit and vegetables combined ranged from -0.933 to 0.783 (Table 3.5 and Figure 3.2c). Once back log-transformed, the mean difference for vegetables was 0.93 which corresponded to an overall difference of 7%. The limit of agreement when back log-transformed ranged from 0.39 to 2.19, indicating that the difference varied between -61% and +119%.

Overall the limits of agreement of the present study indicated that the fruit and vegetables FFQ is not a valid tool to measure fruit and vegetable intakes at the individual level.

Table 3.5 Limits of agreement and mean differences, log-transformed data (Bland and Altman) (n=100)

	95% limits of agreement		mean difference	
	lower limit	upper limit	value	[CI 95%]
Fruit	-1.516	1.371	-0.073	-0.216-0.070
Vegetables	-1.143	0.976	-0.084	-0.189-0.022
Fruit and vegetables	-0.933	0.783	-0.075	-0.160-0.010

Figure 3.2a Bland and Altman plot for fruit, log-transformed data (n=100)

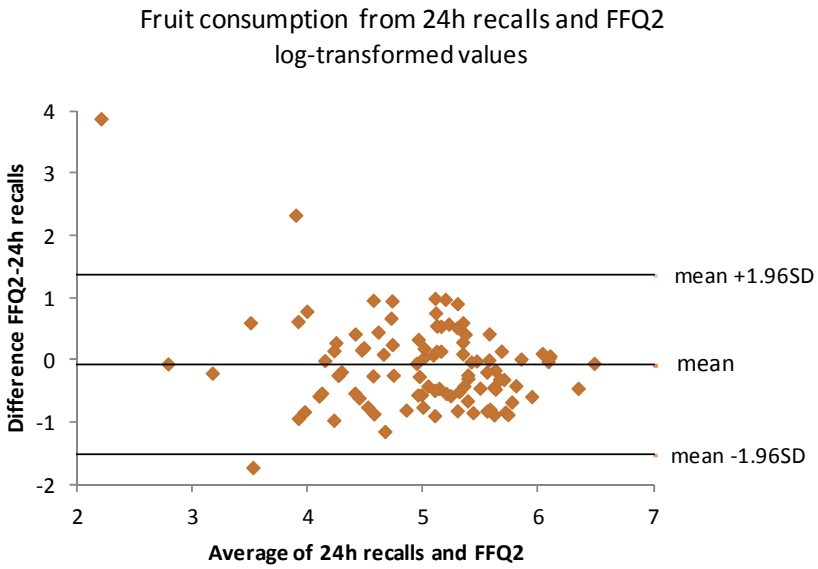


Figure 3.2b Bland and Altman plot for vegetables, log-transformed data (n=100)

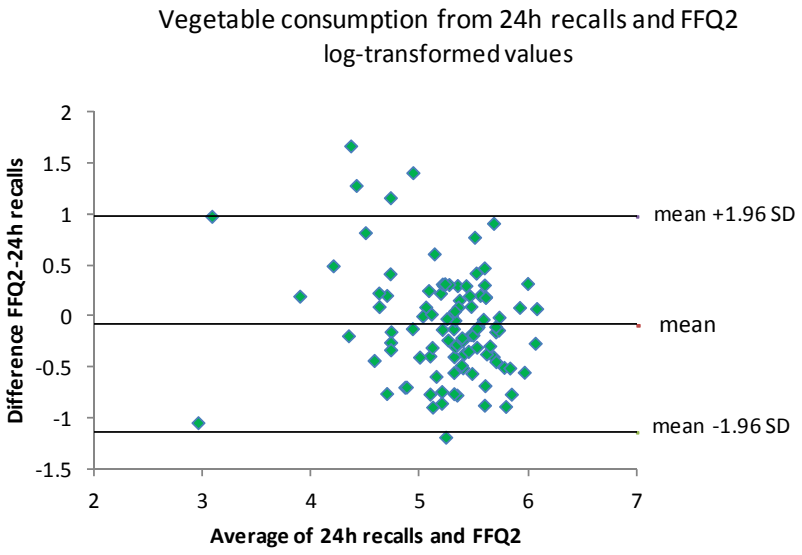
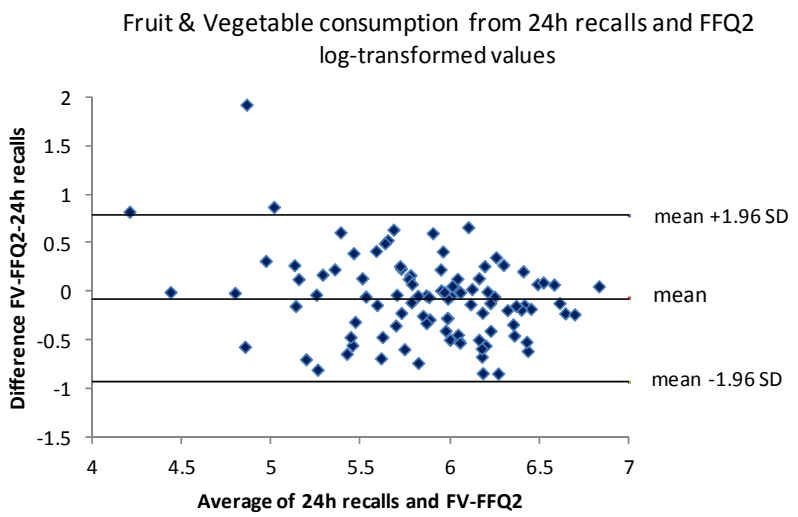


Figure 3.2c Bland and Altman plot for fruit and vegetables, log-transformed data (n=100)



3.3 Study 3: Population survey

The aims of the population survey were to quantify the amount of fruit and vegetable consumed and to investigate potential determinants of fruit and vegetable consumption, such as socio-demographic and psychosocial determinants.

Amongst all the women randomly selected, 56 refused to participate in the study (5.9% refusal rate). 895 women were interviewed within 45 clusters. One woman was excluded from the analysis because no food consumption data had been recorded for her. For data presented in this chapter the sample size was either n=894 for data from the FFQ, or n=855 for data from the 24-hour recall, as a result of misreporters exclusion (see section 3.1.1).

3.3.1 Under- and over-reporters

The Goldberg method identified 38.0% (n=340) of women as misreporters; the Willett method identified 4.4% (n=39) of women as misreporters; and the third method identified 10% (n=88) of women as misreporters.

With the Goldberg cut-off method, the Mean energy intake was 1986 kcal ([1914-2058]) for the accurate reporters (AR); misreporters (MR) were more likely to be uneducated (50.8% MR vs. 35.9% AR never attended school, $p<0.001$), have a lower economic level (36.3% MR vs. 30.1% AR in the lowest tertile, $p<0.05$), be obese, i.e. BMI ≥30 kg/m² (39.8% MR vs. 28.1% AR, $p<0.05$) compared to AR.

With the arbitrary cut-off, the Mean energy intake was 1625 kcal ([1570-1680]) for the AR); MR were more likely to be unmarried (55.6% MR vs. 32.9% AR, $p<0.01$).

With the thresholds at the lower and upper 5% of the distribution the Mean energy intake was 1617 kcal ([1568-1666]) for the AR; there was no difference in socio-demographic characteristics between MR and AR.

As the method using the Willett approach excluded less subjects than the approach based on the 5 lower and upper percentiles of the distribution, this sample (where n=855) was kept for all further analysis on food consumption (Table 3.6).

Table 3.6 Description of the whole sample and the 3 remaining samples after exclusion of the outliers

	Whole sample		Goldberg sample					Willett sample					Percentile sample				
			misreporters		accurate reporters			misreporters		accurate reporters			misreporters		accurate reporters		
	n=894		n=340		n=554			n=39		n=855			n=88		n=806		
Mean energy intake (kcal/day)**± se**	1669±35.6		1986±35.9					1625±27.3					1618±24.5				
Age	n	%	n	%	n	%	*p*	n	%	n	%	*p*	n	%	n	%	*p*
20-29y	255	28.3	93	24.7	162	30.4		12	27.8	243	28.3		31	32.5	224	27.9	
30-39y	313	31.6	113	30.6	200	32.1	*n.s*	16	38.9	297	32.2	*n.s*	26	26.8	287	32.0	*n.s*
40-49y	326	40.1	134	44.7	192	37.5		11	33.3	315	40.5		31	40.7	295	40.1	
Marital Status																	
married	653	66.1	247	68.9	406	64.5	*n.s*	22	44.4	631	67.1	*<0.01*	58	59.4	595	66.1	*n.s*
unmarried	241	33.9	93	31.1	148	35.5		17	55.6	224	32.9		30	40.6	211	33.9	
Number of children																	
none	219	30.0	81	26.3	138	32.2		11	37.0	208	29.7		26	34.2	193	29.5	
1 or 2	336	30.7	128	30.6	208	30.8	*n.s*	13	29.6	323	30.8	*n.s*	29	27.6	307	31.1	*n.s*
3 and over	339	39.3	131	43.1	208	37.0		15	33.4	324	39.5		33	38.2	306	39.4	
Educational level																	
none	351	41.3	156	50.8	195	35.9		11	27.8	340	42.0		35	39.0	316	41.6	
primary/partial secondary	409	43.8	145	38.1	264	47.1	*<0.001*	22	57.4	387	43.1	*n.s*	37	44.7	372	43.7	*n.s*
secondary/ university	134	14.9	39	11.1	95	17.0		6	14.8	128	14.9		16	16.3	118	14.7	
Employment																	
employed	168	19.9	65	19.5	103	20.1	*n.s*	8	25.9	160	19.6	*n.s*	14	17.1	154	20.2	*n.s*
unemployed	726	80.1	275	80.5	451	79.9		31	74.1	695	80.4		74	82.9	652	79.8	
Economic status																	
high	323	35.5	106	28.5	217	39.6		13	37.0	310	35.4		29	35.8	294	35.4	
medium	274	32.1	108	35.2	166	30.3	*<0.05*	14	31.5	260	32.1	*n.s*	26	28.4	248	32.5	*n.s*
low	297	32.4	126	36.3	171	30.1		12	31.5	285	32.5		33	35.8	264	32.1	
BMI																	
normal	294	33.9	107	29.8	187	36.3		16	46.3	278	33.3		34	38.2	260	33.4	
overweight	309	33.7	104	30.4	205	35.6	*<0.05*	14	35.2	295	33.6	*n.s*	29	32.5	280	33.8	*n.s*
obese	291	32.4	129	39.8	162	28.1		9	18.5	282	33.1		25	29.3	266	32.8	

[1] weighted percentages; n.s: non significant

3.3.2 Sample description

Over two-thirds of the respondents were married (66.1%) and had at least one child (70.0%) (Table 3.7). Around two out of five women had never attended school (41.3%) and the majority of women were unemployed (80.1%). Slightly less than two-thirds of the sample (65.0%) lived in the medina, which is the traditional living area in Morocco. Two-thirds of respondents were either overweight or obese (66.1%).

Table 3.7 Socio-demographic characteristics of the sample (n=894)

	n	%[1]	se[2]	[CI 95%]
Age				
20-29y	255	28.3	0.02	24.4-32.3
30-39y	313	31.6	0.02	27.6-35.4
40-49y	326	40.1	0.02	35.5-44.8
Marital Status				
married	653	66.1	0.02	61.6-70.7
Number of children				
none	219	30.0	0.02	25.5-34.5
1 or 2	336	30.7	0.02	26.1-35.3
3 and over	339	39.3	0.03	33.7-44.8
Educational level				
none	351	41.3	0.03	34.6-48.1
primary or partial secondary	409	43.8	0.02	38.8-48.7
secondary/ university	134	14.9	0.02	10.5-19.3
Employment				
unemployed	726	80.1	0.02	76.0-84.3
Living area				
modern	178	17.9	0.06	6.8-29.5
medina[3]	557	65.0	0.07	50.2-79.0
precarious[4]	159	17.1	0.06	5.8-28.6
BMI				
underweight/normal	294	33.9	0.02	30.0-37.7
overweight	309	33.7	0.02	30.3-37.1
obese	291	32.4	0.02	28.5-36.4

[1] weighted percentage
[2] standard error
[3] traditional Moroccan living area
[4] precarious living area and shanty town

3.3.3 Fruit and vegetable consumption

One of the main objectives of the present study was to estimate precise fruit and vegetable intake and also to develop scores and indices that would reflect the quality of such intake (see section 1.3 objectives (ii)).

3.3.3.1 Mean fruit and vegetable intakes

During the previous 24-hours, nearly two-thirds of respondents ate fresh fruit (60.3%), but much fewer (13%) ate dried fruit, nearly all women ate vegetables (94.2%) and slightly more than one-quarter of women ate beans or pulses (28.0%). Only a very small proportion of women (2.6%) did not eat fruit or vegetables during the previous day.

When looking at intake of the previous week, only a very small minority did not eat vegetables (0.9%) or fruit (5.8%) at all during this period. On average, women ate fruit less than once a day (5.4 times per week) and the Mean intake was 102g per day; women ate vegetables more often (6.6 times per week), with a Mean intake of 110g per day. Altogether fruit and vegetables were consumed nearly twelve times per week and the Mean daily intake was 213g, which corresponded to about 2.7 portions of fruit and vegetables per day.

Nearly three-quarters of women consumed <280g of fruit and vegetables per day and were thus considered as low consumers (Table 3.8). Only one out of ten women met WHO recommendations regarding fruit and vegetable intake.

Table 3.8 Mean weekly (times/week) and daily (g/day) fruit and vegetable intake, data based on FFQ

				Week frequency	Daily intake g/day		
		n	mean ± se	[CI 95%]	mean ± se	%[1] ± se	[CI 95%]
Fruit juice		894	0.2±0.03	0.1-0.2	4 ± 0.9	100	2-6
Fruit		894	4.0±0.15	3.7-4.3	93 ± 4.5	100	84-102
Dried fruit		894	1.2±0.09	1.0-1.4	5±0.4	100	5-6
Total fruit		894	5.4±0.33	4.9-5.8	102±4.8	100	93-112
Green salad		894	0.9±0.11	0.7-1.1	4±0.5	100	3-5
Beans, pulses		894	1.6±0.09	1.4-1.7	33±2.1	100	29-37
Cooked vegetables		894	2.6±0.12	2.4-2.8	54±2.9	100	48-60
Vegetables as starter		894	1.5±0.14	1.2-1.8	19±2.0	100	15-23
Total vegetables		894	6.6±0.26	6.0-7.1	110±4.7	100	101-120
Total fruit and vegetables		894	11.9±0.39	11.1-12.7	213±8.2	100	196-229
Number of portion		894	------	------	2.7±0.1	------	2.5-2.9
Level of consumption :	low (<280g/d)	671	------	------	154±3.7	76.3±2.2	71.8-80.7
	medium	140	------	------	329±2.4	15.2±1.4	12.3-18.1
	high (≥400g/d)	83	------	------	530±15.5	8.5±1.3	5.8-11.2

[1] weighted percentages

3.3.3.2 Mean fruit and vegetable portion size

To answer the research questions outlined in section 1.3 about whether one Mean fruit or vegetable portion size=80g and whether one time could be considered as one portion, a Mean fruit and a Mean vegetable portion size were calculated, based on data from the 24-hour recall. The weight of a reference fresh fruit or any kind of vegetables portion size is 80g (see section 1.1.3). It was then interesting to look if a Mean portion of fruit or vegetables was equivalent to 80g. In this study, based on data from the 24-hour recall, the weight of a Mean fruit portion size was 155g (which was about twice the weight of a reference portion size) whereas the weight of the Mean vegetable portion size was half the weight of the reference portion size (Table 3.9). The weight of a Mean dried fruit portion size was 31g (which was about the weight of the reference portion size) and the weight of a mean beans or pulses portion size was 126g.

Table 3.9 Mean fruit and vegetables portion size, data based on 24-hr

	n	mean[1]±se	[CI 95%]
Fruit	903	155±5.6	144-166
Dried fruit	108	31±3.7	24-39
Vegetables	2891	39±1.1	37-41
Beans/pulses	294	126±6.5	113-139

[1] weighted mean

3.3.3.3 Contribution of fruit and vegetable to macro-and micronutrient intakes

According to one of the objectives (ii) mentioned in section 1.3 the contribution of fruit and vegetables to macro and micronutrient intake in women's diet were investigated. For women in the sample, fruit and vegetables contributed to 10% of the energy intake; 11% of protein intake; nearly 14% of carbohydrates intake; 35% of dietary fibre intake and 2.7% of fat intake (Table 3.10). Beans and pulses were the major contributors to energy, protein, fibres and fat intakes. Fruit was the main contributor to carbohydrates intake.

Fruit and vegetables taken together contributed one-fifth of the magnesium, calcium and iron intakes; one-third of potassium intake; and 12% of zinc intake. Beans and pulses were the major contributors to all minerals.

Fruit and vegetables also contributed to nearly two-thirds of vitamin C intake; more than 40% of vitamin A intake; one-third of folic acid (vitamin B9)

intakes; and less than one-fifth of vitamin B1, vitamin B2 and vitamin B3 intakes. Vegetables were the major contributor to vitamin A intake; fruit was the major contributor to vitamin C and vitamin B6. Beans and pulses were the major contributors to vitamin B1, vitamin B2, vitamin B3 and vitamin B9.

Table 3.10 Means nutrient intakes from fruit and vegetables and their contribution to energy and nutrient intakes, data based on 24-hr (n=855)

		Fruit & Vegetables	Fruit	Dried Fruit	Vegetables	Beans/Pulses	Fruit & Vegetables
		mean[1] ± s.e	%[2] ± s.e	%[2] ± s.e	%[2] ± s.e	%[2] ± s.e	%[2] ± s.e
Energy	**kcal**	81.9	7.9±0.39	4.2±0.40	2.1±0.11	10.0±0.51	10.1±0.50
	kJ	347.6	8.0±0.39	4.3±0.41	2.1±0.11	10.1±0.5	10.2±0.50
Macronutrient							
Proteins (g)		3.2	3.6±0.20	1.2±0.14	3.1±0.15	21.3±1.17	11.2±0.60
Carbohydrates (g)		15.5	12.1±0.63	7.3±0.79	2.7±0.13	11.0±0.6	13.8±0.71
Fibres (g)		3.8	19.1±0.62	9.6±1.13	15.0±0.68	30.9±1.25	35.5±0.88
Lipids (g)		0.6	1.5±0.18	0.2±0.04	0.9±0.20	3.4±0.32	2.7±0.31
SFA (g)		0.1	0.8±0.10	0.2±0.03	0.5±0.09	2.1±0.18	1.6±0.16
MUFA (g)		0.1	0.8±0.2	0.05±0.02	0.5±0.23	2.0±0.28	1.5±0.30
PUFA (g)		0.2	1.8±0.15	0.4±0.08	1.9±0.25	6.3±0.51	4.6±0.39
Cholesterol (mg)		0.2	0.4±0.14	0.04±0.01	0.8±0.21	3.1±0.77	1.8±0.40
Micronutrient							
Sodium (mg)		33.2	0.4±0.03	0.2±0.03	3.8±0.20	1.0±0.15	4.1±0.21
Magnesium (mg)		26.4	12.9±0.61	5.6±0.51	8.7±0.35	17.8±0.89	21.8±0.74
Phosphorus (mg)		65.0	4.0±0.19	2.5±0.27	4.8±0.19	21.3±1.18	13.3±0.60
Potassium (mg)		384.2	20.7±0.88	9.4±0.99	15.2±0.57	22.5±1.06	34.3±0.96
Calcium (mg)		40.9	9.6±0.67	4.1±0.46	12.2±0.58	14.5±0.84	21.8±0.72
Iron (mg)		1.2	6.4±0.31	7.8±0.74	8.4±0.36	30.1±1.29	21.2±0.78
Zinc (mg)		0.5	4.5±0.44	1.4±0.25	4.7±0.19	19.3±1.07	12.7±0.61
Vitamin A RAE[3] (µg)		106.6	8.4±0.87	2.3±0.87	38.5±1.56	0.6±0.09	41.8±1.55
Vitamin C (mg)		28.8	58.0±2.11	1.9±0.46	26.9±1.29	10.9±1.35	63.6±1.9
Vitamin B1 (mg)		0.1	10.6±0.60	2.1±0.32	6.9±0.36	13.9±1.02	17.0±.70
Vitamin B2 (mg)		0.1	9.3±0.44	3.5±0.39	7.0±0.31	11.4±0.75	15.9±0.55
Vitamin B3 (mg)		0.8	6.8±0.40	3.8±0.43	6.2±0.29	10.0±0.78	13.3±0.58
Vitamin B6 (mg)		0.2	19.3±1.01	4.1±0.51	11.7±0.44	16.6±1.04	27.8±1.02
Vitamin B9 (µg)		52.2	20.4±1.00	2.6±0.24	14.0±0.71	32.3±1.45	34.9±1.11

[1]weighted means
[2]weighted percentages
[3]RAE=Retinol Activity Equivalent

3.3.3.4 Fruit and Vegetable Diversity Score

Besides exploring patterns of the overall fruit and vegetable consumption, the diversity of this intake was also investigated. This diversity represented the number of different fruit or vegetables consumed per day taking into account a minimum amount consumed (see section 2.4.9.5.1). As a consequence, Mean Fruit diversity score (FDS) was 0.9±0.05 and the Mean vegetables diversity score (VDS) was 1.4±0.05 whereas the Mean Fruit and Vegetable Diversity Score (FVDS) was 2.3±0.07.

3.3.3.5 Fruit and Vegetable Quality Index

The health benefits of fruit and vegetables is both a question of quantity and diversity. Therefore the FVQI was developed in order to assess the overall quality of fruit and vegetable intake (see section 1.3 objectives (ii) and section 2.4.9.5.2).

Almost three-quarters of women (71.1%) scored <6 out of 10 possible points. The mean Fruit and Vegetable Quality Index (FVQI) was 3.7±0.12; the mean score for the recommendations component was 1.7±0.08; and the mean score for the diversity component was 2.0±0.06 (Table 3.11).

Table 3.11 Fruit and Vegetable Quality Index and its components, data based on 24-hr (n=855)

	mean ± se	[CI 95%]
Amount of fruit and vegetables consumed per day/3pts	1.14±0.05	1.05-1.23
Amount of beans/pulses consumed per day/2pts	0.52±0.03	0.46-0.58
Recommendations score/5pts	**1.66±0.06**	**1.53-1.78**
Number of different fruit consumed per day/2pts	0.81±0.02	0.85-0.94
Number of different vegetables consumed per day/2pts	0.89±0.03	0.76-0.87
Consumption of fruit or vegetable rich in vitamin A per day/1pt	0.30±0.02	0.27-0.33
Diversity score/5pts	**2.00±0.05**	**1.92-2.09**
FVQI/10pts	**3.66±0.10**	**3.47-3.85**

3.3.4 Overall diet

Besides the evaluation of the overall fruit and vegetable quality intakes, one objective was also to assess overall diet quality (see section 1.3 objectives (ii), section 2.4.9.5.3 and section 2.4.9.5.4). Therefore two different indices were computing: one simple focusing on diversity and one more complex including information at both food and nutrient levels.

3.3.4.1 Nutrient intakes

Amongst the 894 women for whom food data were collected, 39 were considered as misreporters and thus were excluded from the analysis, making a final sample of n=855.

Nutrient intakes have been recalculated for 1800 kcal, which corresponds to what intakes would be if the energy needs of women were covered. This adjustment to 1800 kcal permits differences in nutrient intakes observed between the subjects to be eliminated, that are due to differences in the amount of food consumed.

Overall, the diet of the women in the sample was well balanced regarding the recommendations for energy from macronutrients (World Health Organization, 2003). Indeed, 56% of energy came from carbohydrates (sugars included), 14% from protein and 29% from lipids. Energy from Saturated Fatty Acids (SFA) represented <8% of total energy intake; energy from PolyUnsaturated Fatty Acids (PUFA) represented slightly <6% of dietary energy (Table 3.12). The WHO (2003) recommends that energy from SFA should be <10% of total energy and that energy from PUFA should be between 6-10% of total energy.

As mentioned earlier (see section 2.3.9.5.2) Moroccan Dietary Reference Intake for nutrients does not exist, consequently, those developed by the FAO/WHO were used as a reference (World Health Organization, 2003; Food and Agriculture Organization /World Health Organization, 2004).

As all the nutrients of interest did not follow a normal distribution, the Median, rather than the Mean, was calculated. The median energy intake was 1554kcal (the Mean energy intake was 1625 kcal per day [1570-1680]).

The median fibre intake recalculated for 1800 kcal was less than recommendations, i.e. the Median fibre intake of Moroccan women was 20.1g whereas the daily WHO recommendation is at least 25g (World Health Organization, 2003).

Regarding minerals, if women in the sample met their energy needs, it was assumed that their magnesium and phosphorus[5] needs would be covered. On the contrary, calcium, iron and zinc intakes would be insufficient to meet their needs.

Regarding vitamins, if women met their energy needs, thiamine (vitamin B1), riboflavin (vitamin B2), niacin (vitamin B3), pyridoxine (vitamin B6) and vitamin C intakes contrary to vitamin A, folic acid (vitamin B9) and vitamin B12, would be sufficient to cover the needs (Table 3.12).

The WHO advocates that sodium intake should be <2000mg, which corresponds to a sodium chloride intake of 5g (World Health Organization, 2003). Women from the area of Rabat-Sale had a slightly excessive sodium intake with regards of this recommendation, as the Median intake was 2134mg/day.

The WHO recommendation for cholesterol intake is that cholesterol intake should be ≤300mg/day (World Health Organization, 2003). The Median cholesterol intake of women recalculated for 1800 kcal did not exceed this limit, as it was 129mg/day.

[5] Based on French phosphorus recommendations (Martin, 2001)

Table 3.12 Macro and micronutrient intakes recalculated for 1800 kcal, data based on 24-hr (n=855)

	median	daily recommendation	references
Macronutrient			
Protein % energy	14.4	10-15	WHO, 2003
Carbohydrates % energy	55.9	55-75	WHO, 2003
Fibres (g)	20.1*	>25	WHO, 2003
Fats % energy	28.6	15-30	WHO, 2003
SFA % energy	7.6	<10	WHO, 2003
MUFA % energy	10.1	by difference	WHO, 2003
PUFA % energy	5.9	6-10	WHO, 2003
Cholesterol (mg)	129	≤300	WHO, 2003
Micronutrient			
Sodium (mg)	2134.5	<2000	WHO, 2003
Magnesium (mg)	252.5	220.0	FAO/WHO, 2004
Phosphorus (mg)	1087.9	750	Martin, 2001
Potassium (mg)	2237.7		
Calcium (mg)	401.8*	750.0	FAO/WHO, 2004
Iron (mg)	10.5*	29.4[1]	FAO/WHO, 2004
Zinc (mg)	8.1*	9.8[2]	FAO/WHO, 2004
Vitamin A RAE (µg)	360.2*	500	FAO/WHO, 2004
Vitamin C (mg)	58.9	45	FAO/WHO, 2004
Vitamin B1 (mg)	1.5	1.1	FAO/WHO, 2004
Vitamin B2 (mg)	1.1	1.1	FAO/WHO, 2004
Vitamin B3 (mg)	14.9	1.4	FAO/WHO, 2004
Vitamin B6 (mg)	1.4	1.3	FAO/WHO, 2004
Vitamin B9 (µg)	282.1*	400.0	FAO/WHO, 2004
Vitamin B12 (µg)	1.5*	2.4	FAO/WHO, 2004

[1]based on 10% dietary iron bio-availability
[2]based on a low bio-availability diet
* Uncovered needs

3.3.4.2 Dietary Diversity Score

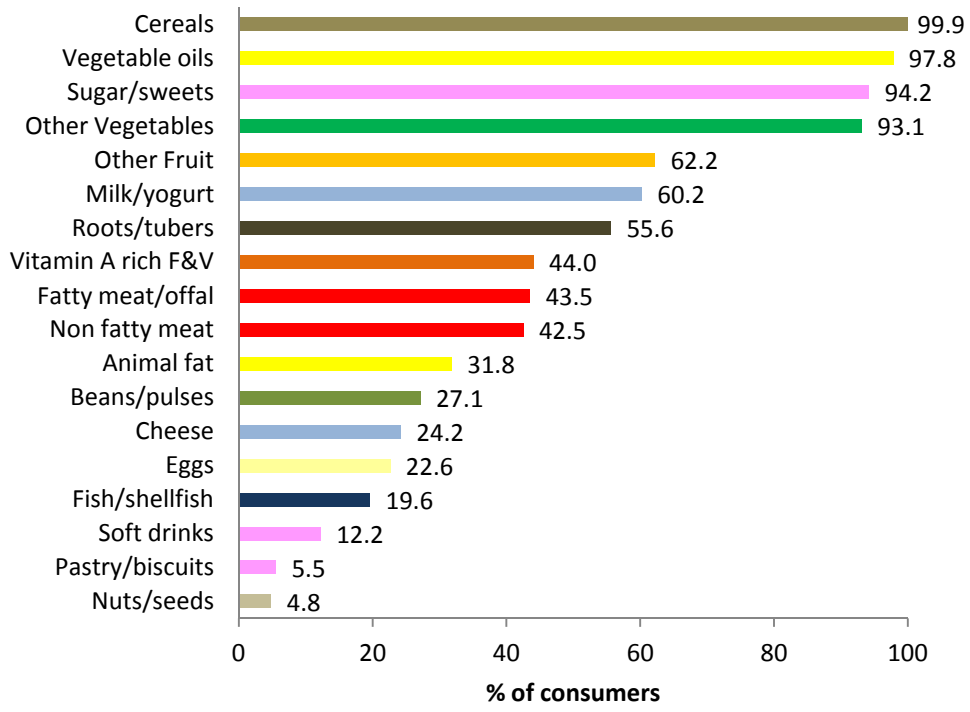
In Morocco, 'couscous' and 'tajines' are the two traditional dishes usually consumed at lunch and also sometimes for the evening meal. 'Couscous' is commonly consumed on Friday which is a special day for Muslim people, but consumption is not restricted to Friday. 'Tajine' is made up of a meat, more rarely of fish, vegetables, vegetable oil, spices and is usually consumed by the aid of bread. 'Couscous' is a dish made up of semolina, meat, vegetables, oil, fat and spices. Thus, over the previous 24-hours, most women consumed cereals (99.9%), vegetables (93.1%), meat and added fats (97.8% were vegetable fats) (Figure 3.3).

Considering the other food groups, over the previous 24-hours, almost all women ate sugar and sweets (94.2%) mainly as white sugar added in tea,

coffee or milk; almost two-thirds of the women consumed milk and yogurts; nearly two-thirds of the women (62.2%) ate non vitamin A rich fruit; slightly more than half of the sample ate roots or tubers (55.6%) with potatoes as the main contributor to this food group; 27.1% of women ate beans and pulses; slightly more than one out of ten women consumed soft drinks (12.2%); less than one out of four women ate eggs (22.6%); and 5.5% of women ate pastries or biscuits.

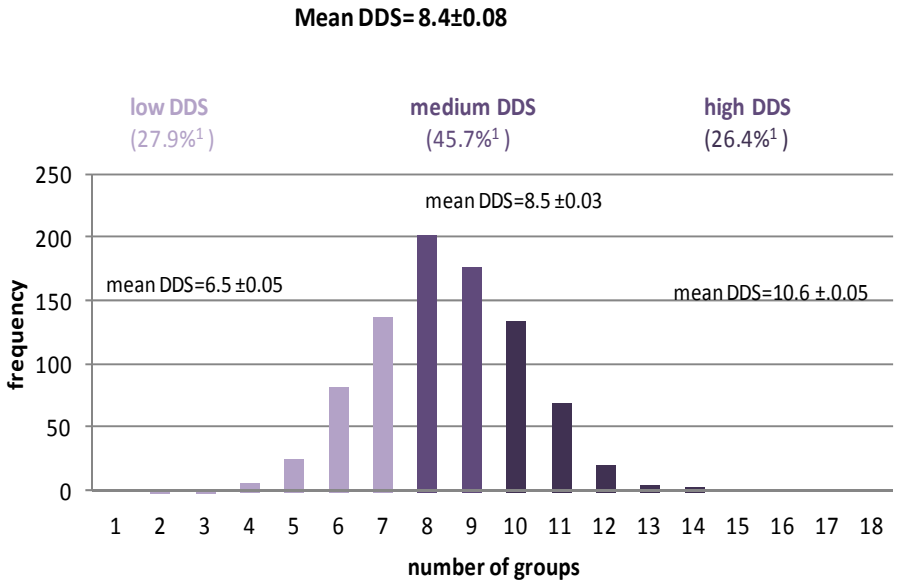
The majority of fats consumed were vegetable fats and the main source of animal protein was meat.

Figure 3.3 Percentage of consumers consuming each food group, data based on 24-hr (n=855)



Based on the DDS-18, women in the sample consumed a Mean of 8.4 different food groups (Figure 3.4). No woman consumed only one food group and no women consumed more than fifteen out of the eighteen possible food groups. More than one-quarter of the sample (27.9%) belonged to the low DDS-18 group and consumed an average of 6.3 different food groups over the last 24-hours. Less than half of the sample (45.7%) belonged to the medium DDS-18 group and consumed 8.5 different food groups over the last 24-hours. Slightly more than one-quarter (26.4%) belonged to the high DDS-18 group with a Mean food group intake of 10.7.

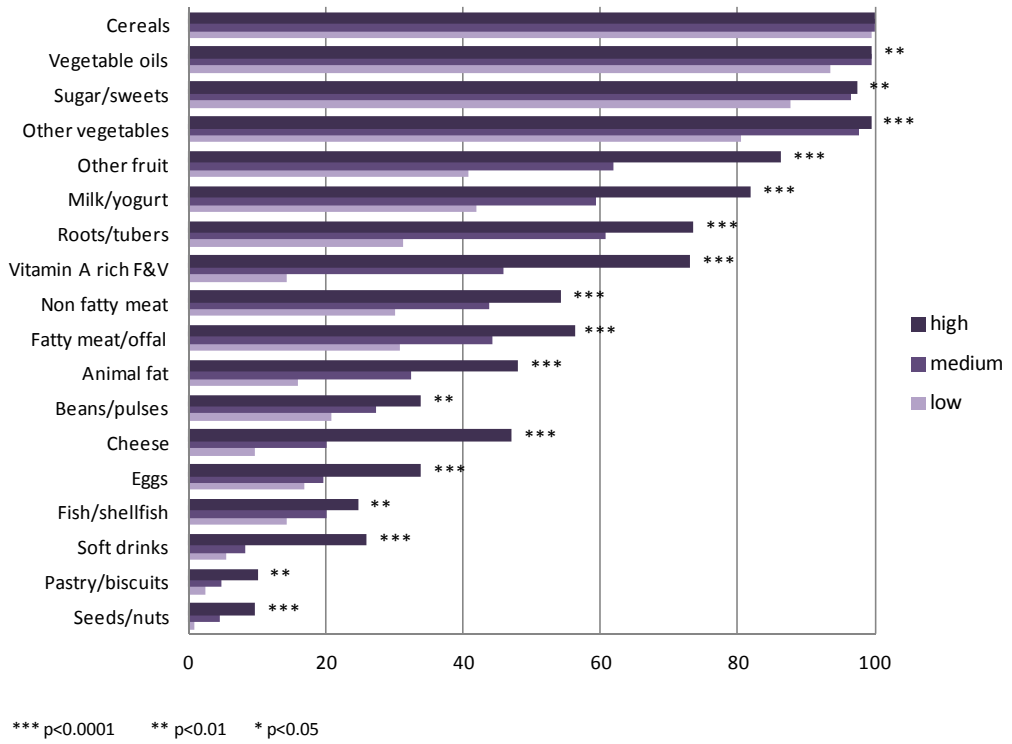
Figure 3.4 Distribution of the 3 groups of DDS-18, data based on 24-hr (n=855)



[1] % weighted percentages

Overall, data suggests that apart from cereals, food frequencies consumption were significantly different between the three levels of DDS-18 (Figure 3.5). Considering the different food groups, the consumption of women belonging to the medium DDS-18 group was sometimes close to women from the high DDS-18 group and sometimes close to women from the low DDS-18 group. Thus, for vegetable oils, sugar and sweets and other vegetables groups, the consumption of women with medium DDS-18 was similar to the consumption of women from the high DDS-18. On the contrary, considering biscuits and pastries, nuts and seeds, eggs and soft drinks, the consumption of women with medium DDS-18 was similar to the consumption of women with a low DDS-18.

Figure 3.5 Percentage of women who consumed food groups as a function of levels of DDS-18, data based on 24-hr (n=855)



3.3.4.3 Diet Quality Index-International

The mean Diet Quality Index-International (DQI-I) was 57.9/100 and 43.2% of Moroccan women had a good quality diet, based on the DQI-I ≥60. Women scored above the Mean for *adequacy* (25.8/40), for *moderation* (18.8/30) and for *variety* (11.4/20). For *overall balance*, the Mean score was low (1.9/10). Despite what was observed for macronutrients (see section 3.3.6.1) the very low level of this component in the DQI-I was due to the extremely rigorous scoring criterion.

The relationship between fruit and vegetable consumption and certain components of the DQI-I such as *adequation*, *overall balance* and *moderation*, were also investigated to see whether women who ate more fruit and vegetables were also those having an overall healthier diet. As part of the variety score was based on fruit and vegetable consumption, a modified DQI-I score was created by removing points due to the variety component from the original DQI-I score. There were highly significant relationships between the modified DQI-I and fruit, vegetables and fruit and vegetables ($p<0.001$ in all cases before and after adjustment for energy and all the socio-demographic

characteristics), indicating that women who ate more fruit and vegetables scored significantly higher, i.e. had healthier diets.

Women were classified into two classes, according to their modified DQI-I score by using a cut-off at 48 points and whether they ate ≥400g of fruit and vegetables per day. Women who ate ≥400g of fruit and vegetables per day were about eight times more likely to have a healthier diet than the other women (adjusted OR=7.80; [4.91-12.38]; p<0.001).

3.3.5 Socio-demographic determinants of food consumption

As the socio-demographic characteristics of women, such as age, marital status, education, employment are potential determinants of food consumption. Therefore the relationships between socio-demographic characteristics of the women in the sample and fruit and vegetable intakes, as well as overall food intake were investigated (see section 1.3 objectives (iii)).

3.3.5.1 Relationship between socio-demographic characteristics of women and fruit and vegetable consumption

3.3.5.1.1 Overall fruit and vegetable consumption

When investigating whether fruit and vegetable intake varied with socio-demographic characteristics, no association was found for fruit and vegetable intake and marital status, employment or living area (Table 3.13); nor with vegetable or fruit consumption. Neither was there any association between fruit and vegetable consumption and age; nor with vegetable when considered separately. The only socio-demographic factors associated with fruit and vegetables consumption were education and economic status. Indeed, women with a higher educational level or a higher economic status ate significantly more fruit (p<0.0001 before adjustment, p<0.05 after adjustment), more vegetables (p<0.001 before adjustment, p<0.05 after adjustment) and more fruit and vegetables (p<0.0001 before adjustment, p<0.01 after adjustment) (Table 3.13).

Table 3.13 Relationship between socio-demographic characteristics of women and fruit and vegetable consumption, data based on FFQ (n=894)

		Fruit (g/day)				**Vegetables** (g/day)				**Fruit and vegetables** (g/day)			
		univariate		**multivariate**		**univariate**		**multivariate**		**univariate**		**multivariate**	
	n	mean ± se	p^1	adjusted mean ± se	p^2	mean ± se	p^1	adjusted mean ± se	p^2	mean ± se	p^1	adjusted mean ± se	p^2
Age													
20-29y	255	112±6.6				106±5.6				218±9.1			
30-39y	313	108±7.2	*0.0404*		*0.5370*	118±6.1	*0.1268*		*0.0612*	227±11.3	*0.0597*		*0.2158*
40-49y	326	91±6.6				106±6.5				198±11.0			
Marital Status													
married	653	104±5.3	*0.5374*		*0.1372*	112±4.6	*0.5101*		*0.1980*	216±8.8	*0.4728*		*0.2257*
unmarried	241	99±7.0				107±8.3				206±13.2			
Number of children													
none	219	106±8.4				109±7.8				216±14.4			
1 or 2	336	112±6.1	*0.0477*		*0.7803*	119±5.9	*0.1238*		*0.2695*	231±10.0	*0.0299*		*0.4692*
3 and over	339	91±6.3				104±5.5				196±10.1			
Educational level													
none	351	81±5.7		82±5.0		93.6±4.3		94±3.8		174±8.4		177±7.2	
primary or partial secondary	409	107±5.3	*<0.0001*	108±4.7	*0.0379*	119±6.2	*0.0003*	120±5.8	*0.0181*	226±9.5	*<0.0001*	229±8.3	*0.0065*
secondary/ university	134	149±12.1		152±11.1		130±8.0		132±8.0		279±16.9		285±15.9	
Employment													
employed	726	116±10.5	*0.1027*		*0.2655*	111±7.7	*0.8991*		*0.5620*	227±16.5	0.2759		*0.7164*
unemployed	168	99±4.8				110±5.0				209±8.4			
Economic status													
high	323	137±6.5		139±6.0		128±6.2		130±5.9		265±10.7		269±10.0	
medium	274	91±5.9	*<0.0001*	93±5.2	*0.0001*	109±5.8	*0.0001*	111±5.5	*0.0069*	200±9.9	*<0.0001*	205±9.0	*0.0001*
low	297	76±7.1		78±6.4		92±5.9		93±5.1		168±11.3		171±9.8	
Living area													
modern	178	122±13.3				122±12.4				245±21.5			
medina	557	98±5.5	*0.2351*		*0.5444*	108±5.8	*0.4791*		*0.7388*	206±9.8	*0.2314*		*0.5676*
precarious	159	98±9.8				105±7.2				203±13.7			

[1] crude associations ; [2] associations adjusted for all the variables of the model

3.3.5.1.2 Fruit and vegetable diversity

The socio-demographic variation in fruit and vegetable diversity was investigated, finding that there was no association for FDS and age, marital status, number of children, employment or living area (Table 3.14). On the other hand, there was an association between FDS with education and economic status of women, with economic status acting as a modifier of the effect of educational level on FDS (p-value of the interaction=0.0125 before adjustment and p-value of the interaction=0.0189 after adjustment). As there was a problem of small size when data were desagregated, levels of education from primary to university were grouped. The educational level has no effect in the high and medium economic groups. However, in low economic group, the most educated were more likely to have a higher FDS.

Table 3.14 Relationship between socio-demographic characteristics of women and Fruit Diversity Score, data based on 24-hr (n=855)

		Fruit Diversity Score				
			univariate		multivariate	
Explanatory terms	**Interactions terms**	n	mean ± se	p^1	adjusted mean ± se	p^2
Age						
20-29y		243	0.84±0.06			
30-39y		297	0.87±0.08	*0.3507*		*0.1304*
40-49y		315	0.97±0.07			
Marital Status						
married		631	0.94±0.05	*0.2449*		*0.1758*
unmarried		224	0.83±0.08			
Number of children						
none		208	0.88±0.08			
1 or 2		323	0.90±0.07	*0.9127*		*0.7319*
3 and over		324	0.92±0.06			
Economic status	**Educational level**					
high	none	58	0.88±1.56	*0.379*	1.20±0.16	*0.8626*
	primary to university	252	0.93±1.21		1.09±0.06	
medium	none	107	0.66±1.00	*0.953*	0.81±0.08	*0.7648*
	primary to university	153	0.68±0.97		0.83±0.07	
low	none	175	0.45±0.75	*0.003*	0.59±0.08	*0.0018*
	primary to university	110	0.77±1.32		1.05±0.14	
Employment						
employed		160	0.93±0.09	*0.7593*		*0.9145*
unemployed		695	0.90±0.05			
Living area						
modern		168	0.88±0.08			
medina		538	0.95±0.06	*0.1498*		*0.1302*
precarious		149	0.75±0.08			

[1] crude associations
[2] adjusted for all the variables of the model and the interaction education#economic level

There was no association for VDS or FVDS with age, marital status, number of children, employment or living area (Table 3.15). However, there was a relationship between FVDS and educational level. Indeed, before adjustment, women with a higher level of education had a better diversity score; which meant that they ate significantly a larger number of different fruit and vegetables. However, this association did not remain after adjustment. Both before and after adjustment, women belonging to the higher economic level had better scores for VDS and FVDS ($p<0.05$ and $p<0.01$, respectively).

Table 3.15 Relationship between socio-demographic characteristics of women and Vegetable and Fruit and Vegetable Diversity Score, data based on 24-hr (n=855)

		Vegetables Diversity Score				Fruit & Vegetables Diversity Score			
	n	mean ± se	p^1	adjusted mean ± se	p^2	mean ± se	p^1	adjusted mean ± se	p^2
Age									
20-29y	243	1.40±0.09				2.24±0.11			
30-39y	297	1.44±0.10	*0.8606*		*0.7855*	2.31±0.15	*0.8391*		*0.3199*
40-49y	315	1.36±0.08				2.34±0.11			
Marital Status									
married	631	1.41±0.06	*0.6437*		*0.9637*	2.35±0.08	*0.3397*		*0.5037*
unmarried	224	1.36±0.10				2.19±0.14			
Number of children									
none	208	1.35±0.09				2.23±0.14			
1 or 2	323	1.56±0.09	*0.0858*		*0.2217*	2.46±0.13	*0.2664*		*0.4468*
3 and over	324	1.31±0.08				2.23±0.10			
Educational level									
none	340	1.32±0.08				2.10±0.09			
primary /partial secondary	387	1.43±0.08	*0.4357*		*0.7416*	2.41±0.11	*0.0234*		*0.2475*
secondary /university	128	1.50±0.13				2.54±0.13			
Employment									
employed	160	1.36±0.11	*0.7439*		*0.496*	2.29±0.14	*0.9362*		*0.5492*
unemployed	695	1.40±0.06				2.30±0.09			
Economic status									
high	310	1.52±0.08		1.54±0.07		2.62±0.09		2.65±0.10	
medium	260	1.24±0.07	*0.0127*	1.26±0.07	*0.0376*	2.07±0.10	*0.0014*	2.09±0.09	*0.0091*
low	285	1.42±0.10		1.43±0.09		2.18±0.14		2.20±0.14	
Living area									
modern	168	1.51±0.09				2.39±0.13			
medina	538	1.35±0.07	*0.377*		*0.5889*	2.30±0.10	*0.6862*		*0.9732*
precarious	149	1.46±0.15				2.21±0.16			

[1] crude associations ; [2] associations adjusted for all the variables of the model

3.3.5.1.3 Fruit and Vegetable Quality Index

There was no association for FVQI with age, marital status, number of children, educational level, employment and living area (Table 3.16); nor with the recommendation component, the diversity component or the FVQI in two classes (data for FVQI in two classes not shown). However, there was a relationship between the FVQI and the economic level of women. Indeed, women with a higher economic level scored higher ($p<0.05$ before and after adjustment). There was also a relationship between the diversity component of the FVQI and the economic level. Women with higher economic level scored higher than the other women ($P<0.01$ before adjustment and $p<0.05$ after adjustment).

Table 3.16 Relationship between socio-demographic characteristics of women and Fruit and Vegetable Quality Index, data based on 24-hr (n=855)

		FVQI /10				**Recommendations** /5				**Diversity** /5			
		univariate		**multivariate**		**univariate**		**multivariate**		**univariate**		**multivariate**	
	n	mean ± se	p^1	adjusted mean ± se	p^2	mean ± se	p^1	p^2		adjusted mean ± se	p^1	mean ± se	p^2
Age													
20-29y	243	3.52±0.20				1.53±0.12				1.99±0.10			
30-39y	297	3.78±0.22	*0.3144*		*0.1346*	1.75±0.14	*0.1508*	*0.0702*		2.03±0.10	*0.7186*		*0.4172*
40-49y	315	3.73±0.19				1.71±0.12				2.02±0.09			
Marital Status													
married	631	3.72±0.14	*0.7830*		*0.6785*	1.68±0.09	*0.954*	*0.8382*		2.04±0.07	*0.5870*		*0.5032*
unmarried	224	3.62±0.25				1.65±0.16				1.96±0.11			
Number of children													
none	208	3.69±0.25				1.69±0.17				2.01±0.11			
1 or 2	323	3.74±0.19	*0.9489*		*0.8864*	1.65±0.12	*0.7898*	*0.8668*		2.08±0.08	*0.8505*		*0.7943*
3 and over	324	3.64±0.18				1.67±0.12				1.97±0.08			
Educational level													
none	340	3.37±0.18				1.51±0.12				1.86±0.07			
primary/partial secondary	387	3.87±0.17	*0.3712*		*0.5825*	1.76±0.11	*0.5834*	*0.7115*		2.11±0.08	*0.2562*		*0.594*
secondary/university	128	4.06±0.25				1.85±0.17				2.20±0.12			
Employment													
employed	160	3.78±0.24	*0.9160*		*0.7530*	1.75±0.16	*0.749*	*0.9982*		2.03±0.11	*0.8240*		*0.5266*
unemployed	695	3.67±0.15				1.65±0.10				2.02±0.07			
Economic status													
high	310	4.20±0.17		4.21±0.17		1.95±0.13				2.25±0.07		2.26±0.07	
medium	260	3.43±0.17	*0.0102*	3.46±0.16	*0.0223*	1.53±0.12	*0.0751*	*0.0812*		1.90±0.08	*0.0064*	1.92±0.07	*0.0396*
low	285	3.38±0.23		3.37±0.20		1.50±0.15				1.88±0.09		1.89±0.08	
Living area													
modern	168	3.66±0.25				1.57±0.17				2.09±0.11			
medina	538	3.75±0.16	*0.8162*		*0.8107*	1.72±0.10	*0.7792*	*0.6555*		2.03±0.08	*0.4910*		*0.7838*
precarious	149	3.48±0.28				1.58±0.21				1.90±0.10			

[1] associations adjusted for energy; [2] associations adjusted for energy and all the variables of the model

3.3.5.2 Relationship between sioco-demographic characteristics of women and overall diet

3.3.5.2.1 Dietary Diversity Score

In crude associations, the DDS-18 was linked to the economic and educational level of women (Table 3.17), without any interaction between these two variables (p-value of interaction=0.4262). Indeed, women having a higher economic status as well as the most educated women scored significantly higher than other women (p<0.001 for DDS-18 with economic level; p<0.0001 for DDS-18 with educational level), indicating that their diets were more likely to be diversified. However, after adjustment for all the variables in the model, only the association with educational level and the DDS-18 remained (p<0.01).

Table 3.17 Relationship between the socio-demographic characteristics of women and the DDS-18, data based on 24-hr (n=855)

		DDS-18				
		univariate			multivariate	
	n	mean ± se	[CI 95%]	p^1	adjusted mean ± se	p^2
Age						
20-29y	243	8.7 ±0.15	8.4-9.0			
30-39y	297	8.5 ±0.08	8.3-8.7	*0.0636*		*0.5019*
40-49y	315	8.2 ±0.12	8.0-8.5			
Marital Status						
married	631	8.4 ±0.09	8.2-8.6	*0.2427*		*0.6809*
unmarried	224	8.5 ±0.12	8.3-8.8			
Number of children						
none	208	8.6 ±0.13	8.4-8.9			
1 or 2	323	8.5 ±0.11	8.3-8.8	*0.0553*		*0.814*
3 and over	323	8.2 ±0.12	8.0-8.4			
Educational level						
none	340	8.0 ±0.09	7.8-8.2		8.0 ±0.09	
primary or partial secondary	387	8.7 ±0.09	8.5-8.9	*<0.0001*	8.7 ±0.09	*0.001*
secondary/ university	128	8.9 ±0.13	8.6-9.2		8.9 ±0.14	
Employment						
employed	160	8.6 ±0.16	8.3-8.9	*0.2607*		*0.9187*
unemployed	695	8.4 ±0.08	8.2-8.5			
Economic status						
high	310	8.7 ±0.08	8.5-8.9			
medium	260	8.5 ±0.12	8.2-8.7	*0.0003*		*0.1258*
low	285	8.1 ±0.11	7.9-8.3			
Living area						
modern	168	8.7 ±0.21	8.3-9.1			
medina	538	8.4 ±0.09	8.2-8.6	*0.1902*		*0.3168*
precarious	149	8.2 ±0.15	7.9-8.5			

[1] crude associations
[2] associations adjusted for all the variables of the model

3.3.5.2.2 Diet Quality Index-International

No significant association were found between the total DQI-I and all the socio-demographic characteristics of the sample (Table 3.18). The same figure was observed for the overall component. There was no association between any of the components of the DQI-I and women's marital status, their employment, or their living area. *Variety* was significantly associated with age, number of children, level of education and economic level. Indeed, the youngest women ($p<0.05$), women with no child ($p<0.05$), women with higher education ($p<0.001$) or higher economic level ($p<0.001$) scored significantly higher than the others ($p<0.001$. After adjustment for energy and all the variables of the model, only the association with educational level ($p<0.05$) and economic status ($p<0.01$) remained. *Adequacy* was significantly related to educational and economic levels, as women with higher education and higher economic status scored significantly higher than other women ($P<0.05$). However, these associations did not remain after adjustment for energy and all the variables of the model. *Moderation* was related to education and economic level. Contrary to what was observed for the previous components, women with lower level of education and lower economic status scored higher than other women in the sample ($p<0.05$). Once adjusted, these two associations did not remain. *Overall balance* was not related to any of the socio-demographic variables before and after adjustment.

Table 3.18 Relationship between socio-demographic characteristics of women and the DQI-I and its components, data based on 24-hr (n=855)

	DQI-I total /100			**Variety** /20				**Adequacy** /40			**Moderation** /30			**Overall balance** /10		
	univariate		**multiv.**	**univariate**		**multiv.**		**univariate**		**multiv.**	**univariate**		**multiv.**	**univariate**		**multiv.**
	mean ± se	p^1	p^2	mean ± se	p^1	adjusted mean ± se	p^2	mean ± se	p^1	p^2	mean ± se	p^1	p^2	mean ± se	p^1	p^2
Age																
20-29y	58.4 ±0.75			12.1 ±0.35				26.4 ±0.42			17.9 ±0.46			2.0 ±0.14		
30-39y	58.1 ±0.92	*0.9481*	*0.7698*	11.4 ±0.32	*0.0392*		*0.495*	25.8 ±0.57	*0.7560*	*0.5275*	18.7 ±0.35	*0.0841*	*0.2335*	2.1 ±0.20	*0.1410*	*0.1941*
40-49y	57.4 ±0.72			11.0 ±0.28				25.3 ±0.43			19.5 ±0.39			1.7 ±0.15		
Marital status																
married	57.8 ±0.53	*0.7059*	*0.2646*	11.3 ±0.22	*0.3112*		*0.1784*	25.8 ±0.35	*0.8415*	*0.2407*	18.8 ±0.27	*0.5262*	*0.9207*	1.9 ±0.11	*0.3488*	*0.6452*
unmarried	58.1 ±0.88			11.6 ±0.36				25.9 ±0.50			18.7 ±0.40			2.0 ±0.16		
Number of children																
none	58.9 ±0.87			12.0 ±0.38				26.3 ±0.51			18.5 ±0.44			2.1 ±0.16		
1 or 2	58.2 ±0.69	*0.2095*	*0.2469*	11.7 ±0.28	*0.0161*		*0.2249*	26.3 ±0.40	*0.2757*	*0.2945*	18.3 ±0.38	*0.0868*	*0.7824*	2.0 ±0.18	*0.2321*	*0.3753*
3 and over	56.9 ±0.59			10.8 ±0.28				25.0 ±0.44			19.4 ±0.31			1.7 ±0.16		
Educational level																
none	56.6 ±0.59			10.3 ±0.29		10.3±0.24		24.4 ±0.39			19.9 ±0.32			2.1 ±0.14		
primary /partial secondary	58.5 ±0.73	*0.1779*	*0.7387*	12.1 ±0.23	*0.0001*	12.0±0.22	*0.0274*	26.6 ±0.38	*0.0040*	*0.1487*	18.0 ±0.39	*0.0154*	*0.1541*	1.8 ±0.15	*0.0563*	*0.0704*
secondary/ university	59.6 ±1.0			12.7 ±0.32		12.7±0.31		27.2 ±0.51			18.0 ±0.55			1.7 ±0.21		
Employment																
employed	59.4 ±1.01	*0.1254*	*0.2385*	12.3 ±0.46	*0.0584*		*0.1996*	26.5 ±0.54	*0.2777*	*0.5572*	18.6 ±0.50	*0.9130*	*0.6488*	2.0 ±0.21	*0.5595*	*0.4826*
unemployed	57.5 ±0.56			11.2 ±0.25				25.6 ±0.36			18.8 ±0.28			1.9 ±0.11		
Economic level																
high	58.8 ±0.71			12.4 ±0.20		12.4±0.20		26.9 ±0.36			17.8 ±0.35			1.7 ±0.14		
medium	57.9 ±0.81	*0.3926*	*0.752*	11.4 ±0.31	*0.0001*	11.5±0.23	*0.0021*	25.6 ±0.47	*0.0148*	*0.2492*	19.0 ±0.41	*0.0102*	*0.0626*	1.9 ±0.15	*0.1173*	*0.4361*
low	56.9 ±0.73			10.4 ±0.33		10.4±0.25		24.7 ±0.48			19.6 ±0.37			2.2 ±0.19		
Living area																
modern	57.8 ±0.85			11.9 ±0.50				25.4 ±0.45			18.6 ±0.67			1.8 ±0.15		
medina	58.2 ±0.65	*0.6763*	*0.6534*	11.5 ±0.28	*0.1771*		*0.2786*	26.0 ±0.40	*0.6323*	*0.2163*	18.7 ±0.33	*0.8408*	*0.8109*	2.0 ±0.15	*0.5172*	*0.3474*
precarious	56.8 ±1.04			10.7 ±0.46				25.3 ±0.66			19.2 ±0.54			1.7 ±0.18		

[1] adjusted for energy; [2] adjusted for energy and all the variables of the model

3.3.6 Eating behaviours

Eating behaviours, such as processed food consumption, eating in a shared dish and eating out of home were considered as potential determinants of fruit and vegetable consumption. Therefore these particular behaviours were investigated (see section 1.3 objectives (iii)).

3.3.6.1 Processed food consumption

In crude associations, all the socio-demographic characteristics of the sample were linked to processed foods consumption (Table 3.19). These foods were consumed significantly more frequently by the youngest ($p<0.001$), unmarried women ($p<0.01$) without any children ($p<0.001$), women with higher educational level ($p<0.001$), employment ($p<0.01$), higher economic level ($p<0.001$) and women living in a modern area ($p<0.05$). After adjustment for all the socio-demographic variables, all the associations remained except those for marital status and number of children.

Table 3.19 Relationship between socio-demographic characteristics of women and processed foods[1] consumption, data based on 24-hr (n=855)

		Processed foods consumption (times/day)			
		univariate		**multivariate**	
	n	mean ± se	*p*[2]	adjusted mean ± se	*p*[3]
Age					
20-29y	243	0.92±0.12		0.89±0.11	
30-39y	297	0.63±0.07	*0.0007*	0.62±0.07	*0.0341*
40-49y	315	0.46±0.06		0.48±0.05	
Marital Status					
married	631	0.54±0.05	*0.0016*		*0.0661*
unmarried	224	0.84±0.10			
Number of children					
none	208	0.85±0.11			
1 or 2	323	0.71±0.07	*0.0001*		*0.469*
3 and over	324	0.43±0.05			
Educational level					
none	340	0.35±0.05		0.36±0.05	
primary or partial secondary	387	0.73±0.06	*<0.0001*	0.72±0.07	*0.0139*
secondary/ university	128	1.19±0.16		1.19±0.15	
Employment					
employed	160	0.93±0.11	*0.0026*	0.95±0.11	*0.0484*
unemployed	695	0.57±0.06		0.58±0.05	
Economic level					
high	310	0.88±0.07		0.87±0.06	
medium	260	0.62±0.08	*<0.0001*	0.63±0.07	*0.0086*
low	285	0.41±0.06		0.42±0.06	
Living area					
modern	168	0.97±0.17		0.98±0.15	
medina	538	0.60±0.06	*0.0106*	0.61±0.05	*0.0169*
precarious	149	0.43±0.06		0.41±0.06	

[1] processed foods: biscuits, meat products, processed cheese, yogurts and soft drinks
[2] crude associations
[3] associations adjusted for all the variables of the model

The link between processed food and fruit and vegetable intake was investigated to see whether the consumption of processed food was to the detriment of fruit and vegetable consumption. However, there was no association of processed food consumption with fruit and vegetable consumption; nor with fruit consumption when treated separately (Table 3.20). However, there was a relationship between eating vegetables and processed food consumption. Indeed, women who ate more processed foods were also those who ate significantly fewer amounts of vegetables ($p<0.001$ before adjustment and after adjustment for all the socio-demographic variables).

Table 3.20 Relationship between processed food consumption and fruit and vegetable consumption, data based on 24-hr (n=855)

		Fruit (g/day)			**Vegetables** (g/day)				**Fruit and vegetables** (g/day)		
		univariate		**multivariate**	**univariate**		**multivariate**		**univariate**		**multivariate**
	n	mean ± se	p^1	p^2	mean ± se	p^1	adjusted mean ± se	p^2	mean ± se	p^1	p^2
Processed foods											
0	503	152±11.1			182±9.2		182±3.1		334±16.2		
1	216	154±14.0	*0.9959*	*0.5316*	177±12.5	*0.0006*	177±4.3	*0.0003*	332±22.3	*0.2306*	*0.0501*
2 and more	136	171±22.7			152±11.7		152±5.5		323±28.9		

[1] associations adjusted for energy
[2] associations adjusted for energy, age, marital status, number of children, employment, educational level, economic level and living area

3.3.6.2 Meal patterns, common dish and eating out of home

Meal patterns during week and week end days were similar (Table 3.21). Considering the main meals, almost all women had breakfast and lunch (more than 90% and about 98%, respectively) and slightly more than three-quarters had dinner. Considering the 'in-between meals', around one out of ten women had a mid morning snack (11.7% during week days and 8.2% during week end days); eight out of ten women had a mid afternoon collation; and around 6% of the women had a bed time snack.

Table 3.21 Meal patterns (n=894)

	week days		weekend days	
	n	% ± se[1]	n	% ± se[1]
Breakfast	832	93.2±1.16	848	94.6±0.94
Mid morning	100	11.7±1.68	75	8.2±1.21
Lunch	880	98.1±0.58	882	98.3±0.52
Mid afternoon	710	80.0±2.13	718	80.6±2.10
Dinner	677	75.4±2.09	691	77.4±2.09
Bed time	61	6.5±1.05	57	6.2±1.06

[1] weighted percentages

The majority of the women ate in a shared dish (86.6%); only 4.5% ate in a separate plate; and 8.9% ate either in a common dish or in an individual plate in the same way. The relationship between vegetable consumption and the way the dish was consumed was investigated. Vegetable intake did not vary with the way a dish was eaten, i.e. shared vs. individual dish.

Over two-thirds (70.6%) of women declared that they ate out of their home during the previous month to the study. For these women, the mean overall number of eating out of home occasions was roughly twice a week. Amongst these women, 16% ate at work place five times per week; 30.2% ate in a fast-food restaurant weekly (1.1 times/week); 80.3% ate at family or friends' houses slightly <once a week (0.9 times/week); and 8.9% ate in a restaurant more than once a week (1.2 times/week).

The relationship between eating out of home and socio-demographic characteristics was investigated. As a consequence, relationship were found between the overall number of eating occasions and all the socio-demographic characteristics of the women, except living area. Indeed, before adjustment, women that were the youngest, single, childless, with a higher education, employed and with a higher economic level tended to eat more frequently out of their home than other women (Table 3.22).

Table 3.22 Relationship between socio-demographic characteristics of women and eating out of home occasions (n=894)

			Eating out of home occasions (times /week)			
			univariate		multivariate	
Explanatory terms	**Interactions terms**	n	mean ± se	p^1	adjusted mean ± se	p^2
Number of children	**Age**					
none	20-29y	117	2.70±0.35	*0.0136*	2.64±0.29	*0.0017*
	30-39y	65	1.33±0.39		1.31±0.33	
	40-49y	37	1.58±0.35		1.70±0.24	
1 or 2	20-29y	119	1.19±0.22	*0.3491*	1.18±0.21	*0.008*
	30-39y	130	1.58±0.29		1.57±0.25	
	40-49y	87	1.11±0.19		1.07±0.21	
3 and over	20-29y	19	0.47±0.16	*0.2003*	0.47±0.31	*0.4189*
	30-39y	118	0.84±0.16		0.82±0.12	
	40-49y	202	0.93±0.22		0.95±0.20	
Marital Status						
married		653	1.05±0.12	*0.0002*		*0.6328*
unmarried		241	2.04±0.24			
Economic status	**Educational level**					
high	none	58	0.67±0.13	*0.0392*	0.60±0.14	*0.8889*
	primary to university	265	2.07±0.24		1.97±0.18	
medium	none	110	1.12±0.31	*0.4919*	1.11±0.26	*0.6151*
	primary to university	164	1.40±0.27		1.36±0.22	
low	none	183	0.99±0.24	*0.7078*	0.97±0.19	*0.7394*
	primary to university	114	1.08±0.18		0.98±0.21	
Employment						
employed		168	3.54±0.42	*<0.0001*	3.52±0.38	*<0.0001*
unemployed		726	0.85±0.08		0.83±0.07	
Living area						
modern		178	1.91±0.40			
medina		557	1.24±0.14	*0.2977*		*0.3981*
precarious		159	1.38±0.24			

[1] crude associations

[2] associations adjusted for marital status, employment, living area and the 2 interactions: age#number of children and education#economic level

Several interactions between the socio-demographic variables were investigated. There were two significant interactions: one between age and number of children (p=0.0084) and one between education and economic level (p=0.007). These two interactions, as well as the relationship between employment and eating out of home occasions remained significant after adjustment for all the variables in the model. Hence, the number of children was a modifier of the effect of age on eating out of home occasions for women having two or less children. Indeed for women without any children, the youngest were more likely to eat out of home. For women with one or two children, women between 30 and 39 years of age were more likely to eat out of home. Similarly, economic status was a modifier of the effect of

education on eating out of home occasions but only for women belonging to the high economic group. Indeed, before adjustment, in the high economic group, the most educated women were more likely to eat out of home. However, after adjustement, this association was not significant anymore (Table 3.22).

There was also an association between eating at workplace and marital status. Indeed, women who were not married ate significantly more frequently at work than others ($p<0.01$). However this association did not remain after adjustment.

Before adjustment, the number of eating occasions in a fast-food restaurant was significantly related to all socio-demographic variables, except employment and living area, with the same tendencies as observed for the overall number of eating out of home occasions (Table 3.23). After adjustment all the previous associations remained except the association with the number of children.

Table 3.23 Relationship between socio-demographic characteristics of women and fast-food eating occasions (n=894)

		Fast-food (times per week)			
		univariate		multivariate	
	n	mean±s.e	p^1	adjusted mean±s.e	p^2
Age					
20-49y	255	0.47±0.11		0.44±0.09	
30-39y	313	0.20±0.05	*0.0007*	0.18±0.05	*0.0009*
40-49y	326	0.09±0.02		0.10±0.03	
Marital Status					
married	653	0.11±0.02	*0.0038*	0.13±0.02	*0.0071*
unmarried	241	0.47±0.12		0.48±0.11	
Number of children					
none	219	0.48±0.13			
1 or 2	336	0.21±0.04	*0.0015*		*0.5069*
3 and over	339	0.07±0.02			
Educational level					
none	219	0.06±0.01		0.06±0.02	
primary /partial secondary	336	0.25±0.04	*0.0003*	0.23±0.04	*0.0189*
secondary /university	339	0.68±0.23		0.65±0.21	
Employment					
employed	168	0.34±0.10	*0.1403*		*0.9336*
unemployed	726	0.21±0.04			
Economic status					
high	323	0.32±0.07		0.31±0.05	
medium	274	0.29±0.10	*0.0047*	0.29±0.08	*0.0246*
low	297	0.09±0.02		0.08±0.03	
Living area					
modern	178	0.54±0.21			
medina	557	0.17±0.03	*0.2184*		*0.2028*
precarious	159	0.16±0.05			

[1] crude associations
[2] associations adjusted for all the variables of the model

Eating at friends or family's home was not related to any socio-demographic variables, suggesting this is a widespread cultural practice.

There was a significant interaction between education and economic level (p=0.0031, before adjustment and p=0.0036 after adjustment). Indeed, economic status was a modifier of the effect of educational level on restaurant eating occasions for women belonging to the high economic group. Hence, for women belonging to the high economic group, the most educated were more likely to eat in restaurants. (Table 3.24). However, after adjustment, this association did not remain. Employed women ate

significantly more frequently in restaurants than other women even after adjustment for all the variables of the model ($p<0.05$).

After adjustment, women who lived in a modern area ate significantly more frequently in restaurants than other women ($p<0.01$).

Table 3.24 Relationship between socio-demographic characteristics of women and restaurant eating occasions (n=894)

			Restaurant (times /week)			
			univariate		**multivariate**	
Explanatory terms	**Interaction terms**	n	mean ± se	p^1	adjusted mean ± se	p^2
Age						
20-29y		255	0.2±0.05			
30-39y		313	0.1±0.02	*0.0136*		*0.3512*
40-49y		326	0.03±0.01			
Marital Status						
married		653	0.1±0.03	*0.4898*		*0.1441*
unmarried		241	0.1±0.03			
Number of children						
none		219	0.2±0.05			
1 or 2		336	0.1±0.03	*0.0087*		*0.1903*
3 and over		339	0.01±0.01			
Educational level	**Economic status**					
high	none	58	0.012±0.012	*0.0012*		*0.9644*
	primary to university	265	0.217±0.058			
medium	none	110	0.003±0.003	*0.116*		*0.1444*
	primary to university	164	0.067±0.040			
low	none	183	0	*0.3278*		*0.3465*
	primary to university	114	0.003±0.003			
Employment						
employed		168	0.2±0.08	*0.0227*	0.24±0.06	*0.0400*
unemployed		726	0.04±0.01		0.04±0.01	
Living area						
modern		178	0.3±0.09		0.27±0.06	
medina		557	0.03±0.01	*0.0581*	0.03±0.01	*0.0095*
precarious		159	0.05±0.03		0.04±0.02	

[1] crude associations
[2] associations adjusted for all the variables of the model and the interaction education#economic level

The association for the number of eating out of home occasions and fruit and vegetable consumption were investigated to see whether eating out of home had a negative impact on fruit and vegetable consumption. Fruit

consumption was significantly associated with eating out of home behaviour, before and after adjustment ($p<0.05$), i.e women who ate out of home at least once over the previous month ate significantly more fruit (Table 3.25). The same tendency was observed for eating in a restaurant and for vegetable consumption, as well as for eating in a restaurant and fruit consumption. Nevertheless, after adjustment neither vegetable nor fruit consumption did increase with higher frequency of eating in a restaurant. After adjustment fruit and vegetable consumption was not related to any of eating out of home behaviour.

Table 3.25 Relationship between eating out of home behaviour and fruit and vegetable consumption, data based on FFQ (n=894)

		Fruit (g/day)				**Vegetables** (g/day)			**Fruit and vegetables** (g/day)		
		univariate		**multivariate**		**univariate**		**multivariate**	**univariate**		**multivariate**
	n	mean ± se	p^1	adjusted mean ± se	p^2	mean ± se	p^1	p^2	mean ± se	p^1	p^2
Eating out of home											
yes	632	108±5.7	*0.011*	108±3.2	*0.048*	112±5.4	*0.233*	*0.422*	220±9.6	*0.029*	*0.100*
no	262	89±5.9		89±2.3		105±5.1			194±9.6		
Canteen/work place											
yes	85	119±10.9	*0.083*		*0.845*	99±10.0	*0.266*	*0.078*	219±17.3	*0.704*	*0.293*
no	809	100±4.8				112±5.0			212±8.4		
Fast-food											
yes	188	113±8.1	*0.102*		*0.813*	118±9.6	*0.246*	*0.815*	232±13.9	*0.089*	*0.989*
no	706	99±5.1				108±4.2			207±8.3		
Family/friends											
yes	510	107±5.5	*0.081*		*0.085*	113±5.3	*0.337*	*0.39*	220±9.0	*0.117*	*0.129*
no	384	96±5.8				107±5.9			203±10.3		
Restaurant											
yes	67	156±16.6	*0.001*		*0.253*	134±10.6	*0.024*	*0.894*	290±24.0	*0.001*	*0.417*
no	827	99±4.4				109±4.7			207.4±7.8		

[1] crude associations
[2] associations adjusted for age, marital status, number of children, education, employment, economic status and living area

3.3.7 Psychosocial and cognitive factors

As part as all the potential determinants of fruit and vegetable consumption, psychosocial, as well as cognitive factors were investigated to answer research questions related to objectives (iv) (see section 1.3).

3.3.7.1 Attitudinal scales

Some of the items from the attitudinal construct were more behavioural beliefs than attitudes *sensu stricto*. As a consequence, these items were finally incorporated into the behavioural beliefs construct. As there was only one item remaining in the attitudinal construct this construct was not included in the present study.

The two items of the subjective norm construct were more a group norm than a subjective norm *sensu stricto*. Hence as this kind of construct was not part of the framework of the Theory of Planned Behaviour it was removed from the analyses.

Internal consistency was assessed for the remaining items by computing Cronbach's α coefficient (Table 3.26).

Table 3.26 Internal consistency by attitudinal construct

Attitudinal construct	Cronbach's α
Behavioural beliefs towards fruit	0.68
Behavioural beliefs towards vegetables	0.66
Normative beliefs towards fruit	0.60
Normative beliefs towards vegetables	0.67
Perceived behavioural control-self efficacy towards fruit	0.32
Perceived behavioural control-self efficacy towards vegetables	0.39
Control beliefs towards fruit	0.38
Control beliefs towards vegetables	0.42

Behavioural beliefs towards fruit and vegetables

Regarding behavioural beliefs towards fruit and vegetables, almost all women (98.2%) considered that eating either fruit or vegetables is good for health (Table 3.27). Many positive attitudes of the health benefits of eating fruit and vegetables were held, as the majority of women (>80%) reported that eating either fruit or vegetables helps them feel good, have a nice skin and be healthy. This is in contradiction with the fact that only half of the sample believed that they may develop health problems if they do not eat enough fruit or vegetables. Around two-thirds of the sample believed that eating fruit or vegetables helps control their bodyweight.

Except for the items ‘I may develop health problems if I do not eat enough fruit’ and ‘I may develop health problems if I do not eat enough vegetables’ the mean attitudes and behavioural beliefs towards fruit and vegetables were extremely positive (Table 3.28).

Table 3.27 Behavioural beliefs towards fruit and vegetables (n=894)

	Strongly Agree/ Agree	Neither agree/ Disagree	Disagree/ Strongly Disagree
		% [1]	
To me, eating fruit is good for health	98.2	1.1	0.7
Eating fruit makes me feel good	91.5	6.3	2.3
Eating fruit helps me control my bodyweight	63.2	19.2	17.5
Eating fruit helps me have nice skin	88.0	9.8	2.2
Eating fruit makes me healthy	94.1	4.2	1.7
To me, eating vegetables is good for health	98.8	0.7	0.5
I may develop health problems if I do not eat enough fruit	45.2	26.0	28.8
Eating vegetables makes me feel good*	90.9	5.1	4.0
Eating vegetables helps me control my bodyweight	65.3	17.5	17.2
Eating vegetables helps me have nice skin	84.6	12.2	3.2
Eating vegetables makes me healthy	95.1	3.5	1.5
I may develop health problems if I do not eat enough vegetables	53.1	24.7	22.2

[1] weighted percentage ; * n=893

Table 3.28 Mean behavioural beliefs towards fruit and vegetables (n=894)

	Mean[1]	1	2	3	4	5
To me, eating fruit is good for health	1.2		♦			
To me, eating vegetables is good for health	1.2		♦			
Eating fruit makes me feel good	1.4		♦			
Eating fruit helps me control my bodyweight	2.2			♦		
Eating fruit helps me have nice skin	1.5		♦			
Eating fruit makes me healthy	1.4		♦			
I may develop health problems if I do not eat enough fruit	2.7			♦		
Eating vegetables makes me feel good*	1.5		♦			
Eating vegetables helps me control my bodyweight	2.2			♦		
Eating vegetables helps me have nice skin	1.6		♦			
Eating vegetables makes me healthy	1.4		♦			
I may develop health problems if I do not eat enough vegetables	2.5			♦		

[1] weighted mean ; * n=893 for Morocco

Normative beliefs towards fruit and vegetables

Most respondents (>80%) reported some social normative pressures to eat more fruit and vegetables from family and friends but there was not a strong force to conform, as less than half (<40%) of women reported feeling under pressure to eat fruit and vegetables, although over half of women reported that family and friends expected them to eat healthily (Table 3.29).

Whilst most women agreed that 'My family and friends want me to eat fruit/vegetables' there was less agreement for the other items as around half of women agreed with the statements (Table 3.30).

Table 3.29 Normative beliefs towards fruit and vegetables (n=894)

	Strongly Agree/ Agree	Neither agree/ Disagree	Disagree/ Strongly Disagree
		% [1]	
My family and friends want me to eat fruit	82.6	7.6	9.7
I feel under pressure from my family and friends to eat fruit	35.2	8.9	55.9
My family and friends expect me to eat fruit	51.3	9.5	39.2
My family and friends want me to eat more vegetables	80.1	7.1	12.8
I feel under pressure from my family and friends to eat vegetables	36.2	6.6	57.2
My family and friends expect me to eat vegetables	53.6	8.4	38.1

[1] weighted percentage

Table 3.30 Mean normative beliefs towards fruit and vegetables (n=894)

	Mean[1]	1	2	3	4	5
My family and friends want me to eat fruit	1.8		♦			
I feel under pressure from my family and friends to eat fruit	3.3				♦	
My family and friends expect me to eat fruit	2.9			♦		
My family and friends want me to eat more vegetables	1.9		♦			
I feel under pressure from my family and friends to eat vegetables	3.3				♦	
My family and friends expect me to eat vegetables	2.9			♦		

[1] weighted mean

Perceived behavioural control-self efficacy towards fruit and vegetables

Most respondents (>80%), reported high self-efficacy for controlling their dietary habits to eat fruit and vegetables (Table 3.31) although over half of the sample reported that it would be hard to increase their consumption of fruit and vegetables. Over one-third of women (38.1%) agreed that it is difficult for them to eat fruit on a daily basis and over a quarter (28.6%) agreed that it is difficult for them to eat vegetables every day.

There was agreement that eating either fruit or vegetables depended on women's volition; and that eating vegetables daily was less difficult than eating fruit on a daily basis (Table 3.32).

Table 3.31 Perceived behavioural control-self efficacy towards fruit and vegetables (n=894)

	Strongly Agree/ Agree	Neither agree/ Disagree	Disagree/ Strongly Disagree
		% [1]	
Eating fruit is entirely up to me	88.5	3.5	8.1
To me, eating fruit daily is difficult	38.1	3.2	58.7
I cannot increase my consumption of fruit	54.2	5.0	40.8
If I wanted I could eat more fruit	81.6	1.6	16.8
Eating vegetables is entirely up to me	90.9	1.3	7.8
To me, eating vegetables daily is difficult	28.6	2.8	68.5
I cannot increase my consumption of vegetables	54.1	3.9	42.1
If I wanted I could eat more vegetables	78.8	2.5	18.7

[1] weighted percentage

Table 3.32 Mean perceived behavioural control-self efficacy towards fruit and vegetables (n=894)

	Mean[1]	1	2	3	4	5
Eating fruit is entirely up to me	1.6	.....	.....♦.....	.....	.....	.....
To me, eating fruit daily is difficult	3.3	.....	.....	.....	.....♦.....	.....
I cannot increase my consumption of fruit	2.8	.....	.....	.....♦...	.....	.....
If I wanted I could eat more fruit	1.9	.....	.....♦.	.....	.....	.....
Eating vegetables is entirely up to me	1.6	.....	.....♦.....	.....	.....	.....
To me, eating vegetables daily is difficult	3.7	.....	.....	.....	.....♦.....	.....
I cannot increase my consumption of vegetables	2.8	.....	.....	.....♦...	.....	.....
If I wanted I could eat more vegetables	1.9	.....	.....♦.	.....	.....	.....

[1] weighted mean

Control beliefs towards fruit and vegetables

Most Moroccan women agreed that when they eat at home they are able to eat more fruit and vegetables compared to when they eat out of home (Table 3.33).

The cost of eating fruit or vegetables was generally seen as an obstacle by most women. Indeed, around two-thirds of women agreed that vegetables are expensive and two-thirds of Moroccan women agreed that fruit is expensive (Table 3.33). Around three-quarters of women stated that they would eat more fruit or vegetables if they were less expensive.

Whilst more than 80% of women stated that vegetables were always available at home, only 43.4% stated that this was the case for fruit. The time and skills needed to prepare fruit was not seen as an obstacle to consumption. Indeed, more than 90% of women agreed that fruit is easy to prepare and more than 90% disagreed that it is time consuming to prepare. Skills needed to prepare vegetables were not seen as a barrier (more than 70% of the women agreed that vegetables are easy to prepare) whereas time was seen as on obstacle. Indeed, half of Moroccan women agreed that it is time consuming to prepare vegetables; in addition 16.9% of Moroccan women agreed that they have no time to prepare vegetables.

Physical access to shops where fruit and vegetables can be bought was not seen as a barrier as around 80% of Moroccan respondents stated that fruit and vegetables can be bought close to where they live or work. Most women did not see concern about pesticides as an obstacle to fruit and vegetables consumption (Table 3.33).

There was much agreement that eating out of home was not a way of helping to eat more fruit or vegetables (Table 3.34).

There were agreement that fruit is easy to prepare; vegetables are available at home; fear of pesticides were not seen as a barrier to fruit and vegetable consumption and time was not reported as a barrier to fruit and vegetable consumption (Table 3.34).

Table 3.33 Control beliefs towards fruit and vegetables (n=894)

	Strongly Agree/ Agree	Neither agree/ Disagree	Disagree/ Strongly Disagree
		% [1]	
When I eat at home, I can eat more fruit	70.7	5.2	24.1
When I eat away from home, I can eat more fruit	11.7	5.6	82.8
Fruit is too expensive	68.5	15.1	16.3
Fruit can be brought in shops close to where I live or work	78.9	3.3	17.8
At home, fruit is always available	43.4	10.5	46.0
Fruit is easy to prepare	95.3	1.6	3.1
It is time consuming to prepare fruit	16.7	2.3	81.1
Fruit is cheap	16.7	19.7	63.6
If fruit was less expensive I would eat more	75.9	5.1	19.1
I do not eat fruit because they are full of pesticides	5.4	2.7	91.9
When I eat at home, I can eat more vegetables	77.2	4.9	17.9
When I eat away from home, I can eat more vegetables	8.3	4.0	87.7
I can eat more vegetables if they are well prepared	84.0	3.3	12.7
Vegetables are too expensive	63.0	15.7	21.3
Vegetables are easy to prepare	73.5	8.9	17.6
Vegetables can be brought in shops close to where I live or work	80.4	1.9	17.8
If vegetables were less expensive I would eat more	72.1	3.9	24.0
I have no time to prepare vegetables	16.9	5.0	78.1
It is time consuming to prepare vegetables	51.7	6.8	41.5
At home, vegetables are always available	82.3	6.0	11.7
I do not eat vegetables because they are full of pesticides	3.8	2.3	93.9
Vegetables are cheap	21.9	17.8	60.3

[1] weighted percentage

Table 3.34 Mean control beliefs towards fruit and vegetables (n=894)

	Mean[1]	1	2	3	4	5
When I eat at home, I can eat more fruit	2.1			♦		
When I eat away from home, I can eat more fruit	4.2					♦
Fruit is too expensive	2.0		♦			
Fruit can be bought in shops close to where I live or work	2.0		♦			
At home, fruit is always available	3.0			♦		
Fruit is easy to prepare	1.4					
It is time consuming to prepare fruit	4.2					♦
Fruit is cheap	3.9				♦	
If fruit was less expensive I would eat more	1.9		♦			
I do not eat fruit because they are full of pesticides	4.6					♦
When I eat at home, I can eat more vegetables	1.9		♦			
When I eat away from home, I can eat more vegetables	4.3					♦
I can eat more vegetables if they are well prepared	1.7		♦			
Vegetables are too expensive	2.2			♦		
Vegetables are easy to prepare	2.1			♦		
Vegetables can be brought in shops close to where I live or work	2.0		♦			
If vegetables were less expensive I would eat more	2.0		♦			
I have no time to prepare vegetables	4.1					♦
It is time consuming to prepare vegetables	2.9			♦		
At home, vegetables are always available	1.7		♦			
I do not eat vegetables because they are full of pesticides	4.7					♦
Vegetables are cheap	3.8				♦	

[1] weighted mean

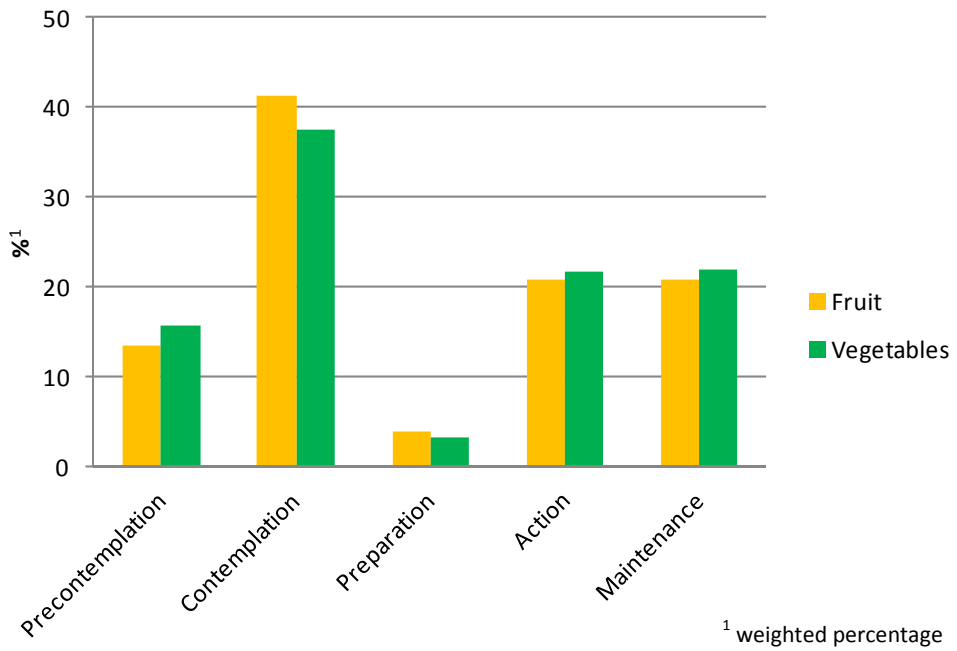
Intention to eat fruit and vegetables

Regarding fruit intake, more women stated that they were in the stage of contemplation (i.e. they were thinking about eating more fruit) than in the stages of preparation (i.e. they were definitely planning on eating more fruit) or action (i.e. they were trying to eat more fruit) (Figure 3.6). The same tendencies were observed for vegetables (Figure 3.6).

Whilst around one-quarter of women reported taking action to try and eat more fruit, fewer (20.7%) actually stated that they were already eating fruit at least twice a day (Figure 3.6). Around 40% of women were contemplating whether to change to eat more fruit.

Whilst around one-quarter of women reported taking action to try and eat more vegetables, only 21.9% actually stated that they were already eating vegetables at least 3 times a day (Figure 3.6). Around 40% of women were contemplating whether to change to eat more vegetables.

Figure 3.6 Stage of change regarding fruit and vegetable consumption (n=894)



3.3.7.2 Knowledge about fruit and vegetables

Of the three domains of knowledge assessed (fruit and vegetable food based guidelines, fruit and vegetable link with NCD and the nutrient value of fruit and vegetable) understanding was best for food based guidelines, as the mean percentage of correct answers was 46.2% (with a range between 8.4% and 73.3% (Table 3.35). Regarding this domain of knowledge, around three-quarters of the respondents knew that it was recommended to eat at least 5 fruit and vegetables per day, but also one-third of them were under the misconception that it is recommended to eat 5 fruit per day. Amongst these recommendations, only 8.4% of women knew that potatoes should not be counted as part of the 5 a day. Only one-third of women knew that almonds were not a fruit. Two-thirds of respondents knew that any kind of vegetables could be counted in the vegetable recommendations (not only dark green vegetables). The same tendency was observed for the item about yellow fruit.

The second domain of knowledge for which women scored the best was for nutrient values, as the mean percentage of correct responses was 41.4% with a range between 6.8% and 80.9% (Table 3.35). Overall knowledge was better understood for fruit than for vegetables (mean percentage of correct responses was 45.7% for fruit and 37.0% for vegetables).

Women scored less well regarding the link between fruit and vegetable and NCDs, (32.0% correct). Contrary to what was observed for knowledge about nutrient values, knowledge was better understood for the vegetables-NCD relationship than for the fruit-NCD relationship (mean percentage of correct answers was 35.7% for vegetables and 28.3% for fruit). Knowledge was better understood for fruit and vegetables-heart problems relationship and was the least understood for fruit and vegetables-cancers relationship.

The internal consistency which measured the reliability of each set of items in measuring each domain indicated that the overall item-to-item correlation was acceptable (α=0.84). Cronbach's α for knowledge of a link with NCDs as well as knowledge of nutrient value were above 0.80 (α=0.81 and α=0.83, respectively) (Table 3.35). Internal consistency for knowledge about food based dietary guidelines was below the suggested cut-off point of 0.7 (α=0.52). Even so, this domain of knowledge was retained because difficulty and item discrimination were convincing (except for the item 'Potatoes count as a vegetable').

Table 3.35 Percentage of correct answers, coefficient of Cronbach's α and item-to-item score correlation (n=894)

	%[1] of correct answer	Cronbach's α		item discrimination
Link with Non Communicable Diseases				
Low intake of fruit can contribute to heart problems	37.7	0.78		0.71
Low intake of fruit can contribute to obesity	21.5	0.78		0.70
Low intake of fruit can contribute to certain cancers	25.8	0.77		0.74
Low intake of vegetables can contribute to heart problems	46.5	0.78	0.81	0.72
Low intake of vegetables can contribute to obesity	27.9	0.78		0.68
Low intake of vegetables can contribute to certain cancers	32.7	0.77		0.74
Food based guidelines				
It recommended to eat at least 5 fruit daily	36.1	0.44		0.62
It is recommended to eat preferentially yellow fruit	56.9	0.46		0.55
It is recommended to eat only dark green vegetables	67.0	0.51		0.43
It is recommended to eat at least 5 fruit and vegetables a day	73.3	0.43	0.52	0.63
Amongst these 5 fruit and vegetables :				
Almonds count as a fruit	35.5	0.47		0.57
Potatoes count as a vegetable	8.4	0.51		0.41
Nutrient value				
Dried fruit are poor in vitamins	65.8	0.84		0.29
Fruit is low in vitamins	80.9	0.84		0.23
Fruit is high in calories	8.9	0.81		0.73
Fruit is low in fat	72.1	0.83		0.48
Fruit is high in protein	7.2	0.80		0.77
Fruit is high in fibre	39.6	0.80	0.83	0.78
Vegetables are high in fibre	43.6	0.80		0.79
Vegetables contain few vitamins	75.9	0.83		0.38
Vegetables are high in protein	6.8	0.81		0.73
Vegetables are high in calories	9.8	0.81		0.73
Canned vegetables have lost all their vitamins	9.9	0.84		0.41
Vegetables are low in fat	75.8	0.83		0.46

[1] weighted percentage

Seventeen of the 24 items fell within the recommended range of 20–80% of correct responses (Anderson, 2002). One of the remaining seven items was too easy (19.1% incorrectly answered 'fruit is low in vitamins') and six were too difficult (91.6% incorrectly answered 'Potatoes count as a vegetable', 91.1% incorrectly answered 'fruit is high in calories', 92.8% incorrectly answered 'fruit is high in protein', 93.2% incorrectly answered

'vegetables are high in protein', 90.2% incorrectly answered 'vegetables are high in calories' and 90.1% incorrectly answered 'Canned vegetables have lost all their vitamins') (Table 3.34). As the item 'fruit is low in vitamins' was very close to the recommended cut-off it was retained. All the items considered as too difficult, except the one about potatoes which was removed, were retained on the grounds of content validity.

Item discrimination ranged from 0.23 ('fruit is low in vitamins ') to 0.79 ('vegetables are high in fibre) (Table 3.35). All items had an item discrimination score correlation above 0.2, and therefore were considered as acceptable (Streiner and Norman, 2003).

The mean total knowledge score was 41.6/100 (Table 3.36). Women scored best for their knowledge about food based guidelines (mean score of 53.8) and scored least for their knowledge about the link between fruit and vegetables and NCD (mean score of 32.0/100).

Table 3.36 Knowledge scores (n=894)

	mean[1] ± se	[CI 95%]
Total score /100	41.6±0.9	39.9-43.3
Food based guidelines score /100	53.8±1.1	51.5-56.0
Nutrient value score /100	41.4±1.2	39.0-43.7
Link with NCD score /100	32.0±1.6	28.9-35.2

[1] weighted mean

All the different knowledge scores were highly and significantly associated with educational level of the women. Indeed, women with a higher level of education scored significantly better than women with a lower level of education, before and after adjustment. Similarly, women with higher economic status scored better than women with low or medium economic status for the total knowledge score, as well as the food guidelines score and the score about fruit and vegetables link with NCDs. However, the relationship between the food based guidelines score and the economic status was not robust to adjustment (Table 3.37).

An association between the nutrients value score and women's employment was found ($p<0.05$). Thus, women who were employed scored significantly higher than women without a job. This association was not robust when adjusted for potential confounding factors.

No association was found between employment or living area and the different knowledge scores (Table 3.37). Before adjustment, women aged between 30 and 39 years, had significantly better total knowledge score

($p<0.05$) and food based guidelines score ($p<0.05$) than the other respondents. However, all those associations did not remain after adjustment.

Marital status was not related with any of the different knowledge scores except for the score about fruit and vegetables link with NCD ($p<0.001$ after adjustment for all the socio-demographic variables of the model). Indeed, women who were married had a significant better score for this domain of knowledge (Table 3.37). The same tendency was observed for women without any children.

Table 3.37 Relationship between socio-demographic characteristics of women and knowledge scores (n=894)

		Total knowledge score /100				**Recommendations score** /100				**Link with NCD score** /100			
		univariate		**multivariate**		**univariate**		**multivariate**		**univariate**		**multivariate**	
	n	mean ± se	p^1	adjusted mean ± se	p^2	mean ± se	p^1	adjusted mean ± se	p^2	mean ± se	p^1	adjusted mean ± se	p^2
Age													
20-29y	255	42.9±1.22				55.6±1.13				28.8±2.17			
30-39y	313	43.4±1.21	*0.0109*		*0.1118*	55.6±1.45	*0.0406*		*0.3762*	34.5±2.28	*0.1219*		*0.1526*
40-49y	326	39.3±1.09				51.0±1.82				32.3±2.43			
Marital Status													
married	653	41.6±0.96	*0.901*		*0.0844*	53.5±1.30	*0.7264*		*0.597*	33.7±1.73	*0.0856*	33.4±1.67	*0.0004*
unmarried	241	41.7±1.30				54.2±1.67				28.8±2.50		28.4±2.36	
Number of children													
none	219	43.6±1.40				55.6±1.61				32.2±2.56		35.6±2.48	
1 or 2	336	41.4±1.09	*0.1619*		*0.3068*	54.3±1.61	*0.1435*		*0.8871*	28.9±2.01	*0.1947*	28.7±1.78	*0.0178*
3 and over	339	40.3±1.21				51.9±1.78				34.4±2.72		34.6±2.64	
Educational level													
none	351	36.6±1.04		36.8±0.99		49.3±1.84		49.6±1.78		34.1±2.46		34.2±2.38	
primary or partial secondary	409	42.7±0.98	*<0.0001*	42.8±0.93	*<0.0001*	56.8±1.42	*0.001*	56.9±1.33	*0.0149*	28.5±1.82	*0.0472*	28.7±1.78	*0.0396*
secondary/ university	134	52.5±1.74		52.7±1.66		57.2±1.79		57.0±1.83		36.5±3.37		36.8±3.13	
Employment													
employed	168	42.9±1.78	*0.3789*		*0.9911*	53.7±2.15	*0.9748*		*0.751*	29.4±2.88	*0.2729*		*0.3807*
unemployed	726	41.3±0.86				53.8±1.42				32.7±1.62			
Economic status													
high	323	47.1±1.29		47.3±1.11		57.2±1.71				33.1±2.45			
medium	274	40.1±1.14	*<0.0001*	40.5±1.05	*0.0002*	52.8±2.10	*0.0211*		*0.2567*	32.4±2.41	*0.5774*		*0.6365*
low	297	37.1±0.85		37.3±0.76		50.9±1.52				30.4±2.23			
Living area													
modern	178	43.2±1.50				52.4±2.10				30.8±2.16			
medina	557	40.9±1.04	*0.4343*		*0.4664*	53.3±1.42	*0.3335*		*0.1649*	31.29±2.16	*0.6607*		*0.7292*
precarious	159	42.6±2.36				57.1±2.52				35.1±4.13			

[1] crude associations ; [2] associations adjusted for all the variables of the model

There were two significant interactions regarding the nutrient value knowledge score: one between age and number of children (p=0.0138) which was not robust to adjustment (p=0.0573); and one between education and economic level (p=0.0004, before adjustment and p=0.0003, after adjustment). Hence, the score was disaggregated according to these interactions (Table 3.38). Thus, the number of children was a modifier of the effect of age on the nutrient value knowledge score. Indeed, the effect of age is different within the three categories of number of children. After adjustment, for women with one or two children as well as for women with three or more children, women between 30 and 39 years of age were more likely to score better. Similarly, economic status was a modifier of the effect of educational level on nutrient value knowledge score. Indeed, the effect of educational level is different within the three level of economic status. Thus, for women belonging to any of the economic classes, the most educated were more likely to have higher nutrient value score.

Table 3.38 Relationship between socio-demographic characteristics of women and nutrient value knowledge score (n=894)

			Nutrient value score/100			
			univariate		multivariate	
Explanatory terms	**Interactions terms**	n	mean ± se	p^1	adjusted mean ± se	p^2
Number of children	**Age**					
none	20-29y	117	48.3±2.44		48.4±1.91	
	30-39y	65	40.1±2.72	*0.0171*	40.8±2.00	*0.3744*
	40-49y	37	38.7±4.00		39.5±3.27	
1 or 2	20-29y	119	40.9±1.96		40.5±1.61	
	30-39y	130	45.9±1.67	*0.0166*	46.5±1.41	*0.0153*
	40-49y	87	38.9±3.04		38.5±2.02	
3 and over	20-29y	19	33.3±3.55		33.3±2.24	
	30-39y	118	41.7±1.80	*0.0614*	41.9±1.39	*0.045*
	40-49y	202	37.4±1.49		38.2±1.19	
Marital Status						
married		653	40.5±1.28	*0.1875*		*0.7578*
unmarried		241	43.0±1.71			
Economic status	**Educational level**					
high	none	58	33.0±1.69	*<0.0001*	33.1±1.66	*<0.0001*
	primary to university	265	53.8±1.69		53.9±1.60	
medium	none	110	32.4±1.52	*<0.0001*	32.5±1.55	*0.0005*
	primary to university	164	43.6±1.40		43.8±1.37	
low	none	183	32.4±1.63	*0.012*	32.5±1.41	*0.0068*
	primary to university	114	38.5±1.53		38.4±1.53	
Employment						
employed		168	45.1±2.28	*0.0393*		*0.1699*
unemployed		726	40.4±1.13			
Living area						
modern		178	45.6±2.57			
medina		557	41.4±1.33	*0.2120*		*0.3328*
precarious		159	40.3±2.47			

[1] crude associations

[2] associations adjusted for marital status, employment, living area and the interaction education#economic level

A significant association was observed between overall knowledge and the consumed amount of fruit, vegetables and fruit and vegetables eaten considered together ($p<0.001$, $p<0.05$ and $p<0.001$, respectively) (Table 3.39). Indeed, women with better knowledge consumed significantly more fruit and vegetables. The association between knowledge and vegetable consumption did not remain after adjustment for education and economic level (Table 3.39).

Table 3.39 Relationship between knowledge scores and fruit and vegetable consumption, data based on FFQ (n=894)

			Fruit (g/day)				**Vegetables** (g/day)			**Fruit and vegetables** (g/day)			
			univariate		**multivariate**		**univariate**		**multivariate**	**univariate**		**multivararate**	
	n	% ± se	mean ± se	p^1	adjusted mean ± se	p^2	mean ± se	p^1	p^2	mean ± se	p^1	adjusted mean ± se	p^2
Score													
low	351	39.9±2.4	85±5.4		85±5.1		97±4.7			181±7.8		181±7.8	
medium	259	29.7±2.0	98±7.7	*0.0001*	100±7.1	*0.0113*	112±9.1	*0.0004*	*0.0702*	211±14.5	*<0.0001*	212±13.2	*0.0082*
high	284	30.4±2.3	129±8.3		129±6.6		126±6.4			255±12.2		255±9.9	

[1] crude associations
[2] associations adjusted for education and economic level

3.3.7.3 Theory of Planned Behaviour model

The overall internal consistency for self-efficacy towards fruit and vegetables was low (Cronbach's α of 0.32 and 0.39, respectively). As a consequence, the perceived behavioural control construct was removed from analysis. Finally, from the original framework of the Theory of Planned Behaviour only behavioural, normative and control beliefs constructs, which were respectively the determinants of attitude, subjective norm and perceived behavioural control, were retained. External variables, such as age, education, knowledge and economic level were included into the model as they were potentially related to these determinants.

Behavioural Beliefs (BB) towards fruit was significantly correlated with age ($r=0.17$, $p<0.001$), knowledge ($r=0.29$, $p<0.001$), education ($r=-0.08$, $p<0.05$) and Control Beliefs (CB) ($r=0.16$, $p<0.001$) (Table 3.40). Knowledge was the strongest predictor ($\beta=0.31$; $p<0.0001$) whilst having a medium level of education was the weakest predictor ($\beta=-0.12$; $p=0.001$). Overall these determinants explained 15% of the variance in BB (Figure 3.7).

CB towards fruit was significantly correlated with age ($r=-0.12$, $p<0.001$), knowledge ($r=0.22$, $p<0.001$), education ($r=0.21$, $p<0.001$), economic level ($r=-0.26$, $p<0.001$) and BB (Table 3.40). Belonging to the low economic class was the strongest predictor ($\beta=-0.24$; $p<0.0001$) whilst having a medium level of education was the weakest predictor ($\beta=0.10$; $p=0.007$). Overall these determinants explained 12% of the variance in CB (Figure 3.7).

Intention to eat fruit was significantly correlated with BB ($r=0.07$, $p<0.05$), Normative Beliefs (NB) ($r=0.08$, $p<0.05$), and CB (($r=0.25$, $p<0.001$) (Table 3.39). CB was the strongest predictor of Intention ($\beta=0.25$; $p<0.0001$), NB was the weakest predictor of Intention ($\beta=0.09$; $p=0.006$) and BB was not a significant predictor of Intention ($\beta=0.03$; $p=0.365$). Overall all these constructs explained 7% of the variance in Intention which was equated to a small effect size ($f^2=0.08$) (Figure 3.7).

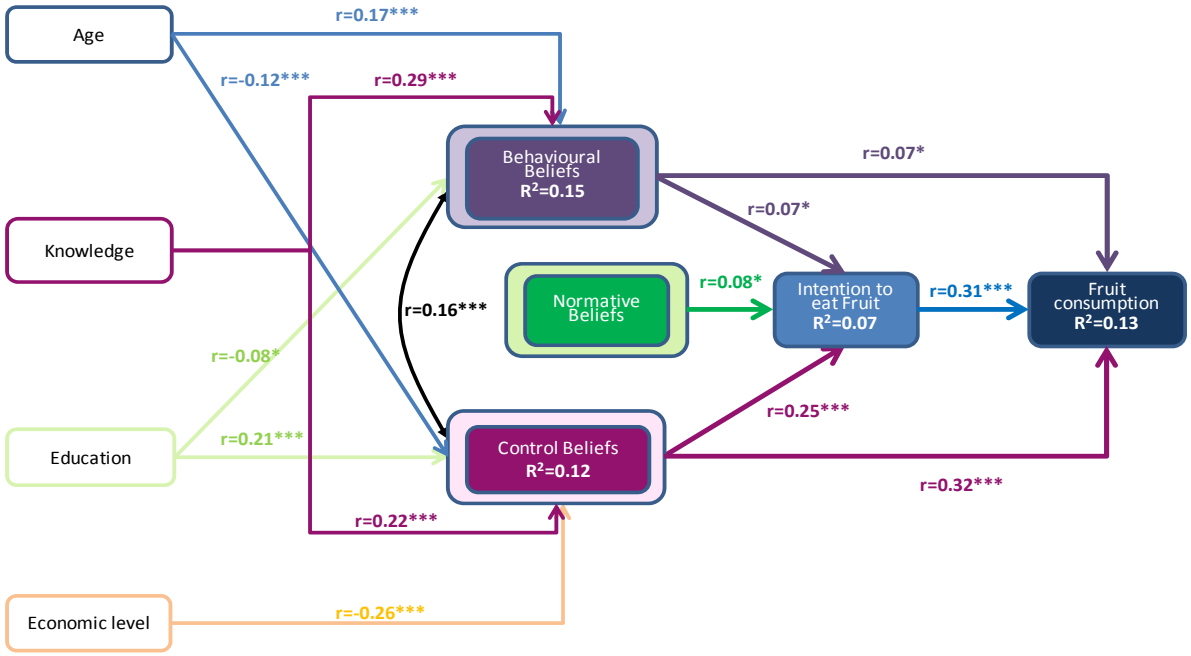
Fruit consumption was significantly correlated with BB ($r=0.07$, $p<0.05$), CB ($r=0.32$, $p<0.001$), and Intention ($r=0.32$, $p<0.001$), (Table 3.39). Intention was the strongest predictor ($\beta=0.25$; $p<0.0001$) and CB was the weakest predictor ($\beta=0.20$; $p<0.0001$). BB was not a significant predictor of fruit consumption ($\beta=-0.06$; $p=0.054$). Overall all these constructs explained 13% of the variance in fruit consumption which was equated to a medium effect size ($f^2=0.15$) (Figure 3.7).

Table 3.40 Correlation matrix for fruit (n=894)

	Consumption	Intention	Behavioural Beliefs	Normative Beliefs	Control Beliefs	Knowledge	Age	Education	Economic level
Consumption	1.0000								
Intention	0.311***	1.0000							
Behavioural Beliefs	0.0678*	0.069*	1.0000						
Normative Beliefs	-0.0412	0.0821*	0.0472	1.0000					
Control Beliefs	0.3157***	0.2519***	0.1574***	0.0281	1.0000				
Knowledge	0.2064***	0.1234***	0.2936***	-0.0384	0.2151***	1.0000			
Age	-0.0918**	-0.0824*	0.167***	0.0166	-0.1245***	0.0029	1.0000		
Education	0.2648***	0.2142***	-0.075*	0.0220	0.2088***	0.2525***	-0.2532***	1.0000	
Economic level	-0.303***	-0.2735***	-0.0243	-0.0227	-0.2648***	-0.2213***	0.0455	-0.4422***	1.0000

* p<0.05; **p<0.01; ***p<0.001

Figure 3.7 Path analysis for fruit consumption (n=894)



* p<0.05; **p<0.01; ***p<0.001

BB towards vegetables was significantly correlated with age (r=0.17, p<0.001), knowledge (r=0.23, p<0.001), NB (r=0.08, p<0.05) and CB (r=0.21, p<0.001) (Table 3.41). Being between 30 and 49 years was the strongest predictor (β=0.24; p<0.0001) and NB was the weakest predictor (β=0.09; p=0.004). Overall these determinants explained 13% of the variance in BB towards vegetables (Figure 3.8).

NB towards vegetables was significantly correlated with education (r=0.07, p<0.05) and BB. However BB was the only significant predictor of NB (β=0.09; p=0.008).

CB towards vegetables was significantly correlated with knowledge (r=0.18, p<0.001), economic level (r=-0.13, p<0.001) and BB (r=0.21, p<0.001) (Table 3.41). BB was the strongest predictor (β=0.17; p<0.0001) whilst belonging to the low economic class was the weakest predictor (β=-0.10; p=0.007). Overall these determinants explained 8% of the variance in CB (Figure 3.7).

Intention to eat vegetables was significantly correlated with NB (r=0.11, p<0.01) and CC (r=0.12, p<0.001) (Table 3.40). NB and CB predicted Intention in the same way (β=0.12, p<0.0001 and β=0.11, p=0.001, respectively). BB was not a significant predictor of Intention (β=-0.05, p=0.178). Overall all these constructs explained 2% of the variance in Intention which was equated to a small effect size (f^2=0.02) (Figure 3.8).

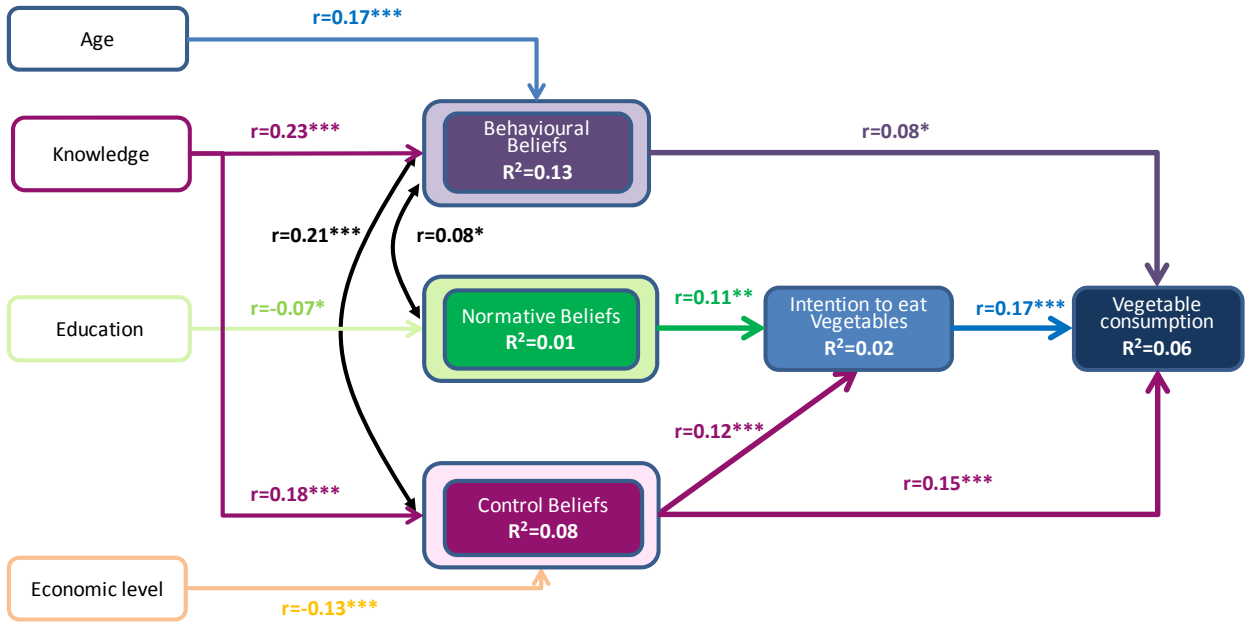
Vegetable consumption was significantly correlated with Intention (r=0.17, p<0.001), BB (r=0.08, p<0.05) and CB (r=0.15, p<0.001) (Table 3.39). Intention was the strongest predictor (β=0.17, p<0.0001) and CB was the weakest predictor (β=0.13, p<0.0001). BB was not a significant predictor of vegetable consumption (β=0.06, p=0.083). Overall all these constructs explained 6% of the variance in vegetables consumption which was equated to a small effect size (f^2=0.06) (Figure 3.8).

Table 3.41 Correlation matrix for vegetables (n=894)

	Consumption	Intention	Behavioural Beliefs	Normative Beliefs	Control Beliefs	Knowledge	Age	Education	Economic level
Consumption	1.0000								
Intention	0.1650***	1.0000							
Behavioural Beliefs	0.0818*	-0.0200	1.0000						
Normative Beliefs	-0.0130	0.1094**	0.0773*	1.0000					
Control Beliefs	0.1518***	0.1208***	0.2102***	0.0432	1.0000				
Knowledge	0.1597***	0.0668*	0.2303***	0.0400	0.1807***	1.0000			
Age	-0.0151	0.0181	0.1676***	-0.0380	-0.0011	-0.0600	1.0000		
Education	0.1836***	0.1374***	-0.0457	0.0663*	0.0098	0.3389***	-0.2532***	1.0000	
Economic level	-0.1994***	-0.1559***	-0.0497	-0.0501	-0.1306***	-0.2972***	0.0455	-0.4422***	1.0000

* p<0.05; **p<0.01; ***p<0.001

Figure 3.8 Path analysis for vegetable consumption (n=894)



* p<0.05; **p<0.01; ***p<0.001

3.3.8 Fruit and vegetable consumption, weight status and diet-related non communicable diseases

To answer the research questions (v) outlined in section 1.3, the relationship between fruit and vegetable consumption and anthropometric status, as well as diabetes, high blood pressure and metabolic syndrome were investigated.

3.3.8.1 Overall fruit and vegetable consumption

There was no association for the overall daily amount of fruit and vegetable consumed and anthropometric status (BMI and abdominal obesity), High Blood Pressure, diabetes, or metabolic syndrome (dtat not shown). When women were classified into two classes according to the WHO recommendations for fruit and vegetable consumption (i.e. ≥400g) the p-values associated with the odds ratio were not significant for anthropometric status as well as for all diseases investigated. This meant that women who <400g of fruit and vegetable per day were not significantly more at risk of being obese or developing these diseases (Table 3.42).

Table 3.42 Relationship between fruit and vegetable consumption and nutritional status and diet-related NCDs, data based on FFQ

Obesity (n=894)								
				univariate			**multivariate**	
F&V[1] (g/day)	yes	no	OR	[95%CI]	p^2	adjusted OR	[95%CI]	p^3
<400	271	540	1.61	0.82-3.19	*0.164*	1.46	0.74-2.88	*0.263*
≥400	20	63	1					
Abdominal obesity (n=894)								
				univariate				**multivariate**
	yes	no	OR	[95%CI]	p^2			p^3
<400	354	457	1.49	0.95-2.33	0.079	1.38	0.88-2.17	0.154
≥400	28	55	1					
High Blood Pressure (n=894)								
				univariate				**multivariate**
	yes	no	OR	[95%CI]	p^2			p^3
<400	205	606	1.04	0.55-1.98	0.893	0.93	0.47-1.87	0.845
≥400	18	65	1					
Diabetes (n=812)								
				univariate				**multivariate**
	yes	no	OR	[95%CI]	p^2			p^3
<400	50	685	0.95	0.30-2.96	0.925	0.82	0.20-3.32	0.771
≥400	4	73	1					
Metabolic syndrome (n=811)								
				univariate				**multivariate**
	yes	no	OR	[95%CI]	p^2			p^3
<400	260	474	1.22	0.66-2.25	0.506	1.16	0.28-2.30	0.672
≥400	23	54	1					

[1] fruit and vegetable intakes ; [2] crude associations

[3] associations adjusted for: age, marital status, employment, number of children , education, living area, economic level & physical activity level

3.3.8.2 Fruit and vegetable scores

No relationship between diversity (FDS, VDS or FVDS) with BMI, abdominal obesity, High Blood Pressure, diabetes or metabolic syndrome were found (data not shown).

No relationship was found between the FVQI and anthropometric status or diet-related NCDs (adjusted p-values range from 0.095 for diabetes to 0.978 for obesity) (data not shown). No relationship was found between FVQI≥6 and anthropometric status or diet-related NCDs except for diabetes. Indeed, women who scored <6 points, were more likely to have diabetes than other women (adjusted OR=2.58, p<0.05) (Table 3.43).

Table 3.43 Relationship between Fruit and Vegetable Quality Index nutritional status and diet-related NCDs, data based on 24-hr

Obesity (n=855)								
			univariate			**multivariate**		
	yes	no	OR	[95%CI]	p^1	adjusted OR[2]	[95%CI]	p^2
FVQI<6	201	410	0.96	0.64-1.45	*0.854*	1.05	0.69-1.59	*0.824*
FVQI≥6	81	163	1					
Abdominal obesity (n=855)								
			univariate			**multivariate**		
	yes	no	OR	[95%CI]	p^1	adjusted OR[2]	[95%CI]	p^2
FVQI<6	272	339	1.29	0.85-1.98	*0.249*	1.56	0.97-2.53	*0.069*
FVQI≥6	97	147	1					
High Blood Pressure (n=855)								
			univariate			**multivariate**		
	yes	no	OR	[95%CI]	p^1	adjusted OR[2]	[95%CI]	p^2
FVQI<6	157	454	1.02	0.65-1.59	*0.931*	1.10	0.69-1.76	*0.677*
FVQI≥6	59	185	1					
Diabetes (n=778)								
			univariate			**multivariate**		
	yes	no	OR	[95%CI]	p^1	adjusted OR[2]	[95%CI]	p^2
FVQI<6	45	506	2.27	0.96-5.40	*0.062*	2.58	1.10-6.04	*0.030*
FVQI≥6	8	219	1					
Metabolic syndrome (n=777)								
			univariate			**multivariate**		
	yes	no	OR	[95%CI]	p^1	adjusted OR[2]	[95%CI]	p^2
FVQI<6	196	355	1.11	0.69-1.78	*0.653*	1.28	0.77-2.10	0.333
FVQI≥6	77	149	1					

[1] associations adjusted for energy

[2] associations/OR adjusted for age, marital status, employment, number of children, education, living area, economic level & physical activity level

Chapter 4: Discussion

The present study aimed to develop and validate a brief quantitative fruit and vegetable FFQ in order to measure fruit and vegetable intakes, to investigate the quality of fruit and vegetable intakes, as well as to explore potential determinants of fruit and vegetable consumption, such as socio-demographic determinants, eating behaviours and psychosocial determinants. To a lesser extent, this study also aimed to investigate the overall diet quality and the relationship between fruit and vegetable intakes and both weight status and diet-related NCDs.

Fruit and vegetable FFQ validation

One of the objectives of this study was to develop and validate a short quantitative Food Frequency Questionnaire that with a moderate number of fruit and vegetables items (n=8), would give an accurate measure of fruit and vegetable intakes. The validity of the present FFQ was assessed by evaluating both reproducibility and relative validity. Reproducibility was assessed by repeating the same FFQ twice on the same subjects. The relative validity was assessed by comparing intakes from the FFQ with intakes from the three 24-hour recalls.

As advocated by Cade *et al.*, (2002), the reproducibility was assessed by computing Spearman's correlation coefficients, IntraClass Correlation coefficients, as well as weighted Kappa.

The mean fruit and vegetable daily intakes from FFQ2 was higher than mean fruit and vegetable daily intakes from FFQ1 (375g/day and 344g/day, respectively). The greatest difference between the two FFQs was observed for vegetables.

The Spearman's correlation coefficients between the repeated FFQs ranged from 0.48 for vegetables to 0.56 for fruit and vegetables combined, indicating a moderate relationship between the two FFQs. The ICC coefficients ranged from 0.47 for vegetables to 0.71 for fruit. The ICC for fruit and vegetable considered together was 0.68 indicating good reproducibility of the fruit and vegetable FFQ developed. Most of the short fruit and vegetable FFQs validation studies conducted previously investigated validity but not reliability (Thompson *et al.,* 2000; Warneke, *et al.*, 2001; Traynor *et al.*, 2006). However, some studies assessing reliability reported either Pearson or Spearman's correlation coefficients ranging from 0.44 to 0.90 (Lechner *et al.*, 1997; Smith-Warner *et al.*, 1997; Ling *et al.*, 1998; Cullen *et al.*, 1999). Other studies also reported ICC as a way to assess reliability that ranged from 0.49 to 0.65 and

were higher for fruit compared to vegetables (Cullen *et al.*, 1999; Mohammadifard *et al.*, 2011). As for the present study, results from these previous studies led to the conclusion that compared to vegetables, reliability was higher for fruit. This finding may result from the fact that usually fruit is eaten in ready-made portions.

The proportion of subjects classified into the same tertile ranged from 59% for fruit to 42% for vegetables; the proportion of subjects grossly misclassified ranged from 8% for fruit to 10% for vegetables; the weighted Kappa ranged from 0.24 for vegetables to 0.43 for fruit. Once again, these results suggested that reliability was higher for fruit than for vegetables (Masson *et al.*, 2003).

Altogether, these results indicated an acceptable reliability of the FFQ to measure consumption of either fruit or fruit and vegetable considered together, and a moderate reliability of the FFQ to measure vegetable intake.

As advocated by Cade *et al.*, (2002), the relative validity of the developed fruit and vegetable FFQ was assessed by computing Spearman's correlation coefficient, Wilcoxon signed-rank test, as well as Bland and Altman plots.

The Spearman correlation coefficients ranged from 0.48 for vegetables to 0.69 for fruit and vegetables and were within the range of what was found in other studies focusing on the same topic. Indeed, according to a review conducted by Kim and Holowaty (2003) over ten brief fruit and vegetable FFQ validation studies, overall Pearson and Spearman correlation coefficients ranged from 0.29 to 0.80. According to Willett (1994), when FFQs are compared to other dietary assessment reference methods, correlation coefficients should be ≥0.6, suggesting that the relationship between the FFQ and the 24-hour recalls is stronger for fruit and fruit and vegetables combined and not acceptable for vegetables.

Compared to the 24-hour recalls, the fruit and vegetable FFQ developed for the present study slightly underestimated fruit and vegetable intakes. Significant intakes differences between the two methods were found for vegetable or fruit and vegetables combined, but not for fruit. However these differences were considered acceptable.

In their review, Kim and Holowaty (2003), reported inconsistencies regarding misreporting attributable to the FFQ. Indeed, means fruit and vegetable intakes measures by FFQs were either under- or over-reported compared to the reference methods.

The 95% limits of agreement calculated by computing Bland and Altman procedures (Bland and Altman, 1999) for fruit and vegetables combined were rather large and were larger for fruit compared to vegetables. Therefore, the brief FV-FFQ cannot be considered as an acceptable tool to measure overall fruit and vegetable intakes at the individual level. Contrary to what is advocated within the literature (Cade *et al.*, 2002), few studies used the Bland and Altman procedures to assess brief fruit and vegetables FFQ validity. However, in a study investigating the validity of a short fruit and vegetable FFQ, Ling *et al.*, (1998) reported wide limit of agreements which corresponded to about 1.25 servings that led the authors to conclude that their FFQ was not an acceptable tool to measure individual intakes, as for the present study.

The amount of fruit consumed was estimated slightly more accurately than the amount of vegetables consumed. In a study that investigated precision and bias of food frequency based measures of fruit and vegetables intakes, Kristal *et al.*, (2000) reported the same finding, i.e. precision of measuring fruit intake was usually higher than precision of measuring vegetable intake. In the present study, this constitutes an expected finding, because usually in Morocco fruit is consumed on its own, whereas vegetables are consumed along with other foods and in a common dish. Therefore the estimation of the portion size for vegetables is more difficult than for fruit. In addition, the amount of vegetables consumed was estimated using photographs of portion size presented on an individual plate, whilst most women ate them in a shared dish.

Overall, the results suggested that the short quantitative fruit and vegetable FFQ developed for the present study is a reliable and valid tool to measure mean fruit and vegetable intakes combined rather than considered separately, at the population level, but not at the individual level. Hence, this brief tool might constitute an alternative method to measure fruit and vegetable intakes that is less burdensome for both respondents and researchers compared to the 24-hour dietary recall.

Some limitations were associated with this validation study. Indeed, this questionnaire was designed to be administered by well trained interviewers and therefore may not be suitable to be self-administrated. In the same way, this FFQ has been developed and validated for woman in childbearing age living in urban areas and might be not suitable for use in a different context with different subjects.

Furthermore, when investigating the reproducibility of FFQs the time interval between the two repeated FFQs should not be too short (Cade *et al.*, 2002). In the case of the present study, due to logistical constraints, the time

interval between FFQ1 and FFQ2 was only five days whilst it should have been 7 days at least. Hence, this short time interval could have overestimated the reliability of the measure as respondents may have remembered earlier answers. In addition, only one aspect of the reliability was investigated. Indeed, the intra-rater reliability, which measures whether a repeated administration of the questionnaire by the same interviewer yields the same answers, was assessed whilst the inter-rater reliability was not assessed.

Another limitation associated with the present FFQ is misreporting. Misreporting can be due to the subject or to the tool itself. Regarding the subject there is a potential memory bias associated with such a retrospective method (Gibson, 2005). This type of bias includes both errors of omission and errors of commission, i.e. when respondents declare food that they have actually not eaten. Moreover, it has been well described within the literature that depending on its length, FFQs can lead either to under- or over-reporting. Hence, the longer the food list, the more likely that intake will be overestimated, and inversely, the shorter the list, the more likely that intake will be underestimated (Cade *et al.*, 2002). In the case of the present study, the fruit and vegetable FFQ was short and based on 8 items and that may explain why, compared to the 24-hour recalls, the FFQ slightly under-estimated fruit and vegetable intakes.

Even if this validation study showed that the brief fruit and vegetable FFQ developed is a valid tool to measure fruit and vegetable intakes, it is worth noting that validation was based on another dietary assessment method (24-hour recall) that is subject to measurement errors and bias. Therefore, to reinforce the validity of the present FFQ, it would be also interesting to investigate a biomarker, such as plasma vitamin C, which is the most related biomarker to fruit and vegetable intakes (Block *et al.*, 2001).

To assess the relative validity of the brief fruit and vegetable FFQ, classification of individuals was not investigated. Indeed, one of the objectives of the present study was to develop and validate a short FFQ that would give an accurate measure of absolute rather than relative intake. In other words, ranking individuals according to their levels of consumption was out of scope. Moreover, according to De Moor *et al.*, (2003) current dietary assessment methods are not reliable enough to correctly classify individuals and misclassification only becomes negligible for correlations above 0.9, which is very uncommon for dietary studies.

Fruit and vegetable intake and overall dietary quality

The Mean daily fruit and vegetable intake, was 213g. Almost three-quarters of women were considered as low consumers because they consumed <280g/day, and only one out of ten ate ≥400g/day, i.e. met the WHO recommendations. In comparison, in high-income country such as the US, less than one-third of adults ate the daily recommended amount of fruit and vegetables (26.3% ate ≥3 servings of vegetables and 32.5% ate ≥2 servings of fruit) (CDC, 2010). In Brazil, a country ongoing the nutrition transition and with higher economic development compared to Morocco, one in five adults met the WHO daily recommendations (20.5% of women) (Ministério da Saude, 2010). It is worth noting that these results are based on different dietary assessment methods and therefore are not completely comparable. As there is no previous data on fruit and vegetable intake in Morocco, it is impossible to establish a fruit and vegetable consumption trend. Within the next years, with increasing economic development the amount of fruit and vegetables consumed in Morocco might increase, as reported in South Korea (Lee *et al.*, 2002) or decrease, as reported in Brazil (Ministério da Saude, 2006 and 2010) or the Philippines (Food and Agriculture Organization, 2006).

Almost all the women in the sample stated that they consume more fruit during summer compared to the rest of the year because during summer fruit is more available and cheaper. Considering season, the same kind of findings was reported in low-income countries such as Sub-Saharan African countries (Ruel *et al.*, 2006). On the other hand, in high-income countries season was inconsistently associated with fruit and vegetable consumption (Kamphuis *et al.*, 2006; Kamphuis *et al.*, 2007). However, it is worth noting that this study was interrupted from July to September because during summer holidays, many Moroccans are hard to find at home and also because of Ramadan, during which intake is atypical. Therefore it might be possible that fruit intake has been slightly underestimated. Hence, in order to have a better accurate of the estimates of fruit intakes, it would be better to capture seasonality, i.e. conduct survey also during summer if there is no Ramadan, even if people are harder to find at this time of the year.

According to data from the 24-hour recall, fruit and vegetables (beans and pulses included) contributed 10% of the daily energy intake of women, 35.5% of fibres intake, 63.6% of vitamin C, 41.8% of vitamin A and 34% of vitamin B9 and potassium intakes. Therefore, fruit and vegetables are the most important source of vitamin C in the diet.

The Mean Fruit and Vegetable Diversity Score, representing the number of different fruit and vegetables consumed during the previous day, was relatively low (2.3), with the number of vegetables higher than the

number of fruit consumed (1.4 and 0.9, respectively). The mean Fruit and Vegetable Quality Index was 3.7 out of 10 possible points. Women scored slightly higher for the *diversity* score component than for the *recommendations* component. Only slightly more than one-quarter of women had a good FVQI, i.e. they scored ≥6 points. Most studies that have investigated fruit and vegetable intakes have focused on the amount consumed rather than on the number consumed. Few studies have investigated fruit and vegetable diversity (Jansen *et al.*, 2004; Thompson *et al.*, 2006; Bhupathiraju and Tucker, 2011) but the results were expressed in a way that made no comparison possible with the present study.

Contrary to other studies where one eating occasion was assimilated to one portion (Yarnell *et al.*, 1983; BRFSS, 1998; Thompson *et al.*, 1999), in the present context one eating occasion could not be assimilated to one portion. Indeed, from the amount and frequency of fruit and vegetables consumed during the previous week the daily mean portion size was 2.7. When considering that one occasion=one serving, then the Mean daily number of portion size would have been 1.7. Moreover, when looking into more detail at the weight of Mean portion sizes of fruit and vegetables, based on data from the 24-hour recall, the weight of a Mean fruit portion size was 155g, i.e. twice the weight of a reference portion size, and the weight of a Mean vegetable portion size was 39g, i.e. half the weight of a reference portion size. These findings led to the conclusion that, in the present context when investigating fruit and vegetable intakes, the amount consumed should be recorded in addition to frequency.

The overall diet quality was investigated by looking into details at nutrient intakes and by computing a Dietary Diversity Score, as well as the Diet Quality Index-International developed by Kim *et al.* (2003).

Overall the diet of Moroccan women was well balanced in terms of energy coming from macronutrients. Women did not cover their needs for fibres, calcium, iron, zinc, vitamin B9 and vitamin B12 and they consumed too much sodium.

The mean number of different food groups consumed daily was 8.4 out of the eighteen possible. The maximum number of food groups consumed was fifteen. The percentage of women consuming each food group reflected the dietary patterns of Moroccan women. Indeed the most commonly consumed food groups were cereals, vegetable oils, sugar, vegetables, meat, fruit and root vegetables. Traditionally in Morocco, the main dish consumed

daily is basically made up of vegetables, vegetable oil, potatoes and meat, and is consumed with bread. In the same way, Moroccans traditionally drink tea or coffee with milk in which they add sugar. This DDS was computed because several studies have shown that high diversity diets are accompanied by positive health outcomes (Kant *et al.*, 1993; Kant *et al.*, 1995; Bernstein *et al.*, 2002) and that diversity in certain context was a good proxy of both overall diet quality and nutrient adequacy (Torheim *et al.*, 2004; Savy *et al.*, 2005; Steyn *et al.*, 2006). The total number of food groups used in this study, that was based on the nine food groups recommended by the FAO, the IFPRI and the WHO (Food and Agriculture Organization/International Food Policy Research Institute/World Health Organization, 2004) and adapted to the Moroccan context, did not allow any comparison with what was found within the literature.

The Mean DQI-I was 57.9/100 and it indicated that 43.2% of Moroccan women had a good quality diet. Women scored best for the *adequacy* component and least for the *overall balance* component. The DQI-I has been calculated for adults of both sex living in different contexts, such as the US, China, and the Balearic Islands (Kim *et al.*, 2003; Tur *et al.*, 2005). The mean DQI-I observed in China and in the US was higher than in Morocco, whereas it was lower for subjects in the Balearic Islands. In China, subjects scored best for *adequacy*, then *moderation*, then *variety* and scored worse for *overall balance*. The exact same pattern was observed for Moroccan women. In the US, as well as in the Balearic Islands, subjects scored best for *variety* and *adequacy* and worse for *moderation* and *overall balance*. Therefore, in Morocco, one can assume that with growing economic development, variety will increase whereas moderation will decrease.

Investigating the relationship between fruit and vegetable intake and the modified DQI-I, highlighted the fact that these two variables were highly and positively related, indicating that Moroccan women who ate more fruit and vegetables had a healthier diet overall. In the literature, fruit and vegetable consumption has often been associated with a healthy lifestyle. Several studies have also concluded that subjects who consumed larger amounts of fruit and vegetables were more likely to have a healthy diet, to be non smokers, to be physically active and to be moderate alcohol drinkers (Trudeau *et al.*, 1998; Friel *et al.*, 2005; Estaquio *et al.*, 2008; Mirmiran *et al.*, 2009; Azagba and Sharaf, 2011; Bhupathiraju and Tucker, 2011).

All the scores and indices developed for the present study were based on data collected from a single 24-hour recall. Therefore, the interpretation of results should be treated with caution, since a single 24-hour recall gives no

information on intra-individual variability in food intakes, and then it is less likely to reflect true long-term individual intakes (Willett, 1998). Moreover, the assessment of the amount of food consumed was based on photographs of food portion size presented in an individual plate whereas Moroccan women traditionally eat in a shared dish. As a consequence, this may have introduced a bias in the reported amount of food consumed.

Factors influencing fruit and vegetable consumption

The core objective of the present study was to investigate the determinants of fruit and vegetable consumption. Hence, two kinds of determinants were investigated: firstly sociodemographic determinants, such as age, marital status, education, economic level; and secondly psychosocial determinants, such as knowledge, beliefs and intention to eat more fruit and vegetables.

In terms of socio-demographic variables, fruit, vegetables and fruit and vegetables combined were positively and independently associated with both education and economic status. Indeed, women with higher economic status, as well as women with higher education ate more fruit and vegetables. In terms of economic status, this finding was supported by data from the focus group discussions and findings from the control beliefs constructs. From the focus groups, women from low socio-economic status reported that fruit and vegetable consumption depended on household income, particularly fruit intake. For these women, the main barrier to fruit and vegetable consumption was cost, this being more marked for fruit than for vegetables because in Morocco most fruit are more expensive than vegetables. Survey data found that about two-thirds of women agreed that fruit and vegetables are too expensive and about three-quarters agreed that if fruit and vegetables were less expensive, they would eat more. Most studies that investigated the socio-demographic determinants of fruit and vegetable consumption, out in different contexts, reported the same trends, i.e. individuals with higher education and economic status had higher fruit and vegetable intakes (Johansson and Andersen, 1998; Ball *et al.*, 2006; Ricciuto *et al.*, 2006; Elfhag *et al.*, 2008; Estaquio *et al.*, 2008; Hall *et al.*, 2009; Lallukka *et al.*, 2010). Contrary to what was observed in the present study, in the literature, several studies reported associations between age or marital status and fruit and vegetable consumption. Concerning age, and depending on the context, associations were inconsistent. Indeed, some studies led to the conclusion that older individuals ate more fruit and vegetables (Agudo and Pera, 1999; Estaquio *et al.*, 2008; Azagba and Sharaf, 2011) whereas other studies reported the opposite (Hall *et al.*, 2009; CDC, 2010; Esteghamati *et al.*, 2011). Marital status has also been reported as a determinant of fruit and vegetable

intake. Indeed, two systematic reviews investigating studies that focused on determinants of fruit and vegetable consumption reported consistent findings about marital status. According to these reviews, married individuals were more likely to consume more fruit and vegetables compared to single people (Pollard *et al.*, 2002; Kamphuis *et al.*, 2006). The differences may be cultural, given that in Morocco, single people tend to stay living within families until they are married.

As for the amount of fruit and vegetable consumed, Fruit Diversity Score, Vegetable Diversity Score, as well as Fruit and Vegetable Diversity Score were positively related to economic status. In a study conducted amongst Australian adults, the same finding was reported by Giskes *et al.,* (2002) for fruit, as well as for vegetables. In another study conducted amongst French adults, Estaquio *et al.*, (2008) reported different patterns. Indeed in this study, whereas fruit variety was positively associated with marital status, vegetable variety was positively related to age, education and marital status. In the present study, Fruit Diversity Score was related to education and economic level, economic status acting as a modifier of the effect of education on Fruit Diversity Score. Indeed, in the low economic group the most educated women had higher Fruit Diversity Score. This finding suggests that to increase fruit diversity a programme that would focus on the less educated women amongst the poorest woud have a great impact.

As FVQI did not bring additional discrimination, these results suggest that a simple score, such as the FVDS is probably sufficient to measure the quality of fruit and vegetable intakes and to discriminate subjects, compared to a more complex index.

This study also investigated the relationship between certain eating behaviours, such as processed food consumption, eating in a shared dish, eating out of home and their potential impact on fruit and vegetable consumption.

The processed foods identified for the present study were biscuits, meat products, processed cheese, yogurts and soft drinks. These food items were investigated because they were emblematic of more modern dietary patterns in contrast to traditional dietary patterns. In Morocco, as ready-to-eat food (defined as foods intended to be consumed as they are) are rarely consumed, they were not included in the analyses. Processed food consumption was related to education, employment, economic level and neighbourhood. Indeed, the youngest, most educated, with higher economic level and living in a modern neighbourhood were more likely to consume

processed food. Compared to the oldest women, the youngest ate processed foods more frequently possibly because they are more exposed to television advertising and also probably because during their childhood they have been more exposed to such foods. It was also assumed that compared to modern neighbourhoods, these kinds of foods were less likely to be available in either precarious or more traditional neighbourhoods. Furthermore, in Morocco, these processed foods are probably more expensive than unprocessed foods and therefore are less affordable for low economic groups. The same kinds of findings have been reported in other studies in LMIC. Indeed, a study that investigated the role of global producers in 80 countries, in the increased consumption of unhealthy commodities including processed foods, concluded that rising income was strongly associated with higher consumption of processed foods in low-and middle-income countries (Stuckler *et al.*, 2012). According to the same study, the authors predicted that in Morocco, soft drink consumption will increase to about 50% in the next five years. A review of Budget Consumption Surveys conducted in the late 1990's in Brazil reported that the use of industrialised foodstuffs was positively and directly related to income (de Oliveira, 1997). In the same way, in urban India, households with higher income spent more money on beverages and processed foods compared to poorer households (Food and Agriculture Organization, 2004). In high-income countries, the opposite results are usually reported. Indeed, several studies have shown that subjects with lower economic status ate unhealthier processed foods. Indeed, in these countries energy-dense foods, which are usually high in sugar and fats, are less expensive per calorie than healthier foods (Drewnowski and Darmon, 2005; Andrieu *et al.*, 2006).

In terms of fruit and vegetable intakes, women who consumed more processed foods were more likely to eat less vegetable, when adjusting for all the socio-demographic variables. In other words, these results suggest that processed foods were consumed to the detriment of vegetables and hence to the detriment of the main traditional dish, that is the tajine. Therefore, it means that women who eat more processed foods are probably less likely to eat tajines, i.e. to have a traditional diet. Several studies in other contexts have reported that eating fruit and vegetables was associated with an overall healthy diet and with overall healthy lifestyle (Friel *et al.*, 2005; Estaquio *et al.*, 2008; Mirmiran *et al.*, 2009; Bhupathiraju and Tucker, 2011). As a consequence, in the present context, consumption of processed foods that are part of an unhealthy diet probably explains why women consuming more processed foods also consumed fewer vegetables. In the context of high-income countries the socio-economic trend is different. Indeed, in that context, where unhealthy foods are more affordable than healthy foods,

subjects with lower income are more likely to consume more processed foods and then are less likely to consume fruit and vegetables. In a study that investigated diet cost in France, Drewnowski *et al.*, (2004) reported that each additional 100g of fat and sugar was associated with a decrease in the daily diet cost whereas each additional 100g of fruit and vegetable was associated with an increase in the daily diet cost.

This study also investigated the association between eating out of home and fruit and vegetable intakes. As expected, unmarried and employed women ate out of home more often compared to married and unemployed women. Amongst women with either a high or middle economic status, the most educated were more likely to eat out of home as anticipated. Some studies have concluded that eating away from home was not related to marital status, or number of children in the household (Siwik and Senf, 2006), but was inversely related to age (Siwik and Senf, 2006; Krige *et al.*, 2012) and positively related to socio-economic status (Siwik and Senf, 2006; Krige *et al.*, 2012; Lachat *et al.*, 2012), as in the present study.

Employed, unmarried and educated women of high to middle economic status were most likely to eat out of home, particularly in fast-food restaurants. The same kinds of conclusions were reported within the literature for age (Mohr *et al.*, 2007), for marital status (French *et al.*, 2000) and for economic status (French *et al.*, 2000; Mohr *et al.*, 2007).

Investigations for restaurant eating occasions highlighted the fact that employed women, as well as women living in a modern neighbourhood were more likely to eat in restaurants. The association between eating in restaurants and neighbourhood can be explained by the fact that most of the restaurants are located in modern areas of the city where the study took place. As for what was found for overall eating out of home occasions, amongst women belonging to the high or the middle economic groups, the most educated were more likely to eat in restaurants.

Women who ate more frequently out of home during the previous month consumed significantly larger amounts of fruit than women who did not eat outside their household (108g/day and 89g/day, respectively). This finding was corroborated by what emerged from the focus group discussions. Indeed, most women, and particularly women from the low economic group, reported that they consumed more fruit when they ate out of home, and especially when they were invited to eat at the home of friends or family members. However, no association between eating at friends or members of their family at their homes and the amounts of fruit consumed were found.

This finding differ from what is generally observed within the literature where studies suggest that eating out of home, as well as eating at a friend's house was associated with a lower fruit and vegetables consumption (Treiman *et al.*, 1996; Cox *et al.*, 1998). One of the potential explanations of this difference probably results from Moroccan traditional habits to serve guests with fruit at the end of the meal.

In terms of knowledge, three-quarters of women knew that it is recommended to eat at least five fruit and vegetables per day. However, only one out of ten ate the daily recommended amount of fruit and vegetables. This inconsistent finding was probably due to the fact that the knowledge item asked for the number of fruit and vegetables and not for the number of servings. Moreover, as knowledge about what represented a serving was not investigated it was impossible to know if women knew how much a serving of fruit or vegetable was. A large majority also knew that fruit and vegetables contain a lot of vitamins. These findings were supported by findings from the focus groups in which almost all women stated that fruit and vegetables are full of vitamins and that they are good for health. Less than 10% of women correctly answered the question about vitamin content of canned vegetables. This result was consistent with findings from the focus groups in which most of women declared that fruit loses all its vitamins once it is canned.

The overall knowledge score developed for this study was low at 41.6/100; women scored best for their knowledge about food based guidelines (53.8/100) and least for their knowledge about the link between fruit and vegetable intake and NCDs (32.0/100). The overall knowledge score was related to education and economic status. Indeed, the most educated and those belonging to higher economic group had higher knowledge scores. Education was also significantly associated with all the different knowledge scores. Fruit, as well as fruit and vegetable intakes were positively associated with the overall knowledge score, indicating that the most knowledgeable women ate significantly more fruit and more fruit and vegetables than the less knowledgeable ones. The present results were similar to those from several studies conducted in high-income countries that focused on fruit and vegetables consumption and knowledge (Havas *et al.*, 1998; Wardle *et al.*, 2000; Baker and Wardle, 2003; Moynihan *et al.*, 2007).

Findings from the attitudinal scales indicated that three-quarters of women found fruit and vegetables easy to prepare and that not time consuming, indicating that, in the present context in Morocco, convenience

and time constraints do not constitute barriers to fruit and vegetable consumption. These results are supported by findings from the focus groups where women stated that fruit and vegetables are easy to prepare and that vegetables are slightly more difficult to prepare compared to fruit. Focus groups conducted in high-income countries that investigated barriers to fruit and vegetables consumption have concluded that, contrary to what was observed in this study, convenience and time constraints were perceived as barriers (Brug *et al.*, 1995; Treimann *et al.*, 1996; Yeh *et al.*, 2008). The fact that fruit and vegetables are hard to store and that they spoil quickly was also perceived as a barrier in those contexts, however this kind of barrier did not emerge from the focus groups of the present study.

Certain women stated that fruit and vegetables are full of pesticides but this did not appear as a barrier to consumption as most of them disagreed that they avoid eating fruit and vegetables because they might be contaminated with pesticides. The same finding emerged from focus groups conducted in the US where pesticides were of concern. However in the US study, it seemed that pesticides were a barrier to fruit and vegetable consumption as participants reported a fear of an adverse health effect from consuming fruit and vegetables that could be contamined with pesticides (Yeh *et al.*, 2008).

Most women reported high self-efficacy about their dietary habits to eat fruit and vegetables although over half of them agreed that it would be hard to increase their fruit and vegetable intakes.

According to what is advocated in the literature, (Moreau *et al.*, 2004) the focus groups should have been repeated until a clear pattern emerged. Due to time constraints they were not repeated. However, this seemed not to be a limitation as findings from focus groups were consistent with those from the attitudinal scales indicating that these findings were likely to be valid.

The different constructs investigated in this study did not predict intention or behaviour in the same way and with the same stength for fruit and for vegetables. The strongest predictor of intention to eat fruit was Control Beliefs ($\beta=0.25$; $p<0.0001$) whereas intention was the strongest predictor of fruit consumption ($\beta=0.25$; $p<0.0001$). Intention to eat vegetables was equally predicted by Normative Beliefs ($\beta=0.12$; $p<0.0001$) and Control Beliefs ($\beta=0.11$; $p=0.001$) and intention was the strongest predictor of vegetable consumption ($\beta=0.17$; $p<0.0001$). Overall the model did not predict intention or behaviour very well but performed slightly better in predicting fruit compared to vegetable consumption. Such a finding is consistent with

results from other studies that investigated fruit and vegetable separately and that also reported higher predictiveness for fruit than for vegetables (Brug *et al.*, 1995; Bogers *et al.*, 2004; Guillaumie *et al.*, 2010).

The framework of the Theory of Planned Behaviour, developed for the present study explained only 7% of the variance in intention to eat fruit, representing a small effect size, and only 13% of overall fruit consumption, representing a medium effect size. The model explained 2% of the variance in intention to eat vegetables and 6% of the variance in vegetable consumption, both results corresponding to a small effect size. This suggests that, using findings from the present model, the potential to increase fruit consumption is greater than for vegetable consumption. Total explained variance for fruit, as well as for vegetable intention or consumption were lower compared to that found in other studies that investigated similar behaviours (R^2 ranged from 0.06 to 0.572) (Povey *et al.*, 2000; Bogers *et al.*, 2004.; Brug *et al.*, 2006; Wolf *et al.*, 2008; Blanchard *et al.*, 2009). However, it is worth noting that these studies have investigated more precise behaviour than it has been done in the present study. Indeed, whilst this study investigated behaviours such as "eating fruit" or "eating vegetables", other studies have investigated more precise behaviours, such as "eating at least two servings of fruit per day" (Bogers *et al.*, 2004; Brug *et al.*, 2006) or "eating five servings of fruit and vegetables per day" (Povey *et al.*, 2000; Blanchard *et al.*, 2009). As a consequence, this may explains why our model did not predict fruit and vegetable intakes well.

Another reason why the model did not explain the behaviour very well was because not all the constructs of the original model were included in the analysis. Here, only the determinants of the core constructs, i.e behavioural beliefs, normative beliefs and control beliefs, were included in the model. According to a review conducted amongst 21 cross-sectional and 14 prospective studies that investigated psychosocial predictors of fruit and vegetable consumption based on different theories (Theory of Planned Behaviour, TransTheoritical Model, Health Belief Model, Theory of Reasoned Action, Social Cognitive Theory) the strongest predictors of fruit and vegetable consumption were knowledge, self-efficacy and social support (Shaikh *et al.*, 2008). However, these constructs were measured in the current study.

Moreover, the control beliefs construct for fruit, as well as for vegetables, had a rather low internal consistency. Indeed, the overall internal validity for the control beliefs construct was relatively low indicating that the construct was not homogeneous. Actually, this construct investigated several domains of barriers, such as cost, availability, convenience and time constraints. As a consequence, the heterogeneity of this construct could

explain why the present model based on the Theory of Planned Behaviour model explained only a small part of the variance of both intention to eat fruit and vegetables and fruit and vegetable consumption. Moreover, the items used to measure intention to eat fruit and vegetables measured the readiness for change rather than behavioural intention. That could also explained why our model did not predict fruit and vegetable consumption well.

Furthermore, in a systematic review focusing on psychosocial determinants of fruit and vegetable intake, that included 22 studies (amongst which seven studies used the Theory of Planned Behaviour model), Guillaumie *et al.*, (2010) concluded that efficacy of prediction depended on study design. Indeed, prediction of fruit and vegetable intake combined or fruit intake was significantly better in studies using a longitudinal design compared to studies using a cross-sectional design. Therefore, one possible way to increase the efficacy of the model used in the present study, that was cross-sectional, would be to use a longitudinal design to follow fruit and vegetable consumption.

Apart from the Theory of Planned Behaviour model, there are many other models that have been used to explore psychosocial determinants of fruit and vegetable consumption. The TransTheoritical Model, the Health Belief Model, the Theory of Reasoned Action and the Social Cognitive Theory are amongst the most commonly used. Therefore, the use of the Theory of Planned Behaviour model could be reconsidered. However, according to a review that investigated the efficacy of these different models in predicting fruit and vegetable consumption, the authors reported that the Theory of Planned Behaviour, as well as the Social Cognitive Theory are the preferable models to predict fruit and vegetable consumption in adults (Guillaumie *et al*., 2010).

Factors influencing overall diet

As scores and indices, such as the dietary diversity score and the DQI-I, that reflect the overall diet quality were calculated, their relationship with socio-demographic characteristics were sought.

The Dietary Diversity Score was positively related to education, i.e. the most educated women having higher DDS. Usually dietary diversity in the context of low-and middle-income countries, as well as in high-income countries, is associated with economic status. Several studies conducted in different contexts reported that subjects from higher economic groups were more likely to have a high diversity diet (Kant *et al.*, 1991; Torhein *et al.*, 2004; Clausen *et al.*, 2005; Savy *et al.*, 2008). Most of these studies also reported an

association between diversity and education. The DQI-I did not discriminate between factors. Indeed, the overall DQI-I was not associated with any of the socio-demographic variables investigated. These results suggested that, in the present context, simple indices compared with more sophisticated indices are sufficient to discriminate people. To date, authors that used the DQI-I (Kim *et al.*, 2003; Tur *et al.*, 2005) did not investigate the relationship between the DQI-I and socio-demographic characteristics. Therefore, there is no possible comparison between previous studies and findings from the present study.

Fruit and vegetable consumption, weight status and diet-related NCDs

Contrary to what was reported in the literature where several studies found inverse relationship between fruit and vegetable consumption, with weight status or diabetes, that led to the conclusion of protective effects of fruit and vegetables on weight and related diseases (Alinia *et al.*, 2009; Buijsse *et al.*, 2009; Keast *et al.*, 2011 for weight; Harding *et al.*, 2008; Carter *et al.*, 2010; Kurotani *et al.*, 2012 for diabetes), no significant association was found in the present study.

Risk factors for diabetes and cardiovascular diseases, such as high blood pressure and metabolic syndrome were not associated with fruit and vegetable intakes, or with FVDS or FVQI. Concerning metabolic syndrome, one study conducted amongst Iranian women reported that fruit and vegetable intakes were associated with a lower risk of metabolic syndrome (Esmaillzadeh *et al.*, 2006). Concerning blood pressure, several studies reported that a high consumption of fruit and vegetable was associated with a lower risk of hypertension (Beitz *et al.*, 2003; Alonso *et al.*, 2004; Utsugi *et al.*, 2008).

The lack of an association between fruit and vegetable intakes and weight status, diabetes, high blood pressure or metabolic syndrome, can partly be explained by the fact that the FVDS, as well as the FVQI were based on data from a single 24-hour recall and therefore did not reflect usual fruit and vegetable intakes. The fruit and vegetable intakes from the previous day may not be representative of the usual intake. Moreover, most of the studies that reported such health outcomes were prospective cohort studies whilst the present study was cross-sectional. Furthermore, in the present study only the association between overall fruit and vegetable intakes and their potential health outcomes were investigated. Notwithstanding, several studies that also reported no association between overall fruit or vegetable intakes and NCDs reported significant associations when looking into more details at particular fruit or vegetables such as cruciferous vegetables, (e.g. broccoli, cabbage,

cauliflower, kale), or tangerines (Zhang *et al.*, 2011; Jung *et al.*, 2012; Masala *et al.*, 2012).

A relationship between FVQI≥6 and diabetes was found. Indeed women with a higher FVQI were significantly less likely to have diabetes (adjusted OR=2.58, $p<0.05$), indicating that in the present context in Morocco and in terms of fruit and vegetable intakes, both quantity and diversity probably matter when investigating relationships between fruit and vegetables and NCDs, and that a complex index could perform better than a simpler index.

Chapter 5: Conclusion

The aim of the present study was to contribute to knowledge about fruit and vegetables intake, both in terms of quantity and quality; potential socio-demographic and psychosocial determinants of their consumption; and the relationship between fruit and vegetable intakes with weight status and diet-related non-communicable diseases.

Findings from the FFQ validation study suggest that the brief quantitative fruit and vegetable FFQ developed for the present work is a reliable and valid tool to measure fruit and vegetable intake combined but not when considered separately.

Findings from the population survey suggest that, according to the WHO recommendations (400g), fruit and vegetables intakes are inadequate. Indeed, the Mean daily fruit and vegetable intake was 213g and three-quarters of women were low consumers. Based on the Fruit and Vegetable Quality Index, about one-quarter of women were classified as having had a 'good' fruit and vegetable intake. Women who ate larger amounts of fruit and vegetables had a healthier diet.

Women with higher economic status ate more fruit and vegetables and had a higher Fruit and Vegetable Diversity Score. The most educated women ate larger amounts of fruit and vegetables compared to the least educated. Processed foods were consumed to the detriment of vegetables. Most women consumed more fruit when they ate out of home, especially when eating with friends or members of their family at their homes.

In terms of psychosocial determinants, overall knowledge score of fruit and vegetables was rather low. Nevertheless, knowledge was strongly and positively related to fruit and vegetable intake. Indeed, the most knowledgeable women ate more fruit and vegetables. Even though overall knowledge of fruit and vegetables was low, most women knew that it is recommended to eat at least five fruit and vegetables per day and that fruit and vegetables are rich in vitamins.

Whilst cost was perceived as a barrier, pesticides, time constraints and convenience did not constitute barriers to fruit and vegetable intake.

Overall, the model developed for the present study, based on the Theory of Planned Behaviour, predicted fruit consumption better than vegetable consumption.

Neither weight status, nor risk factors related to type 2 diabetes or cardiovascular disease, such as high blood pressure and metabolic syndrome, were associated with fruit and vegetable intakes.

Implications for Public health nutrition policy

The brief quantitative fruit and vegetable FFQ developed in this study is a valid and reliable tool to measure fruit and vegetable intakes. Therefore, it can be used to monitor fruit and vegetable intake of Moroccan women.

Psychosocial variables that can highly predict behaviour provide effective levers to promote behaviour change. Therefore, as knowledge was strongly associated with fruit and vegetable intakes, interventions that aim at increasing fruit and vegetable consumption should include strategies to increase nutrition education with a focus on positive health outcomes of fruit and vegetable consumption.

Future work

A relatively wide range of determinants of fruit and vegetable consumption have been investigated in the present study, such as socio-demographic determinants, knowledge, eating behaviours, intention to eat fruit or vegetables. However, there are other determinants that, in addition to those already investigated, could give a more integrated understanding of fruit and vegetable consumption.

Indeed, in order to more effectively identify levers to increase fruit and vegetable consumption, the Theory of Planned Behaviour model could have been used with all its original constructs, i.e. could have included attitudes, subjective norm and perceived behavioural control constructs, and not only the determinants of the main constructs, as it was done for the present study. Furthermore, including measurements of habits in the model could also increase its performance as advocated by Verplanken and Haarts, (1999) and confirmed by Brug *et al.*, (2006) for fruit consumption.

The food environment may play a significant role in eating fruit and vegetables. This kind of determinant has not been investigated in this study. In Morocco, there are a lot of corner shops that sell fruit and vegetables, making fruit and vegetable purchase easy outside home. Thus, in the present study, there was no perceived lack of grocery stores that sell fruit and vegetables and hence, this aspect did not constitute a barrier to their consumption, as it has been reported in other contexts of high-income countries (Brug *et al.*, 1995; Kamphuis *et al.*, 2007; Yeh *et al.*, 2008). However

with economic development, there is an increase in fast-food outlets in cities, making fast-food easily available and accessible, and an increase in supermarkets in the suburbs which could have an impact on food availability. Several studies have reported that the food environment, such as food shopping environments and the proximity of fast-food outlets had a significant impact on fruit and vegetable consumption (Rose and Richards, 2004; Jeffery *et al*., 2006; Bodor *et al.*, 2008) whilst other studies reported no relationship between food environment and food consumption (Pearson *et al.*, 2005; Pearce *et al.*, 2008; Giskes *et al.*, 2009). Hence, it would be interesting to examine the extent to which the food environment in urban Morocco is related to fruit and vegetable consumption, and if so, to explore environmental change strategies in order to increase consumption.

Cost was found to be a strong barrier to increase fruit and vegetable consumption. As a consequence, it would be pertinent to examine stakeholder perspectives on which economic policy, e.g. subsidies or vouchers, would be feasible and acceptable to increase fruit and vegetable consumption of Moroccans.

Chapter 6: Bibliography

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Appendixes

Appendix 1. Examples of fruit and vegetables' portion size

- **USA examples of fruit and vegetables portion size**

	Amount that counts as 1 cup of vegetables	**Amount that counts as ½ cup of vegetables**
Dark-Green vegetables		
Broccoli	1 cup chopped or florets 3 spears 5" long raw or cooked	
Greens (collards, mustard greens, turnip greens, kale)	1 cup cooked	
Spinach	1 cup cooked 2 cups raw	1 cup raw
Raw leafy greens: Spinach, romaine, watercress, dark green leafy lettuce, endive, escarole	2 cups raw	1 cup raw
Orange vegetables		
Carrots	1 cup, strips, slices, or chopped, raw or cooked 2 medium piece 1 cup baby carrots (about 12)	 1medium piece About 6 baby carrots
Pumpkin	1 cup mashed, cooked	
Sweet potato	1 large baked (2 ¼" or more diameter) 1 cup sliced or mashed, cooked	
Winter squash (acorn, butternut, hubbard)	1 cup cubed, cooked	½ acorn squash, baked = ¾ cup
Dry beans and peas		
Dry beans and peas (Such as black, garbanzo, kidney, pinto, or soy beans, or black eyed peas or split peas	1 cup whole or mashed, cooked	

Tofu	1 cup ½" cubes (about 8 ounces)	1 piece 2 ½ " x 2 ¾ " x 1" (about 4 ounces)
Starchy vegetables		
Corn, yellow or white	1 cup 1 large ear (8” to 9” long)	 1 small ear (about 6” long)
Green peas	1 cup	
White potatoes	1 cup diced, mashed 1 medium boiled or baked potato (2 ½ " to 3" diameter) French fried: 20 medium to long strips (2 ½” to 4” long)	
Other vegetables		
Bean sprouts	1 cup cooked	
Cabbage, green	1 cup, chopped or shredded raw or cooked	
Cauliflower	1 cup pieces or florets raw or cooked	
Celery	1 cup, diced or sliced, raw or cooked 2 large stalks (11" to 12" long)	 1large stalk (11" to 12" long)
Cucumbers	1 cup raw, sliced or chopped	
Green or wax beans	1 cup cooked	
Green or red peppers	1 cup chopped, raw or cooked 1large pepper (3” diameter, 3-¾” long)	 1 small pepper
Lettuce, iceberg or head	2 cups raw, shredded or chopped	1 cup raw, shredded or chopped
Mushrooms	1 cup raw or cooked	
Onions	1 cup chopped, raw or cooked	
Tomatoes	1 large raw whole (3") 1 cup chopped or sliced, raw, canned, or cooked	1 small raw whole (2 ¼ ") 1 medium canned
Tomato or mixed vegetable juice	1 cup	½ cup
Summer squash or zucchini	1 cup cooked, sliced or diced	

- **English examples of fruit and vegetables portion size (one portion = 80g)**
    - 1 apple, banana, pear, orange or other similar sized fruit
    - 2 plums or similar sized fruit
    - ½ a grapefruit or avocado
    - 1 slice of large fruit, such as melon or pineapple
    - 3 heaped tablespoons of vegetables (raw, cooked, frozen or tinned)
    - 3 heaped tablespoons of beans and pulses (however much you eat, beans and pulses count as a maximum of one portion a day)
    - 3 heaped tablespoons of fruit salad (fresh or tinned in fruit juice) or stewed fruit
    - 1 heaped tablespoon of dried fruit (such as raisins and apricots)
    - 1 handful of grapes, cherries or berries
    - a dessert bowl of salad
    - a glass (150ml) of fruit juice (however much you drink, fruit juice counts as a maximum of one portion a day)

- **French examples of fruit and vegetables portion size (one portion=80g)**
    - 1 small apple
    - 2 apricots
    - 1 slice of cantaloupe
    - 1 cup fruit salad
    - 1 cup of fruit compote (without added sugar)
    - 1 banana
    - 5-6 strawberries
    - 1 orange
    - 1 tomato
    - 5-6 cherry tomatoes
    - 1 portion of salad
    - 2 full table spoon of spinach
    - 1 large carrot
    - 1 handful of green beans

Appendix 2: Equations for predicting Basal Metabolic Rate

Equation for predicting Basal Metabolic Rate from using weight (W) in kg[1]		
Age group (years)	Kcal/day	
	Males	Females
0-3	60.9W-54	61.0W-51
3-10	22.7W+495	22.5W+499
10-18	17.5W+651	12.2W+746
18-30	15.3W+679	14.7W+496
30-60	11.6W+879	8.7W+829
>60	13.5W+487	10.5W+596
[(1)] from FAO/WHO/UNU report		
Equation for predicting Basal Metabolic Rate using body weight (W) in kg and height (H) in cm [(2)]		
	Males	Females
	10*W+6.25*H-5*age+5	10*W+6.25*H-5*age-161
[(2)] from Miflin *et al.* 1990		
Equation for predicting Basal Metabolic Rate using Fat Free Mass (FFM) in kg [(2)]		
	19.7*FFM+413	
[(2)] from Mifflin *et al.* 1990		

Appendix 3. List of the least developed Countries

Africa

1 Angola
2 Benin
3 Burkina Faso
4 Burundi
5 Central African Republic
6 Chad
7 Comoros
8 Democratic Republic of the Congo
9 Djibouti
10 Equatorial Guinea
11 Eritrea
12 Ethiopia
13 Gambia
14 Guinea
15 Guinea-Bissau
16 Lesotho
17 Liberia
18 Madagascar
19 Malawi
20 Mali
21 Mauritania
22 Mozambique
23 Niger
24 Rwanda
25 São Tomé and Príncipe
26 Senegal
27 Sierra Leone
28 Somalia
29 Sudan
30 Togo
31 Uganda
32 United Republic of Tanzania
33 Zambia

Asia

1 Afghanistan
2 Bangladesh
3 Bhutan
4 Cambodia
5 Kiribati
6 Lao People's Democratic Republic
7 Myanmar
8 Nepal
9 Samoa
10 Solomon Islands
11 Timor-Leste
12 Tuvalu
13 Vanuatu
14 Yemen

Latin America and the Caribbean

1 Haiti

Appendix 4. The Rapid Risk Factor Surveillance System Food Frequency Questionnaire

1. How many times per day, week or month do you drink 100 percent fruit juices such as orange, grapeFruit, or tomato juice?

Interviewer: If R says "it varies", ask about a typical month.

- If they say, there is no typical month, ask about the last month.
- If R says 'a few times, a couple of times, once in a while, etc.," ask for their best guess at an exact number.

If "R" asks what we mean by 100% fruit juice, say "a juice with no sugar or sweetener added."

2. Not counting juice, how many times per day, week or month do you eat fruit? Interviewer: If required, this includes canned, frozen and fresh fruit, eaten on its own or with other food, cooked or raw.

3. And how many times per day, week or month do you eat a green salad? Interviewer: A green salad includes lettuce with or without other ingredients.

4. NOT including French fries, fried potatoes, or potato chips, how many times per day, week or month do you eat potatoes? Interviewer: If asked, sweet potatoes and yams do NOT count.

5. What about carrots? How many times per day, week or month do you eat carrots? Interviewer: If required, includes canned, frozen and fresh, eaten on their own or with other food, cooked or raw.

6. Not counting carrots, potatoes, or green salad, how many times per day, week or month do you eat other vegetables?

Appendix 6. National Health Interview Survey Questionnaire

The answers' modalities are the following:
Never / 1-3 times last month / 1-2 times per week / 3-4 times per week
5-6 times per week / 1 time per day / 2 times per day / 3 times per day
4 times per day / 5 or more times per day / Refused / Don't know

1. Juice

During the past month…How often did you drink 100% FRUIT JUICE, such as orange, mango, apple, and grape juices? Do NOT count fruit drinks.

*Read if necessary: INCLUDE only 100% pure juices. Do NOT include fruit drinks with added sugar, like Kool-aid, Hi-C, lemonade, cranberry cocktail, Gatorade, Tampico, and Sunny Delight.

2. Fruit flavored drink

NOW we are going to ask about FRUIT-FLAVORED drinks WITH ADDED SUGAR. How often did you drink FRUIT-FLAVORED DRINKS with sugar (such as Kool-aid, Hi-C, lemonade, or cranberry cocktail)? Do NOT include diet drinks.

*Read if necessary: INCLUDE Gatorade and other sports drinks with added sugar. INCLUDE Tampico, Sunny Delight and Twister. Do NOT include 100% fruit juices or soda. Do NOT include yogurt drinks or carbonated water.

3. Fruit

During the past month . . . How often did you eat FRUIT? COUNT fresh, frozen, or canned fruit. Do NOT count juices.

*Read if necessary: Include Fruits such as apples, bananas, applesauce, melon, berries, fruit salad, mangos, papayas, oranges, and grapes.

4. Salad

During the past month, how often did you eat a green leafy or lettuce SALAD, with or without other vegetables?

*Read if necessary: INCLUDE spinach salads

5. French fries

During the past month . . . How often did you eat FRENCH FRIES, home fries, or hash brown potatoes?

6. Potatoes

During the past month . . . How often did you eat other WHITE POTATOES? COUNT baked potatoes, boiled potatoes, mashed potatoes and potato salad.

*Read if necessary: Do not include yams or sweet potatoes. INCLUDE red-skinned and Yukon Gold potatoes.

7. Cooked dried beans

During the past month . . . How often did you eat COOKED DRIED BEANS, such as refried beans, baked beans, bean soup, and pork and beans? Do NOT include green beans.

8. Other vegetables

During the past month . . . Not counting what you just told me about (lettuce salads, white potatoes, cooked dried beans), and not counting rice, how often did you eat OTHER VEGETABLES?

*Read if necessary: Examples of other vegetables include tomatoes, string beans, carrots, corn, sweet potatoes, cabbage, bean sprouts, collard greens, and broccoli.

9. Tomato sauce

During the past month . . . How often did you have TOMATO SAUCES such as spaghetti sauce or pizza with tomato sauce?

Appendix 7. Knowledge questionnaire

I'm going to read a list of statements. For each of them, tell me whether you think it is true, false or whether you don't know. *(For each item tick the right box)*	**True**	**False**	**Does not know**
25. Low intake of fruit can contribute to heart problems	☐1	☐2	☐3
26. Low intake of fruit can contribute to obesity	☐1	☐2	☐3
27. Low intake of fruit can contribute to certain cancers	☐1	☐2	☐3
28. Low intake of vegetables can contribute to heart problems	☐1	☐2	☐3
29. Low intake of vegetables can contribute to obesity	☐1	☐2	☐3
30. Low intake of vegetables can contribute to certain cancers	☐1	☐2	☐3
31. fruit and vegetables should be eaten daily	☐1	☐2	☐3
32. Dried fruit contains more vitamins than fresh fruit	☐1	☐2	☐3
33. Vegetables are high in protein	☐1	☐2	☐3
34. Fruit contains lots of vitamins and minerals	☐1	☐2	☐3
35. Fruit is high in protein	☐1	☐2	☐3
36. Fruit is high in fibre	☐1	☐2	☐3
37. Vegetables contain lots of vitamins and minerals	☐1	☐2	☐3
38. Vegetables are high in fibre	☐1	☐2	☐3
39. Fruit is high in calories	☐1	☐2	☐3
40. Vegetables are high in calories	☐1	☐2	☐3
41. Fruit is low in fat	☐1	☐2	☐3
42. Vegetables are low in fat	☐1	☐2	☐3
43. Canned vegetables have lost all their vitamins	☐1	☐2	☐3
44. It is recommended to eat at least 5 fruit and vegetables a day	☐1	☐2	☐3
Amongst these 5 fruit and vegetables :			
45. Almonds count as a fruit	☐1	☐2	☐3
46. Potatoes count as a vegetable	☐1	☐2	☐3
47. Olives count as a vegetable	☐1	☐2	☐3
48. Dates count as a fruit	☐1	☐2	☐3

Appendix 8. Attitudinal scale questionnaire

1. To me, fruit is :					
a. Tasty	❑1	Tasteless	❑2	Neither tasty/tasteless	❑3
b. Bad for health	❑1	Good for health	❑2	Neither bad for health/good for health	❑3
c. Pleasant	❑1	Unpleasant	❑2	Neither pleasant/ unpleasant	❑3
2. To me, vegetables are :					
d. Tasty	❑1	Tasteless	❑2	Neither tasty/tasteless	❑3
e. Bad for health	❑1	Good for health	❑2	Neither bad for health/good for health	❑3
f. Pleasant	❑1	Unpleasant	❑2	Neither pleasant/ unpleasant	❑3

3. *I'm going to read several statements. For each of them, tell me, according to the present scale, how much you agree or disagree with them* *(For each item tick the right box)*	**Totally agree**	**Agree**	**Neither agree / disagree**	**Disagree**	**Totally disagree**
a) Eating fruit makes me feel good	☐1	☐2	☐3	☐4	☐5
b) Eating fruit helps me control my bodyweight	☐1	☐2	☐3	☐4	☐5
c) Eating fruit helps me have nice skin	☐1	☐2	☐3	☐4	☐5
d) Eating fruit makes me healthy	☐1	☐2	☐3	☐4	☐5
e) I may develop health problems if I do not eat enough fruit	☐1	☐2	☐3	☐4	☐5
a) Eating vegetables makes me feel good	☐1	☐2	☐3	☐4	☐5
b) Eating vegetables helps me control my bodyweight	☐1	☐2	☐3	☐4	☐5

c) Eating vegetables helps me have nice skin	☐1	☐2	☐3	☐4	☐5
d) Eating vegetables makes me healthy	☐1	☐2	☐3	☐4	☐5
e) I may develop health problems if I do not eat enough vegetables	☐1	☐2	☐3	☐4	☐5
a) My family and friends want me to eat fruit	☐1	☐2	☐3	☐4	☐5
b) I feel under pressure from my family and friends to eat fruit	☐1	☐2	☐3	☐4	☐5
c) My family and friends expect me to eat fruit	☐1	☐2	☐3	☐4	☐5
a) My family and friends want me to eat more vegetables	☐1	☐2	☐3	☐4	☐5
b) I feel under pressure from my family and friends to eat vegetables	☐1	☐2	☐3	☐4	☐5
c) My family and friends expect me to eat vegetables	☐1	☐2	☐3	☐4	☐5
a) I should eat more fruit than other people because I am a woman	☐1	☐2	☐3	☐4	☐5
b) Obese people should not eat fruit	☐1	☐2	☐3	☐4	☐5
c) Growing children are those who should eat fruit most	☐1	☐2	☐3	☐4	☐5
d) Men should eat fruit most	☐1	☐2	☐3	☐4	☐5
e) Everybody should eat fruit	☐1	☐2	☐3	☐4	☐5
a) As a woman, I should eat more vegetables than other people	☐1	☐2	☐3	☐4	☐5
b) Obese people should not eat vegetables	☐1	☐2	☐3	☐4	☐5

c) Growing children are those who should eat vegetables most	☐1	☐2	☐3	☐4	☐5
d) Men are those who should eat vegetables most	☐1	☐2	☐3	☐4	☐5
e) Everybody should eat vegetables	☐1	☐2	☐3	☐4	☐5
a) Eating fruit is entirely up to me	☐1	☐2	☐3	☐4	☐5
b) I cannot increase my consumption of fruit	☐1	☐2	☐3	☐4	☐5
c) When I eat at home, I can eat more fruit	☐1	☐2	☐3	☐4	☐5
d) When I eat away from home, I can eat more fruit	☐1	☐2	☐3	☐4	☐5
a) Eating vegetables is entirely up to me	☐1	☐2	☐3	☐4	☐5
b) I cannot increase my consumption of vegetables	☐1	☐2	☐3	☐4	☐5
c) When I eat at home, I can eat more vegetables	☐1	☐2	☐3	☐4	☐5
d) When I eat away from home, I can eat more vegetables	☐1	☐2	☐3	☐4	☐5
e) I can eat more vegetables if they are well prepared	☐1	☐2	☐3	☐4	☐5
a) Fruit is easy to prepare	☐1	☐2	☐3	☐4	☐5
b) Fruit can be brought in shops close to where I live or work	☐1	☐2	☐3	☐4	☐5
c) Fruit is cheap	☐1	☐2	☐3	☐4	☐5
d) I do not eat fruit because they are full of pesticides	☐1	☐2	☐3	☐4	☐5
e) I do not like the taste of fruit	☐1	☐2	☐3	☐4	☐5
f) Fruit is expensive	☐1	☐2	☐3	☐4	☐5
g) It is time consuming to prepare fruit	☐1	☐2	☐3	☐4	☐5
h) At home, fruit is always available	☐1	☐2	☐3	☐4	☐5

i) In the past, fruit tasted better	☐1	☐2	☐3	☐4	☐5
a) Vegetables are easy to prepare	☐1	☐2	☐3	☐4	☐5
b) Vegetables can be brought in shops close to where I live or work	☐1	☐2	☐3	☐4	☐5
c) Vegetables are cheap	☐1	☐2	☐3	☐4	☐5
d) I do not eat vegetables because they are full of pesticides	☐1	☐2	☐3	☐4	☐5
e) I do not like the taste of vegetables	☐1	☐2	☐3	☐4	☐5
f) Vegetables are expensive	☐1	☐2	☐3	☐4	☐5
g) It is time consuming to prepare vegetables	☐1	☐2	☐3	☐4	☐5
h) At home, vegetables are always available	☐1	☐2	☐3	☐4	☐5
i) In the past, vegetables tasted better	☐1	☐2	☐3	☐4	☐5

13. *Amongst the 5 following statement chose the one which suit you the best* *(Tick one of the 5 boxes)*	
I am not thinking about eating more fruit	☐1
I am thinking about eating more fruit	☐2
I am definitely planning on eating more fruit	☐3
I am trying to eat more fruit	☐4
I already eat fruit, at least twice a day	☐5
14. *Amongst the 5 following sentences, chose the one which suit you the best* *(Tick one of the 5 boxes)*	
I am not thinking about eating more vegetables	☐1
I am thinking about eating more vegetables	☐2
I am definitely planning on eating more vegetables	☐3
I am trying to eat more vegetables	☐4
I already eat vegetables, at least 3 times a day	☐5

Appendix 9. Final version of the questionnaire

SECTION 1 : **NUMBERING OF HOUSEHOLD MEMBERS**

Code	Firstname	Relationship with head of household		Sex	Date of Birth	Marital status		Level of Education	
					dd / mm / yyyy	Not applicable	0	Not applicable	0
						Single	1	Never went to school	1
		Head of Household	1	M=1		Married	2	Primary school	2
		Spouse/husband	2			Widow/ed	3	Incomplete Secondary	3
		Daughter/son	3	F=2		Divorced	4	Secondary school	4
		Other	4			Separated	5	University	5
_0_1_			__	__	____/____/____		__		__
_0_2_			__	__	____/____/____		__		__
_0_3_			__	__	____/____/____		__		__
_0_4_			__	__	____/____/____		__		__
_0_5_			__	__	____/____/____		__		__
_0_6_			__	__	____/____/____		__		__
_0_7_			__	__	____/____/____		__		__
_0_8_			__	__	____/____/____		__		__
_0_9_			__	__	____/____/____		__		__
_1_0_			__	__	____/____/____		__		__
_1_1_			__	__	____/____/____		__		__
_1_2_			__	__	____/____/____		__		__
_1_3_			__	__	____/____/____		__		__

SECTION 2 : **HOUSEHOLD CARACTERISTICS**

Questions	***Possible answers***		**CODE**
1.Does the head of household have an employment? **واش مول(مولات) الدار خدام؟**	YES	1	|__|
	Unemployed	2	
	Housewife	3	
	Pupill/Student/Trainnee	4	
	Retired	5	
	Elderly without pension	6	
	Inapte au travail	7	
	Other	8	
	If other, precise……		|__|
2. if YES, precise……			|__|__|
3. Does head of household's partner have an employment? **واش مرات(راجل) مول الدار خدامة؟**	YES	1	|__|
	Unemployed	2	
	Housewife	3	
	Pupill/Student/Trainnee	4	
	Retired	5	
	Elderly without pension	6	
	Unfit	7	
	Other	8	
	If other, precise……..……..		
4. if YES, precise ……			|__|__|
5. Number of persons living in the household **شحال بيكم في الدار**	…… ……		|__|__|
6. Number of persons employed in the household **شحال من واحد في الدار خدام**	…… ……		|__|
Accomodation characteristics			
7. What kind of accomodation ?	Traditionnal Moroccan House	1	|__|
	House/ house with floors	2	
	Flat	3	
	Modern Moroccan House	4	
	Slum	5	

	Other	6	
	If other, precise ……..……...		
8. Which kind of sewage disposal have you got?	Sewer	1	
	Septic tank	2	
	RII	3	
9. Which kind of WC have you got? **أشمن نوع ديال بيت الماء (الكابنة) عندكم ؟**	Private	1	
	In common with several other housings	2	
10. What is the source of drinking water? **منين كتجيبو الماء ديال الشريب؟**	Running water at home	1	
	Private tap out of the house	2	
	Public running water	3	
	Cistern	4	
	Bottle of water	5	
	Other	6	
	If other, precise ……..……...		
11. What is your accomadation status ? **الدار اللي ساكنين فيها واش ديالكم, كاريين أو ساكنين فابور؟**	Owner	1	
	On the way to become owner	2	
	Tenant	3	
	Freely accomodated (by familly/friends accommodation provided with job)	4	

Household equipment		
12. How many rooms in your house (not counting kitchen and bathroom) **شحال عندكم من بيت (بدون حساب المطبخ و الحمام)؟**	…… ……	
13. Have you got a kitchen? **واش عندكم كوزينا؟**	(1) yes (2) no	
14. Have you got a bathroom? **واش عندكم حمام؟**	(1) yes (2) no	
15. Have you got a fridge? **واش عندكم ثلاجة؟**	(1) yes (2) no	
16. Have you got a washing machine? **واش عندكم ماكينة التصبين؟**	(1) yes (2) no	
17. Have you got a dish washer? **واش عندكم ماكينة الغسيل المواعن؟**	(1) yes (2) no	
18. Have you got a receiver dish? **واش عندكم البارابول؟**	(1) yes (2) no	

19. Have you got an Internet access at home? واش عندكم الأنترنيت؟	(1) yes (2) no	|__|
20. Have you got a TV? واش عندكم التلفزة؟	(1) yes (2) no	|__|
If yes, precise the number	……	|__|
21. Have you got a heat system? واش عندكم المدفأة؟	(1) yes (2) no	|__|
If yes, precise the nature	……	|__|
22. Have you got an air conditioner? واش عندكم المكيف؟	(1) yes (2) no	|__|
If yes, precise the number	……	|__|
23. Have you got a telephone *(landline ou mobile)*? واش عندكم الهاتف؟	(1) yes (2) no	|__|
If yes, precise the number	……	|__|
49. Have you got a car? واش عندكم طوموبيل؟	(1) yes (2) no	|__|
If yes, precise the number	…… ……..	|__|
50. Have you got a computer? واش عندكم الكمبيوتر؟	(1) yes (2) no	|__|
If yes, precise the number	……	|__|
Access to care system		
26. What is your usual use of helth services? فين تاتمشي تداواي	Private 1 Public 2	|__|
Financial access to care system		
27. What kind of social insurance have you got? أشمن نوع ديال التغطية الصحية عندكم	Without social insurance 1 National Social Insurance System 2 Mutual Insurance company 3 Insurance 4 Other 5	|__|
	If other, precise …… …..	|__|

SECTION 3: **FOOD CONSUMPTION AND FOOD HABITS**

1	Tick the day of the week that it is **today** : (1) monday (2) tuesday (3) wednesday (4)thrusday (5) friday (6) saturday (7) sunday	|__|
2	Tick the day of the week you are recalling : (1) monday (2) tuesday (3) wednesday (4)thrusday (5) friday (6) saturday (7) sunday	|__|

I want you to think back to when you woke up yesterday morning.

Now I want you to try to remember what you ate and drank yesterday from the moment that you got up until you went to sleep again last night. Run through the whole day in your mind and try to remember everything you ate and drank.

Now, I would like you to tell me what you ate and drank starting in the morning after you got up.

من فضلك حاولي تفكري أشنو كليتي و شربتي البارح من اللي فقتي حتى نعستي.

و دبا من فضلك كولي لي أشنو كليتي و شربتي البارح في الصباح من اللي فقتي.

BREAKFAST الفطور												
Food, beverage, dish				**Photo**				**Household measures (HM)**			**Weight**	
Name of food, beverage, or dish	Description: preparation method, cooking method, brand name	Food Code	Preparation : 1 at home 2 out of home	Book : 1 suvi 2 be	N° photo	Portion size	number	Name/description	HM Code	Proportion MM	state : 1 AP 2 prep nc 3 cooked	Known weight (g)
|1|		|_|_|_|_|_|	|_|	|_|	|_|_|_|	|_|	|_|,|_|		|_|	|_|/|_| |_|,|_|_|	|_|	|_|_|_|_|
|1|		|_|_|_|_|_|	|_|	|_|	|_|_|_|	|_|	|_|,|_|		|_|	|_|/|_| |_|,|_|_|	|_|	|_|_|_|_|
|1|		|_|_|_|_|_|	|_|	|_|	|_|_|_|	|_|	|_|,|_|		|_|	|_|/|_| |_|,|_|_|	|_|	|_|_|_|_|
|1|		|_|_|_|_|_|	|_|	|_|	|_|_|_|	|_|	|_|,|_|		|_|	|_|/|_| |_|,|_|_|	|_|	|_|_|_|_|
|1|		|_|_|_|_|_|	|_|	|_|	|_|_|_|	|_|	|_|,|_|		|_|	|_|/|_| |_|,|_|_|	|_|	|_|_|_|_|
|1|		|_|_|_|_|_|	|_|	|_|	|_|_|_|	|_|	|_|,|_|		|_|	|_|/|_| |_|,|_|_|	|_|	|_|_|_|_|
|1|		|_|_|_|_|_|	|_|	|_|	|_|_|_|	|_|	|_|,|_|		|_|	|_|/|_| |_|,|_|_|	|_|	|_|_|_|_|
|1|		|_|_|_|_|_|	|_|	|_|	|_|_|_|	|_|	|_|,|_|		|_|	|_|/|_| |_|,|_|_|	|_|	|_|_|_|_|
|1|		|_|_|_|_|_|	|_|	|_|	|_|_|_|	|_|	|_|,|_|		|_|	|_|/|_| |_|,|_|_|	|_|	|_|_|_|_|
|1|		|_|_|_|_|_|	|_|	|_|	|_|_|_|	|_|	|_|,|_|		|_|	|_|/|_| |_|,|_|_|	|_|	|_|_|_|_|

<table>
<tr><th colspan="13">IN BETWEEN الفطور</th></tr>
<tr><th colspan="4">Food, beverage, dish</th><th colspan="4">Photo</th><th colspan="3">Household measures (HM)</th><th colspan="2">Weight</th></tr>
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LUNCH الفطور												
Food, beverage, dish				**Photo**				**Household measures (HM)**			**Weight**	
Name of food, beverage, or dish	Description: preparation method, cooking method, brand name	Food Code	Preparation : 1 at home 2 out of home	Book : 1 suvi 2 be	N° photo	Portion size	number	Name/description	HM Code	Proportion MM	state : 1 AP 2 prep nc 3 cooked	Known weight (g)
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DINER الفطور													
Food, beverage, dish				**Photo**				**Household measures (HM)**			**Weight**	
Name of food, beverage, or dish	Description: preparation method, cooking method, brand name	Food Code	Preparation : 1 at home 2 out of home	Book : 1 suvi 2 be	N° photo	Portion size	number	Name/description	HM Code	Proportion MM	state : 1 AP 2 prep nc 3 cooked	Known weight (g)
5		__|__|__|__|__	__	__	__|__|__	__	__|,|__		__|__	__/__ __,__|__	__	__|__|__|__
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RECIPE NAME 1:	|_|_|_|_|_|
Recipe description (list of ingredients) من فضلك كولي لي المقادير اللي استعملتي فهاد الأكلة:	

Ingredient			Photo				Household measures (HM)				Known weight	
Name of ingredient	Description: preparation method, cooking method, brand name	Food Code	book : 1 suvi 2 be	N° photo	Portion size	Number	Name/description	If unity, specify 1 small 2 medium 3 large	HM Code	HM Proportion	state : 1 AP 2 prep nc 3 cooked	Known weight(g)
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3	What you ate and drank yesterday, was it…: **واش هاد الشي اللي كليتي و شربتي البارح, إلى قارناه مع الكمية اللي كتاكلي ديما واشنفس الكمية** (1) The same as usual **نفس الكمية** (2) More than usual **زايدة على ديما** (3) Less than usual **ناقصة على ديما**	|__|
4	Would you say that yesterday was a typical day? (1) Yes (2) No **واش النهار ديال البارح كان بالنسبة ليك نهار عادي؟**	|__|
5	If not, why: ……	|__|
6	**Usually do you eat** : (1) individual plate (2) common bowl (3) both in the same way	|__|

During the last 7 days, how many times per day or per week, do you eat or drink:							
Foods		**Consumption**	**Frequency**		**Amount**		
			times per day	times per week	Photo	Code photo	Portion
1	100% fruit juices such as orange, grapeFruit, i.e. juices without added sugar	1 yes 2 no	|__|__|	|__|	237 238	|__|__|__|	|__|
2	Fruit (fresh, cooked, canned or frozen), **NOT counting** fruit juice	1 yes 2 no	|__|__|	|__|	220	|__|__|__|	|__|
3	Dried fruit (plums, raisins, apricots, dried figs)	1 yes 2 no	|__|__|	|__|	228	|__|__|__|	|__|
4	Green salad (including salad with or without other ingredients)	1 yes 2 no	|__|__|	|__|	58	|__|__|__|	|__|
5	Potatoes, boiled, baked, mashed, French fries, fried potatoes, potato chips	1 yes 2 no	|__|__|	|__|	160 162 164	|__|__|__|	|__|
6	Cooked dried pulses such as beans, lens, chickpeas, green peas	1 yes 2 no	|__|__|	|__|	156	|__|__|__|	|__|
7	Cooked vegetables, **NOT counting** potatoes, green salad, and pulses	1 yes 2 no	|__|__|	|__|	145	|__|__|__|	|__|
8	Vegetables consumed as starter, **NOT counting** potatoes, green salad, and pulses	1 yes 2 no	|__|__|	|__|	47	|__|__|__|	|__|

Usuallly, during week days		**Do you have…**			**Where?**			**Who with?**			
		Yes	No	At home	In office	Restaurant	Fast food	With family	Alone	With friends, Neighbours	Colleagues
1	Breakfast	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
2	Mid-Morning	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
3	Lunch	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
4	Mid-Afternoon	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
5	Dinner	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
6	Bedtime	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
Usually, during the weekend		**Do you have…**			**Where ?**			**Who with ?**			
		Yes	No	At home	In office	Restaurant	Fast food	With family	Alone	With friends, Neighbours	Colleagues
7	Breakfast	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
8	Mid-Morning	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
9	Lunch	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
10	Mid-Afternoon	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
11	Dinner	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4
12	Bedtime	☐ 1	☐ 2	☐ 1	☐ 2	☐ 3	☐ 4	☐ 1	☐ 2	☐ 3	☐ 4

13	During the last month, did you eat out of home? (1) Yes (2) No							
If yes, where and how often?		**Frequency**						
		never	**1-3 times/ month**	**once/ week**	**2-4 times/ week**	**5-6 times/ week**	**once/ day**	**+ than once/ day**
14	**Works canteen / restaurant/ work place**	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
15	**Fast food restaurant**	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
16	**At friends or member of my family's home**	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
17	**Restaurant**	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

SECTION 4: KNOWLEDGE

I'm going to read a list of statements. For each of them, tell me whether you think it is true, false or whether you don't know. *(For each item tick the right box)*	**True**	**False**	**Does not know**
1. Low intake of fruit can contribute to heart problems	☐1	☐2	☐3
2. Low intake of fruit can contribute to obesity	☐1	☐2	☐3
3. Low intake of fruit can contribute to certain cancers	☐1	☐2	☐3
4. Low intake of vegetables can contribute to heart problems	☐1	☐2	☐3
5. Low intake of vegetables can contribute to obesity	☐1	☐2	☐3
6. Low intake of vegetables can contribute to certain cancers	☐1	☐2	☐3
7. It recommended to eat at least 5 fruit and vegetable daily	☐1	☐2	☐3
8. Dried fruit are poor in vitamins	☐1	☐2	☐3
9. Vegetables are high in protein	☐1	☐2	☐3
10. Fruit contains few vitamins and minerals	☐1	☐2	☐3
11. Fruit is high in protein	☐1	☐2	☐3
12. Fruit is high in fibre	☐1	☐2	☐3
13. Vegetables contain few vitamins	☐1	☐2	☐3
14. It is recommended to eat only dark green vegetables	☐1	☐2	☐3
15. Vegetables are high in fibre	☐1	☐2	☐3
16. Fruit is high in calories	☐1	☐2	☐3
17. Vegetables are high in calories	☐1	☐2	☐3
18. Fruit is low in fat	☐1	☐2	☐3
19. Vegetables are low in fat	☐1	☐2	☐3
20. Canned vegetables have lost all their vitamins	☐1	☐2	☐3
21. It is recommended to eat preferentially yellow fruit	☐1	☐2	☐3
22. It is recommended to eat at least 5 fruit and vegetables a day	☐1	☐2	☐3
Amongst these 5 fruit and vegetables :			
23. Almonds count as a fruit	☐1	☐2	☐3
24. Potatoes count as a vegetable	☐1	☐2	☐3

SECTION 5: ATTITUDINAL SCALES

3. *I'm going to read several statements. For each of them, tell me, according to the present scale, how much you agree or disagree with them* *(For each item tick the right box)*	**Strongly agree**	**Agree**	**Neither agree / disagree**	**Disagree**	**Strongly disagree**
1. To me, eating fruit is good for health	☐1	☐2	☐3	☐4	☐5
2. To me, eating fruit is tasteless	☐1	☐2	☐3	☐4	☐5
3. To me, eating vegetables is good for health	☐1	☐2	☐3	☐4	☐5
4. To me, eating vegetables is tasteless	☐1	☐2	☐3	☐4	☐5
5. Eating fruit makes me feel good	☐1	☐2	☐3	☐4	☐5
6. Eating fruit helps me control my bodyweight	☐1	☐2	☐3	☐4	☐5
7. Eating fruit helps me have nice skin	☐1	☐2	☐3	☐4	☐5
8. Eating fruit makes me healthy	☐1	☐2	☐3	☐4	☐5
9. I may develop health problems if I do not eat enough fruit	☐1	☐2	☐3	☐4	☐5
10. Eating vegetables makes me feel good	☐1	☐2	☐3	☐4	☐5
11. Eating vegetables helps me control my bodyweight	☐1	☐2	☐3	☐4	☐5
12. Eating vegetables helps me have nice skin	☐1	☐2	☐3	☐4	☐5
13. Eating vegetables makes me healthy	☐1	☐2	☐3	☐4	☐5
14. I may develop health problems if I do not eat enough vegetables	☐1	☐2	☐3	☐4	☐5
15. My family and friends want me to eat fruit	☐1	☐2	☐3	☐4	☐5
16. I feel under pressure from my family and friends to eat fruit	☐1	☐2	☐3	☐4	☐5
17. My family and friends expect me to eat fruit	☐1	☐2	☐3	☐4	☐5
18. Women are those who should eat more fruit than others	☐1	☐2	☐3	☐4	☐5
19. Men are those who should eat fruit most	☐1	☐2	☐3	☐4	☐5

20. My family and friends want me to eat more vegetables	☐1	☐2	☐3	☐4	☐5
21. I feel under pressure from my family and friends to eat vegetables	☐1	☐2	☐3	☐4	☐5
22. My family and friends expect me to eat vegetables	☐1	☐2	☐3	☐4	☐5
23. Women are those who should eat more vegetables than others	☐1	☐2	☐3	☐4	☐5
24. Men are those who should eat vegetables most	☐1	☐2	☐3	☐4	☐5
25. Eating fruit is entirely up to me	☐1	☐2	☐3	☐4	☐5
26. To me eating fruit daily is difficult	☐1	☐2	☐3	☐4	☐5
27. I cannot increase my consumption of fruit	☐1	☐2	☐3	☐4	☐5
28. When I eat at home, I can eat more fruit	☐1	☐2	☐3	☐4	☐5
29. If I wanted I could eat more fruit	☐1	☐2	☐3	☐4	☐5
30. When I eat away from home, I can eat more fruit	☐1	☐2	☐3	☐4	☐5
31. Eating vegetables is entirely up to me	☐1	☐2	☐3	☐4	☐5
32. To me eating vegetables daily is difficult	☐1	☐2	☐3	☐4	☐5
33. I cannot increase my consumption of vegetables	☐1	☐2	☐3	☐4	☐5
34. When I eat at home, I can eat more vegetables	☐1	☐2	☐3	☐4	☐5
35. If I wanted I could eat more vegetables	☐1	☐2	☐3	☐4	☐5
36. When I eat away from home, I can eat more vegetables	☐1	☐2	☐3	☐4	☐5
37. I can eat more vegetables if they are well prepared	☐1	☐2	☐3	☐4	☐5
38. Fruit is too expensive	☐1	☐2	☐3	☐4	☐5
39. Fruit can be brought in shops close to where I live or work	☐1	☐2	☐3	☐4	☐5
40. At home, fruit is always available	☐1	☐2	☐3	☐4	☐5
41. Fruit is easy to prepare	☐1	☐2	☐3	☐4	☐5
42. It is time consuming to prepare fruit	☐1	☐2	☐3	☐4	☐5
43. Fruit is cheap	☐1	☐2	☐3	☐4	☐5

44. If fruit was less expensive I would eat more	☐1	☐2	☐3	☐4	☐5
45. I do not eat fruit because they are full of pesticides	☐1	☐2	☐3	☐4	☐5
46. Vegetables are expensive	☐1	☐2	☐3	☐4	☐5
47. Vegetables are easy to prepare	☐1	☐2	☐3	☐4	☐5
48. Vegetables can be brought in shops close to where I live or work	☐1	☐2	☐3	☐4	☐5
49. If vegetables were less expensive I would eat more	☐1	☐2	☐3	☐4	☐5
50. I have no time to prepare vegetables	☐1	☐2	☐3	☐4	☐5
51. It is time consuming to prepare vegetables	☐1	☐2	☐3	☐4	☐5
52. At home, vegetables are always available	☐1	☐2	☐3	☐4	☐5
53. I do not eat vegetables because they are full of pesticides	☐1	☐2	☐3	☐4	☐5
54. Vegetables are cheap	☐1	☐2	☐3	☐4	☐5

55. ***Amongst the 5 following statement chose the one which suit you the best*** *(Tick one of the 5 boxes)*	
I am not thinking about eating more fruit	☐1
I am thinking about eating more fruit	☐2
I am definitely planning on eating more fruit	☐3
I am trying to eat more fruit	☐4
I already eat fruit, at least twice a day	☐5
56. ***Amongst the 5 following sentences, chose the one which suit you the best*** *(Tick one of the 5 boxes)*	
I am not thinking about eating more vegetables	☐1
I am thinking about eating more vegetables	☐2
I am definitely planning on eating more vegetables	☐3
I am trying to eat more vegetables	☐4
I already eat vegetables, at least 3 times a day	☐5